

DESCRIPTION

[Title of Invention]

METHOD FOR MANUFACTURING MAGNETIC-DISK SUBSTRATE AND
METHOD FOR MANUFACTURING MAGNETIC DISK

5 [Technical Field]

[0001] The present invention relates to a method for manufacturing a magnetic-disk substrate and a method for manufacturing a magnetic disk.

[Background Art]

[0002] Conventionally, a glass substrate has been preferably used in a magnetic
10 disk used as one type of information recording medium. Nowadays, in order to meet the demand for an increase in the storage capacity of hard disk drive apparatuses, attempts have been made to increase the magnetic recording density. Accompanying this, the magnetic recording information area has been made smaller by making the flying height of the magnetic head from the
15 magnetic recording surface extremely low. In such a magnetic-disk glass substrate, in order to achieve a lower flying height of the magnetic head, which is necessary for a hard disk drive apparatus with a high recording density, demand for a decrease in surface unevenness of the substrate, and in particular, demand for a decrease in microwaviness has been increasing.

20 [0003] In contrast, a method for manufacturing a glass substrate for a magnetic recording medium having excellent parallelism is known (PLT1).

An upper surface plate and a lower surface plate of a double-side polishing apparatus for a glass substrate used in the manufacturing method each have a disk shape having an inner circumferential end and an outer
25 circumferential end, polishing pads are attached to surfaces of the upper surface plate and the lower surface plate that face the glass substrate, dressing treatment is performed using a dressing jig in order to give a polishing surface of the polishing pad on the upper surface plate and a polishing surface of the polishing pad on the lower surface plate predetermined shapes. At this time, in
30 the above-described method for manufacturing a glass substrate, $\Delta T_{sd} (=T_s - T_d)$

obtained by subtracting a temperature T_d of dressing water used in dressing treatment from a temperature T_s of a polishing liquid when the glass substrate is polished is set to -5°C to $+7^{\circ}\text{C}$.

[Citation List]

5 [Patent Literature]

[0004] [PLT1]: Japanese Patent 5056961

[Summary of Invention]

[Technical Problem]

[0005] In recent years, following a reduction in size of a magnetic head, a
 10 reduction in the flying height of a magnetic head, an increase in rotation speed of
 a magnetic disk, and the like, a wavelength band of microwaviness that needs to
 be reduced in a magnetic-disk glass substrate has become smaller. In particular,
 a sufficient reduction in microwaviness having a wavelength of 50 to 200 μm on
 the glass substrate is required. In circumstance, with the above-described
 15 method for manufacturing a glass substrate for a magnetic recording medium, a
 glass substrate having excellent parallelism can be produced, but the
 above-described microwaviness was not reduced.

In order to reduce microwaviness of the glass substrate, the state of a
 surface of the polishing pad is an important element. Thus, more precise
 20 management of the state of the surface of the polishing pad is required. In final
 polishing processing for achieving a surface roughness of a main surface that
 satisfies the quality requirement for a magnetic-disk glass substrate, a polishing
 pad made of polyurethane foam having multiple voids (pores) is used as the
 polishing pad. A suede polishing pad may be used as such a polishing pad.
 25 Dressing treatment is performed on this polishing pad in advance so that
 openings of the voids having predetermined sizes are exposed at its surface.
 Specifically, a surface of a new polishing pad that has not been used in polishing
 has no openings, and thus dressing treatment for shaving the surface at a
 constant thickness is performed to provide the surface with openings. Also, if
 30 the polishing pad is repeatedly used in polishing processing, polishing abrasive
 particles and glass sludge and the like that are produced in the polishing
 processing attach, as residue, to the openings of the surface of the polishing pad,

reducing the polishing rate and the surface roughness of the glass substrate. Thus, the surface of the polishing pad is provided with new openings by performing dressing treatment for shaving the surface at a constant thickness on the polishing pad that has been repeatedly used in the polishing processing.

5 However, glass substrates on which final polishing processing was performed simultaneously using such a polishing pad that had undergone dressing treatment were problematic in that variation in microwaviness on main surfaces of the glass substrates occurred. Such a problem in glass substrates also arises in an aluminum alloy substrate.

10 [0006] In view of this, an object of the present invention is to provide a method for manufacturing a magnetic-disk substrate and a method for manufacturing a magnetic disk with which when polishing processing is performed simultaneously on a plurality of substrates using the same polishing apparatus, variation in microwaviness having a wavelength of 50 to 200 μm among the substrates can be
15 suppressed.

[Solution to Problem]

[0007] The inventor of the present invention conducted detailed studies on dressing treatment that was performed on a polishing pad in order to solve the above-described problem.

20 In order to decrease the above-described microwaviness and suppress variation in microwaviness among the glass substrates, the inventor studied surface roughnesses of glass substrates after dressing treatment and polishing processing were performed on polishing pads, and upon doing so, the inventor found that the smaller the sizes of the openings of the surfaces of the polishing
25 pads that were used in the polishing processing were and the slighter the variation in the sizes of the openings was, the more effectively the microwaviness decreased, and on the surfaces of polishing pads that were obtained after dressing treatment was performed on the polishing pads that had been repeatedly used in the polishing processing, the sizes of the openings did not vary significantly
30 depending on location, which was effective for suppressing variation in microwaviness among glass substrates.

In general, polyurethane foam having multiple voids (pores) is used in the polishing pad. The voids in polyurethane foam each have a shape in which a void cross section increases in size from the surface to the inner portion. Thus, if the sizes of the openings of the surface of the polishing pad are reduced in order to reduce microwaviness, it is preferable to reduce a dressing amount (an amount by which the surface is shaved through dressing treatment) of the surface of a new polishing pad that has not been used in polishing processing, and it is preferable to reduce a dressing amount in the polishing pad that has been repeatedly used in polishing processing. Moreover, in order to suppress variation in microwaviness among glass substrates, the dressing amount by which the surface of the polishing pad is shaved is preferably constant regardless of location. However, the dressing amount of the polishing pad often changes depending on location, and the sizes of the openings of the polishing pad change and tend to vary depending on location. The locations herein refer to locations whose positions in the radial direction of the polishing pad are different from each other, for example. In particular, if the sizes of the openings of the polishing pad are reduced by making the dressing amount smaller than a conventional dressing amount in order to reduce microwaviness, the sizes of the openings tend to vary depending on location, which is a problem to be solved in order to reduce microwaviness and suppress variation in microwaviness among a plurality of glass substrates in polishing processing for polishing the glass substrates simultaneously.

