

MANUFACTURING METHOD OF GLASS SUBSTRATE FOR MAGNETIC DISC
AND
MANUFACTURING METHOD OF MAGNETIC DISC

The present disclosure relates to subject matters contained in Japanese Patent Application No. 2006-251644 filed on September 15, 2006, 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 used as a recording medium such as a computer and a manufacturing method of a magnetic disc.

2. Description of the Related Art

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

due to its superiority in flatness of the surface of the substrate and strength in comparison with the aluminum substrate. Especially, because a magnetic disc is required to be mounted in a cellular phone, a digital camera, a portable music player, or the like, a magnetic disc is required to be smaller and to have higher recording density.

[0003] Moreover, to efficiently make use of a main surface of a magnetic disc, a load unload (LUL) method has been used instead of conventional contact start stop (CSS) method. The CSS method is to cause a magnetic head to touch a CSS zone provided on a main surface of the magnetic disc, while the LUL method is to cause a magnetic head to be evacuated into a ramp provided in an external portion of the magnetic disc. Not only is the CSS zone unable to be used as a recording area, but the CSS zone also needs to have a certain degree of surface roughness to prevent suction of the magnetic head. However, by adopting the LUL method, it becomes possible to use the whole surface of a magnetic disc as a recording area and at the same time to realize extreme smoothness on the magnetic disc surface because it is unnecessary to provide a convex/concave portion on the surface.

[0004] Further, 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). However, due to high sensitivity of the GMR head and high recording density, the head picks up information of adjacent recording bit if the head and

a substrate are kept away. Therefore, it is necessary to keep the floating amount of the magnetic head low.

[0005] Because of such circumstances, a magnetic head is required to have low floating amount and the floating amount from a substrate of the magnetic head is narrowed to around 8 nm.

[0006] When a magnetic head has low floating amount, head crush or thermal asperity may occur. Head crush is a trouble by which a magnetic head is crushed to a convex portion of a magnetic disc and damaged. Thermal asperity is a trouble which causes a reading error when a magnetoresistance effect element is heated by adiabatic compression of air or by contact by a magnetic head when the magnetic head is in float flight and passes above minute convexity or concave portion on a magnetic disc surface. Therefore, extremely high-level of smoothness and flatness, that is, low roughness, are required on the surface of a magnetic disc of a magnetic head mounting a magnetoresistance element.

[0007] Especially, to further improve recording density, perpendicular magnetic recording method has been recently adopted. In case of this perpendicular magnetic recording medium, compared to longitudinal magnetic recording method, recording density is higher and therefore roughness of a glass substrate affects more significantly. Therefore, lower roughness is required to a glass substrate.

[0008] In the above-mentioned condition, an invention to realize low roughness in texture process by tape polishing and

to lower the floating amount has been conventionally proposed. In the Patent Document 1 (Japanese Published Unexamined Patent Application No. H2005-141824), a method for tape polishing while supplying polishing solution including two kinds of abrasive grains, diamond abrasive grain and silica abrasive grain, is described. Then, the Patent Document 1 says that it is possible to stably form fine texture without disorder in shape of texture and to obtain a magnetic disc which can prevent a trouble such as head crush even with low floating amount. [Patent Document 1] Japanese Published Unexamined Patent Application No. H2005-141824

[0009] Meanwhile, even if average roughness Ra (avg) on the magnetic disc surface is low, there is a case where head crush occurs when the magnetic disc is actually functioned as a hard disc. This is because when a magnetic head is caused to float and run stably on a disc, low roughness is required on all the positions of the magnetic disc surface. Here, the average roughness Ra (avg) is an average roughness of a plurality of arithmetic mean roughness Ra measured at a plurality of farther points, though the arithmetic mean roughness Ra (Japan Industrial Standard (JIS) B0601) itself is an average value within a certain range. Moreover, in the present application, a maximum one among the plurality of measured arithmetic mean roughness Ra will be referred to as Ra (max), while the minimum one will be referred to as Ra (min).

