

SPECIFICATION

METHOD OF WRAPPING INFORMATION RECORDING MEDIUM GLASS SUBSTRATE, WRAPPING BODY FOR INFORMATION RECORDING MEDIUM GLASS SUBSTRATE, METHOD OF MANUFACTURING INFORMATION RECORDING MEDIUM GLASS SUBSTRATE, AND METHOD OF MANUFACTURING MAGNETIC RECORDING MEDIUM

TECHNICAL FIELD

[0001] The present invention relates to a method of wrapping an information recording medium glass substrate, a wrapping body for an information recording medium glass substrate, a method of manufacturing an information recording medium glass substrate, and a method of manufacturing a magnetic recording medium.

BACKGROUND

[0002] In the past, as for magnetic disk substrates, aluminum alloys have been used for stationary type devices such as desktop computers and servers, and glass substrates have been employed for portable type devices such as notebook computers and mobile computers. However, surface-smoothness of an aluminum alloy substrate after polishing tends to be insufficient since not only aluminum alloys are deformable, but also their hardness is insufficient. In the case of the aluminum alloy substrate, there was also another problem such that a magnetic film was easy to be peeled off the substrate when a head was brought into contact with a magnetic disk. Thus, glass substrates exhibiting reduced deformation, excellent surface-smoothness and high mechanical strength are expected to be utilized from now on for stationary type devices as well as portable type information devices, and also for other home information appliances.

[0003] Incidentally, the smaller the distance between the magnetic head and the magnetic disk surface is, the larger the recording capacity of the magnetic disk. However, when the distance between the magnetic head and the magnetic disk surface is minimized, and irregular protrusions as well as foreign matter are present on the surface of a glass substrate, there appears a problem such that the magnetic head collides with the protrusions and the foreign matter on the magnetic disk. Accordingly, the irregular protrusions and the foreign matter should be removed in order to increase the recording capacity of the magnetic disk by minimizing the distance between the magnetic head and the magnetic

disk surface. For this reason, the glass substrate surface is smoothed via a polishing step by which the glass substrate is polished with a polishing agent such as cerium oxide or the like to such an extent that surface roughness $R_{\max}$ and arithmetic average roughness R_a reach 2 – 6 nm and 0.2 – 0.4 nm, respectively. Thereafter, the surface is washed with isopropyl alcohol or ultrapure water to obtain an ultraclean surface.

[0004] However, such an ultraclean glass substrate surface is in an active state where foreign matter such as particle dust or the like is easy to be adsorbed in the air. Therefore, proposed are processes conducted in a clean room after the polishing step, but in cases where a site of magnetic disk manufacturing equipment is far away from a site where glass substrates are manufactured, and prepared glass substrates are shipped out to customers after evaporating a magnetic film and others on the glass substrate surface, the glass substrates have to be wrapped, stored and transported.

[0005] A wrapping body is made by vacuum-packing a holding body in which the predetermined number of glass substrates is held so as not to attach foreign matter and so forth onto each of the glass substrates when storing and transporting the glass substrates, and a method of storing and transporting the wrapping body is disclosed in Patent Document 1.

Patent Document 1: Japanese Patent O.P.I. Publication No. 2006-151435

DISCLOSURE OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0006] However, generated was a phenomenon in which a magnetic head collided with foreign matter on the magnetic disk surface, resulting in the head crash, even though the magnetic disk was manufactured by using the glass substrate wrapped, stored, and transported by the method disclosed in Patent Document 1, whereby there appeared a problem such that yield could not be raised.

[0007] When the cause of foreign matter attached onto the glass substrate surface was examined, no foreign matter at a level of head crash occurrence on the surface of the glass substrate before wrapping was observed, but new foreign matter at a level of head crash occurrence, which was attached onto the surface of the glass substrate subjected to unwrapping after wrapping and transporting was observed. For this reason, it is confirmed that foreign matter is attached on the surface of the glass substrate in a wrapping body, even though using the method disclosed in Patent Document 1.

[0008] The present invention was made on the basis of the foregoing situation. It is the first object of the present invention to provide a method of wrapping information recording medium glass substrates of which no foreign matter is newly attached onto each of the surfaces in the processes of

storage and transportation even though the information recording medium glass substrate is wrapped, stored and transported, and is moved to production facilities where magnetic recording media are manufactured; and also to provide a wrapping body for an information recording medium glass substrate and a method of manufacturing the information recording medium glass substrate thereof.

[0009] Further, It is the second object of the present invention to provide a method of manufacturing a magnetic recording medium, which is capable of manufacturing the magnetic recording medium exhibiting excellent properties by using the information recording medium glass substrate to be transported in the form of such a wrapping body for an information recording medium glass substrate.

MEANS TO SOLVE THE PROBLEMS

[0010] The above-described problems are solved by the following structures.

[0011] (Structure 1) A method of wrapping an information recording medium glass substrate, comprising the steps of holding the information recording medium glass substrate in a holding body, packaging the holding body in which the information recording medium glass substrate is held, with a packaging member, and sealing an opening of the packaging member, in such a way that the information recording medium glass substrate held in the holding body is sealed in a space containing lower alcohol.

[0012] (Structure 2) The method of Structure 1, wherein the space containing lower alcohol has a concentration of 3 – 100 ppm.

[0013] (Structure 3) The method of Structure 1 or 2, wherein the lower alcohol comprises at least one selected from the group consisting of methanol, ethanol, propanol, butanol and pentanol.

[0014] (Structure 4) The method of any one of Structures 1 – 3, wherein the sealing step comprises the step of depressurizing atmospheric pressure in the space where the holding body is sealed.

[0015] (Structure 5) The method of Structure 4, wherein the atmospheric pressure having been reduced has a pressure of 200 – 600 hPa.

[0016] (Structure 6) The method of any one of Structures 1 – 5, comprising the step of filling gas for which concentration of the lower alcohol is adjusted, in the space inside the packaging member before conducting the sealing step.

[0017] (Structure 7) The method of any one of Structures 1 – 5, comprising the step of adjusting concentration of the lower alcohol as atmosphere in an operation room to conduct the sealing step.

[0018] (Structure 8) A wrapping body for an information recording medium glass substrate, comprising the information recording medium glass substrate, a holding body in which the information

recording medium glass substrate is held, and a packaging member with which the information recording medium glass substrate held in the holding body is sealed in a space containing lower alcohol.

[0019] (Structure 9) The wrapping body of Structure 8, wherein concentration of the lower alcohol in the space is 3 – 100 ppm.

[0020] (Structure 10) The wrapping body of Structure 8 or 9, wherein atmospheric pressure in the space is 200 – 600 hPa.

[0021] (Structure 11) A method of manufacturing an information recording medium glass substrate, comprising the step of wrapping the information recording medium glass substrate by the method of any one of Structures 1 – 7.

[0022] (Structure 12) A method of manufacturing a magnetic recording medium, comprising the steps of taking out an information recording medium glass substrate from the wrapping body of any one of Structures 8 – 10, and forming at least a magnetic layer on a surface of the information recording medium glass substrate.

EFFECT OF THE INVENTION

[0023] According to a method of wrapping information recording medium glass substrates in the present invention, and a wrapping body thereof, the glass substrates can be transported to production facilities where magnetic recording media are manufactured in the ultraclean state after washing with no adhesion of floating foreign matter inside the wrapping body, foreign matter generated inside the wrapping and so forth to the glass substrate during storage and transportation. Thus, when the magnetic recording medium is prepared employing the information recording medium glass substrate wrapped by such a wrapping method, it is possible to manufacture magnetic recording media to avoid generation of head crash.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] Fig. 1 is a diagram showing a whole structure of an information recording medium glass substrate.