As a result of intensive studies on reasons why the dressing amount of the polishing pad changes depending on location and the sizes of the openings tend to vary depending on location, the inventor of the present invention found that the parallelism between an upper surface plate and a lower surface plate of an apparatus that was used in dressing treatment slightly changed during dressing treatment due to frictional heat of the polishing pad generated during dressing treatment, and that the dressing amount of the polishing pad had variation due to variation in an amount of heat of a frictional surface of the polishing pad during dressing treatment, and the inventor of the present invention accomplished the following invention.

[0008] Aspect 1

A method for manufacturing a magnetic-disk substrate, including
polishing processing in which a substrate is sandwiched between a pair of
suede polishing pads provided on a pair of surface plates, a slurry containing
5 polishing abrasive particles is supplied between the polishing pads and the
substrate, and both main surfaces of the substrate are polished by sliding the
polishing pads and the substrate relative to each other,

in which before the polishing processing is performed on the substrate,
dressing treatment for removing surfaces of the polishing pads is performed on
10 the polishing pads by sliding a dresser and the polishing pads relative to each
other while a coolant is supplied to the surfaces of the polishing pads provided on
the surface plates, and

in the dressing treatment, a temperature of the coolant or a coolant
supply amount per unit time is controlled such that an amount of heat that the
15 coolant draws from the polishing pads is made larger at a time at which the
dressing treatment ends than at a time at which the dressing treatment starts.

[0009] Aspect 2

A method for manufacturing a magnetic-disk substrate, including
polishing processing in which a substrate is sandwiched between a pair of
20 polishing pads provided on a pair of surface plates, a slurry containing polishing
abrasive particles is supplied between the polishing pads and the substrate, and
both main surfaces of the substrate are polished by sliding the polishing pads and
the substrate relative to each other,

in which before the polishing processing is performed on the substrate,
25 dressing treatment for removing surfaces of the polishing pads is performed on
the polishing pads by sliding a dresser and the polishing pads relative to each
other while a coolant is supplied to the surfaces of the polishing pads provided on
the surface plates, and

in the dressing treatment, a temperature of the coolant that is supplied to
30 the polishing pads is made lower at a time at which the dressing treatment ends
than at a time at which the dressing treatment starts.

[0010] Aspect 3

A method for manufacturing a magnetic-disk substrate, including
polishing processing in which a substrate is sandwiched between a pair of
polishing pads provided on a pair of surface plates, a slurry containing polishing
abrasive particles is supplied between the polishing pads and the substrate, and
both main surfaces of the substrate are polished by sliding the polishing pads and
the substrate relative to each other,

in which before the polishing processing is performed on the substrate,
dressing treatment for removing surfaces of the polishing pads is performed on
the polishing pads by sliding a dresser and the polishing pads relative to each
other while a coolant is supplied to the surfaces of the polishing pads provided on
the surface plates, and

in the dressing treatment, a supply amount per unit time of the coolant
that is supplied to the polishing pads is made larger at a time at which the
dressing treatment ends than at a time at which the dressing treatment starts.

[0011] Aspect 4

The method for manufacturing a magnetic-disk substrate according to
any one of Aspects 1 to 3, in which in the dressing treatment, an amount of heat
that the coolant draws from the polishing pads is increased in a gradual or
stepwise manner over an elapsed time of the dressing treatment.

[0012] Aspect 5

The method for manufacturing a magnetic-disk substrate according to
any one of Aspects 1 to 4,

in which polishing surfaces of the polishing pads each have an annular
shape, and

among average opening diameters of openings resulting from the dressing
treatment in three regions, namely, an inner circumferential region, an outer
circumferential region, and an intermediate region between the inner
circumferential region and the outer circumferential region on each polishing
surface of the polishing pads, a difference between an average maximum
diameter and an average minimum diameter is 3 μm or less.

[0013] Aspect 6

The method for manufacturing a magnetic-disk substrate according to any one of Aspects 1 to 5,

5 in which the dressing treatment removes 5 μm or less of surfaces of the polishing pads.

[0014] Aspect 7

The method for manufacturing a magnetic-disk substrate according to any one of Aspects 1 to 6,

10 in the polishing processing, a plurality of substrates are slid relative to the polishing pads by causing a plurality of plate-shaped carriers to rotate while revolving about a rotation center of the surface plates by turning the surface plates, with the plurality of substrates respectively held in a plurality of holding holes for substrates in the plurality of carriers, and

15 the holding holes for substrates are provided at a plurality of positions that are located at different distances from rotation center positions of the plurality of carriers.

[0015] Aspect 8

20 A method for manufacturing a magnetic disk in which at least a magnetic layer is formed on a main surface of the magnetic-disk substrate manufactured with the method for manufacturing a magnetic-disk substrate according to any one of aspects 1 to 7.

[Advantageous Effects of the Invention]

25 [0016] With the above-described method for manufacturing a magnetic-disk substrate and the above-described method for manufacturing a magnetic disk, when polishing processing is simultaneously performed on a plurality of substrates with the same polishing apparatus, it is possible to suppress variation in microwaviness having a wavelength of 50 to 200 μm among the substrates.

[Brief Description of Drawings]

30 [0017] FIGS. 1(a) and 1(b) are schematic configuration diagrams of a polishing apparatus used in second polishing in this embodiment.

FIG. 2 is a diagram illustrating polishing with the polishing apparatus shown in FIGS. 1(a) and 1(b).

FIG. 3 is a diagram illustrating dressing treatment.

FIG. 4 is a diagram illustrating a problematic thickness of a polishing pad that has undergone dressing treatment.

FIG. 5 is a diagram illustrating a structure of the polishing pad.

5 [Description of Embodiments]

[0018] Hereinafter, a method for manufacturing a magnetic-disk substrate and a magnetic-disk substrate of the present invention will be described in detail. Note that although the magnetic-disk substrate of the present invention can be applied to an aluminum alloy substrate in addition to the glass substrate, the
10 magnetic-disk glass substrate is used as this embodiment in the following description.

