

MANUFACTURING METHOD OF GLASS SUBSTRATE

FOR

MAGNETIC DISC

The present disclosure relates to subject matters contained in Japanese Patent Application No. 2007-333469 filed on December 26, 2007, 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 Prior 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along with space saving, flattening, and high density recording of the magnetic disc, the aluminum substrate has been replaced by a glass substrate having superior flatness of the substrate surface and substrate strength to those of an aluminum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 magnetoresistance 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 crash 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 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, polishing is carried out by use of an abrasive pad while an 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 unevenness on the glass substrate, the abrasive pads are attached to fixed platens, the glass substrate is sandwiched therebetween, a planetary gear mechanism is used, and the glass substrate and the abrasive pads are relatively moved so that the glass substrate can be evenly polished.

[0007]

There may be a case where a surface of the abrasive pad used in the polishing step cannot be flat when simply attached to a fixed platen or a case where a surface of the abrasive pad cannot be flat due to a wave generated by polishing processing. If polishing processing is carried out to the glass substrate in a condition where the pad surface is not flat, undulation on a glass substrate after polishing becomes large. Such a wave may cause bad influence on float stability of a recording head as mentioned above.

[0008]

As a method to improve prevention of occurrence of such a wave on the pad surface, there is known a method to correct wave of the abrasive pad by use of a correction plate. For example, a method to flatten a pad surface by providing a correction plate to a processing carrier so that a wave on a surface of the abrasive pad is corrected before or during polishing step is disclosed in the Patent Document 1.

[0009]

Moreover, as polishing processing proceeds, roughness of the pad surface is lost and the pad surface becomes smooth. This causes polishing ability of the pad surface to be decreased and polishing rate in the polishing step is lowered. Here, the polishing rate means polishing efficiency and is a value obtained by dividing chamfering by time. Such a decrease in polishing rate could be improved by correcting the pad surface to an appropriate roughness by the above-mentioned correction method.

[Patent Document 1] Japanese Unexamined Patent Publication No.
2006-159352

[0010]

However, even if polishing rate is restored by the above-mentioned correction method, the polishing rate cannot be completely restored and because a period of time for the restored polishing rate to be lowered again is short, correction of the pad surface had to be carried out frequently with a short span of time. Because the pad surface is polished by a correction plate for correction of the pad surface, frequent correction planes away the pad surface. As a result, the abrasive pad becomes thinner and thinner and life of the abrasive pad becomes short.

SUMMARY OF THE INVENTION

[0011]

The present invention has been made in consideration of the above-mentioned problem and is aimed at providing a manufacturing method of a glass substrate for a magnetic disc which can improve polishing efficiency to improve production efficiency by efficiently correcting surface condition of an abrasive pad.

[0012]

As the inventors of the present application keenly discussed to solve the above-mentioned problem, the inventors thought that the reason why polishing efficiency was lowered within a short period of time was that retention force of the polishing surface of the abrasive pad to retain a loose grain

was not fully restored. Then, following reasons could be thought as causes which prevent the abrasive pad to retain the loose grain.

[0013]

A soft abrasive pad includes a base layer including a nonwoven fabric or the like and a nap layer including an inner layer having a plurality of independent foams and a surface layer having an opening of the foams. The foam has a drop shape with a large inner part and a nap hole on the surface layer is a minute aperture. In a polishing step, a loose grain included in a polishing liquid is retained by the nap hole so that a glass substrate is polished. Moreover, including a foam in the inner part allows the nap layer to become a soft material having small elastic force.

[0014]

Because a loose grain is polished and polishing ability thereof is lowered as polishing proceeds, a loose grain facing the glass substrate must be replaced by new one. However, the loose grains are gradually accumulated in the nap hole and the nap hole is clogged by the loose grains. The inventors thought that in such a condition, a loose grain could not be replaced in the nap hole and therefore polishing efficiency was lowered.