[0010] That is, when the arithmetic mean roughness Ra is measured from a plurality of points on the whole of the magnetic

disc and low average roughness Ra (avg) is calculated, if there is huge gap between the Ra (max) which is the maximum value and the Ra (min) which is the minimum value, it means that there is a point where Ra (max) is large. It is considered that on such a point with the large Ra (max), it is impossible to carry out stable float drive and head crush occurs.

[0011] Therefore, in pursuing low floating amount of a single layer magnetic head, when considering low roughness, not only average roughness Ra (avg) as a whole of a magnetic disc but also having no large Ra (max), that is, value acquired by subtracting Ra (min) from Ra (max), must be evaluated.

SUMMARY OF THE INVENTION

[0012] Therefore, the present invention is aimed at providing a manufacturing method of a glass substrate for a magnetic disc and a magnetic disc which can lower a value acquired by subtracting Ra (min) from Ra (max) in arithmetic mean roughness Ra acquired by measuring a plurality of points on a main surface of a glass substrate and can improve low floating amount of the magnetic head.

[0013] As a result of keen consideration by inventors of the present application, it was concluded that there is a correlation between hardness of a polishing tape and a value acquired by subtracting Ra (min) from Ra (max) of a glass substrate and it is necessary to set the hardness of the polishing tape within a specific range so that the value acquired by subtracting Ra (min) from Ra (max) is set within

a predetermined range. Thus, the present invention was completed.

[0014] That is, to solve the above-mentioned problems, a typical configuration of a manufacturing method of a glass substrate for a magnetic disc according to the present invention is a manufacturing method of a glass substrate for a magnetic disc including a step of polishing a main surface of a disc-shaped glass substrate, wherein a step of pressing a polishing tape having an Ascar C hardness of 88 or more on both surfaces of a glass substrate and a step of carrying out polishing by relatively moving the glass substrate and the polishing tape while supplying polishing solution including abrasive agent are included. Thus, it is possible to lower a value acquired by subtracting R_a (min) from R_a (max) in arithmetic mean roughness R_a acquired by measuring a plurality of points on a main surface of a glass substrate and to improve low floating amount of a magnetic head in a case where a magnetic head is used.

[0015] It is preferable that a surface layer of the polishing tape includes resin foam and more specifically, includes foamed polyurethane. Moreover, it is preferable that compression ratio of the polishing tape is 15% or less in a case where pressing force is 5 g/cm^2 and thickness is 0.4 mm or less. Using a polishing tape which satisfies such conditions, the present invention can be achieved more preferably.

[0016] It is preferable that the abrasive agent is diamond abrasive grain with a grain diameter of $0.20 \text{ }\mu\text{m}$ or less. Thus,

it is possible to obtain desired surface roughness.

[0017] Moreover, it is preferable to carry out a main surface polishing step for polishing a main surface of a glass substrate using abrasive agent and an abrasive cloth before carrying out polishing by use of the polishing tape and the polishing tape includes the same material as the abrasive cloth used in the main surface polishing step. If the same material as the abrasive cloth used in the main surface polishing step is used, it is easy to use the polishing tape because characteristics in polishing show similar tendency. Moreover, the material can be easily acquired and therefore it is preferable.

[0018] It is preferable that polishing by use of a polishing tape is carried out with the following conditions: pressing force 5 to 10 g/cm², disc rotating speed 150 to 1,500 rpm, tape feeding speed 0.5 to 3 mm/s, and tape polishing time 20 to 40 seconds. The present invention can be achieved more preferably within these ranges.

[0019] A typical configuration of a manufacturing method of a magnetic disc according to the present invention includes a step of forming at least a magnetic layer on a surface of a glass substrate for a magnetic disc obtained by the manufacturing method of a glass substrate for a magnetic disc. Thus, it is possible to manufacture a magnetic disc which can lower a value acquired by subtracting Ra (min) from Ra (max) in arithmetic mean roughness Ra acquired by measuring a plurality of points on a main surface of a glass substrate and

can improve low floating amount of a magnetic head.

[0020] Moreover, the magnetic disc may be perpendicular magnetic recording type, the magnetic layer thereof may include a plurality of layers, and at least one of the layers may be a soft magnetic layer. The perpendicular magnetic recording type is much influenced by the surface roughness of a substrate and therefore effect of the present invention is useful.