[0019] The method for manufacturing a magnetic-disk glass substrate of the present embodiment includes polishing processing in which a substrate is sandwiched between a pair of suede polishing pads provided on a pair of surface
15 plates (an upper surface plate and a lower surface plate), a slurry containing polishing abrasive particles is supplied between the polishing pads and the glass substrate, and both main surfaces of the glass substrate are polished by sliding the polishing pads and the glass substrate relative to each other. Before the polishing processing is performed on the glass substrate, dressing treatment for
20 removing surfaces of the polishing pads is performed on the polishing pads by sliding a dresser and the polishing pads relative to each other while a coolant is supplied to the surfaces of the polishing pads provided on the surface plates. At this time, in the dressing treatment, a temperature of the coolant or a coolant supply amount per unit time is controlled such that an amount of heat that the
25 coolant draws from the polishing pads is made larger at the time at which the dressing treatment ends than at the time at which the dressing treatment starts. For example, in the dressing treatment, the temperature of the coolant that is supplied to the polishing pads is made lower at the time at which the dressing treatment ends than at the time at which the dressing treatment starts.
30 Alternatively, in the dressing treatment, the supply amount per unit time of the coolant that is supplied to the polishing pads is made larger at the time at which the dressing treatment ends than at the time at which the dressing treatment

starts. In this case, in the dressing treatment, the amount of heat that the coolant draws from the polishing pads may be increased in a gradual or stepwise manner over the elapsed time of the dressing treatment. Increasing the amount of heat drawn by the coolant in a gradual manner over the above-described elapsed time means continuously increasing the above-described amount of heat as time elapses (for example, increasing the above-described amount of heat at a constant speed). Increasing the amount of heat drawn by the coolant in a stepwise manner means keeping the above-described drawn amount of heat constant in a certain period and increasing and keeping constant the above-described drawn amount of heat in another period. For example, it is sufficient that when the drawn amount of heat is plotted with respect to the elapsed time, the plot has a stepwise profile. A period after the above-described drawn amount of heat is increased is preferably at least 20% or more of the overall dressing treatment time, and more preferably 50% or more thereof. Also, in the dressing treatment, the above-described amount of heat may be increased in a gradual manner along with the elapsed time of the dressing treatment, and may be increased in a stepwise manner in a certain amount of time.

The suede polishing pad is made of a resin foam material using a polyurethane resin, and is provided with voids (bubbles) having a droplet shape whose cross section decreases in size from the inner portion of the resin foam material to its surface.

[0020] The dressing treatment includes dressing treatment in which openings of voids in a predetermined range are newly provided by using a dresser to shave a surface of the polishing pad in which glass sludge and polishing abrasive particles are attached to openings due to a plurality of instances of usage in polishing processing, in addition to dressing treatment in which openings of voids in a predetermined range are exposed using a dresser by shaving the surface of a new polishing pad that has not been used in polishing processing. The polishing processing is preferably final polishing processing as described later.

The surface plates each have a temperature distribution due to frictional heat of the polishing pads generated during dressing treatment being transmitted to the surface plates, and when such dressing treatment is performed,

as described above, the amount of heat that the coolant draws from the polishing pads is made larger at the time at which the dressing treatment ends than at the time at which the dressing treatment starts in order to suppress minute deformation of the surface plates caused by these temperature distributions.

5 Precise parallelism between the surfaces of the surface plates and the dressers deteriorates due to minute deformation of the surface plates and the surface plates are inclined. Since the surfaces of the surface plates are provided with the polishing pads, when the surface plates press the dressers against the polishing pads to perform the dressing treatment on the polishing pads, the
10 pressure that the polishing pads receive from the dressers is not uniform. As described above, when the surface plates are inclined due to minute deformation and pressure increases at one location, the dressing amount of the polishing pad increases at the above-described one location and decreases at the other location. As a result, the openings of the polishing pads provided through the dressing
15 treatment are large at one location and small at the other location.

Also, the reason why the amount of heat that the coolant draws from the polishing pad is made larger at the time at which the dressing treatment ends than at the time at which the dressing treatment starts is as follows. That is, it is inferred that the amount of heat of a frictional surface of the polishing pad that
20 undergoes friction with the dresser is larger at the time at which the dressing treatment ends than at the time at which the dressing treatment starts, as a result of which the frictional heat of the polishing pads that is generated during the dressing treatment varies. It is inferred that variation in the dressing amount caused by variation in this frictional heat can be suppressed by making
25 the amount of heat that the coolant draws from the polishing pads larger at the time at which the dressing treatment ends than at the time at which the dressing treatment starts. Also, it is inferred that variation in the frictional heat can be suppressed by suppressing increases in the amount of heat of the frictional surfaces of the polishing pads, and variation in the dressing amount can be
30 suppressed. If variation in the dressing amounts of the polishing pads is not suppressed, for example, the dressing amount will increase on one side in the radial direction and decrease on the other side. In this case, the opening

diameter of the polishing pad provided through the dressing treatment is large on one side in the radial direction and small on the other side. Note that the amount of heat of the frictional surface of the polishing pad that comes into contact with the dresser is unlikely to appear as a measurable temperature of the polishing pad, and is difficult to measure. Also, the temperature of the polishing pad surface during dressing treatment cannot be measured directly.

Here, variation in the frictional heat or variation in the dressing amount refers to a temporal fluctuation or a locational fluctuation in the frictional heat or the dressing amount.

On the other hand, as will be described below, in the polishing processing using the polishing pads that have undergone the dressing treatment, a plurality of glass substrates are held and polished simultaneously at a plurality of positions in the radial direction on the carriers, and thus the locations of the polishing pads with which the glass substrates come into contact tend to be different from each other. Thus, when the glass substrates are subjected to the polishing processing using the polishing pads having openings with different sizes depending on the locations of the polishing pads, microwaviness in the glass substrates that have undergone the polishing processing tends to vary depending on location in the radial direction of the glass substrates held by the carriers. In order to suppress such variation in microwaviness between glass substrates, that is, in order to suppress variation in the dressing amount during dressing treatment, the amount of heat that the coolant draws from the polishing pads when the dressing treatment is performed is made larger at the time at which the dressing treatment ends than at the time at which the dressing treatment starts. This makes it possible to reduce variation in microwaviness having a wavelength of 50 to 200 μm among a plurality of glass substrates when the glass substrates are subjected to the polishing processing simultaneously with the same polishing apparatus.

[0021] One example of a method for manufacturing a magnetic-disk glass substrate of the present embodiment including such dressing treatment and polishing processing will be described below.

First, a glass blank that serves as the blank for a plate-shaped magnetic-disk glass substrate having a pair of main surfaces is molded. Next, this glass blank is processed as appropriate to produce a ring-shaped (annular) glass substrate that has a hole in the central portion and has a chamfered edge portion. Accordingly, the glass substrate is produced. Thereafter, polishing processing is performed on the main surfaces to reduce microwaviness having a wavelength of 50 μm to 200 μm . The polishing processing may be divided into a plurality of processes as needed. Also, the main surface may be ground, an edge surface (including the chamfered portion) may be polished, and chemical strengthening may be performed as needed. In this case, the order of processes may be determined as appropriate.

