DESCRIPTION

PROCESS FOR PRODUCING GLASS SUBSTRATE FOR MAGNETIC DISKS

TECHNICAL FIELD

The present invention relates to a process for producing a glass substrate for magnetic disks and particularly relates to a method of polishing a main surface of a glass circular disk.

BACKGROUND ART

There has been a strong demand for higher recording density of a magnetic disk to be mounted on an information-processing device such as a hard disk drive, and under such a circumstance, a glass substrate has started to be widely used instead of a conventional aluminum substrate.

For example, a glass substrate for magnetic disks is produced in such a manner that forming a circular hole in the center of a circular glass plate, chamfering, lapping the main surface and mirror polishing the edge surface are sequentially carried out, and the main surface of the circular glass plate is polished.

In order to increase the recording capacity of a magnetic disk, it is necessary to expand the recording area, so that the main surface of the glass substrate for magnetic disks is desirably flat as far as possible

towards the outer circumference. Fig. 1 is a cross-sectional view schematically illustrating the vicinity of the edge surface of a glass substrate for magnetic disks after its main surface is polished. In the Figure, a is a chamfered surface, b is an outer circumferential edge surface, c is an outer peripheral portion of the main surface, and d is a boundary between the chamfered surface a and the outer peripheral portion c of the main surface. However, roll-off (sagging of edge surface) is formed continuously from the outer peripheral portion c of the main surface to the chamfered surface a, whereby the recording area is reduced.

Further, in Fig. 1, the straight line shown by a dot-line is a reference line g to define the degree of roll-off. Such a reference line g is set as a straight line to overlap a portion f which is a portion of the outer peripheral portion c of the main surface corresponding to from 2.5 mm to 5 mm towards the center of the main surface from the boundary d; or it is set as a straight line closest to such a portion f. A portion of the outer peripheral portion c of the main surface corresponding to from 0.25 mm to 5 mm towards the center of the main surface from the boundary d, is a roll-off measuring region e. Further, the degree of the roll-off is a difference between the highest and lowest heights from the reference line g of the outer peripheral portion c of the main surface in the roll-off measuring region e.

Accordingly, in order to increase the recording capacity, reduction of the roll-off is essential, and heretofore it has been attempted not only to improve the polishing apparatus, but also to improve the polishing fluid. For example, there has been known a polishing fluid containing water, abrasive grains such as silica powder, a surfactant made of a polyoxyethylene polyoxypropylene alkyl ether or polyoxyethylene polyoxypropylene copolymer, and an inorganic acid or organic acid (Patent Document 1); or a polishing fluid containing water, silica powder, an acid and a surfactant made of sulfonic acid or its salt, and having a pH of from 0 to 4 (Patent Document 2).

Patent Document 1: JP-A-2002-167575

Patent Document 2: JP-A-2007-63372

DISCLOSURE OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

When an acidic polishing fluid is used, a glass surface is softened, and polishing with abrasive grains is efficiently carried out, whereby the polishing rate will be improved. Further, it has an advantage such that there is less weak point. However, the surfactant added in the polishing fluid described in Patent Document 1 lowers dispersibility of silica in an acidic region, thereby to cause agglomeration.

On the other hand, the polishing fluid described in

Patent Document 2 contains a surfactant containing an aromatic ring, whereby even though it has an effect of reducing roll-off, the polishing rate is low, and it is not preferred from the viewpoint of production efficiency.

Therefore, the present invention has an object to reduce the roll-off without lowering the polishing rate in a polishing step of a main surface of a circular glass plate when producing a glass substrate for magnetic disks.

MEANS TO SOLVE THE PROBLEMS

In order to solve the above problems, the present invention provides a process for producing a glass substrate for magnetic disks, which comprises a step of polishing a main surface of a circular glass plate by using an acidic polishing fluid containing colloidal silica or fumed silica, and a water-soluble polymer having at least one member selected from a group consisting of a carboxylic acid group, a carboxylate group, a sulfonic acid group and a sulfonate group, bonded to its main chain; and a process for producing a glass substrate for magnetic disks, which comprises a step of polishing a main surface of a circular glass plate by using an acidic polishing fluid containing 100 parts by mass of colloidal silica or fumed silica, and from 0.02 to 0.1 part by mass of a surfactant having a

sulfonic acid group.

EFFECTS OF THE INVENTION

By the polishing fluid to be used in the present invention, it is possible to efficiently produce a glass substrate for magnetic disks having little roll-off, i.e. having a large recording area, whereby a higher recording capacity has been made available.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic view illustrating the vicinity of the outer peripheral portion of a circular glass substrate after its main surface is polished.

MEANINGS OF SYMBOLS

a: Chamfered surface

b: Outer circumferential edge surface

c: Outer peripheral portion of the main surface

d: Boundary between the chamfered surface a and the outer peripheral portion c of the main surface

e: Roll-off measuring region

g: Reference line to determine the degree of roll-off

BEST MODE FOR CARRYING OUT THE INVENTION

Now, the present invention will be described in further detail.

In the process for producing a glass substrate for magnetic disks of the present invention, a circular glass plate is treated by known steps until the polishing of the main surface.