[0015]

Then the inventors thought that one of the reasons why the abrasive pad could not retain the loose grain was that structure of the nap layer was folded in a polishing direction by the polishing step and therefore even if the correction plate

was slid in the same direction, the loose grains clogging the nap hole could not be removed.

[0016]

The inventors also thought that another reason why the abrasive pad could not retain the loose grain was that since the abrasive pad is polished by use of the correction plate, physical structure of the abrasive pad surface in the polishing direction was weakened and retention force to retain the loose grain was lowered.

[0017]

Therefore, the inventors discussed more to efficiently remove clogging of the nap hole and to carry out a correction step which does not weaken physical structure in polishing direction to complete the present invention.

[0018]

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 a polishing liquid including a loose grain between a glass substrate and an abrasive pad having a nap layer for polishing a main surface of the glass substrate and for relatively moving the glass substrate and the abrasive pad to polish the glass substrate; and a correction step for causing a correction member having a correction surface, to which a polishing grain is fixed, to be in contact with a surface of the abrasive pad which polished the glass substrate and for relatively moving the correction member and the abrasive pad to correct the abrasive pad, wherein

moving directions of the glass substrate and the correction member to the abrasive pad differ in the polishing step and in the correction step.

[0019]

To improve polishing efficiency, a pad surface needs to have retention force to retain a polishing grain and for this purpose, the pad surface must have an appropriate roughness. In case the abrasive pad used for polishing is a soft pad, especially, if the pad is slid on a glass substrate in the polishing step, it is conceivable that directionality toward the polishing direction (fold of the surface structure or clogging) is generated on the surface of the abrasive pad. Therefore, causing the moving direction in the polishing step and in the correction step to be different enables to disperse the directionality generated on the abrasive pad surface in a different direction.

[0020]

It is preferable that the moving direction in the above-mentioned polishing step and the correction step includes rotational component and the rotational component in the polishing step and the correction step is in opposite directions.

[0021]

Although purposes of the polishing step and the correction step differ, almost same operations are carried out by use of the same apparatus, except that a target is a glass substrate or a correction member. Moreover, since a target (the

glass substrate or the correction member) and the abrasive pad are continuously and relatively moved and slid in each step, it becomes possible to draw an endless track by including the rotational component in the relative moving direction. Then, in the polishing step, directionality to the rotation direction is generated in the structure of the abrasive pad surface. Therefore, causing the rotational component of moving direction of the abrasive pad in the correction step to be opposite enables to correct directionality generated on the abrasive pad surface.

[0022]

It is preferable that the abrasive pad includes a nap layer having an inner layer including a plurality of independent foams and a surface layer including an opening of the foams.

[0023]

Including the above-mentioned nap layer on the pad surface of the abrasive pad enables the abrasive pad to be a soft material having small elastic force. Moreover, including a nap hole which is an opened foam enables the abrasive pad to retain a loose grain included in the polishing liquid supplied in the polishing step and to improve polishing efficiency. Further, as mentioned above, causing the moving direction or rotation direction of a carrier, the correction member, the abrasive pad, or the like to be different or opposite in the polishing step and the correction step enables to remove loose grains accumulated (clogging) in a nap hole of the nap layer of the abrasive pad as well as to disperse (correct)

directionality of the abrasive pad surface.

[0024]

The above-mentioned glass substrate may be retained by a carrier, which is engaged with a sun gear and an internally-toothed gear which are relatively rotating, to carry out planetary gear movement and may be moved relatively to the abrasive pad, and the correction member may be caused to carry out planetary gear movement by being engaged with the relatively rotating sun gear and the internally-toothed gear to be moved relatively to the abrasive pad.

[0025]

In the polishing step, the carrier which orbits while rotating by the planetary gear movement is caused to retain the glass substrate so that the glass substrate can be moved in various different directions to the abrasive pad. Thus, it becomes possible to evenly polish the glass substrate and therefore generation of a polishing trace or unevenness on the glass substrate can be reduced. Similarly, in the correction step, the correction member is caused to carry out the planetary gear movement so that the correction member can draw a trajectory which is more complicated than the rotation movement in a constant direction. Therefore, it becomes possible to disperse directionality of the abrasive pad surface generated in the polishing step to more various directions.