Hereinafter, the respective processes will be described.

[0022] (a) Glass blank molding processing

A float method is used, for example, in molding of a glass blank. In the glass blank molding processing, first, plate-shaped glass is obtained by continuously pouring molten glass into a bath filled with molten metal such as tin. The molten glass flows in an advancing direction in the bath where the temperature is strictly controlled, and ultimately the plate-shaped glass adjusted to a desired thickness and width is formed. A plate-shaped glass blank with a predetermined shape (a shape that is quadrangular in plan view, for example) from which a magnetic-disk glass substrate is to be made is cut out from this plate-shaped glass.

Also, the plate-shaped glass blank can also be molded with a press molding method, for example, instead of the float method. Furthermore, the plate-shaped glass blank can be molded using a known manufacturing method such as a down draw method, a redraw method, or a fusion method. A disk-shaped glass blank from which a magnetic-disk glass substrate is to be made is cut out by performing appropriate shaping processing on the plate-shaped glass blank manufactured with these known manufacturing methods.

30 [0023] (b) Shaping processing

Next, in shaping processing, a disk-shaped glass substrate having a circular through hole is produced by forming a circular hole using a known

processing method after the glass blank molding processing. Thereafter, chamfering may be further performed. Also, the main surfaces may be ground in order to adjust the thickness and reduce the flatness, for example.

[0024] (c) First polishing processing

5 Next, first polishing processing is performed on the main surfaces of the glass substrate. The first polishing processing is performed in order to mirror-polish the main surfaces. Specifically, the main surfaces on both sides of the glass substrate are polished while the glass substrate is held in a holding hole provided in a holding member (carrier) that is attached to a double-side polishing
10 apparatus. The machining allowance for first polishing is about several micrometers to 100 μm , for example. The first polishing processing is performed in order to eliminate blemishes and distortions that remain on the main surfaces and to adjust minute unevenness of the surface, for example. Note that in order to further reduce surface unevenness or more finely perform adjustment, the first
15 polishing processing may be divided into a plurality of polishing processes.

[0025] In the first polishing processing, the glass substrate is polished while a polishing slurry is supplied, using a known double-side polishing apparatus that includes an upper surface plate, a lower surface plate, an internal gear, carriers, and a sun gear, and that has a planetary gear mechanism. In the first polishing
20 processing, a polishing slurry containing polishing abrasive particles (loose abrasive particles) is used. Abrasive particles (particle size: diameter of about 0.3 to 3 μm) of cerium oxide, zirconia, or colloidal silica, for example, are used as the loose abrasive particles that are used in first polishing. In the double-side polishing apparatus, the glass substrate is held between the pair of upper and
25 lower surface plates. Tabular polishing pads each having an annular shape overall are attached to the upper surface of the lower surface plate and the bottom surface of the upper surface plate. The glass substrate and the surface plates are moved relative to each other by moving one or both of the upper surface plate and the lower surface plate. Accordingly, both main surfaces of the glass
30 substrate are polished.

[0026] (d) Chemical strengthening processing

The glass substrate can be chemically strengthened as appropriate. A

molten liquid obtained by heating potassium nitrate, sodium nitrate, or a mixture thereof, for example, to 300°C to 500°C can be used as a chemical strengthening liquid. The glass substrate is then immersed in the chemical strengthening liquid for 1 hour to 10 hours, for example.

5 Although the timing at which the chemical strengthening processing is performed can be determined as appropriate, it is particularly preferable that polishing processing is performed after the chemical strengthening processing because it is possible to smooth the surface and remove foreign matter adhering to the surface of the glass substrate through the chemical strengthening
10 processing. It is not essential to perform the chemical strengthening processing.
[0027] (e) Second polishing (final polishing) processing

 Next, second polishing processing is performed on the glass substrate that has undergone the chemical strengthening processing. The second polishing processing is performed in order to mirror-polish the main surfaces. A
15 double-side polishing apparatus having a configuration similar to that of the double-side polishing apparatus that is used in first polishing is used in second polishing as well. The machining allowance for the second polishing is about 0.5 μm to 10 μm , for example.

 In the second polishing processing, polishing is performed using a slurry
20 containing loose abrasive particles. Colloidal silica is preferably used as the loose abrasive particles. The average particle diameter of the colloidal silica is preferably 5 nm or more and 50 nm or less in light of the fact that microwaviness having a wavelength of 50 to 200 μm on a main surface of a glass substrate G is reduced. If the average particle diameter is larger than 50 nm, there is a
25 concern that the microwaviness having a wavelength of 50 to 200 μm cannot be reduced sufficiently. Also, there is a concern that the surface roughness cannot be reduced sufficiently. On the other hand, if the average particle diameter is less than 5 nm, there is a concern that the polishing rate will dramatically decrease and productivity will decrease. The value of microwaviness having a
30 wavelength of 50 to 200 μm is preferably 0.8 nm or less, and more preferably 0.6 nm or less from the viewpoint of the flying stability of the magnetic head.

Note that in the present embodiment, the above-described average particle diameter denotes a particle diameter at which a cumulative curve reaches 50% when the cumulative curve is obtained by setting the total volume of powder particles in the particle size distribution measured with a laser diffraction method to 100% (also referred to as "cumulative average particle diameter (50% diameter)", or D50).

FIGS. 1(a) and 1(b) are schematic configuration diagrams of a polishing apparatus 10 that is used in second polishing. A similar apparatus can also be used in the first polishing processing.

[0028] As shown in FIGS. 1(a) and 1(b), the polishing apparatus 10 includes a lower surface plate 12, an upper surface plate 14, an internal gear 16, carriers 18, polishing pads 20, a sun gear 22, and a temperature adjustment unit 30.

The polishing apparatus 10 sandwiches the internal gear 16 between the lower surface plate 12 and the upper surface plate 14 from above and below. The internal gear 16 holds a plurality of carriers 18 at the time of polishing. Five carriers 18 are shown in FIG. 1(b). The polishing pads 20 are attached in a planar manner to the lower surface plate 12 and the upper surface plate 14. The lower surface plate 12 and the upper surface plate 14 are configured to rotate (revolve) around a rotation axis of the lower surface plate 12 and the upper surface plate 14.

The polishing apparatus 10 is used in the polishing processing and is also used as a dressing treatment apparatus for performing the dressing treatment on the polishing pads 20 described later. If the polishing apparatus 10 is used in the dressing treatment, a coolant is used instead of the slurry containing polishing abrasive particles. The slurry or the coolant may be repeatedly used while being circulated in the polishing processing or the dressing treatment.