Fig. 2 is a diagram showing an example of a magnetic recording medium in which a magnetic film is provided on the front main surface of an information recording medium glass substrate.

Fig. 3 shows a manufacturing process chart showing steps to manufacture an information recording medium glass substrate.

Fig. 4 is a process chart to explain individual steps in a wrapping step in the present invention.

Fig. 5 is a schematic illustration showing an example of a scrub washing apparatus.

Fig. 6 is a schematic diagram showing a holding body to hold glass substrates.

Fig. 7 shows a side view looking at a situation where glass substrates are stored in a storage container from the connected plate side.

Fig. 8 is a schematic diagram showing a wrapping body for an information recording medium glass substrate of the present invention.

EXPLANATION OF NUMERALS

- [0025] 1 Information recording medium glass substrate (glass substrate)
 2 Magnetic film
 5 Hole
 7a Glass substrate surface (front main surface)
 7b Glass substrate surface (Back main surface)
 10t Outer circumferential surface
 20t Inner circumferential surface
 10a, 10b Sponge roller
 20 Nozzle
 30 Washing liquid
 60 Storage container
 61 Upper lid
 63 Fixed member
 64 Supporting plate
 65, 66 side plate
 67, 68 Connected plate
 69 Bottom plate
 70 Rib
 71 Groove
 200 Packaging member
 201 Opening
 300 Wrapping body for information recording medium glass substrate
 600 Holding body
 D Magnetic disk

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0026] The present invention will be described, based on embodiments relating to figures, but the present invention is not limited to the embodiments.

[0027] Fig. 1 shows the whole structure of information recording medium glass substrate (hereinafter, referred to also as glass substrate) 1. As shown in Fig. 1, glass substrate 1 is in the form of a torus-shaped disk of which hole 5 is formed in the center. Symbol 10t represents an outer circumferential edge face, 20t represents an inner circumferential edge face, each of 7a and 7b represents a glass substrate surface, 7a represents the front main surface, and 7b represents the back main surface. Further, Fig. 2 is a figure showing an example of magnetic recording medium (hereinafter, referred to also as magnetic disk) D in which magnetic film 2 is provided on front main surface 7a of glass substrate 1 shown in Fig. 1. Magnetic disk 2 can be formed on back main surface 7b.

[0028] Fig. 3 is a manufacturing step chart showing an example of a manufacturing process of an information recording medium glass substrate in the present invention. After glass melted in the glass melting step is molded in the form of a disk in the press molding step, and a hole is made in the center of the disk in the coring step, the surface is polished in the first lapping step. After the predetermined inner and outer diameters are obtained via grinding, and the edge faces are polished, the surface is polished again in the second lapping step. Next, the glass substrate surface is subjected to a chemical strengthening treatment and subsequently inspected via the polishing step and the washing step, and the wrapping step is conducted to be shipped out as a wrapping body for the information recording medium glass substrate.

[0029] Next, the wrapping body for the information recording medium glass substrate is transported, and information recording medium glass substrates are taken out from the wrapping body for the information recording medium glass substrate at a shipping site. Then, at least a magnetic layer is formed on the surface of the information recording medium glass substrate to manufacture magnetic recording media.

[0030] A method of wrapping the information recording medium glass substrate of the present invention will be described referring to Fig. 4. Fig. 4 is a process chart showing a wrapping step including individual steps. After as to a glass substrate having been subjected to the washing step in Fig. 3, scratches and foreign matter on the glass substrate surface are inspected in the inspection step, the predetermined number of acceptance glass substrates are held in a holding body in the holding step. Next, this holding body is packaged with a packaging member such as a laminate film in the packaging

step. Then, an opening of the packaging member is sealed in the sealing step for wrapping. In this wrapping step, lower alcohol is contained in the space inside the sealed packaging member. Inside the wrapping body, an adsorbed thin layer made from a lower alcohol component is formed on the glass substrate by containing the lower alcohol. When such an adsorbed thin layer made from a lower alcohol component is formed on the glass substrate surface, adhesion of foreign matter present in atmosphere can be inhibited since an activity degree of the glass substrate surface having been at an activation level after conducting the washing step is lowered. Therefore, foreign matter floating inside the wrapping body and foreign matter generated floating inside the wrapping body during transportation are difficult to attached onto the glass substrate surface, whereby magnetic recording media with their clean surfaces can be transported to production facilities.

[0031] Further, the contained lower alcohol preferably has a concentration of 3 – 100 ppm. When the lower alcohol contained in the space inside the sealed packaging member has a concentration of less than 3 ppm, an adsorption layer composed of an alcohol component is insufficiently produced, whereby the effect of inhibiting foreign matter adhesion is lowered. Further, when the lower alcohol has a concentration exceeding 100 ppm, since the alcohol adsorption layer is unevenly produced, drying unevenness appears on the substrate surface after removal thereof, and foreign matter aggregation is generated in the drying unevenness portions, resulting in appearance of a possible problem.

[0032] Further, lower alcohol is formed of at least one selected from the group consisting of methanol, ethanol, propanol, butanol and pentanol. Since lower alcohol has high affinity with the glass surface, it is easy to form a thin film layer on the glass substrate. Since lower alcohol can be easily released from the glass substrate by heating, it is easily removed before forming a magnetic recording layer, and a high quality magnetic recording medium can be manufactured.

[0033] Further, in the sealing step in the cases when information recording medium glass substrates are wrapped, it is preferable to depressurize atmospheric pressure in the space where a holding body in which information recording medium glass substrates are held is sealed. It is preferred that foreign matter in the space inside the packaging member can be removed to some extent by reducing pressure.

[0034] Further, atmospheric pressure in the space inside the packaging member is preferably reduced to the range between 200 – 600 hPa. In the case of an atmospheric pressure of less than 200 hPa, the wrapping body is pressurized by the atmospheric pressure, whereby constituting members are rubbed to each other in the inside, and foreign matter is generated via friction, resulting in easy adhesion thereof onto the substrate surface. Further, since strength of the wrapping body is desired to be increased in order to withstand the atmospheric pressure, it is not preferred that the heavier the weight, the higher the

manufacturing cost is. Further, in the case of an atmospheric pressure exceeding 600 hPa, no large effect can be unfavorably obtained in view of removal of foreign matter inside the packaging member.

[0035] Further, in the case of the process wrapping the information recording medium glass substrate of the present invention, in a step to seal an opening of the packaging member, after sealing, a holding body in which the information recording medium glass substrate inside the packaging member is held is preferably sealed after filling gas for which concentration of lower alcohol is adjusted, in the packaging member in such a way that the lower alcohol in the sealed space reaches a concentration of 3 – 100 ppm. Concentration of lower alcohol as gas having been adjusted in advance P1 ppm can be calculated by $P1 = P2 \times (X / Y)$, where atmospheric pressure of fill gas is represented by X hPa, atmospheric pressure of a space inside a packaging member after sealing is represented by Y hPa, and concentration of lower alcohol contained in the sealed space inside the packaging member.

[0036] A method of filling gas for which concentration of lower alcohol is adjusted in advance, in the space inside the packaging member is not specifically limited, but the step to seal an opening of the packaging member is preferably conducted at least in an operation room where concentration of lower alcohol as atmosphere is adjusted. As to the concentration of lower alcohol as this atmosphere, one having concentration of lower alcohol P1 calculated by the foregoing equation is used.