For example, from silicate glass formed by a float process, a circular glass plate is cut out, and a circular hole is formed in its center, followed sequentially by chamfering, lapping of the main surface and mirror polishing of the edge surface.

Further, it is possible to divide the step of lapping the main surface into a step of rough lapping and a step of refined lapping and between them, provide a step of shape-processing (forming a hole in the center of the circular glass plate, chamfering and edge surface polishing). After the step of polishing the main surface, it is possible to provide a step of chemical strengthening. Further, in a case of producing a glass substrate having no circular hole in the center, obviously, it is unnecessary to form a hole in the center of the circular glass plate.

Then, polishing of the main surface is carried out. As the polishing fluid, the present invention uses an acidic first polishing fluid containing colloidal silica or fumed silica, and a water-soluble polymer having at least one member selected from a group consisting of a carboxylic acid group, a carboxylate group, a sulfonic acid group and a sulfonate group, bonded to its main

chain, or an acidic second polishing fluid containing 100 parts by mass of colloidal silica or fumed silica, and from 0.02 to 0.1 part by mass of a surfactant having a sulfonic acid group.

FIRST POLISHING FLUID

A water-soluble polymer having at least one member selected from a group consisting of a carboxylic acid group, a carboxylate group, a sulfonic acid group and a sulfonate group, bonded to its main chain, is a homopolymer or copolymer containing at least one type of polymerized units derived from a monomer having a carboxylic acid group or a sulfonic acid group, as a monomer component (monomer). A water-soluble polymer having a carboxylate group or a sulfonate group bonded to its main chain is obtained by neutralizing a water-soluble polymer having a carboxylic acid group or a sulfonic acid group bonded to its main chain, with an alkali, and it is one having a proton (H^+) of the carboxylic acid group or a proton of the sulfonic acid group substituted by another positive ion (counter ion). The counter ion which forms a carboxylate group or a sulfonate group may, for example, be an alkali ion such as Na ion or K ion, ammonium ion or an alkyl ammonium ion. Further, a carboxylic acid group or a sulfonic acid group, or their salts may be bonded to terminals of the main chain.

The monomer having a carboxylic acid group may, for

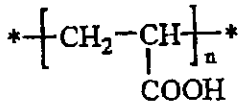
example, be acrylic acid, maleic acid, itaconic acid or methacrylic acid. The monomer having a sulfonic acid group may, for example, be 2-acrylamide-2-methylpropane sulfonic acid, isoprene sulfonic acid, methacryl sulfonic acid, vinyl sulfonic acid, styrene sulfonic acid or allyl sulfonic acid. Further, the sulfonic acid group may be bonded to the main chain via a group A such as a carbon chain (e.g. (6) in the following SULFONIC ACID TYPE POLYMERS).

The water-soluble polymer may be a copolymer further containing polymerized units derived from other monomers. Such other monomers may, for example, be an acrylate, maleate, itaconate, methacrylate, acrylamide, acrylonitrile, styrene, acetylene, butadiene, isobutylene, propylene, vinyl alcohol, vinyl chloride, ethylene, allyl alcohol or vinyl acetate.

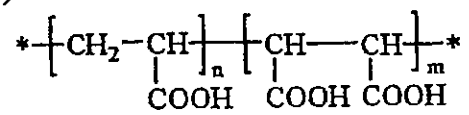
As the water-soluble polymer, it is possible to suitably exemplify carboxylic acid type polymers and sulfonic acid type polymers made of the following polymerized units derived from monomers.

CARBOXYLIC ACID TYPE POLYMERS:

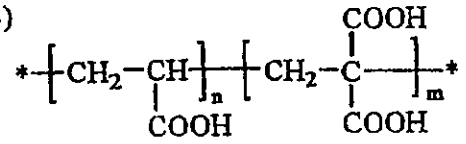
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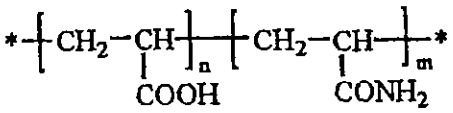
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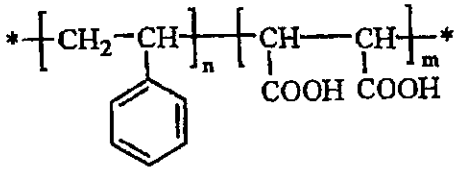
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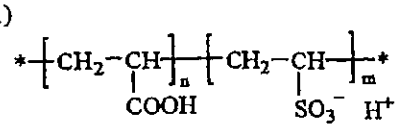


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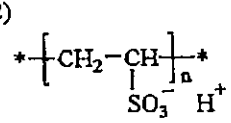


SULFONIC ACID TYPE POLYMERS:

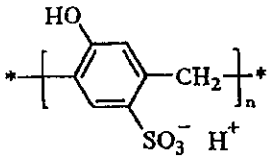
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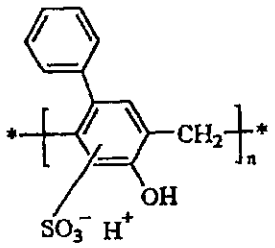
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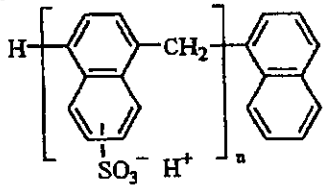
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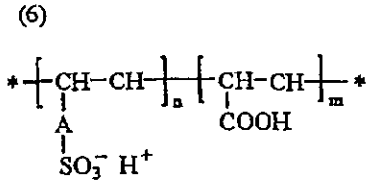
(4)