[0021] According to the present invention, by appropriately setting the hardness of a polishing tape in tape polishing, it is possible to lower a value acquired by subtracting Ra (min) from Ra (max) in arithmetic mean roughness Ra acquired by measuring a plurality of points on a main surface of a glass substrate and to improve low floating amount of a magnetic head. Thus, even in a case where a magnetic head with a floating amount of 8 nm or less is used, floating stability of the magnetic head can be preferably maintained and the magnetic disc can have higher density.

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] is a view for explaining a tape polishing apparatus.
[FIG. 2] is a view for explaining experiment results of the
embodiments and comparative examples.

The Best Mode for Carrying Out the Claimed Invention

[0022] Embodiments of manufacturing methods of a glass
substrate for a magnetic disc and a magnetic disc according to
the present invention will be explained using figures. FIG.
1 is a view for explaining a tape polishing apparatus and FIG.
2 is a view for explaining experiment results of embodiments
and comparative examples. Here, numerical values shown in the
following embodiments are examples for easy of understanding
of the present invention and the present invention is not
limited thereto unless any notice is added.

[0023] FIG. 1 shows a schematic graphical illustration of
a tape polishing apparatus. In the figure, a glass substrate
1 is supported by a spindle 10 and is rotary driven with a
predetermined speed. From a slurry nozzle 11, polishing
solution including abrasive agent is effused and supplied to
a polishing tape 12. The polishing tape 12 is twined around
a roller 13 and the roller 13 presses the polishing tape 12 to
both surfaces of the glass substrate 1. The polishing tape 12
is reeled to an opposite direction to a rotation direction of
the glass substrate 1 at the contact portion with the glass
substrate 1 and new surface of the polishing tape 12 is always
in contact with the glass substrate 1. Thus, the main surface
of the glass substrate 1 is polished and circumferential texture
is formed.

[0024] Moreover, by causing the spindle 10 and the polishing tape 12 to be enabled to relatively wobble in an axial direction of the roller 13, cross texture having a given angle or spiral texture can be formed. At this time, by controlling rotation speed of the glass substrate 1 (rotation speed of the spindle 10) and a period of relative wobbling between the spindle 10 and the polishing tape 12, shape of the texture can be controlled.

[0025] In the present embodiment, hardness of the polishing tape 12 is, as described later, 88 or more in Ascar C hardness. Thus, it is possible to lower a value acquired by subtracting Ra (min) from Ra (max) in arithmetic mean roughness Ra acquired by measuring a plurality of points on a main surface of a glass substrate and to improve low floating amount of a magnetic head.

[0026] Material and shape of the polishing tape 12 is not especially limited and, for example, a pile tape, a woven tape, and a nonwoven tape are included. As a material of the tape, for example, plastic fiber such as polyester and nylon are included. Among them, it is preferable that at least the surface layer of the polishing tape 12 (a surface which comes into contact with the main surface of a glass disc) includes resin foam, especially, foamed polyurethane. Moreover, it is preferable that with regard to elasticity of the polishing tape 12, compression ratio is 15% or less in a case where pressing force is 5 g/cm^2 and thickness is 0.4 mm or less. By using a polishing tape fulfilling these conditions, the present

invention can be more preferably achieved.

[0027] Further, it is preferable that the polishing tape 12 includes the same type of foamed polyurethane as the abrasive cloth used in a later-described main surface polishing step. If the material of the polishing tape 12 is the same as the abrasive cloth used in the main surface polishing step, it has a similar polishing characteristic and therefore it is easy to handle. In addition, it is easy to obtain the material and therefore it is preferable.

[0028] The abrasive agent included in the polishing solution is not especially limited if the abrasive grain is, for example, one used for polishing a glass substrate such as a diamond abrasive grain, alumina, cerium oxide, colloidal silica, or the like. Mixture of any of them may also be used. Among them, it is preferable that diamond abrasive grain with a grain diameter of 0.20 μm or less. Thus, it is possible to obtain desired surface roughness.