The temperature adjustment unit 30 adjusts the temperature of the slurry or the coolant. Adjustment of the temperature of the slurry or the coolant involves a cooling means such as a heat exchanger or a Peltier device, and a heating means such as a heater. The temperature adjustment unit 30 may adjust the temperature in response to an instruction of an operator, but it is preferable that the current temperature is measured and the temperature is

subjected to feedback control such that the temperature of the slurry or the coolant is a set target temperature.

[0029] As shown in FIG. 2, the disk-shaped carriers 18 are arranged such that the main surfaces on the lower side of the glass substrates G come into contact with the polishing pad 20 on the lower surface plate 12 and the main surfaces on the upper side of the glass substrates G come into contact with the polishing pad 20 on the upper surface plate 14. By performing polishing in such a state, the main surfaces on both sides of the glass substrates G that were formed into an annular shape can be polished.

[0030] As shown in FIG. 1(b), the annular glass substrates G are held in circular holes (holding holes for glass substrates) provided in the carriers 18. That is, the glass substrates G are held above the lower surface plate 12 by the carriers 18, which each have a gear 19 on the outer circumference.

The carrier 18 is provided with holding holes for glass substrates at a plurality of positions on two concentric circles having different radii, with a disk central position of the carrier 18 serving as the center. That is, the holding holes for glass substrates are provided at a plurality of positions at different distances from a rotation center position (disk central position) of the carrier 18. The carrier 18 shown in FIG. 1(b) is provided with an outer holding hole group for glass substrates and an inner holding hole group for glass substrates. The carrier 18 engages the sun gear 22 and the internal gear 16 provided in the lower surface plate 12. Due to the sun gear 22 being rotated in the direction of the arrow shown in FIG. 1(b), the carriers 18 respectively revolve while rotating as planet gears in the arrow direction. Accordingly, the glass substrate G is polished using the polishing pads 20. At the time of polishing, the glass substrates G are polished by being pressed at 0.002 to 0.02 MPa, for example. The slurry that is used in the polishing is supplied to the upper surface plate 14 as shown in FIG. 1(a), flows to the lower surface plate 12, and is collected in an external container.

[0031] Note that the type, particle diameter, and variation in the particle diameter of the loose abrasive particles that are used in second polishing, the hardness of a resin used for the polishing pad 20, the size of a later-described

opening on a surface of the polishing pad 20, and the like are changed from those in the first polishing as appropriate. In the present embodiment, in order to reduce microwaviness having a wavelength of 50 to 200 μm on the polished glass substrate in at least final polishing processing, the surfaces of the polishing pads
 5 20 are managed through the dressing treatment that will be described later.

After the second polishing, the glass substrates G are cleaned to obtain magnetic-disk glass substrates.

A magnetic disk is produced thereafter by providing a magnetic layer on a main surface of the magnetic-disk glass substrate. For example, an adherent
 10 layer, a soft magnetic layer, a nonmagnetic base layer, a vertical magnetic recording layer, a protecting layer, a lubricant layer, and the like are formed on the surface of the magnetic disk.

[0032] Dressing treatment

The dressing treatment is performed in a state in which the polishing
 15 pads 20 are attached to the lower surface plate 12 and the upper surface plate 14 in the polishing apparatus 10 shown in FIGS. 1(a), 1(b), and 2, using, instead of the carriers 18, disk-shaped dressers 32 that have surfaces on which diamond abrasive particles or the like are distributed and fixed, and are the same size as the carriers 18. As shown in FIG. 3, a dresser obtained by attaching pellets
 20 containing diamond abrasive particles to portions of a surface of a base material such as stainless steel may be used as the dresser. FIG. 3 is a diagram illustrating the dressing treatment. That is, the dressing treatment is the treatment in which the surfaces of the polishing pads are shaved by sandwiching the dresser between the lower surface plate 12 and the upper surface plate 14,
 25 applying a predetermined pressure, and sliding the dresser and the polishing pads 20 relative to each other.

[0033] However, in such dressing treatment, since the polishing pads 20 and the dressers 32 are slid, even if the coolant is supplied, the polishing pads 20 tend to have a high temperature due to frictional heat generated in the polishing pads 20.
 30 The heat of the polishing pads 20 is transmitted to the lower surface plate 12 and the upper surface plate 14, forming temperature distributions in the lower surface plate 12 and the upper surface plate 14. The lower surface plate 12 and

the upper surface plate 14 slightly deform due to a difference in thermal expansion resulting from these temperature distributions, and the parallelism between the lower surface plate 12, the upper surface plate 14, and the dressers 32 deteriorates. The example shown in FIG. 3 shows a state in which the plane of the upper surface plate 14 is inclined with respect to the plane of the lower surface plate 12 and the planes of the dressers 32 (the upper surface plate 14 is inclined rightward in FIG. 3). For example, the upper surface plate 14 is inclined at a slope of about several tens of micrometers per meter. If dressing treatment is performed with the surface plate that is inclined in this manner, the dressing amount of the polishing pads 20 will vary depending on location due to this inclination, and as shown in FIG. 4, the thickness of the polishing pads 20 will also vary depending on location. FIG. 4 is a diagram illustrating a problematic thickness of the polishing pad that has undergone the dressing treatment. Due to the dressing amount in the dressing treatment varying depending on location, the sizes of openings of the polishing pad 20 that has undergone the dressing treatment also vary depending on location.

Also, since the polishing pads 20 and the dressers 32 are slid, the temperatures of the frictional surfaces of the polishing pads 20 tend to increase due to frictional heat generated in the polishing pads 20. As a result, the amount of heat of the frictional surfaces tends to vary depending on location. The dressing amount by which the polishing pad 20 is shaved also tends to vary due to temporal or locational variation in the amount of heat on these frictional surfaces. For example, as shown in FIG. 4, the thickness of the polishing pad 20 varies depending on location. Due to the dressing amount in the dressing treatment varying depending on location, the sizes of openings of the polishing pad 20 that has undergone the dressing treatment also vary depending on location.