(5)



(6)



The water-soluble polymer preferably has a linear main chain. The linear polymer surrounds the colloidal silica or fumed silica and is adsorbed on its surface thus providing an effect to prevent agglomeration. Further, it is present as being spread over the glass surface as an object to be polished thereby to protect

the glass surface and to function so that convex portions are selectively polished, or to function like a lubricant whereby it is expected to provide an effect to reduce the frictional resistance of a polishing pad, glass or a carrier. Further, it is expected that it penetrates into a polishing pad (usually a urethane pad) to be used at the time of polishing to provide an effect like a plasticizer, and it is possible to adjust the viscosity of the polishing fluid or to impart thixotropic properties. Each of such functions will substantially contribute to reduction of the roll-off. Further, effects to suppress formation of scratches and to reduce deposits (contaminants) on the surface due to improvement of the cleaning properties, can be expected. Whereas, one having a crosslinked main chain is likely to be insolubilized and precipitated in the form of blocks under an acidic condition, thus providing little such effects.

From the viewpoint of the polishing rate, the water-soluble polymer is further preferably one which does not contain a sterically bulky structure such as a benzene ring ((3) or (4) in the above SULFONIC ACID TYPE POLYMERS), a naphthalene ring ((5) in the above SULFONIC ACID TYPE POLYMERS), a glucose or a cellulose in the linear main chain.

Further, the above effects due to the linear polymer tend to appear more distinctly as the molecular weight is

larger. Accordingly, the weight average molecular weight is preferably at least 5,300, more preferably at least 6,000. The upper limit of the weight average molecular weight is not particularly limited, but in view of the production efficiency, the upper limit is suitably 1,000,000.

The content of the water-soluble polymer in the polishing fluid is preferably from 0.001 to 10 parts by mass, more preferably from 0.01 to 5 parts by mass, per 100 parts by mass of the colloidal silica or fumed silica.

The colloidal silica may be obtained by a water glass method wherein an alkali metal silicate such as sodium silicate is used as a starting material, and it is subjected to a condensation reaction in an aqueous solution to grow particles, or an alkoxysilane method wherein an alkoxysilane such as tetraethoxysilane is used as a starting material, and it is subjected to a condensation reaction in water containing a water-soluble organic solvent such as an alcohol to grow particles.

The fumed silica may be obtained by a gas phase method wherein a volatile silicon compound such as silicon tetrachloride is used as a starting material, and it is subjected to hydrolysis at a high temperature of at least 1,000°C by means of an oxygen-hydrogen burner to grow particles.

Further, it is also possible to employ one having

such silica surface-modified or reformed with functional groups, or one composite-particulated with surfactant or other particles.

Among them, colloidal silica is preferred with a view to reducing scratches and surface roughness on the substrate surface. Such silicas may be used alone or in combination as a mixture of two or more of them.

The average particle size of primary particles of such silica, typically colloidal silica or fumed silica is preferably from 1 to 100 nm. The average particle size is more preferably from 1 to 80 nm, further preferably from 3 to 60 nm, particularly preferably from 5 to 40 nm, with a view to reducing scratches and with a view to reducing surface roughness (center line surface roughness: Ra).

Further, the content of the colloidal silica or fumed silica in the polishing fluid is typically from 5 to 40 mass%.

The polishing fluid is adjusted to be acidic by adding an acid. The acidity is not particularly limited. However, if the acidity is too high, the urethane pad tends to be deteriorated, and if the acidity is low, the glass surface tends to be hardly softened, and the polishing rate tends to be low.

Accordingly, the pH is preferably adjusted to be from 1 to 6, more preferably from 1 to 4. As the acid to be used, an inorganic acid such as nitric acid,

hydrochloric acid or sulfuric acid, or an organic acid may be used.

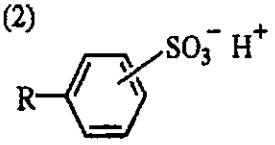
Further, to the polishing fluid, other components may be added, as the case requires. As such other components, those which are electrostatically non-chargeable (nonionic type) or electrostatically negatively chargeable (anionic type) are preferred from the viewpoint of cleaning properties. For example, an anionic polymer or a polyhydric alcohol (such as ethylene glycol, glycerol, sorbitol, mannitol or diglycerol) to prevent drying, an organic acid (such as gluconic acid, citric acid, malic acid, succinic acid, tartaric acid or acetic acid), a saccharide (such as trehalose, Finetose or pullulan) or a cellulose type polymer (such as hydroxyethyl cellulose, hydroxypropyl cellulose or carboxymethyl cellulose) for selective polishing by covering and protecting the glass surface, a phenyl group- or naphthalene group-containing polymer (such as a polystyrene sulfonic acid, a phenol sulfonic acid/formaline condensate or naphthalene sulfonic acid/formaline condensate), or an anionic surfactant (such as an alkyl sulfonic acid, an alkylbenzene sulfonic acid, an alkylnaphthalene sulfonic acid, an alkyldiphenylether disulfonic acid, an arylphenol sulfonic acid/formaldehyde condensate, or dibutylnaphthalene sulfonic acid) may, for example, be added in a suitable amount.