[0037] By conducting the sealing step in such an atmosphere, the concentration can be adjusted to a predetermined concentration without employing a means to fill gas for which concentration of lower alcohol is specifically adjusted in advance, in the space inside the packaging member. Further, the operation room is preferably a clean room. The gas contained in the space inside the packaging member can reach the predetermined concentration of lower alcohol easily, whereby foreign matter incorporation into the space inside the packaging member can be inhibited by sealing the packaging member in the clean room where concentration of lower alcohol is adjusted in advance, as described above.

[0038] Further, as another method of filling gas for which concentration of lower alcohol is adjusted in advance, in the space inside the packaging member, for example, there is one by which an opening of the packaging member may be sealed, after a holding body holding the information recording medium glass substrate, which is packaged with the packaging member, is placed in a depressurized room to subsequently depressurize the depressurized room, and gas for which concentration of alcohol is adjusted in advance (for example, air) is subsequently introduced to adjust it to the predetermined atmospheric pressure. Further, After containing lower alcohol having the predetermined concentration

in gas heavier than air (for example, nitrogen gas), the gas is filled in a state of the side of an opening of the packaging member up, and the opening may be arranged to be sealed.

[0039] A method of manufacturing an information recording medium glass substrate will be further described in detail, referring to the manufacturing flow chart in Fig. 3.

(Glass melting step)

First, glass material is melted in the glass melting step. Usable examples of material used for the glass substrate include soda lime glass composed of SiO_2 , Na_2O , and CaO as principal components, aluminosilicate glass composed of SiO_2 , Al_2O_3 , R_2O ($\text{R} = \text{K}, \text{Na}$ or Li) as principal components, borosilicate glass, Li_2O - SiO_2 system glass, Li_2O - Al_2O_3 - SiO_2 system glass, and $\text{R}'\text{O}$ - Al_2O_3 - SiO_2 system glass ($\text{R}' = \text{Mg}, \text{Ca}, \text{Sr}$ or Ba). Of these, aluminosilicate glass and borosilicate glass are preferable in view of excellent impact resistance and excellent vibration resistance.

(Press molding step)

Next, in a press molding step, a melt glass is cast into a lower mold, and press molding is conducted with an upper mold to obtain a disk-shaped glass substrate precursor. In addition, a disk-shaped glass substrate precursor may be prepared by cutting a sheet glass formed with a grinding stone employing a down-draw process or a float process, for example, without depending on the press molding step.

[0040] There is no limitation to size of a glass substrate to be used. For example, glass substrates having an outer diameter of 2.5 inches, 1.8 inches, 1 inch, and 0.8 inch can be used. Moreover, there is also no limitation to thickness of a glass substrate, and the glass substrate having a thickness of 2 mm, 1 mm or 0.63 mm can be used.

(Coring step)

In the coring step, a hole is made in the central part of the glass substrate precursor having been subjected to a press-molding step. Making a hole is carried out in the central part of the glass via grinding employing a core drill equipped with a diamond grindstone on the cutter part of the core drill.

(First lapping step)

Next, in the first lapping step, both surfaces of a glass substrate are subjected to polishing, and the whole shape of a glass substrate, i.e., parallelism, flatness, and thickness of a glass substrate is preliminarily adjusted.

(Inner and outer diameter precision processing step)

Then, in the inner and outer diameter precision processing step, the outer circumferential edge face and the inner circumferential edge face of the glass substrate are ground employing a grindstone such as a drum-shaped diamond to conduct the inner and outer diameter precision processing.

(Edge face polishing step)

A plurality of glass substrates having been subjected to the inner and the outside diameter processing step are piled up and laminated. In that state, the outer circumferential edge face and the inner circumferential edge face of the glass substrate are polished using an edge face polishing machine.

(Second lapping step)

Further, both surfaces of the glass substrate are polished again to finely adjust parallelism, flatness, and thickness of the glass substrate.

[0041] As a polishing machine to polish both surfaces of a glass substrate in the first and second lapping steps, a well-known polishing machine called a double-sided polishing machine can be used. The double-sided polishing machine is equipped with an upper platen and a lower platen in the form of a disk so as to make the both to be in parallel, so that they rotate to each other in a reverse direction. There are adhered a plurality of diamond pellets on each of the upper platen and the lower platen facing to each other for polishing the main surface of a glass substrate. Between the upper platen and the lower platen, there is a plurality of carriers which rotate by combining with internal gears located at the outer circumference of the lower platen in a circle state and a sun gear located in the circumference of the rotary shaft of the lower platen. In this carrier, a plurality of holes are prepared, and a glass substrate is inserted in this hole to place the glass substrate. The upper platen and the lower platen, the internal gear and the sun gear can be operated via a separate driving system.

[0042] The polishing operation of a polishing machine is performed as follows. The upper platen and the lower platen rotate to each other in the reverse direction. The carrier inserted into the platen through the diamond pellet orbitally rotates in the same direction as that of a lower platen while axially rotating, in the situation where a plurality of glass substrates are supported. In the polishing machine operated as described above, a glass substrate can be polished by introducing a grinding liquid supplied between the upper platen and the glass substrate, and between the lower platen and the glass substrate.

[0043] When this double-sided polishing machine is used, a load of the platen loaded to the glass substrate and the number of rotations of the platen are appropriately adjusted according to desired polishing conditions. As to the load in the first and second lapping steps, it is preferable that the load is $60 - 120 \text{ g/cm}^2$. Moreover, the number of rotations of the platen is preferably set to be about $10 - 30 \text{ rpm}$, and it is preferable to set the number of rotations of the upper platen to be about $30 - 40\%$ smaller

than the number of rotations of the lower platen. When the load from the platen is increased and the number of rotations of the platen is increased, a polishing amount will increase, but the surface roughness will not become satisfactory when the amount of the load is excessive. On the other hand, flatness will not become satisfactory when the number of rotations is too high. Moreover, when the load is small and the number of rotations of the platen is low, there is little polishing quantity, as a result, manufacturing efficiency becomes low.

[0044] At a time when finishing the second lapping step, defects such as large undulation, voids and cracks are preferably removed, and surface roughness of the main surface of a glass substrate preferably has an R_{max} of about $2 - 4 \mu m$ and an R_a of about $0.2 - 0.4 \mu m$. By having such a surface state, the glass substrate can be efficiently polished by the first polishing step through the following chemical strengthening treatment step.

[0045] In addition, in order to efficiently conduct the second lapping step, large undulation, voids, and cracks are roughly removed in the first lapping step. For this reason, in the first lapping step, it is desirable to use diamond pellets having #800 mesh to #1200 mesh, which are coarser than diamond pellets having #1300 mesh to #1700 mesh to be used in the second lapping step. At a time when finishing the first lapping step, it is preferable that surface roughness R_{max} and R_a are roughly $4 - 8 \mu m$, and roughly $0.4 - 0.8 \mu m$, respectively.

[0046] As a step of polishing a glass substrate, usable is a step by which a pad is attached onto the polishing surface of each of upper and lower platens, and polishing liquid containing a polishing agent is supplied to conduct polishing. Examples of the polishing agent include cerium oxide, zirconium oxide, aluminum oxide, manganese oxide, colloidal silica and diamond. Each of these may be dispersed in water, and used in the form of a slurry. The pad can be separated into a hard pad and a soft pad, but the pad can be chosen suitably to use it, if desired. As a hard pad, a pad made from a material such as a hard velour, a urethane foam, a pitch containing suede, or the like may be employed, and as a soft pad, a pad made from a material such as suede, velour, or the like may be employed.

[0047] The polishing step using a pad and a polishing agent can be utilized to conduct rough polishing to precision-polishing by changing the particle size of a polishing agent and a type of pad. This step enables to remove large undulation, voids and cracks in the first lapping step and in the second lapping step so as to obtain the above-described surface roughness by appropriately using the kind of a polishing agent, particle size of the polishing agent and a pad thereof in combination.