[0034] FIG. 5 is a diagram illustrating a structure of the polishing pad. The polishing pad 20 is a suede type polishing pad, and is made of polyurethane foam. As shown in FIG. 5, a surface of a new polishing pad 20 that has not been used in the polishing processing has no openings, and the inner portion thereof includes voids. Each void has a droplet shape, and has a shape that tapers off toward the

surface of the polishing pad 20. Thus, the dressing treatment is performed such that an opening is formed at a tip portion of the void by removing the surface of the new polishing pad 20. However, if the dressing amount varies depending on location, for example, when the dressing treatment is performed along an inclined line X, the size of an opening significantly varies depending on location. Also, in order to reduce microwaviness of a glass substrate, the dressing amount is set to be smaller than a conventional dressing amount (the dressing amount along line Y in FIG. 5). Thus, slight variation in opening diameter according to location also increases due to a slight change in the dressing amount according to location.

Thus, if the dressing amount is reduced in order to reduce microwaviness on the glass substrate, variation in the dressing amount depending on location affects slight variation in opening diameter according to location, which is very problematic. Thus, in the present embodiment, in order to reduce variation in the dressing amount according to location and accordingly eliminate variation in opening diameters (sizes of openings) according to location, in the dressing treatment, the amount of heat that the coolant draws from the polishing pad 20 is made larger at the time at which the dressing treatment ends than at the time at which the dressing treatment starts. Specifically, in the dressing treatment of the present embodiment, the amount of heat of the frictional surface of the polishing pad 20 increases in a gradual or stepwise manner over the elapsed time of the dressing treatment. Thus, the above-described temperature adjustment unit 30 adjusts the temperature of the coolant so as to draw a large amount of the above-described amount of heat from the frictional surface of the polishing pad 20.

[0035] During such dressing treatment, a coolant temperature difference is preferably 0.5 to 10°C, more preferably 1 to 5°C, and more preferably 2 to 4°C, between the time at which the dressing treatment starts and the time at which the dressing treatment ends. Setting the difference in this range makes it possible to keep the dressing amount constant regardless of location. If the above-described coolant temperature difference is less than 0.5°C, temperature control is costly in some cases, whereas if it is more than 10°C, there is a possibility that failure will occur in the polishing apparatus due to condensation.

Also, the temperature of the coolant at the time at which the dressing treatment starts is preferably 15 to 25°C, and more preferably 18 to 24°C. Also, the amount of the coolant supplied to the polishing pad 20 is preferably 3 to 30 L/min per 1 m² of a polishing surface of the polishing pad 20, and more preferably 5 to 15 L/min.

Also, if the amount of the coolant supplied to the polishing pads 20 is increased along with the temperature of the coolant kept constant, a ratio of a supply amount at the dressing treatment end time with respect to a supply amount at the dressing treatment start time is preferably 1.1 to 5.0, more preferably 1.2 to 4.0, even more preferably 1.5 to 3.0 in light of the fact that the dressing amount is kept constant regardless of location. If the above-described supply amount ratio is less than 1.1, variation in the dressing amounts cannot be suppressed in some cases, whereas if it is more than 5, the coolant is costly in some cases. In this case, the amount of the coolant supplied to the polishing pad 20 at the dressing treatment start time is preferably 3 to 15 L/min per 1 m² of a polishing surface of the polishing pad 20, and more preferably 3 to 10 L/min. Also, the temperature of the coolant is preferably in the same range as the above.

Also, in the present embodiment, in order to increase, in a gradual or stepwise manner, the amount of heat that the coolant draws from the polishing pads 20 over the elapsed time of the dressing treatment, a means of adjusting the temperature of the coolant is used, and in addition to this temperature adjustment, the amount of heat that the coolant draws from the polishing pads 20 may be increased in a gradual or stepwise manner over the elapsed time of the dressing treatment by changing, in a gradual or stepwise manner, the amount of the coolant supplied to the polishing pad 20 over the elapsed time of the dressing treatment.

[0036] Also, the polishing surface of the polishing pad 20 has an annular shape, and among average opening diameters of openings resulting from the dressing treatment in three regions of a polishing surface of the polishing pad 20, namely, an inner circumferential region, an outer circumferential region, and a middle region between the inner circumferential region and the outer circumferential region, a difference between the average maximum diameter and the average

minimum diameter is preferably 3 μm or less in light of the fact that microwaviness on the glass substrate and variation in microwaviness are suppressed. The average opening diameters of openings are average opening diameters in the inner circumferential region, the outer circumferential region, and the middle region, each being obtained by observing the surfaces of the polishing pad 20 using a microscope and obtaining opening diameters of 20 or more observed openings in each region. Among these three average opening diameters, the maximum value is referred to as "average maximum diameter" and the minimum value is referred to as "average minimum diameter". Among these three average opening diameters, a difference between the maximum and the minimum is referred to as "difference between the above-described average maximum diameter and average minimum diameter". Here, when a straight line extending from the center of the polishing pad 20 in the radial direction is assumed and a length, on this straight line, from an inner circumferential end of the polishing pad 20 to an outer circumferential end of the polishing pad 20 is assumed to be 100%, starting from the inner circumferential end, a region that is between 5 and 15%, a region that is between 45 and 55%, and a region that is between 85 and 95% are respectively referred to as the inner circumferential region, the middle region, and the outer circumferential region.

Also, the dressing treatment preferably removes 5 μm or less of the surface of the polishing pad in light of the fact that microwaviness on the glass substrate is reduced. The amount by which the surface of the polishing pad 20 is removed is preferably 3 μm or less, and particularly preferably 2 μm or less. An average value of diameters (opening diameters) of openings of the polishing pad 20 that are formed in this manner is preferably 3 to 20 μm , and is more preferably 5 to 15 μm .

[0037] Also, as shown in FIG. 1(b), in the polishing processing on the glass substrates, a plurality of glass substrates are slid relative to the polishing pads 20 by causing the carriers 18 to rotate while revolving about a rotation center of the lower surface plate 12 and the upper surface plate 14 by turning of the lower surface plate 12 and the upper surface plate 14, with the glass substrates respectively held in a plurality of holding holes for glass substrates of

plate-shaped carriers 18. At this time, the holding holes for glass substrates are provided at a plurality of positions that are located at different distances from a rotation center position of the carrier 18 (central position of a disk-shaped carrier 18). In such a case, regions of the polishing pads 20 that come into contact with the glass substrates differ for a glass substrate held in an outer holding hole for a glass substrate of a carrier 18 that is located far from the rotation center position and a glass substrate held in an inner holding hole for a glass substrate of a carrier 18 that is located near the rotation center position. Thus, if the sizes of openings of the polishing pad 20 vary depending on location, a difference in microwaviness tends to increase between a glass substrate held in an inner holding hole for a glass substrate and a glass substrate held in an outer circumferential holding hole for a glass substrate. However, in the present embodiment, variation in the sizes of openings of the polishing pad 20 according to location can be reduced by suppressing variation in the dressing amount, as a result of which variation in microwaviness among glass substrates can be suppressed.