SECOND POLISHING FLUID

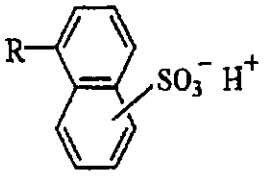
As the surfactant having a sulfonic acid group, the following may be exemplified. In these formulae, R is a C_{12-14} alkyl group.

(1) $R-SO_3^- H^+$

(2)



(3)



The content of the surfactant having a sulfonic acid group is from 0.02 to 0.1 part by mass, preferably from 0.03 to 0.1 part by mass, per 100 parts by mass of the colloidal silica or fumed silica. If the content is less than 0.02 part by mass, the effects to reduce the roll-off and to maintain the polishing rate tend to be inadequate, and if it exceeds 0.1 part by mass, the polishing rate tends to be substantially low.

The colloidal silica, fumed silica, other components and the acidity of the polishing fluid, as well as their preferred embodiments or typical embodiments, are the same as in the case of the first polishing fluid.

The method for polishing the main surface may be carried out in the same manner as a conventional one. For example, the circular glass plate is sandwiched between a pair of polishing pads, and polishing is carried out by rotating the polishing pads while supplying the above described polishing fluid to the interface between the polishing pads and the circular glass plate.

The polishing pads are typically those made of a urethane foam resin having a shore D hardness of from 45 to 75, a compressibility of from 0.1 to 10% and a density of from 0.5 to 1.5 g/cm^3, a urethane foam resin having a shore A hardness of from 30 to 99, a compressibility of from 0.5 to 10% and a density of from 0.2 to 0.9 g/cm^3 or a urethane foam resin having a shore A hardness of from 5 to 65, a compressibility of from 0.1 to 60% and a density of from 0.05 to 0.4 g/cm^3. Here, the shore A hardness of the polishing pads is preferably at least 20. If it is less than 20, the polishing rate tends to be low.

Here, the shore D hardness and the shore A hardness are measured by methods for measuring durometer A hardness and D hardness of plastics as stipulated in JIS K7215, respectively. Further, the compressibility (unit: %) is measured as follows. Namely, with respect to a test specimen cut out from a polishing pad in a proper size, the thickness t_0 of the material when pressed under a load with a stress of 10 kPa for 30 seconds from a non-loaded state by means of a shopper type thickness meter, is obtained, then the thickness t_1 of the material when pressed under a load with a stress of 110 kPa for 5 minutes immediately from the state where the thickness is t_0, is obtained, and from the values of t_0 and t_1, $(t_0-t_1)\times100/t_0$ is calculated, and the obtained value is taken as the compressibility.

The polishing pressure is preferably at least 4 kPa.

If it is less than 4 kPa, the stability of the glass substrate during the polishing tends to be low, the substrate tends to flip-flop, and as a result, waving of the main surface is likely to increase.

The polishing degree of the main surface is properly from 0.3 to 1.5 μm and is adjusted by the supply amount of the polishing fluid, the polishing time, the silica concentration in the polishing fluid, the polishing pressure, the rotational speed, etc.

Further, prior to the above polishing of the main surface, the main surface may preliminarily be polished. Such preliminary polishing of the main surface may be carried out, for example, by sandwiching the circular glass plate between polishing pads and rotating the polishing pads while supplying a cerium oxide abrasive grain slurry.

And, after the above polishing of the main surface, cleaning and drying are carried out to obtain a glass plate for magnetic disks. The cleaning and drying are carried out by known methods. For example, immersion in an acidic cleanser solution, immersion in an alkaline cleanser solution, scrub cleaning with Bellclean and an alkali cleanser, immersion in an alkaline cleanser solution, scrub cleaning with Bellclean and an alkali cleanser, ultrasonic cleaning in a state as immersed in an alkali cleanser solution, ultrasonic cleaning in a state as immersed in pure water, and ultrasonic cleaning

in a state as immersed in pure water, are sequentially carried out, followed by drying by a method such as spin drying or isopropyl alcohol vapor drying.

EXAMPLES

Now, the present invention will be described in further detail with reference to Examples and Comparative Examples, but it should be understood that the present invention is by no means thereby restricted.

TEST 1: With respect to first polishing fluid

PREPARATION OF TEST SPECIMEN

A silicate glass plate formed by a float process was processed into a doughnut-shaped circular glass plate (a circular glass plate having a circular hole in the center) so that a glass substrate having an outer diameter of 65 mm, an inner diameter of 20 mm and a thickness of 0.635 mm can thereby be obtainable. Here, grinding processing of the inner circumference surface and the outer circumference surface was carried out by means of a diamond grind stone, and lapping of the upper and lower surfaces of the glass plate was carried out by means of aluminum oxide abrasive grains.

Then, the inner and outer circumference edge surfaces were chamfered with a width of chamfer of 0.15 mm and an angle of chamfer of 45°. After such inner and outer circumferential processing, the edge surfaces were mirror-finished by brush polishing by using a cerium

oxide slurry as a polishing agent and a brush as a polishing tool. The processed degree was 30 μm by the degree of removal in radial direction.