[0048] Further, it is desirable to conduct a cleaning step to remove a polishing agent and glass powder remaining on the surface of a glass substrate after the first and second lapping steps.

[0049] In addition, the polishing machine used in the first lapping step has the same configuration as that in the second lapping step, but it is desirable to perform a polishing operation employing a different polishing machine prepared exclusively for each step. This is because operation for the exchange is large-scaled since diamond pellets are exclusively attached, and complicated operation is involved for readjustment of the polishing conditions, whereby manufacturing efficiency is lowered.

(Chemical strengthening treatment step)

After completing the second lapping step, in a chemical strengthening treatment step, a glass substrate is immersed in a chemical strengthening liquid to form a chemical strengthening layer on the glass substrate. The chemical strengthening layer is formed to improve impact resistance, vibration resistance and heat resistance.

[0050] The chemical strengthening treatment step is carried out by immersing a glass substrate in the heated chemical strengthening treatment liquid. By this step, conducted is an ion exchange process by which alkali metal ions contained in the glass substrate, such as lithium ions and sodium ions, are substituted with alkali metal ions, such as potassium ions having an ion radius larger than that of the foregoing. Compressive stress is generated in the portion where the ion exchange is done, from distortion caused by the different ion radius, whereby the surface of the glass substrate is strengthened.

[0051] There is no particular restriction to the chemical strengthening treatment liquid, and a commonly known chemical strengthening treatment liquid is usable. Usually, it is common to use molten salt containing potassium ions or molten salt containing potassium ions and sodium ions. As molten salt containing potassium ions or sodium ions, nitrate, carbonate and sulfate of potassium or sodium, and the mixed molten salts of these can be cited. Of these, nitrate is preferably used in view of a low melting point and inhibition of deformation of a glass substrate.

[0052] The chemical strengthening treatment liquid is heated to a temperature higher than the melting temperature of the above-mentioned component. On the other hand, when the heating temperature of the chemical strengthening treatment liquid is too high, the temperature of the glass substrate will rise too much, whereby deformation of the glass substrate tends to be produced. For this reason, the heating temperature of the chemical strengthening treatment liquid is preferably lower than glass transition point T_g of the glass substrate, and it is more preferable that the heating temperature is -50°C lower than the glass transition point.

[0053] In addition, in order to inhibit break and fine cracks of a glass substrate caused by thermal shock during immersion of the glass substrate in the heated chemical strengthening treatment liquid, the

glass substrate may be subjected to a preheating step to heat the glass substrate to the predetermined temperature in a preheating bath before immersing it in the chemical-strengthening treatment liquid.

[0054] The chemical strengthening layer preferably has a thickness of about 5 – 15 μm in consideration of strength of a glass substrate and reduced time in a polishing step. When the thickness of the strengthening layer is in this range, a glass substrate exhibiting excellent flatness and impact resistance in mechanical strength can be obtained.

[0055] The shape of the outer circumferential edge portion of front main surface 7a and back main surface 7b having been subjected to a chemical strengthening treatment step is not changed much, compared with the shape before conducting the chemical strengthening treatment step, and is in the state where the above-mentioned chemical strengthening layer having a thickness of about 5 – 15 μm is uniformly placed on the entire surface of the glass substrate.

(Polishing step)

Next, a polishing step is carried out.

[0056] In the polishing step, the surface of the glass substrate is finished precisely, and at the same time, the form of the outer circumferential edge portion is polished in the predetermined form. A single polishing step may be allowed to be conducted, but two polishing steps are more preferably conducted.

[0057] First, conducted is the first polishing step so as to efficiently obtain the shape of the present invention and to improve surface roughness at the last stage in such a way that the surface roughness to be achieved at the last stage can be efficiently obtained in the second polishing step.

[0058] As the polishing step, a polishing machine having the same configuration as that of the polishing machine used in the first and second lapping steps is used, except that diamond pellets and grinding liquid having been used in the lapping step are replaced by a pad and polishing liquid.

[0059] The pad is a hard pad having a hardness A of about 80 – 90, and it is preferable to use urethane foam, for example. A hard pad is preferably used since change of the polishing surface becomes large in shape when hardness of the pad becomes soft because of heat generated by polishing. It is preferable to use a polishing material by dispersing cerium oxide having a particle diameter of 0.6 – 2.5 μm in water to form slurry. The mixing ratio of water to the polishing agent is preferably about 1 : 9 to 3 : 7.

[0060] A load loaded to the glass substrate from a platen is preferably 90 – 110 g/cm^2 . The load largely affects shape of the outer circumferential edge portion. When the load is increased, the inner side of the circumferential edge portion tends to go down, going up toward the outer side. Further,

when the load is decreased, the outer circumferential edge portion shows a tendency of increasing a surface roll-off, when becoming close to a plane. The load can be determined while observing this tendency.

[0061] Further, in order to improve surface roughness, the number of rotations of the platen is set to 25 – 50 rpm, and the number of rotations of the upper platen is preferably set to be 30 – 40 % smaller than the number of rotations of the lower platen.

[0062] Under the above-described conditions, a polishing amount is preferably set to 30 – 40 μm . In the case of a polishing amount less than 30 μm , scratches and defects cannot be sufficiently removed. In the case of a polishing amount exceeding 40 μm , surface roughness R_{max} and R_a can fall in the range of 2 – 60 nm and in the range of 2 – 4 nm, but polishing proceeds excessively, whereby manufacturing efficiency is lowered.

[0063] The second polishing step is a step of further polishing the surface of a glass substrate precisely after completing the first polishing step. The pad used in the second polishing step is a soft pad having a hardness of about 65 – 80 (Asker-C), which is softer than the pad used in the first polishing step, and urethane foam or suede, for example, is preferably used. As a polishing agent, cerium oxide may be used similarly to the first polishing step, but in order to further smooth the surface of the glass substrate, a polishing agent having a small particle diameter together with reduced variation in particle size is preferably used. A polishing agent having an average particle diameter of 40 – 70 nm is dispersed in water to prepare a slurry, and the slurry is used as polishing liquid. The mixing ratio of water to the polishing agent is preferably 1 : 9 to about 3 : 7.

[0064] A load loaded to a glass substrate from a platen is preferably 90 – 110 g/cm^2 . The load largely affects shape of an outer circumferential edge portion in the same manner as in the first polishing step, but the shape cannot be changed as efficiently as in the first polishing step because of low polishing speed. Change in shape of the outer circumferential edge portion via adjustment of the load is the same as that of the first polishing step, and when the load is increased, there is a tendency that the inner side of the outer circumferential edge portion goes down, going up toward the outer side. Further, when the load is decreased, the outer circumferential edge portion shows a tendency of increasing a surface roll-off, when becoming close to a plane. The load can be determined while observing this tendency in order to acquire the shape of the outer circumferential edge portion. The number of rotations of the platen is set to 15 – 35 rpm, and the number of rotations of the upper platen is preferably set to be 30 – 40% smaller than the number of rotations of the lower platen.

[0065] As described above, the shape of the outer circumferential edge portion is obtained by adjusting the polishing conditions in the second polishing step, and at the same time, surface roughness $R_{\max}$ and R_a can be obtained to be 2 – 6 nm and 0.2 – 0.4 nm, respectively.

[0066] A polishing amount is preferably set to from 2 – 5 μm . When the polishing amount falls within this range, roughness or undulation generated on the surface, or fine defects such as scratches generated in steps having been so far conducted can be efficiently removed.