[0038] Experimental Example

In order to check the effects of the present embodiment, magnetic-disk glass substrates were produced by performing the above-described second (final) polishing processing on a plurality of glass substrates using polishing pads that had undergone dressing treatment under various conditions. In the second polishing processing, ten pieces of glass were arranged in the inner circumferential regions and the outer circumferential regions of five carriers 18, and 50 glass substrates were polished simultaneously with the polishing apparatus 10. The glass substrates used in the experiment were obtained by performing cleaning processing after the first polishing processing was performed with the method described in the above-described embodiment. Chemical strengthening processing was not performed. The outer diameter of the glass substrate was nominally 2.5 inches, and the thickness thereof was approximately 0.635 mm. In the second polishing processing, 50 glass substrates were polished simultaneously in one instance of polishing processing using carriers provided with a plurality of outer circumferential holding holes and a plurality of inner

circumferential holding holes.

The polishing pads 20 were made of polyurethane foam, the area of a polishing surface of the polishing pad 20 was 1.0 m², and conditions of the dressing treatment for the polishing pads 20 were changed in various ways. The
 5 dressing treatment was performed for 10 minutes. An average of opening diameters of the polishing pad 20 was 3 to 20 μm.

In Conventional Examples 1 and 2, the dressing treatment was performed, with the temperature of the coolant when the coolant was supplied to the polishing pads kept constant from the dressing treatment start time to the
 10 dressing treatment end time (the temperature was not adjusted to decrease). In Conventional Examples 1 and 2, temperatures of coolants were made different from each other. A difference between the temperature of the upper surface plate 14 before the dressing treatment and the temperature of the upper surface plate 14 immediately after the dressing treatment (temporal change in the
 15 temperature of the upper surface plate 14) was measured using an infrared temperature sensor with a known method. The measurement of the temperatures before and after the dressing treatment was generally performed in a state in which upper and lower surface plates were located apart from each other, and the measurement immediately after the dressing treatment was
 20 performed immediately after the rotation of the upper surface plate 14 was stopped and the upper surface plate 14 was separated from the dressers.

In Working Examples 1 to 5, the temperatures of the coolants were reduced in a gradual manner over the elapsed time of the dressing treatment with the coolant supply amounts kept constant (the temperature was adjusted to
 25 decrease). The temperatures of the coolants at the dressing treatment start time were set to 22°C. The coolant supply amounts were set to 7 L/min. In Working Examples 1 to 6, differences between temperatures of the coolants at the dressing treatment start time and the dressing treatment end time were the set values shown in Table 2. In Working Examples 1 to 6, the temperatures of the coolants
 30 were reduced at a constant speed.

On the other hand, in Working Examples 6 to 9, as shown in Table 3, the temperatures of the coolants were changed in a stepwise manner at equal

intervals in two steps or three steps with the coolant supply amounts kept constant. In two-step and three-step temperature changes, temperature maintaining times were the same. That is, in the three-step temperature change, there were four types of temperatures and thus the above-described
 5 maintaining time was obtained by dividing the 10-min dressing time by 4.

In Working Examples 10 to 14, the temperatures of the coolants were fixed at 20°C, and the coolant supply amounts were increased in a gradual manner over the elapsed time of the dressing treatment (the coolant supply amount was adjusted to increase). Working Examples 10 to 14 were carried out
 10 such that ratios of the coolant supply amounts at the dressing treatment end time with respect to the coolant supply amounts (5 L/min) at the dressing treatment start time were the set values shown in Table 4.

Variations in opening diameters of the polishing pads 20 in Conventional Examples 1 and 2 and Working Examples 1 to 14 were obtained by measuring 50
 15 opening diameters using an optical microscope and obtaining differences between the maximum diameters and the minimum diameters. With regard to the opening diameters, average opening diameters were obtained by obtaining 30 opening diameters by observing the surfaces of the polishing pads 20 in the above-described inner circumferential region, middle region, and outer
 20 circumferential region using a microscope. The maximum diameters and the minimum diameters of openings were obtained based on those average opening diameters.

[0039] Variation in microwaviness was obtained based on microwaviness on glass substrates arranged in inner holding holes for glass substrates in the
 25 carriers 18 shown in FIG. 1(b) and microwaviness on glass substrates arranged in outer holding holes for glass substrates in the second (final) polishing processing. Microwaviness was calculated as a root mean square roughness Rq of waviness having a wavelength band of 50 to 200 μm by performing measurement on main surfaces of glass substrates using an optical surface shape measurement device.
 30 The calculation of the Rq was performed on front and back surfaces of 50 glass substrates, and an average of the Rq values was obtained using the obtained 100 Rq values. Note that the Rq values were 0.8 nm or less in all examples.

Furthermore, the average values of the Rq values were obtained for glass substrates arranged in inner holding holes for glass substrates and glass substrates arranged in outer holding holes for glass substrates. Variation in microwaviness among the glass substrates was evaluated at four levels A to D in accordance with a difference between average values of the Rq values between the glass substrates arranged in the inner holding holes for glass substrates and the glass substrates arranged in the outer holding holes for glass substrates. Evaluation A means a level in which variation in microwaviness is significantly small (less than 0.05 nm), Evaluation B means a level in which variation in microwaviness is small (0.05 nm or more and less than 0.10 nm), Evaluation C means a level in which variation in microwaviness is closely acceptable (0.10 nm or more and less than 0.15 nm), and Evaluation D means a level in which variation in microwaviness is too large to be acceptable (more than 0.15 nm). [0040] Conditions of the dressing treatment for the polishing pads and evaluation results are shown in Tables 1 to 4 below.