Then, polishing processing of the upper and lower main surfaces was carried out by means of a both side polishing apparatus by using a cerium oxide slurry (average particle size of cerium oxide: about 1.1 μm) as a polishing agent and urethane pads as a polishing tool. The processed degree was a total of 35 μm in thickness direction of the upper and lower main surfaces.

Further, polishing processing of the upper and lower main surfaces was carried out by means of a both side polishing apparatus by using cerium oxide (average particle size: about 0.2 μm) having a smaller average particle size than the above cerium oxide, as a polishing agent, and urethane pads as a polishing tool. The processed degree was a total of 1.6 μm in thickness direction of the upper and lower surfaces. Further, the main surfaces of the circular glass plate thus prepared were measured by using AFM manufactured by Veeco, whereby the surface roughness Ra was 0.48 nm.

PREPARATION OF POLISHING FLUIDS

The compositions of polishing fluids are shown in Table 1. For each Example, a polishing fluid is prepared which comprises a colloidal silica slurry (average particle size of primary particles: 20 to 30 nm, silica particle concentration: 48 mass%), the identified

additive (sulfonic acid type polymer or carboxylic acid type polymer), nitric acid and pure water. The colloidal silica concentration was 15 mass%, and the amount of sulfonic acid type polymer or carboxylic type polymer was identified by an amount to the amount of colloidal silica. Further, the pH of the polishing fluid was 2. In the Table, sulfonic acid type copolymer "A-6021" is manufactured by Toagosei Co., Ltd. and has a weight average molecular weight of 100,000, and sulfonic acid type copolymer "A-6020" is manufactured by Toagosei Co., Ltd. and has a weight average molecular weight of 10,000. Further, ammonium salt of carboxylic acid type copolymer "poise 2100" is manufactured by Kao Corporation and has a weight average molecular weight of 35,000, and ammonium salt of carboxylic acid type copolymer "A-30L" is manufactured by Toagosei Co., Ltd. and has a weight average molecular weight of 6,000, and carboxylic acid type copolymer "A-10LS" is manufactured by Toagosei Co., Ltd. and has a weight average molecular weight of 6,000.

Further, for each Comparative Example, a polishing fluid was prepared which comprises a colloidal silica slurry (average particle size of primary particles: 20 to 30 nm, silica particle concentration: 48 mass%), the identified additive, nitric acid and pure water. Here, the colloidal silica concentration, the definition of the amount of the additive and the pH are the same as in the case of the polishing fluid for each Example. Further,

with respect to Comparative Examples 1 and 2, no additive was added, i.e. the polishing fluid was one comprising a colloidal silica slurry, nitric acid and pure water. In the Table, sulfonic acid type copolymer "A-6016A" is manufactured by Toagosei Co., Ltd. and has a weight average molecular weight of 2,000. Further, naphthalene sulfonic acid/formaldehyde condensate is a synthetic product with a condensation degree of 2 to 3.

With respect to each polishing fluid, the slurry viscosity was measured at 25°C by means of TOKI RESOL manufactured by TOKI SANGYO CO. LTD. Further, the surface tension was measured at room temperature by means of CBVP-Z manufactured by Kyowa Interface Science Co., Ltd.

POLISHING OF MAIN SURFACES

The main surfaces of the above test specimen were polished by using the above polishing fluid and polishing pads for finishing, made of a urethane foam resin, as a polishing tool. As the polishing machine, 9B model both side polishing machine manufactured by Speedfam Co., Ltd. was used, and polishing was carried out for 25 minutes under a polishing pressure of 8 kPa at a carrier circumferential velocity of 40 m/min at a polishing fluid-supplying rate of 40 ml/min (Examples 1 to 8, Comparative Examples 1 and 3 to 14), or for 15 minutes under a polishing pressure of 12 kPa at a carrier circumferential velocity of 40 m/min at a polishing

fluid-supplying rate of 60 ml/min (Example 9 and Comparative Example 2). Then, the test specimen after polishing was subjected to immersion in an acidic cleanser solution, immersion in an alkaline cleanser solution, scrub cleaning with Bellclean and an alkali cleanser, immersion in an alkaline cleanser solution, scrub cleaning with Bellclean and an alkali cleanser, ultrasonic wave cleaning in a state as immersed in an alkaline cleanser solution, ultrasonic wave cleaning in a state as immersed in pure water and ultrasonic wave cleaning in a state as immersed in pure water sequentially, followed by spin drying. Here, every time when the polishing fluid was changed, the polishing pads were subjected to brush cleaning for 3 minutes while supplying pure water.

And, the following evaluation of properties was carried out. The measured results are also shown in Table 1. With respect to Examples 1 to 8 and Comparative Examples 3 to 14, the results are shown by relative values to Comparative Example 1, and with respect to Example 9, the results are shown by relative values to Comparative Example 2.

With respect to Examples 1 to 8 and Comparative Examples 3 to 14, prior to the measurements, the reference values were obtained by measuring the property values by using the polishing fluid of Comparative Example 1, and with respect to Example 9, the reference

values were obtained by measuring the property values by using the polishing fluid of Comparative Example 2, and the respective measured values were compared with the preliminarily obtained reference values.