(Washing step)

Next, a polishing material and foreign matter attached onto a glass substrate in the washing step are washed after completing the polishing step.

[0067] The washing step is not specifically limited, but scrub washing will be described as an example.

[0068] An example of a scrub washing apparatus is shown in Fig. 5. The scrub washing apparatus shown in Fig. 4 is an apparatus by which glass substrate 1 is sandwiched by sponge rollers 10a and 10b as a pair of rotary rollers brought into pressure contact with each other and a pair of rotary rollers 10a and 10b are rotated in the reverse direction to each other while dropping or spraying washing liquid 30 into the vicinity of the contact portion between each of sponge rollers 10a and 10b and glass substrate 1 from nozzle 20 placed in the upper portion, and at the same time, glass substrate 1 is also rotated to wash front and back surfaces of glass substrate 1. As for rotationally driving of glass substrate 1, one of three supporting rollers 60 is used as a drive roller, and other rollers are used as driven rollers.

[0069] As the scrub washing condition, the number of rotations of each of rollers 10a and 10b may be identical to each other, and may be different from each other, if desired. The number of rotations of the roller is conventionally in the range of 100 – 1000 rpm, and more preferably in the range of 300 – 500 rpm. Further, The number of rotations of glass substrate 1 is conventionally in the range of 50 – 500 rpm, and more preferably in the range of 100 – 300 rpm. The feeding rate of washing liquid 30 is conventionally in the range of 10 – 1000 mL/min, and more preferably in the range of 50 – 500 mL/min. The duration of scrub washing is conventionally in the range of 5 – 150 seconds, and more preferably in the range of 10 – 100 seconds.

[0070] As a scrub member, a commonly known brush or pad may be allowed to be used in addition to a sponge roller shown in Fig. 1.

[0071] Sponge rollers 10a and 10b are not specifically limited, and examples of the material constituting the roller include cellulose sponge, polyvinyl alcohol sponge, polyurethane foam, ethylene-vinyl acetate copolymer (EVA) sponge, melamine foam, resin based sponge such as polyethylene foam

or the like, natural rubber (NR) sponge, chloroprene rubber (CR) sponge, ethylene-propylene rubber (EPDM) sponge, and rubber based sponge such as butadiene acrylonitrile rubber sponge or the like. Further, the foregoing resin is preferably a hydrophilic polymer such as polyurethane, a melamine resin, cellulose or polyvinyl alcohol. By doing this, retention ability of contamination from a sponge portion, and supporting ability of washing liquid can be more improved, and contamination-removing ability is further improved since the area in contact with a glass substrate becomes large. Further, hydrogen peroxide water is added into sponge to improve hydrophilicity of the sponge surface, whereby contamination-removing ability can be enhanced.

[0072] Further, pore-to-pore in the sponge portion is communicated to each other. This structure stores a larger amount of contamination and washing liquid in pores of a porous body constituting the sponge portion, whereby retention ability of contamination in the sponge portion and supporting ability of washing liquid are further improved.

[0073] The sponge portion preferably has a pore ratio of 20 – 80%, and more preferably has a pore ratio of 30 – 70%. This produces desired properties of strength and elasticity in the sponge portion, whereby retention ability of contamination in the sponge portion and supporting ability of washing liquid are further improved.

[0074] The sponge portion preferably has a hardness of 30 – 70%, and more preferably has a hardness of 35 – 55%. This produces desired properties of strength and elasticity in the sponge portion, whereby retention ability of contamination in the sponge portion and supporting ability of washing liquid are further improved. In addition, hardness is referred to as one measured in accordance with JIS K 7312.

[0075] Further, in order to effectively remove a polishing agent and foreign matter present on the surface of a glass substrate, the glass substrate is preferably brought into contact with the same liquid as the foregoing washing liquid before scrub washing. The contact time is not specifically limited, but it is desirable to keep touching for 10 minutes or more to float the polishing agent and foreign matter firmly attached onto the glass substrate, depending on a slight corrosion action caused by liquid. On the other hand, the longer the contact time when the glass substrate is brought into contact with liquid, the easier the removal of a polishing agent and foreign matter from the glass substrate surface is, but since productivity of the glass substrate drops, the contact time is preferably 5 – 30 minutes. From the viewpoint of avoiding attaching foreign matter onto the glass substrate, it is recommended to bring the glass substrate into contact with liquid until immediately before scrub washing.

[0076] As an approach to bring the glass substrate into contact with liquid, provided can be commonly known approaches such as an approach to immerse the glass substrate in a storage container in which liquid is stored, an approach to sprinkle liquid to the glass substrate, or an approach to cover a cloth in which liquid is contained, onto the glass substrate. Of these, an approach to immerse a glass substrate in liquid is preferable since the entire surface of the glass substrate can be accurately and evenly brought into contact with liquid.

[0077] Scrub washing is conducted in this way, and a polishing agent and foreign matter attached onto the glass substrate surface can be removed from the substrate surface.

[0078] Next, washing liquid remaining on the glass substrate surface is removed from the surface employing IPA or the like to dry the substrate surface. For example, the glass substrate after conducting scrub washing is subjected to a water-rinse washing step for 2 minutes to remove a residue of washing liquid. Next, an IPA (isopropyl alcohol) washing step is carried out for 2 minutes to remove water from the substrate. Finally, an IPA (isopropyl alcohol) steam drying step is conducted for 2 minutes while removing liquid IPA attached onto the substrate with IPA steam. The drying treatment of a substrate is not limited thereto, and commonly known methods such as spin drying, air knife drying and so forth as the method of drying glass substrates are allowed to be used.

(Inspection step)

As the final inspection step after conducting a washing step, scratches, cracks and foreign matter on the glass substrate are visually inspected to sort out normal glass substrates.

(Wrapping step)

Glass substrates to which no problem is produced in the inspection step are wrapped in a wrapping step as shown in Fig. 4. The wrapping step possesses a step to hold a glass substrate in a holding body, a step to package the holding body in which the glass substrate is held, with a packaging member, and a step to seal an opening of the packaging member. First, a glass substrate is supported by a holding body in the holding step. As a holding body used in the holding step, holding body 600 is usable as shown in Fig. 6. Fig. 6 is an exploded perspective view showing holding body 600 as a whole. Holding body 600 possesses storage container 60 in which a plurality of glass substrates 1 are stored, upper lid 61, and fixed member 63 to be affixed to upper lid 61 to fix glass substrate 1 stored in storage container 60. Fixed member 63 is fitted with supporting plate 64 to support the outer circumferential edge portion of glass substrate 1. The structure of holding body 600 is not limited to the foregoing structure, and is allowed to be used as long as a plurality of glass substrates 1 are held.

[0079] Storage container 60 possesses side plates 65 and 66, communication plates 67 and 68 each having a U-shaped opening communicated with side plates 65 and 66, and bottom plate 69 constituting the lower part of storage container 60, and a plurality of ribs 70 are formed on the inner wall of each of side plates 65 and 66 in predetermined intervals each wider than thickness of glass substrate 1. In this way, a plurality of ribs 70 are formed to form a plurality of grooves 71 to support glass substrate 1 in predetermined intervals in the thickness direction.