[0026]

It is preferable that the relative rotation directions of the sun gear and the internally-toothed gear are opposite

in the polishing step and in the correction step.

[0027]

According to the above-mentioned configuration, it becomes possible to cause moving direction relative to the abrasive pad in the polishing step and in the correction step to be different. Especially, because the orbit of the carrier or the correction member becomes rotational component with the sun gear as center, reverse rotation causes the rotational component (orbit direction) to be opposite. Therefore, the directionality generated on the abrasive pad surface in the polishing step can be efficiently corrected in the correction step.

[0028]

It is preferable that particle size of the loose grain is 80 nm or less. If the particle size of the loose grain is too large, a predetermined quality (roughness) cannot be obtained when the polishing process is carried out. Therefore, it is preferable that particle size of the loose grain is 80 nm or less. Moreover, such a fine loose grain may easily clog in the nap hole. However, as mentioned above, according to the present invention, it is possible to efficiently remove loose grains accumulated in the nap hole.

[0029]

It is preferable that the polishing grain fixed to the correction surface of the correction member includes a diamond grain. The polishing grain is used to correct the pad surface in the correction step of the abrasive pad. The loose grain

included in the polishing liquid supplied in the polishing step is a grain having higher hardness such as silica grain. Therefore, it is preferable that the polishing grain is a grain having higher polishing ability, that is, higher hardness, than the loose grain remaining on the polishing pad which carried out the polishing process. Therefore, the diamond grain is preferable.

[0030]

According to the present invention, it becomes possible to provide a manufacturing method of a glass substrate for a magnetic disc which can improve polishing efficiency to improve production efficiency by efficiently correcting surface condition of an abrasive pad.

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]

A view showing a carrier for a glass substrate.

[FIG. 4]

An enlarged sectional view explaining configuration of an abrasive pad.

[FIG. 5]

A view showing a pad dresser which is an example of a correction member.

[FIG. 6]

A view showing a condition where the pad dresser is mounted on the both surface polishing apparatus.

[FIG. 7]

A view explaining moving direction of a drive mechanism member of the both surface polishing apparatus in a polishing step and in a correction step.

[FIG. 8]

A flow chart showing a flow of processing of a second polishing step.

[FIG. 9]

A view explaining comparison between an embodiment and a comparison example.

The Best Mode for Carrying Out the Claimed Invention

[0031]

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 ease 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.

[0032]

FIG. 1 is an explanatory view of a drive mechanism unit of a both surface polishing apparatus. As shown in FIG. 1, a both surface polishing apparatus 100 includes a carrier mounting unit having a sun gear 130 and an internally-toothed gear (hereinafter referred to as an "internal gear 140") which are respectively rotary driven with predetermined rotation ratio and an upper fixed platen 150 and a lower fixed platen 160 which are rotary driven in opposite directions sandwiching the carrier mounting unit. Later described abrasive pads 200 are respectively attached to surfaces of the upper fixed platen 150 and the lower fixed platen 160 facing a glass substrate 110. A carrier 120 is mounted to be engaged with the sun gear 130 and the internal gear 140.

[0033]

FIG. 2 is an overall view of the both surface polishing apparatus. The lower fixed platen 160 is provided in a fixed manner in vertical direction while the upper fixed platen 150

is enabled to move vertically so that the glass substrate 110 or a pad dresser 300 retained by the carrier 120 can be sandwiched and pressed by the abrasive pads 200.

[0034]

In a polishing step, polishing is carried out while a polishing liquid (slurry) including a loose grain is supplied. A polishing liquid 420 stored in a container 410 is supplied to the upper fixed platen 150 by a pump 430, used for polishing, collected from the lower fixed platen 160, and returned to the container 410 to be circulated. A filter 440 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 410. In a correction step, a coolant (cooling water) is used instead of the polishing liquid 420.