[0041] Table 1

	Conv. Ex. 1	Conv. Ex. 2
Temperature of coolant (°C)	22	18
Coolant supply amount (L/min)	7	7
Temporal change in temperature of upper surface plate 14 (°C)	3.1	2.2
Variation in opening diameters of polishing pad 20 (maximum diameter – minimum diameter) (μm)	5.2	4.8
Variation in microwaviness	D	D

[0042] Table 2

	Work. Ex. 1	Work. Ex. 2	Work. Ex. 3	Work. Ex. 4	Work. Ex. 5
Difference between temperatures of coolant (°C)	1	2	3	4	5
Variation in opening diameters of polishing pad 20 (maximum diameter – minimum diameter) (μm)	2.9	1.1	0.9	1.4	2.3
Variation in microwaviness	B	A	A	A	B

[0043] Table 3

	Work. Ex. 6	Work. Ex. 7	Work. Ex. 8	Work. Ex. 9
Difference between temperatures of coolant (°C)	3	3	5	5
Number of steps	2	3	2	3
Variation in opening diameters of polishing pad 20 (maximum diameter – minimum diameter) (μm)	1.2	1.1	2.2	2.1
Variation in microwaviness	A	A	B	B

[0044] Table 4

	Work. Ex. 10	Work. Ex. 11	Work. Ex. 12	Work. Ex. 13	Work. Ex. 14
Temperature of coolant (°C)	20	20	20	20	20
Ratio of coolant supply amounts	1.2	1.5	2.0	3.0	4.0
Variation in opening diameters of polishing pad 20 (maximum diameter – minimum diameter) (μm)	3.1	1.2	1.0	1.1	2.4
Variation in microwaviness	B	A	A	A	B

[0045] According to Table 1 above, even if a temporal change (°C) in the temperature of the upper surface plate 14 was adjusted, if the temperature of the coolant was not adjusted to decrease or the coolant supply amount was not adjusted to increase, variation in microwaviness was not improved. On the other hand, from Tables 2 to 4 above, it was found that variation in microwaviness was at least at an acceptable level due to the temperature of the coolant being adjusted to decrease and the coolant supply amount being adjusted to increase. Also, it was found that the decrease in the temperature of the coolant during the dressing treatment was preferably 2 to 4°C. It was found that the ratio of coolant supply amounts during the dressing treatment was 1.5 to 3.0.

Also, it was found that variation in the opening diameters (a difference between the average maximum diameter and the average minimum diameter of opening diameters) was preferably 3 μm or less, more preferably 2 μm or less, and even more preferably 1.5 μm or less in light of the fact that variation in microwaviness is suppressed.

Accordingly, the effects of the present embodiment are clear.

[0046] As described above, although a method for manufacturing a magnetic-disk substrate and a method for manufacturing a magnetic disk of the present invention have been described in detail, the present invention is not
 5 limited to the above-described embodiment and working examples, and it will be appreciated that various improvements and modifications can be made without departing from the gist of the present invention.

[Descriptions of Reference Numerals]

	[0047]	10	Polishing apparatus
10		12	Lower surface plate
		14	Upper surface plate
		16	Internal gear
		18	Carrier
		19	Gear
15		20	Polishing pad
		22	Sun gear

CLAIMS

1. A method for manufacturing a magnetic-disk substrate, comprising
polishing processing in which a substrate is sandwiched between a pair
of suede polishing pads provided on a pair of surface plates, a slurry containing
5 polishing abrasive particles is supplied between the polishing pads and the
substrate, and both main surfaces of the substrate are polished by sliding the
polishing pads and the substrate relative to each other,
wherein before the polishing processing is performed on the substrate,
dressing treatment for removing surfaces of the polishing pads is performed on
10 the polishing pads by sliding a dresser and the polishing pads relative to each
other while a coolant is supplied to the surfaces of the polishing pads provided
on the surface plates, and
in the dressing treatment, a temperature of the coolant or a coolant
supply amount per unit time is controlled such that an amount of heat that the
15 coolant draws from the polishing pads is made larger at a time at which the
dressing treatment ends than at a time at which the dressing treatment starts.
2. A method for manufacturing a magnetic-disk substrate, comprising
polishing processing in which a substrate is sandwiched between a pair
of polishing pads provided on a pair of surface plates, a slurry containing
20 polishing abrasive particles is supplied between the polishing pads and the
substrate, and both main surfaces of the substrate are polished by sliding the
polishing pads and the substrate relative to each other,
wherein before the polishing processing is performed on the substrate,
dressing treatment for removing surfaces of the polishing pads is performed on
25 the polishing pads by sliding a dresser and the polishing pads relative to each
other while a coolant is supplied to the surfaces of the polishing pads provided
on the surface plates, and
in the dressing treatment, a temperature of the coolant that is supplied

to the polishing pads is made lower at a time at which the dressing treatment ends than at a time at which the dressing treatment starts.

3. A method for manufacturing a magnetic-disk substrate, comprising polishing processing in which a substrate is sandwiched between a pair of polishing pads provided on a pair of surface plates, a slurry containing polishing abrasive particles is supplied between the polishing pads and the substrate, and both main surfaces of the substrate are polished by sliding the polishing pads and the substrate relative to each other,

wherein before the polishing processing is performed on the substrate, dressing treatment for removing surfaces of the polishing pads is performed on the polishing pads by sliding a dresser and the polishing pads relative to each other while a coolant is supplied to the surfaces of the polishing pads provided on the surface plates, and

in the dressing treatment, a supply amount per unit time of the coolant that is supplied to the polishing pads is made larger at a time at which the dressing treatment ends than at a time at which the dressing treatment starts.

4. The method for manufacturing a magnetic-disk substrate according to any one of claims 1 to 3,

wherein in the dressing treatment, an amount of heat that the coolant draws from the polishing pads is increased in a gradual or stepwise manner over an elapsed time of the dressing treatment.

5. The method for manufacturing a magnetic-disk substrate according to any one of claims 1 to 4,

wherein polishing surfaces of the polishing pads each have an annular shape, and

among average opening diameters of openings resulting from the dressing treatment in three regions, namely, an inner circumferential region,

an outer circumferential region, and an intermediate region between the inner circumferential region and the outer circumferential region on each polishing surface of the polishing pads, a difference between an average maximum diameter and an average minimum diameter is 3 μm or less.

5 **6.** The method for manufacturing a magnetic-disk substrate according to any one of claims 1 to 5,

 wherein the dressing treatment removes 5 μm or less of surfaces of the polishing pads.

10 **7.** The method for manufacturing a magnetic-disk substrate according to any one of claims 1 to 6,

 wherein in the polishing processing, a plurality of substrates are slid relative to the polishing pads by causing a plurality of plate-shaped carriers to rotate while revolving about a rotation center of the surface plates by turning the surface plates, with the plurality of substrates respectively held in a
15 plurality of holding holes for substrates in the plurality of carriers, and

 the holding holes for substrates are provided at a plurality of positions that are located at different distances from rotation center positions of the plurality of carriers.

20 **8.** A method for manufacturing a magnetic disk,
 wherein at least a magnetic layer is formed on a main surface of the magnetic-disk substrate manufactured with the method for manufacturing a magnetic-disk substrate according to any one of claims 1 to 7.