EVALUATION OF PROPERTIES

(1) Polishing rate

The polishing rate was obtained from the weight change as between before and after the polishing, and the polishing area of 30.02 (cm^2) and the specific gravity of the polishing substrate of 2.77 (g/cm^3). The polishing rate of Comparative Example 1 was from 0.020 to 0.030 (μm/min), and the polishing rate of Comparative Example 2 was from 0.035 to 0.045 (μm/min). The results are shown in Table 1, wherein the numerical value being larger than 1 means that the polishing rate is higher than Comparative Example 1 or 2, and the numerical value being smaller than 1 means that the polishing rate is lower than Comparative Example 1 or 2. Such a relative polishing rate being at least 0.7 is a practically acceptable level.

(2) Roll-off

The roll-off value was measured by using NV5000 manufactured by Zygo. The measurements were carried out in such a manner that the measurement of the substrate edge surface (the roll-off measurement) was carried out at the same portion before and after the polishing to measure the roll-off change (the sagging degree of the

edge surface) as between before and after the polishing. The results are shown in Table 1, wherein the smaller the numerical value, the smaller the edge surface sagging and the better. Such a relative roll-off being less than 0.9 is an acceptable level.

(3) Surface roughness

The surface roughness Ra was measured by using AFM manufactured by Veeco. The results are shown in Table 1, wherein the numerical value being larger than 1 means that the surface roughness is deteriorated as compared with Comparative Example 1 or 2, and the numerical value being smaller than 1 means that the surface roughness is improved as compared with Comparative Example 1 or 2, and the smaller the numerical value, the less the surface roughness, such being desirable.

(4) Dispersibility

A polishing fluid before the polishing and the polishing fluid after the polishing were recovered, and the D50 value and the distribution width sd were measured by using a particle size distribution measuring machine (MICROTRAC) manufactured by NIKKISO CO., LTD. A case where they are lower than the measured values of D50 and distribution width sd of Comparative Example 1 or 2 was rated to be "◎", a case where they were substantially the same as such the measured value was rated to be "○", and a case where they were higher, was rated to be "×". The smaller the D50 value and the distribution width sd

of the slurry recovered after the polishing, the less the agglomeration of the slurry during the polishing, and the higher the effect to suppress agglomeration of the slurry (the effects to stabilize the slurry) of the additive.

TABLE 1

	Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ex. 5
Polishing conditions					
Pressure (kPa)	8	8	8	8	8
Circumferential speed of carrier	40	40	40	40	40
Polishing composition-supplying rate (ml/min)	40	40	40	40	40
Time (min)	25	25	25	25	25
Additive					
Type	*1 (A-6021)	*1 (A-6021)	*2 (poise 2100)	*2 (poise 2100)	*3 (A-30L)
Weight average molecular weight	100000	100000	35000	35000	6000
Amount to silica (mass%)	0.25	0.5	0.5	1	0.5
Polishing fluid characteristics					
Particle size distribution D50 (nm)	27	27	27	27	27
Particle size distribution sd (distribution width) (nm)	5	5	6	7	6
Viscosity (cP) @25°C/100 rpm	1.3	1.3	1.3	1.3	1.2
Surface tension (mN/m) @25°C	72	72	70	70	65
Dispersibility	◎	◎	○	○	◎
Evaluation of properties					
Polishing rate (relative ratio)	1.0	1.0	0.9	0.8	0.8
Roll-off (relative ratio)	0.7	0.7	0.8	0.7	0.8
Surface roughness Ra (relative ratio)	1.0	1.0	0.9	0.9	0.9

*1: Sulfonic acid type copolymer
*2: Ammonium salt of carboxylic acid type copolymer
*3: Carboxylic acid type copolymer

TABLE 1 (Continued)

	Ex. 6	Ex. 7	Ex. 8	Ex. 9
Polishing conditions				
Pressure (kPa)	8	8	8	12
Circumferential speed of carrier	40	40	40	40
Polishing composition-supplying rate (ml/min)	40	40	40	60
Time (min)	25	25	25	15
Additive				
Type	*3 (A-30L)	*3 (A-10SL)	*3 (A-10SL)	*1 (A-6020)
Weight average molecular weight	6000	6000	6000	10000
Amount to silica (mass%)	1	0.25	0.5	0.5
Polishing fluid characteristics				
Particle size distribution D50 (nm)	27	27	27	27
Particle size distribution sd (distribution width) (nm)	6	6	6	7
Viscosity (cP) @25°C/100 rpm	1.2	1.3	1.3	1.2
Surface tension (mN/m) @25°C	63	68	68	68
Dispersibility	◎	◎	◎	◎
Evaluation of properties				
Polishing rate (relative ratio)	0.9	0.9	0.8	0.7
Roll-off (relative ratio)	0.8	0.6	0.8	0.7
Surface roughness Ra (relative ratio)	0.9	1.0	1.0	0.8

*1: Sulfonic acid type copolymer
*3: Carboxylic acid type copolymer

TABLE 1 (Continued)