[0035]

FIG. 3 is a view showing a carrier for a glass substrate. As shown in FIG. 3 (a), a plurality of small holes are provided to the carrier 120 having a gear on the outer periphery thereof on the lower fixed platen 160 and the glass substrate 110 is retained by the small hole. The carrier 120 is engaged with the sun gear 130 and the internal gear 140 and if the sun gear 130 is rotated in the direction of an arrow, each of carriers 120 orbits while rotating as a planetary gear in the direction of each arrow. The sun gear 130 and the internal gear 140 may be relatively rotated and one or both may be rotated. If speed of the internal gear 140 differs from that of the sun gear 130,

it is possible to cause the carrier 120 to carry out planetary gear movement. However, it becomes possible to efficiently cause the carrier 120 to rotate in high speed if the internal gear 140 is rotated in an opposite direction of the sun gear 130.

[0036]

The upper fixed platen 150 is rotated together with the sun gear 130 and the lower fixed platen 160 is rotated together with the internal gear 140. In the present embodiment, the sun gear 130 and the internal gear 140 are rotated in opposite directions so that the upper fixed platen 150 and the lower fixed platen 160 are rotated in opposite directions. Here, even if the sun gear 130 and the internal gear 140 are rotated in the same direction, as long as the carrier 120 carries out planetary gear movement, the upper fixed platen 150 and the lower fixed platen 160 are rotated in opposite directions when seen with the carrier 120 as a standard.

[0037]

FIG. 3 (b) is a cross-sectional view taken along A-A line of carrier 120 of FIG. 3 (a). The upper fixed platen 150 can be moved vertically to the lower fixed platen 160 and the abrasive pads 200 are provided to polishing surfaces of the upper fixed platen 150 and the lower fixed platen 160 respectively as shown in FIG. 3 (b). The upper fixed platen 150 and the lower fixed platen 160 sandwich the carrier 120 from above and below and press the abrasive pads 200 to both the front and back surfaces of the glass substrate 110. Then, while

supplying the abrasive liquid including a loose grain (slurry), due to the planetary gear movement of the carrier 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 200 are relatively moved to polish both the front and back surfaces of the glass substrate 110.

[0038]

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 liquid and the abrasive pad 200 which moves relatively to the glass substrate 110 while the abrasive liquid is supplied, 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 liquid to be used and composition of the abrasive pad 200 differ. In general, particle size of the loose grain becomes smaller and the abrasive pad 200 becomes softer in the latter steps.

[0039]

FIG. 4 is an enlarged sectional view explaining

configuration of an abrasive pad. A foam of synthetic resin such as polyurethane or polyester is used as the abrasive pad 200. Especially, under the current condition, foamed polyurethane is preferably used.

[0040]

FIG. 4 (a) is an enlarged sectional view explaining the condition of the abrasive pad before the polishing step and the abrasive pad 200 includes a base layer 210 having a nonwoven fabric or the like and a nap layer 220 laminated on the surface of the base layer 210. The nap layer 220 includes an inner layer 220a having a plurality of independent foams 230 and a surface layer 220b having an opening of the foam 230. The foam 230 is formed to have a tear-drop shape (sectional area thereof in the bottom is large but becomes smaller toward surface layer side) in the thickness direction of the nap layer 220 and a minute aperture formed on the surface layer 220b is called a nap hole 230a. Hardness of such an abrasive pad 200 can be adjusted by the amount of the foam 230 to be mixed in. Moreover, the nap hole 230a retains a loose grain and can effectively polish the main surface of the glass substrate 110.

[0041]

FIG. 4 (b) is an enlarged sectional view explaining the condition of the abrasive pad after the polishing step. In the abrasive pad after the polishing step, loose grains 240 included in the abrasive liquid clog in the nap hole 230a and the foam 230. Moreover, due to the pressure given by the upper fixed platen 150 and the lower fixed platen 160 in the polishing step,

the nap layer 220 is deformed in a diagonal direction and width of the aperture of the nap hole 230a on the surface layer of the nap layer 220 is narrowed.