[0080] Storage container 60, upper lid 61, fixed member 63 and supporting plate 64 constituting holding body 600 are principally made of a resin material. In order to manufacture these, a resin-molding process is usable as an example. In this resin-molding process, usable are conventional resins such as polyolefin (for example, each polyethylene or polypropylene), polyvinyl chloride, TEFLON (registered trademark) and so forth. Specifically, usable examples of the resin in the case of preparation via an injection molding process include polycarbonate, polyamide, thermotropic liquid crystal polymer (LCP), polyetherether ketone (PEEK), polyether ketone (PEK), PEEK based alloy resins {for example, PEEK / thermotropic liquid crystal polymer, PEEK / polybenzimidazole (PBI) and so forth}, polybenzimidazole (PBI), polyphenylene sulfide (PPS), polyether sulfone (PES), polyether imide (PEI), and a fluorine resin such as polytetrafluoroethylene (PTFE). Further, grooves in predetermined shape can be prepared employing a grinding stone.

[0081] Fig. 7 shows a side view looking at a situation where glass substrate 1 is stored in storage container 60 from the connected plate 67 side. Glass substrate 1 is supported by a pair of grooves 71 provided facing to each other. The distance between inner walls of side plates 65 and 66 is slightly larger than the diameter of glass substrate 1, and glass substrate 1 is designed to be put in from the upper portion. Further, the distance between inner walls of side plates 65 and 66 becomes narrower toward bottom plate 69 on the lower side, whereby the outer circumferential edge portion of glass substrate 10 is brought into contact with P1 and P2 of groove 71.

[0082] In this way, the predetermined number of glass substrates 1 are stored in storage container 60 which will be covered by upper lid 61 fitted with fixed member 63 in Fig. 6, whereby a state of holding the glass substrate is obtained.

[0083] Next, holding body 600 in which this glass substrate is held is packaged with packaging member 200 in a packaging step, and further, opening 201 of packaging member 200 is sealed in a sealing step to prepare wrapping body for information recording medium glass substrate 300 as shown in Fig. 8.

[0084] The packaging member may be a material exhibiting an excellent barrier property with respect to lower alcohol. Specifically, a packaging member formed of a plastic film fitted with a metal film or an oxide film is preferable. Further, since the opening of the packaging member is sealed, a packaging member being sealable via thermally pressing adhesion employing a laminating machine is preferable, and a laminate film obtained by evaporating aluminum onto a film such as polypropylene, polyester, nylon or the like is preferable.

[0085] Atmospheric pressure of the space inside the packaging member is preferably reduced in the sealing step, and more preferably reduced to 200 – 60 hPa. This reduced pressure can be achieved by adjusting atmospheric pressure of the space inside the packaging member employing a vacuum pump during thermally pressing adhesion of the laminate film.

[0086] Further, in an operation room where the wrapping step is carried out, concentration of lower alcohol in atmosphere is preferably adjusted in such a way that the concentration of lower alcohol contained in the space inside the sealed packaging member becomes 3 – 100 ppm. By conducting a wrapping step in such an operation environment, the concentration of lower alcohol inside wrapping body for information recording member glass substrate 300 can be easily adjusted to the predetermined concentration.

[0087] The concentration of lower alcohol inside wrapping body for information recording member glass substrate 300 can be measured by preparing a dummy wrapping body in which an alcohol detector is set, and subsequently sealing it. Further, as another method, the resulting wrapping body is placed in a vacuum evaporator, a seal of it is broken therein, and the concentration of lower alcohol in the vacuum evaporator may be designed to be measured. The measuring method is not specifically limited, and conventional measuring devices are usable.

[0088] In addition, steps of from the washing step up to the wrapping step are preferably conducted in a clean room in which concentration of lower alcohol in atmosphere has been adjusted. The clean room preferably has a cleanliness class of 50000 or less, and more preferably has a cleanliness class of 10000 or less, provided that the cleanliness is defined as the number of particles of 0.5 μm or less in size, which is present in atmosphere of one cubic feet. By setting to such a cleanliness, foreign matter attached onto the glass substrate surface during preparation of the information recording medium glass substrate can further be reduced.

[0089] Further, a holding body in which an information recording medium glass substrate packaged with a packaging member is held is once introduced in a decompression chamber. Thereafter, the inside of the decompression chamber is depressurized, and after gas (for example, air) for which

concentration of lower alcohol has been adjusted in advance is introduced to adjust it to predetermined atmospheric pressure, the opening of the packaging member may be sealed in the decompression chamber.

[0090] Further, gas for which lower alcohol having predetermined concentration is contained in gas heavier than air is adjusted, and the gas is filled in the state where the opening side of a packaging member is up. Thereafter, the opening may be sealed employing a lamination machine by reducing pressure to predetermined atmospheric pressure.

[0091] After wrapping body for information recording medium glass substrate 300 is prepared as described above, and stored for a given period of time, it is transported to production facilities where the magnetic recording medium is manufactured.

[0092] Next, the magnetic recording medium fitted with the glass substrate prepared as described above will be described.

[0093] Next, the magnetic recording medium will be described, based on a figure.

[0094] Fig. 2 is an oblique perspective view of a magnetic disk as an example of a magnetic recording medium. Magnetic film 2 is directly formed on the surface of information recording medium glass substrate 1 in magnetic disk D.

[0095] The information recording medium glass substrate is taken out from the wrapping body for the information recording medium glass substrate, which has been transported, and the magnetic film is formed on the surface of the information recording medium glass substrate.

[0096] Examples of the forming method of magnetic film 2 include a method of forming the magnetic film by spin-coating a thermosetting resin in which magnetic particles are dispersed on a substrate, a method of forming the magnetic film via sputtering, and a method of forming the magnetic film via electroless plating. The layer obtained via spin-coating has a thickness of roughly 0.3 – 1.2 μm , the layer obtained via sputtering has a thickness of roughly 0.04 – 0.08 μm , and the layer obtained via electroless plating has a thickness of roughly 0.05 – 0.1 μm . The film formation carried out via sputtering and electroless plating is preferable in view of thin film formation and high recording density.

[0097] Magnetic materials used for magnetic films are not specifically limited, and commonly known ones are usable, but Co exhibiting high magnetocrystalline anisotropy is taken as a base to acquire high coercive force, and the Co system alloy in which Ni and Cr are added is preferable in order to adjust residual magnetic flux density. Examples of the Co system alloy containing Co as a main component include CoPt, CoCr, CoNi, CoNiCr, CoCrTa, CoPtCr, CoNiPt, CoNiCrPt, CoNiCrTa, CoCrPtTa, CoCrPtB, CoCrPtSiO and so forth. A multilayer structure in which magnetic films are sandwiched

and isolated by non-magnetic films (Cr, CrMo, CrV and so forth, for example) to make noise reduction may also be utilized. Examples thereof include CoPtCr / CrMo / CoPtCr, CoCrPtTa / CrMo / CoCrPtTa, and so forth. A granular structure in which magnetic particles made of Fe, Co, FeCo, CoNiPt or such are dispersed in a non-magnetic film formed from a ferrite system, an iron-rare earth system, SiO₂, BN or such, other than the above-described materials may also be utilized. Further, the magnetic film may also be utilized in any of an in-plane type recording method and a perpendicular type recording method.

[0098] A lubricant may be thinly coated on the magnetic film surface in order to improve sliding of a magnetic head. As the lubricant, provided is one in which a liquid lubricant such as perfluoropolyether (PFPE) is diluted with a freon based solvent.

[0099] An underlayer and a protective layer may also be provided, if desired. The underlayer provided for a magnetic disk is selected depending on the utilized magnetic film. The underlayer is made of at least one selected from the group consisting of Cr, Mo, Ta, Ti, W, V, B and Al as non-magnetic metals, and Ni. In the case of a magnetic film containing Co as a main component, they are preferably a single piece of Co and a Co alloy in view of improvement of magnetic properties. Further, the underlayer is not always a single layer, and a multilayer structure in which identical layers or non-identical layers are laminated may be allowed to be utilized. Examples of the underlayer having the multilayer structure which may be usable include Cr / Cr, Cr / CrMo, Cr / CrV, NiAl / Cr, NiAl / CrMo, NiAl / CrV, and so forth.