[0029] Further, polishing condition in tape polishing can be set within the following conditions: pressing force 5 to 10 g/cm^2 , disc rotating speed 150 to 1,500 rpm, tape feeding speed 0.5 to 3 mm/s, and tape polishing time 20 to 40 seconds. The present invention can be achieved more preferably within these ranges.

[0030]

[Embodiment]

Hereinafter, an embodiment of a manufacturing method of a glass substrate for a magnetic disc and a magnetic disc to

which the present invention is applied will be explained. The glass substrate for a magnetic disc and the magnetic disc are manufactured as a magnetic disc having a predetermined shape such as a 0.8-inch disc (inner diameter 6 mm, outside diameter 21.6 mm, thickness of plate 0.381 mm), a 1.0-inch disc (inner diameter 7 mm, outside diameter 27.4 mm, thickness of plate 0.381 mm), or a 1.8-inch magnetic disc (inner diameter 12 mm, outside diameter 48 mm, thickness of plate 0.508 mm). Moreover, the glass substrate and the disc may be manufactured as a 2.5-inch disc or a 3.5-inch disc.

[0031]

(1) Shape processing step and first wrapping step

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

[0032]

Next, both main surfaces of the plate-shaped glass are wrapping processed to make a disc-shaped glass base material. Wrapping process is grinding process to press wrapping platen

on a main surface of the plate-shaped glass to scabble.

[0033]

(2) Cutting process (coring, forming)

Next, using a cylindrical diamond drill, an inner hole is formed (coring) at the center. Then, inner circumference edge surface and outer circumference edge surface are ground by a diamond grinder to carry out predetermined chamfering process (forming).

[0034]

(3) Edge surface polishing step

Next, an edge surface of the glass substrate was mirror polished by brush polishing method. By this edge surface polishing step, the edge surface of the glass substrate was processed to have a mirror surface condition which can prevent generation of particles or the like.

[0035]

(4) Second wrapping step

Next, on both main surfaces of the glass substrate thus obtained, second wrapping process is carried out in a similar manner as the first wrapping step. By carrying out the second wrapping step, 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.

[0036] In the second wrapping step, #1000 was selected as

a particle size of the abrasive grain and flatness of the main surface was set to $3\mu\text{m}$, surface roughness R_{max} was set to about $2\mu\text{m}$, and arithmetic means roughness R_a was set to about $0.2\mu\text{m}$ (R_{max} and R_a follow the Japanese Industrial standards (JIS) B0601). Here, R_{max} and R_a are measured by an atom force microscope (AFM, Digital Instruments Nanoscope). Flatness was measured by a flatness measuring device and is distance (difference in height) between the highest portion and the lowest portion in vertical direction (direction vertical to the surface).

[0037]

(5) First main surface polishing step

As a main surface polishing step, the first polishing step was performed. The first polishing step is mainly aimed at removing flaw or distortion remaining on the main surface after the wrapping step so that the main surface is polished before the second polishing step (mirror polishing step) which is the following step.

[0038] In the first polishing step, polishing was performed by use of a both-side polishing apparatus which can polish 100 to 200 glass substrates at a time. The both-surface polishing apparatus holds the plurality of glass substrates by an upper platen and a lower platen while intervening an abrasive cloth between the glass substrates and carries out polishing by relatively moving the glass substrates by a planetary gear mechanism. As an abrasive cloth used in the first polishing step, hard resin polisher was used. As polishing liquid, cerium

oxide abrasive grain having a maximum particle diameter of 3.5 μm , average value of 1.1 μm , and D50 value of 1.1 μm was solved in water and used.

[0039] 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.

[0040]

(6) Second main surface polishing step

Next, second polishing step was performed as the main surface polishing step. The second polishing step is aimed at finishing the main surface to have a mirror surface. In the second polishing step, same both-surface polishing apparatus as the one used in the first polishing step was used and flexible resin foam polisher, specifically, foamed polyurethane, was used as an abrasive cloth to carry out mirror polishing on the main surface.