[0042]

If the abrasive pad 200 is in the above-mentioned condition, the foam 230 is clogged and the nap layer 220 loses its flexibility. Therefore, it becomes difficult to carry out accurate mirror polishing. Moreover, because the nap hole 230 cannot retain a new loose grain and the aperture of the nap hole 230a is narrowed, directionality is generated on the abrasive pad surface and the abrasive pad is smoothed. Therefore, polishing rate is significantly decreased and it becomes impossible to carry out desired polishing within a predetermined processing time. Therefore, as explained in the conventional art, a correction member is used to slide and scrub the abrasive pad surface to restore polishing ability. However, in the conventional art, the polishing ability cannot be fully restored and a period of time for the restored polishing rate to decrease again is short. Therefore, the pad surface has to be corrected frequently by a short span.

[0043]

Therefore, a polishing surface of the abrasive pad 200 is corrected by a method shown below in the present embodiment to improve polishing efficiency.

[0044]

FIG. 5 is a view showing a pad dresser which is an example of the correction member. A carrier 310 shown in FIG. 5 (a)

has a configuration which can replace the carrier 120 shown in FIG. 3 (a). That is, the pad dresser may be retained by the carrier 310 having a gear on its periphery and may be the one configured by attaching a fixed grain 330, which is a fixed abrasive grain on an SUS substrate, on both top and bottom of a metallic core material 320 such as an SUS. Otherwise, though not shown, an abrasive grain may be directly retained on the surface of a core material. Moreover, although the disc-shaped fixed grain 330 is shown, an arc-shaped or a rectangular one may be used.

[0045]

The fixed grain 330 is attached along the outer periphery of the core material 320. Center of the core material 320 is a circular hollow space and the fixed grain 330 is not attached thereto. In the present embodiment, the core material 320 to which the fixed grain 330 is attached is assumed to be a pad dresser 300. Although the pad dresser 300 is inserted into a hollow space of the carrier 310, the pad dresser 300 and the carrier 310 may be integrated as one. Because it is assumed that there remains the loose grain 240 supplied in the polishing step in the abrasive pad 200 after the polishing step, it is preferable that the abrasive grain of the fixed grain 330 has higher hardness than the loose grain 240. For example, a diamond grain can be used as the abrasive grain.

[0046]

Here, the fixed grain 330 is not provided to the whole surface of the pad dresser 300. This is because if the fixed

grain 330 is provided to the whole surface, frictional force when the abrasive pad 200 comes into contact with the pad dresser 300 becomes too large. Therefore, the pad dresser 300 cannot be rotated toward the abrasive pad 200 and correction of the pad surface of the abrasive pad 200 cannot be achieved. Moreover, there is an advantage in reduction of material cost of the diamond grain or the like because the whole surface of the pad dresser 300 does not need to be covered by the fixed grain 330.

[0047]

Further, thickness of the position of the pad dresser 300 where the fixed grain 330 is provided may be equal to or thicker than the glass substrate 110 shown in FIG. 3 (b). The reason why such a thickness is required for the pad dresser 300 is that this raises correction ability of the pad dresser 300. In case of the both surface polishing apparatus including the upper fixed platen 150 and the lower fixed platen 160, the thicker a processing target is, the easier it becomes to process because bending strength of the target becomes stronger. Same is applied to a case where the upper fixed platen 150 and the lower fixed platen 160 are corrected and the thicker the pad dresser 300 becomes, the more the correction ability is improved. That is, a wave generated by processing a thin processing target such as the glass substrate 110 can be reduced by processing a target which is thicker than the processing target.

[0048]

The correction surface of the pad dresser 300 thus

configured with such a thickness and pad surfaces of the abrasive pad 200 provided to the upper fixed platen 150 and the lower fixed platen 160 are pressed to each other to be slid while coolant is supplied to increase smoothness of polishing surfaces of the upper and lower fixed platens 150 and 160.