[0100] Examples of the protective layer to prevent wear and corrosion of magnetic films include a Cr layer, a Cr alloy layer, a carbon layer, a carbon hydride layer a zirconia layer, a silica layer and so forth. These protective layers, together with underlayers, magnetic films and so forth can be continuously formed with an in-line type sputtering apparatus. the protective layer may be a single layer, or a multilayer structure in which identical layers or non-identical layers are laminated may be allowed to be utilized. In addition, a different kind of a protective layer may be formed on the above-described protective layer, or the above-described protective layer may be replaced by a different kind of a protective layer. For example, in place of the above-described protective layer, a silicon dioxide (SiO₂) layer may be formed by coating one, in which colloidal silica particles are dispersed in what tetraalkoxy silane is diluted with an alcohol based solvent, on a Cr layer, and further by baking it.

[0101] Occurrence of head crash can be avoided by using a magnetic recording medium prepared by a method of manufacturing the magnetic recording medium as described above, whereby operation of the magnetic head during high-speed rotation thereof can be stabilized.

[0102] The information recording medium glass substrate in the present invention is not limited to magnetic recording media, and can be utilized for magneto-optical disks, optical disks and so forth.

EXAMPLE

[0103] (Examples 1 – 19)

(1) Glass melting step and press molding step

Aluminosilicate glass having a Tg of 480 °C was used as a glass material to prepare a blank material having an outer diameter of 68 mm and a thickness of 1.3 mm by press-molding the molten glass.

(2) Coring step

Next, a circular hole having a diameter of 18 mm was made in the center of a glass substrate employing a diamond grind stone in the form of a cylinder.

(3) First lapping step

Both surfaces of the glass substrate were polished employing a polishing machine (manufactured by HAMAI Corporation).

[0104] Used are the polishing conditions such as a diamond pellet of #1200 mesh, a load of 100 g/cm², 30 rpm as the number of rotations of the upper platen and 10 rpm as the number of rotations of the lower platen.

[0105] The resulting glass substrate had a thickness of 0.9 mm, and an Rmax of 1.5 μm and an Ra of 1.0 μm as the surface roughness.

(4) Inner and outer diameter precision processing step

Inner and the outer diameter processing was carried out employing a drum-shaped diamond grind stone to obtain an inner diameter of 20 mm and an outer diameter of 65 mm.

(5) Edge face polishing step

100 glass substrates having been subjected to the inner and outer diameter precision processing step were piled up, and the edge faces of the inner and outer circumferences were polished employing an edge face polishing machine.

[0106] Nylon fibers having a diameter of 0.2 mm was used for brush hair of the polishing machine. Cerium oxide particles having a particle diameter of 3 μm were used for polishing liquid. An Rmax of 0.3 μm and an Ra of 0.03 μm were obtained as the surface roughness of the edge face of the inner circumference of the resulting glass substrate.

(6) Second lapping step

Both surfaces of the glass substrate were polished employing a polishing machine (manufactured by HAMAI Corporation).

[0107] Used are the polishing conditions such as a diamond pellet of #1200 mesh, a load of 100 g/cm², 30 rpm as the number of rotations of the upper platen and 10 rpm as the number of rotations of the lower platen.

[0108] The resulting glass substrate had an Rmax of 3 μm and an Ra of 0.3 μm as the surface roughness.

(7) Chemical strengthening treatment step

Next, the glass substrate was immersed in a chemical strengthening treatment solution to conduct the chemical strengthening treatment step. A mixed molten salt composed of potassium nitrate (KNO₃) and sodium nitrate (NaNO₃) was used for the chemical strengthening treatment solution. The mixing ratio of potassium nitrate (KNO₃) to sodium nitrate (NaNO₃) in a weight ratio was 1 : 1. Further, the temperature of the chemical strengthening treatment solution was set to 400 °C and the immersing time was set to 40 minutes.

(8) Polishing step

Next, urethane form having a hardness A of 80° was used for a pad in the first polishing step employing a polishing machine (manufactured by HAMAI Corporation). The polishing material was used in the form of a slurry obtained by dispersing cerium oxide particles having an average diameter of 1.5 μm in water. The mixed ratio of water to the polishing agent was set to 2 : 8. The load was set to 100 g/cm², and the number of rotations of the upper platen was set to 30 rpm and the number of rotations of the lower platen was set to 10 rpm. The quantity to be polished was set to 30 μm.

[0109] The resulting glass substrate had an Rmax of 30 nm and an Ra of 3 nm as the surface roughness.

[0110] Next, urethane form having a hardness A of 70° was used for a pad in the second polishing step employing a polishing machine (manufactured by HAMAI Corporation). The polishing material was used in the form of a slurry obtained by dispersing cerium oxide particles having an average diameter of 60 nm in water. The mixed ratio of water to the polishing agent was set to 2 : 8. The load was set to 90 g/cm², and the number of rotations of the upper platen was set to 30 rpm and the number of rotations of the lower platen was set to 10 rpm. The quantity to be polished was set to 30 μm.

[0111] The resulting glass substrate had an Rmax of 5 nm and an Ra of 0.3 nm as the surface roughness.

(9) Washing step

The scrub washing was conducted employing a washing apparatus shown in Fig. 5 after completing the second polishing step. The scrub washing was conducted with hydrogen peroxide water having a hydrogen peroxide content of 0.5% by weight. As for supply of washing liquid, an amount of 100 mL/min was continuously supplied via spraying from 3 seconds before starting the scrub washing until terminating the scrub washing. A polyvinyl alcohol sponge was used as a scrub member sponge. A pore ratio and hardness thereof were 50% and 45° (JIS K7312), respectively. The number of rotations of sponge rollers 10a and 10b was set to 300 rpm. The number of rotations of glass substrate 1 was set to 200 rpm. The glass substrate after conducting the scrub washing is subjected to a water-rinse washing step for 2 minutes. Next, an IPA (isopropyl alcohol) washing step is carried out for 2 minutes, and finally, an IPA (isopropyl alcohol) steam drying step is conducted for 2 minutes for drying.

(10) Inspection step

After conducting a washing step, scratches, cracks and foreign matter on the glass substrate are visually inspected to remove those observed as scratches, cracks and adhesive material from the glass substrate.

(11) Wrapping step

The surface of the glass substrate after completing the inspection step was evaluated before wrapping by counting the number of foreign matter having a height of 10 nm, attached onto the glass substrate surface, employing an optical defect tester (ODT: RZ350, manufactured by Hitachi High Technologies Corp.).

[0112] After the evaluation was made before wrapping, the wrapping step shown in Fig. 4 was carried out. In the holding step, 25, glass substrates were first held in holding body 600 shown in Fig. 6. Polycarbonate was used as a resin material for holding body 600. Next, holding body 600 in which these glass substrates were held was packaged with packaging member 200 in the packaging step, and further, opening 201 of packaging member 200 was sealed in the sealing step to prepare wrapping body for information recording medium glass substrate 300 as shown in Fig. 8. A laminate film in which aluminum was evaporated onto a polypropylene film having a film thickness of 40 μm was used for the packaging member. Further, atmospheric pressure inside the packaging member was depressurized so as to give atmospheric pressure shown in Table 1, employing a vacuum bagging apparatus manufactured by Fuji Impulse Co. Ltd. as a laminating machine in the sealing step.