	Comp. Ex. 1	Comp. Ex. 2	Comp. Ex. 3	Comp. Ex. 4
Polishing conditions				
Pressure (kPa)	8	12	8	8
Circumferential speed of carrier	40	40	40	40
Polishing composition-supplying rate (ml/min)	40	60	40	40
Time (min)	25	15	25	25
Additive				
Type	Nil	Nil	*1 (A-6016A)	*1 (A-6016A)
Weight average molecular weight	-	-	2000	2000
Amount to silica (mass%)	-	-	0.25	1
Polishing fluid characteristics				
Particle size distribution D50 (nm)	27	27	27	27
Particle size distribution sd (distribution width) (nm)	7	7	7	8
Viscosity (cP) @25°C/100 rpm	1.3	1.3	1.2	1.2
Surface tension (mN/m) @25°C	73	73	63	60
Dispersibility	-	-	◎	◎
Evaluation of properties				
Polishing rate (relative ratio)	1	1	0.7	0.8
Roll-off (relative ratio)	1	1	1.1	1.3
Surface roughness Ra (relative ratio)	1	1	1.0	0.8

*1: Sulfonic acid type copolymer

TABLE 1 (Continued)

	Comp. Ex. 5	Comp. Ex. 6	Comp. Ex. 7	Comp. Ex. 8
Polishing conditions				
Pressure (kPa)	8	8	8	8
Circumferential speed of carrier	40	40	40	40
Polishing composition-supplying rate (ml/min)	40	40	40	40
Time (min)	25	25	25	25
Additive				
Type	*4	*4	*5	*5
Weight average molecular weight	n=2-3	n=2-3	-	-
Amount to silica (mass%)	0.1	0.25	0.25	0.5
Polishing fluid characteristics				
Particle size distribution D50 (nm)	27	27	27	27
Particle size distribution sd (distribution width) (nm)	6	6	6	6
Viscosity (cP) @25°C/100 rpm	1.3	1.3	1.3	1.3
Surface tension (mN/m) @25°C	72	72	72	72
Dispersibility	◎	◎	◎	◎
Evaluation of properties				
Polishing rate (relative ratio)	0.5	0.5	0.8	0.6
Roll-off (relative ratio)	0.8	0.9	1.0	1.0
Surface roughness Ra (relative ratio)	0.8	0.8	1.01	1.095

*4: Naphthalene sulfonic acid/formaldehyde condensate
*5: Trehalose

TABLE 1 (Continued)

	Comp. Ex. 9	Comp. Ex. 10	Comp. Ex. 11	Comp. Ex. 12	Comp. Ex. 13	Comp. Ex. 14
Polishing conditions						
Pressure (kPa)	8	8	8	8	8	8
Circumferential speed of carrier	40	40	40	40	40	40
Polishing composition-supplying rate (ml/min)	40	40	40	40	40	40
Time (min)	25	25	25	25	25	25
Additive						
Type	*6	*6	*7	*7	*8	*8
Weight average molecular weight	-	-	-	-	-	-
Amount to silica (mass%)	1	5	1	5	1	5
Polishing fluid characteristics						
Particle size distribution D50 (nm)	27	28	28	28	28	28
Particle size distribution sd (distribution width) (nm)	5	7	5	6	6	6
Viscosity (cP) @25°C/100 rpm	1.3	1.5	1.3	1.3	1.3	1.3
Surface tension (mN/m) @25°C	73	73	73	73	73	73
Dispersibility	○	○	○	○	○	○
Evaluation of properties						
Polishing rate (relative ratio)	1.1	0.8	0.9	1.1	1.0	0.8
Roll-off (relative ratio)	1.0	1.0	1.2	1.2	0.9	1.2
Surface roughness Ra (relative ratio)	0.9	1.0	1.0	0.9	1.0	1.0

*6: Ethylene glycol
*7: Glycerol
*8: Sorbitol

As shown in Table 1, by using an acidic polishing fluid having a carboxylic acid type polymer or a sulfonic acid type polymer added in accordance with the present invention, it is possible to reduce the roll-off while suppressing a decrease of the polishing rate. Further, the surface state is good, and the dispersibility of colloidal silica is excellent.

TEST 2: WITH RESPECT SECOND POLISHING FLUID

PREPARATION OF POLISHING FLUIDS

As shown in Table 2, a polishing fluid was prepared which comprises a colloidal silica slurry (average particle size of primary particles: 20 to 30 nm, silica particle concentration: 48 mass%), the identified additive (sulfonic acid type surfactant), nitric acid and pure water. The colloidal silica concentration was 15 mass%, and the amount of the sulfonic acid type surfactant was identified by an amount to the amount of the colloidal silica. Further, the pH of the polishing fluid was 2. In the Table, alkylsulfonic acid "LATEMUL PS" is manufactured by Kao Corporation, alkylbenzene sulfonic acid "LH200" is manufactured by Lion Corporation, alkylbenzene sulfonic acid "LH250" is manufactured by Lion Corporation, and alkylbenzene sulfonic acid "LH900" is manufactured by Lion Corporation.

POLISHING OF MAIN SURFACES AND EVALUATION OF PROPERTIES

In the same manner as in Test 1, the main surfaces

were polished, and the same evaluation of properties was carried out. The results are also shown in Table 2, and they are shown by relative values to Comparative Example 1.