[0049]

FIG. 5 (b) is a view showing that the pad dresser 300 can be replaced by the carrier 120. When polishing the glass substrate 110, the carrier 120 may be used as a planetary gear and when correcting the abrasive pad, instead of the carrier 120, the pad dresser 300 shown in FIG. 5 (a) may be used as a planetary gear.

[0050]

FIG. 6 is a view showing a condition where the pad dresser is mounted on the both surface polishing apparatus. FIG. 6 (a) is a plan view and thus the carrier 120 of the glass substrate 110 which is a polishing target can be replaced by the pad dresser 300.

[0051]

FIG. 6 (b) is a cross-sectional view taken along X-X line of the pad dresser 300 of FIG. 6 (a). When the abrasive pad is corrected, the pad dresser 300 which replaced the carrier 120 is sandwiched between the upper fixed platen 150 and the lower fixed platen 160 to which the abrasive pad 200 is provided, similarly to the case of polishing. Then, the abrasive pad 200 provided to the upper fixed platen 150 and the lower fixed platen 160 and the fixed grain 330 of the pad dresser 300 are pressed

to each other and slid.

[0052]

Here, according to a typical configuration of the present embodiment, relative moving direction of the abrasive pad 200 and the carrier 120 in the polishing step and relative moving direction of the abrasive pad 200 and the pad dresser 300 in the correction step are in different directions, or relative rotation direction of the sun gear 130 and the internal gear 140 in the polishing step and the relative rotation direction of the sun gear 130 and the internal gear 140 in the correction step are in opposite directions. Thus, it becomes possible to efficiently correct the pad surface of the abrasive pad 200.

[0053]

FIG. 7 is a view explaining moving direction of a drive mechanism member of the both surface polishing apparatus in the polishing step and in the correction step. Here, because the upper fixed platen 150 and the sun gear 130 are joined in the both surface polishing apparatus 100, the upper fixed platen 150 is rotated in the rotation direction of the sun gear 130. Moreover, because the lower fixed platen 160 and the internal gear 140 are joined, the lower fixed platen 160 is rotated in the rotation direction of the internal gear 140. Further, the abrasive pad 200 is rotated in the rotation direction of each of the fixed platens 150 and 160 to which the abrasive pad 200 is attached.

[0054]

FIG. 7 (a) is a view showing relative moving direction

of the abrasive pad and the carrier (glass substrate) in the polishing step. In the polishing step, if the sun gear 130 (upper fixed platen 150) is rotated in counterclockwise direction, the abrasive pad 200 provided to the upper fixed platen 150 is rotated in the same direction, and the carrier 120 orbits counterclockwise with the sun gear 130 as the center of the orbit while being rotated clockwise. Moreover, the internal gear 140 (lower fixed platen 160) is rotated clockwise at this time and the abrasive pad 200 provided to the lower fixed platen 160 is rotated in the same direction. Therefore, moving direction of the glass substrate 110 is (assuming that the lower fixed platen 160 is a standard) one obtained by overlapping the counterclockwise rotation component by the orbit and repetition component in radial direction by rotation.

[0055]

FIG. 7 (b) is a view showing relative moving direction of the abrasive pad and the pad dresser (fixed grain) in the correction step. In the correction step, relative moving direction of the abrasive pad 200 and the pad dresser 300 is opposite to (different from) the direction in the polishing step. That is, in the correction step, the sun gear 130 (upper fixed platen 150) is rotated clockwise. Then, the abrasive pad 200 provided to the upper fixed platen 150 is rotated in the same direction and the pad dresser 300 is rotated counterclockwise while orbiting around the sun gear 130 clockwise. Moreover, at this time, the internal gear 140 (lower fixed platen 160) is rotated counterclockwise and the abrasive pad 200 provided

to the lower fixed platen 160 is rotated in the same direction. Therefore, the moving direction of the glass substrate 110 is (assuming that the lower fixed platen 160 is a standard) one obtained by overlapping the clockwise rotation component by the orbit and repetition component in radial direction by rotation.