[0041] As abrasive agent, colloidal silica grain particle having a grain diameter of 40 nm was prepared and water, sulfuric acid as dissociative inorganic acid, and dihydroxysuccinic acid which is organic acid as chemical having buffer action were added to the colloidal silica to generate polishing solution. It is preferable that the content of silica in the polishing solution is between 5 and 40% by weight. In the present embodiment, it was set to 10% by weight. Remaining part of the polishing solution is ultrapure water.

[0042]

(7) Cleansing step after mirror polishing process

The glass substrate after the second polishing step was dipped in NaOH aqueous solution having concentration of 3 to 5 wt% for alkaline washing. Here, ultrasonic wave was applied during washing. In addition, the glass substrate was sequentially dipped in washing tanks of neutral detergent, pure water, pure water, IPA, and IPA (steam drying) for cleansing. Here, ultrasonic wave was applied to each washing tank.

[0043]

(8) Chemical strengthening step

Next, chemical strengthening was conducted to the glass substrate after the above-mentioned wrapping and polishing steps. The chemical strengthening was conducted by preparing chemical strengthening solution in which 60% of potassium nitrate and 40% of sodium nitrate are mixed. The chemical strengthening solution was heated to 375°C and the cleansed glass substrate was heated to 300°C. Then, the glass substrate was dipped into the chemical strengthening solution for about 3 hours. To chemically strengthen the whole surfaces of the glass substrate, the dipping was conducted while the glass substrate was placed in a holder so that a plurality of glass substrates are retained by their edge surface.

[0044] By dipping the glass substrate into the chemical strengthening solution, lithium ion and sodium ion on the surface layer of the glass substrate are replaced by sodium ion and potassium ion in the chemical strengthening solution and the glass substrate is strengthened. Thickness of compression stress layer formed on the surface layer of the glass substrate

was between about 100 μm and 200 μm .

[0045] The glass substrate after the chemical strengthening step is dipped into a water tank of 20°C to be rapidly cooled down and was kept in the tank for about 10 minutes. Then, the glass substrate after the rapid cool down is dipped in concentrated sulfuric acid heated to about 40°C to be cleansed. Moreover, the glass substrate after cleansing by the concentrated sulfuric acid is sequentially dipped into tanks of pure water and IPA to be cleansed.

[0046]

(9) Tape polishing step

Next, using the tape polishing apparatus (refer to FIG. 1) explained above, tape polishing was carried out to the glass substrate thus cleansed in the step in (8). At this time, Ascar C hardness of a polishing tape was changed as follows. That is, the Ascar C hardness is lowered by the order of embodiment 1, embodiment 2, comparative example 1, and comparative example 2. Here, the embodiments 1 and 2 have the Ascar C hardness of 88 or more, which are embodiments of the present invention, and comparative examples 1 and 2 have the Ascar C hardness of 88 or less, which are therefore comparative examples.

Embodiment 1: 91.1

Embodiment 2: 89.9

Comparative example 1: 86.5

Comparative example 2: 83.5

Other polishing conditions are as follows:

Polishing abrasive grain: Diamond abrasive grain

Particle diameter of polishing abrasive grain: 0.20 μm or less

Pressing force: 5 g/cm^2

Disc rotating speed: 150 rpm

Tape feeding speed: 3 mm/s

Tape polishing time: 20 s

With the hardness of the embodiment 1, when the pressing force was 5 g/cm^2 and thickness was 0.4 mm, compression ratio was 15% or less.

[0047]

(10) Inspection step of glass substrate for magnetic disc

The glass substrate for a magnetic disc thus manufactured was inspected. Roughness on the surface of the glass substrate was measured by an atomic force microscope (AFM) and the results shown in FIG. 2 were obtained. As shown in the figure, Ra (ave) is in a similar range of value and there is not tendency. However, Ra (max) - Ra (min) tends to become smaller as the hardness of the polishing tape becomes higher.

[0048] Here, surfaces of glass substrates of the embodiments and comparative examples were in clean mirror surface condition. On the surfaces, there was no foreign object which prevents float of a magnetic head or causes thermal asperity. That is, flat and smooth glass substrates for a magnetic disc with high rigidity were obtained.

[0049] Using a glass substrate for a magnetic disc manufactured as above, a perpendicular magnetic recording type magnetic disc was manufactured.