[0113] In addition, steps from the washing step to the inspection step and the wrapping step were conducted in a clean room having a cleanliness class of 100. IPA (isopropyl alcohol) in propanol as lower alcohol was contained in atmosphere inside the clean room. The IPA concentration in this atmosphere was adjusted in such a way that concentration of IPA contained in the space inside the sealed packaging member becomes values shown in Table 1.

(Example 20)

A wrapping body for the information recording medium glass substrate was prepared similarly to Example 10, except that IPA as lower alcohol in the clean room was replaced by methanol.

(Example 21)

A wrapping body for the information recording medium glass substrate was prepared similarly to Example 10, except that IPA as lower alcohol in the clean room was replaced by ethanol.

(Example 22)

A wrapping body for the information recording medium glass substrate was prepared similarly to Example 10, except that IPA as lower alcohol in the clean room was replaced by butanol.

(Example 23)

A wrapping body for the information recording medium glass substrate was prepared similarly to Example 10, except that IPA as lower alcohol in the clean room was replaced by pentanol.

(Comparative example 1)

A wrapping body for the information recording medium glass substrate was prepared similarly to Example 10, except that concentration of lower alcohol inside the clean room where a washing step was conducted was not adjusted, and each of the inspection step, the wrapping step, and the washing step was separately carried out in an individual clean room. The concentration of lower alcohol inside the resulting wrapping body in Comparative example 1 was 0 ppm.

(Evaluation method)

As described above, information recording medium glass substrate wrapping bodies in Examples 1 – 23 and Comparative example 1 were prepared, and stored in a room having a cleanliness class of 100 for 24 hours. Thereafter, the wrapping body for the information recording medium glass substrate was opened in the clean room having a cleanliness class of 100, and the surface of the glass substrate was evaluated after wrapping and storing by counting the number of foreign matter having a height of 10 nm, attached onto the glass substrate surface, employing an optical defect tester (ODT: RZ3500, manufactured by Hitachi High Technologies Corp.). Specifically, in Examples 1 – 23 and Comparative example 1, the number of foreign matter before wrapping each glass substrate is

subtracted from the number of foreign matter after wrapping and storing it to determine the increased number of foreign matter. Next, the increased number of foreign matter for 25 glass substrates in each wrapping body for the information recording medium glass substrate was summed. As to this total number of foreign matter, the number of less than 5 indicates rank 7, the number of at least 5 and less than 7 indicates rank 6, the number of at least 7 and less than 10 indicates rank 5, the number of at least 10 and less than 15 indicates rank 4, the number of at least 15 and less than 20 indicates rank 3, the number of at least 20 and less than 30 indicates rank 2, and the number of at least 30 indicates rank 1. In addition, since it is observed that yield of a glide tester on a magnetic disk is deteriorated when the number of foreign matter becomes 30 or more, less than 30 should be obtained for a product.

[0114] Further, a single glass substrate is taken out from each wrapping body for the glass substrate in the above-described Examples 1 – 23 and Comparative example 1, and a magnetic layer having a thickness of 0.1 μm is formed on the surface of the single glass substrate to prepare a magnetic recording medium. A magnetic material CoNi was used, and a layer was formed on the front main surface via sputtering. As to this magnetic recording medium, yield was evaluated employing a glide tester (Type RQ7800, manufactured by Hitachi High Technologies Corp.).

[0115] Evaluation results are shown in Table 1.

[0116] Table 1

	Kinds of lower alcohol	Concentration of lower alcohol inside wrapping body (ppm)	Atmospheric pressure inside wrapping body (hPa)	Rank from the number of foreign matter	Glide tester Yield (%)
Ex. 1	IPA	2	200	4	96.1%
Ex. 2	IPA	2	600	4	96.7%
Ex. 3	IPA	2	650	3	95.2%
Ex. 4	IPA	2	1013	2	93.6%
Ex. 5	IPA	3	150	5	97.3%
Ex. 6	IPA	3	200	7	98.8%
Ex. 7	IPA	3	600	7	98.8%
Ex. 8	IPA	3	650	6	97.7%
Ex. 9	IPA	3	1013	5	97.4%
Ex. 10	IPA	50	400	7	99.1%
Ex. 11	IPA	100	150	5	97.4%
Ex. 12	IPA	100	200	7	98.7%
Ex. 13	IPA	100	600	7	98.8%
Ex. 14	IPA	100	650	6	97.8%
Ex. 15	IPA	100	1013	5	97.5%
Ex. 16	IPA	105	200	4	96.3%
Ex. 17	IPA	105	600	4	96.4%
Ex. 18	IPA	105	650	3	95.5%
Ex. 19	IPA	105	1013	2	93.4%
Ex. 20	Methanol	50	400	7	99.3%
Ex. 21	Ethanol	50	400	7	98.9%
Ex. 22	Butanol	50	400	7	98.1%
Ex. 23	Pentanol	50	400	7	99.1%
Comp. 1	—	0	400	1	90.7%

Ex.: Example

Comp.: Comparative example

[0117] As is clear from Table 1, it is to be understood that when each of Examples is compared with Comparative example, yield of the glide tester in the case of a magnetic recording medium having been prepared is high, and foreign matter adhesion during storage is inhibited by containing lower alcohol in the space inside the sealed packaging member. Further, it is also to be understood that in Examples 1 – 23, the concentration of lower alcohol to be contained is preferably in the range between 3 ppm and 100 ppm to reduce the foreign matter adhesion. In comparison to Examples 5 – 15, it is also to be understood that the foreign matter adhesion during storage is reduced by depressurizing atmospheric pressure in the space inside the packaging member to 200 – 600 hPa.

CLAIMS

1. A method of wrapping an information recording medium glass substrate, comprising the steps of:
holding the information recording medium glass substrate in a holding body,
packaging the holding body in which the information recording medium glass substrate is held, with a packaging member, and
sealing an opening of the packaging member, in such a way that the information recording medium glass substrate held in the holding body is sealed in a space containing lower alcohol.
2. The method of Claim 1,
wherein the space containing lower alcohol has a concentration of 3 – 100 ppm.
3. The method of Claim 1 or 2,
wherein the lower alcohol comprises at least one selected from the group consisting of methanol, ethanol, propanol, butanol and pentanol.
4. The method of any one of Claims 1 – 3,
wherein the sealing step comprises the step of:
depressurizing atmospheric pressure in the space where the holding body is sealed.
5. The method of Claim 4,
wherein the atmospheric pressure having been reduced has a pressure of 200 – 600 hPa.
6. The method of any one of Claims 1 – 5, comprising the step of:
filling gas for which concentration of the lower alcohol is adjusted, in the space inside the packaging member before conducting the sealing step.
7. The method of any one of Claims 1 – 5, comprising the step of:
adjusting concentration of the lower alcohol as atmosphere in an operation room to conduct the sealing step.

8. A wrapping body for an information recording medium glass substrate, comprising:
the information recording medium glass substrate,
a holding body in which the information recording medium glass substrate is held, and
a packaging member with which the information recording medium glass substrate held in the holding body is sealed in a space containing lower alcohol.
9. The wrapping body of Claim 8,
wherein concentration of the lower alcohol in the space is 3 – 100 ppm.
10. The wrapping body of Claim 8 or 9,
wherein atmospheric pressure in the space is 200 – 600 hPa.
11. A method of manufacturing an information recording medium glass substrate, comprising the step of:
wrapping the information recording medium glass substrate by the method of any one of claims 1 – 7.
12. A method of manufacturing a magnetic recording medium, comprising the steps of:
taking out an information recording medium glass substrate from the wrapping body of any one of Claims 8 – 10, and
forming at least a magnetic layer on a surface of the information recording medium glass substrate.