[0056]

According to the above-mentioned configuration, it becomes possible to differ the relative moving direction of the abrasive pad 200 and the glass substrate 110 in the polishing step and relative moving direction of the abrasive pad 200 and the fixed grain 330 in the correction step. Especially, focusing on the rotation component enables to cause moving directions in the polishing step and the correction step to be opposite to each other. Therefore, to disperse directionality (fold of the surface structure or clogging) generated on the nap layer 220 of the abrasive pad 200 in the polishing step enables to correct retention force of the pad surface and to sufficiently restore polishing ability and flexibility. Moreover, because physical structure in polishing direction is not weakened by the correction step, retention force of the loose grain is not decreased.

[0057]

Thus, efficiently correcting the surface condition of the abrasive pad improves polishing efficiency and as a result improves production efficiency.

[0058]

[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.

[0059]

(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 or glass ceramics (crystallized glass) can be used as material of the plate glass. Aluminosilicate glass, soda lime glass, boronsilicate glass, or the like can be used as raw material of the plate glass.

Especially, as the amorphous glass, 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.

[0060]

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 strengthened 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.

[0061]

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 both from top and bottom 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.

[0062]

(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 cylindrical diamond drill, 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).

[0063]

(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 step. 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.

[0064]

(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.

[0065]

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 the inner hole even in a case where a plurality of, about 200 to 300, substrates were laminated and polished.

[0066]

(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 above-mentioned wrapping step. In the first polishing step, main surface was mirror polished by the both surface polishing apparatus which includes a planetary gear mechanism using a hard resin polisher. As a polishing liquid, cerium oxide abrasive grain was used. Surface roughness of the glass substrate main surface after the first polishing step was; arithmetic mean roughness $R_a = 0.8$ nm, maximum height $R_v = 10$ nm.

[0067]

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.

[0068]

(6) Main surface second polishing step

Next, second polishing step was performed as the main surface polishing step. The second polishing step was the above-mentioned polishing step and was aimed at finishing the main surface to have a mirror surface.

[0069]

FIG. 8 is a flowchart showing a flow of processing of the second polishing step. In case of carrying out polishing of the glass substrate, the above-mentioned both surface polishing apparatus including a planetary gear mechanism was used to carry out an attaching step for attaching the abrasive pad 200 to the upper fixed platen 150 and the lower fixed platen 160 first (Step S400). As the abrasive pad 200, a soft resin foam polisher having an Asker C hardness of 75 was used.

[0070]

Next, an initial correction step for polishing the surface of the abrasive pad 200 was carried out by use of the pad dresser 300 (Step S410). The initial correction was carried out because a pad simply attached to the fixed platens lacks flatness and smoothness.

[0071]

Subsequently, the polishing step was carried out and several tens of batches of glass substrate surfaces were polished (Step S420). Coloidal silica having a particle size of 20 nm, which was smaller than the cerium oxide grain used in the first polishing step, was used as the loose grain.

[0072]

Then, to correct smoothness of the abrasive pad 200 decreased in the polishing step, the correction step of the fixed platen was carried out between batches of the polishing step by use of the pad dresser 300 and the coolant (Step S430). The correction step was carried out for 30 minutes with

processing weight of 100 kg and rotation speed of the fixed platen of 20 rpm. Here, as mentioned above, all of the upper fixed platen 150, the lower fixed platen 160, the sun gear 130, and the internal gear 140 in the correction step were rotated in a direction opposite to the direction in the polishing step.

[0073]

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.