TABLE 2

	Ex. 10	Ex. 11	Comp. Ex. 15	Comp. Ex. 16
Polishing conditions				
Pressure (kPa)	8	8	8	8
Circumferential speed of carrier	40	40	40	40
Polishing composition-supplying rate (ml/min)	40	40	40	40
Time (min)	25	25	25	25
Additive				
Type	*9	*9	*9	*10 (LH200)
Amount to silica (mass%)	0.05	0.1	0.25	0.25
Polishing fluid characteristics				
Particle size distribution D50 (nm)	27.3	26.9	27.2	27.6
Particle size distribution sd (distribution width) (nm)	6	5.5	5.6	5.6
Viscosity (cP) @25°C/100 rpm	1.3	1.3	1.3	1.2
Surface tension (mN/m) @25°C	29	28	27	29
Dispersibility	◎	◎	◎	○
Evaluation of properties				
Polishing rate (relative ratio)	0.7	0.7	0.5	0.5
Roll-off (relative ratio)	0.8	0.8	0.9	0.7
Surface roughness Ra (relative ratio)	1.0	0.8	0.8	1.1

*9: Alkyl sulfonic acid (LATEMUL PS)
*10: Alkylbenzene sulfonic acid

TABLE 2 (Continued

	Comp. Ex. 17	Ex. 12	Comp. Ex. 18	Comp. Ex. 19
Polishing conditions				
Pressure (kPa)	8	8	8	8
Circumferential speed of carrier	40	40	40	40
Polishing composition-supplying rate (ml/min)	40	40	40	40
Time (min)	25	25	25	25
Additive				
Type	*10 (LH200)	*10 (LH250)	*10 (LH250)	*10 (LH900)
Amount to silica (mass%)	0.5	0.05	0.25	0.01
Polishing fluid characteristics				
Particle size distribution D50 (nm)	26.7	26.9	26.9	26.8
Particle size distribution sd (distribution width) (nm)	6.5	6.2	6.7	5.3
Viscosity (cP) @25°C/100 rpm	1.3	1.2	1.4	1.34
Surface tension (mN/m) @25°C	28	29.8	28.5	45.6
Dispersibility	○	◎	○	○
Evaluation of properties				
Polishing rate (relative ratio)	0.2	0.7	0.6	0.9
Roll-off (relative ratio)	0.6	0.8	0.7	1.0
Surface roughness Ra (relative ratio)	1.1	0.9	1.0	1.1

*10: Alkylbenzene sulfonic acid

As shown in Table 2, by using a polishing fluid containing a surfactant having a sulfonic acid group in a specific amount, it is possible to reduce the roll-off while suppressing a decrease in the polishing rate. Further, the surface state is good, and the dispersibility of colloidal silica is excellent.

INDUSTRIAL APPLICABILITY

The process for producing a glass substrate for magnetic disks of the present invention, is useful since it is thereby possible to efficiently produce a glass substrate for magnetic disks having a wide recording area to make a high recording capacity possible.

The entire disclosure of Japanese Patent Application No. 2007-216839 filed on August 23, 2007 including specification, claims, drawings and summary is incorporated herein by reference in its entirety.

CLAIMS

1. A process for producing a glass substrate for magnetic disks, which comprises a step of polishing a main surface of a circular glass plate by using an acidic polishing fluid containing colloidal silica or fumed silica, and a water-soluble polymer having at least one member selected from a group consisting of a carboxylic acid group, a carboxylate group, a sulfonic acid group and a sulfonate group, bonded to its main chain.

2. The process for producing a glass substrate for magnetic disks according to Claim 1, wherein in the water-soluble polymer, its main chain is linear.

3. The process for producing a glass substrate for magnetic disks according to Claim 1 or 2, wherein the weight average molecular weight of the water-soluble polymer is at least 5,300.

4. The process for producing a glass substrate for magnetic disks according to any one of Claims 1 to 3, wherein the weight average molecular weight of the water-soluble polymer is at least 6,000.

5. The process for producing a glass substrate for magnetic disks according to any one of Claims 1 to 4, wherein the content of the water-soluble polymer in the polishing fluid is from 0.001 to 10 parts by mass per 100 parts by mass of the colloidal silica or fumed silica.

6. A process for producing a glass substrate for magnetic disks, which comprises a step of polishing a

main surface of a circular glass plate by using an acidic polishing fluid containing 100 parts by mass of colloidal silica or fumed silica, and from 0.02 to 0.1 part by mass of a surfactant having a sulfonic acid group.

7. The process for producing a glass substrate for magnetic disks according to Claim 6, wherein the surfactant having a sulfonic acid group is an alkyl sulfonic acid, an alkylbenzene sulfonic acid or an alkylnaphthalene sulfonic acid.

8. The process for producing a glass substrate for magnetic disks according to any one of Claims 1 to 7, wherein the content of colloidal silica or fumed silica in the above polishing fluid is from 5 to 40 mass%.

9. The process for producing a glass substrate for magnetic disks according to any one of Claims 1 to 8, wherein the average particle size of primary particles of the colloidal silica or fumed silica is from 1 to 100 nm.