[0050]

(11) Magnetic disc manufacturing step

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

[0051]

(12) Inspection step of magnetic disc

The magnetic disc manufactured as above was inspected. Using a head for inspection having 10 nm of floating amount, head crush experiment for floating and driving on the magnetic disc was conducted. The magnetic head did not contact with a foreign object or the like and crush failure did not occur in any of magnetic discs including glass substrate of the embodiment and 2 and the comparative examples 1 and 2.

[0052] Next, head crush experiments were conducted by use of a head for inspection having 8 nm of floating amount. In cases of embodiments 1 and 2, crush failure did not occur. On the other hand, in cases of comparative examples 1 and 2, crush failure occurred. This is because, although Ra (ave) of the comparative examples 1 and 2 are similar to those of the

embodiments 1 and 2, Ra (max) - Ra (min) is large and therefore, there is a point where the Ra (max) is large (rough) and crush failure is assumed to have occurred there. Therefore, it is understood that Ra (max) - Ra (min) must be 0.02 or less and the Ascar C hardness of the polishing tape must be 88 or more.

[0053] Next, to magnetic discs including glass substrates of embodiments 1 and 2, recording/replaying experiment by perpendicular recording method using magnetoresistance effect element as a replay element part and single magnetic pole element as recording element part was conducted. It was confirmed that information was correctly recorded/replayed. Thermal asperity signal was not detected as replay signal. It was possible to record and replay with 100 giga bit per 1 cm².

[0054] Next, glide height tests were conducted to magnetic discs including glass substrates of the embodiments 1 and 2. The test is to confirm in a case where the floating amount of the head for inspection is gradually lowered, at which floating amount the head for inspection and the magnetic disc are contacted. As a result, the magnetic disc of the embodiment did not contact with the head even when the floating amount from inner periphery portion to outer periphery portion of the magnetic disc was 4 nm. In the outer periphery portion of the magnetic disc, glide height was 3.7 nm.

[0055] 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 examples 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.

[0056] The present invention can be utilized as a manufacturing method of a glass substrate for a magnetic disc and a magnetic disc.

What Is Claimed Is:

1. A manufacturing method of a glass substrate for a magnetic disc comprising a step of polishing a main surface of a disc-shaped glass substrate,

wherein a polishing tape having Ascar C hardness of 88 or more is pressed on both main surfaces of a glass substrate and the glass substrate and the polishing tape are relatively moved to carry out polishing while polishing solution including abrasive agent is supplied.

2. The manufacturing method of a glass substrate for a magnetic disc according to claim 1,

wherein at least a surface layer of the polishing tape includes resin foam.

3. The manufacturing method of a glass substrate for a magnetic disc according to claim 2,

wherein the polishing tape is foamed polyurethane.

4. The manufacturing method of a glass substrate for a magnetic disc according to claim 1,

wherein the polishing tape has a compression ratio of 15% or less when the pressing force is 5 g/cm^2 and thickness is 0.4 m or less.

5. The manufacturing method of a glass substrate for a

magnetic disc according to claim 1,

wherein the abrasive agent is diamond abrasive grain having particle diameter of $0.20\ \mu\text{m}$ or less.

6. The manufacturing method of a glass substrate for a magnetic disc according to claim 1 further comprising:

a main surface polishing step for polishing a main surface of the glass substrate using the abrasive agent and an abrasive cloth before polishing by use of the polishing tape,

wherein the polishing tape uses the same material as the abrasive cloth used in the main surface polishing step.

7. The manufacturing method of a glass substrate for a magnetic disc according to claim 1,

wherein conditions for polishing by use of the polishing tape are;

pressing force: 5 to $10\ \text{g/cm}^2$

disc rotating speed: 150 to 1,500 rpm

tape feeding speed: 0.5 to 3 mm/s

tape polishing time: 20 to 40 s.

8. A manufacturing method of a magnetic disc comprising:

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

9. The manufacturing method of a magnetic disc according to claim 8,

wherein the magnetic layer includes a plurality of layers and at least one of the layers is soft magnetic layer.