[0074]

[Evaluation]

As a comparative example to the above-mentioned embodiment, all of the upper fixed platen 150, the lower fixed platen 160, the sun gear 130, and the internal gear 140 in the correction step were rotated in the same direction as in the polishing step. The processing weight, rotation speed of the fixed platen, and processing time were the same as those in the embodiment. FIG. 9 is a view explaining the comparison between the embodiment and the comparative example. FIG. 9 (a) is a view explaining polishing speed according to the embodiment, FIG. 9 (b) is a view explaining polishing speed according to the comparative example, and FIG. 9 (c) is a view comparing micro wave in the embodiment and the comparative example.

[0075]

In FIG. 9 (a) showing the embodiment, polishing rate rose in the first few batches and decrease in the polishing rate

started after the fifth batch. Contrary to this, in FIG. 9 (b) showing the comparative example, the polishing rate kept decreased from the start.

[0076]

It is assumed that the polishing rate rose in the embodiment as mentioned above because moving direction in the polishing step and in the correction step differed and therefore clogging in the nap hole was effectively removed and physical structure in the polishing direction was not weakened. That is, it is assumed that the polishing rate rises in the first few batches of the polishing step as loose grains are filled in the nap hole. Then, it is assumed that once the loose grains filled in the hole are abraded, the polishing rate is decreased again. On the other hand, in the comparative example, it is assumed that in addition to the fact that clogging in the nap hole was not removed, physical structure in the polishing direction was weakened and retention force of the loose grain was lost from the beginning (not restored) and therefore the polishing rate kept decreased.

[0077]

Moreover, in FIG. 9 (c), distribution of root-mean-square roughness R_q of micro wave in the embodiment and in the comparative example are shown. According to FIG. 9 (c), more micro waves of R_q are found in the embodiment than the comparative example and it is possible to confirm that mirror polishing is more effectively carried out in the embodiment.

[0078]

(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.

[0079]

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.

[0080]

The glass substrate after the chemical strengthening process 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.

[0081]

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.

[0082]

(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 were sequentially deposited on both surfaces of a glass substrate obtained through the above procedures to manufacture a perpendicular magnetic disc. Here, the present configuration is an example of a configuration of a perpendicular magnetic disc. However, the above example may include a magnetic layer or the like as a longitudinal magnetic disc.

[0083]

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.

[0084]

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 for supplying a polishing liquid including a loose grain between a glass substrate and an abrasive pad having a nap layer for polishing a main surface of the glass substrate and for relatively moving the glass substrate and the abrasive pad to polish the glass substrate; and

a correction step for causing a correction member having a correction surface, to which a polishing grain is fixed, to be in contact with a surface of the abrasive pad which polished the glass substrate and for relatively moving the correction member and the abrasive pad to correct the abrasive pad, wherein moving directions of the glass substrate and the correction member to the abrasive pad differ in the polishing step and in the correction step.

2. The manufacturing method of a glass substrate for a magnetic disc according to claim 1, wherein the moving direction in the polishing step and the correction step includes rotational component and the rotational component in the polishing step and the correction step is in opposite directions.

3. The manufacturing method of a glass substrate for a

magnetic disc according to either claims 1 or 2, wherein the abrasive pad includes a nap layer having an inner layer including a plurality of independent foams and a surface layer including an opening of the foams.

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 is retained by a carrier, which is engaged with a sun gear and an internally-toothed gear which are relatively rotating, to carry out planetary gear movement and may be moved relatively to the abrasive pad; and

the correction member is caused to carry out planetary gear movement by being engaged with the relatively rotating sun gear and the internally-toothed gear to be moved relatively to the abrasive pad.

5. The manufacturing method of a glass substrate for a magnetic disc according to any one of claims 1 to 4, wherein the relative rotation directions of the sun gear and the internally-toothed gear are opposite in the polishing step and in the correction step.

6. The manufacturing method of a glass substrate for a magnetic disc according to any one of claims 1 to 5, wherein particle size of the loose grain is 80 nm or less.

7. The manufacturing method of a glass substrate for a

magnetic disc according to any one of claims 1 to 6, wherein the polishing grain fixed to the correction surface of the correction member includes a diamond grain.