

DESCRIPTION

[Title of Invention]

METHOD FOR MANUFACTURING GLASS SUBSTRATE FOR
5 INFORMATION RECORDING MEDIUM

[Technical Field]

[0001] The present invention relates to a method for manufacturing a glass substrate for an information recording medium.

10 [Background Art]

[0002] Conventionally, an aluminum substrate or a glass substrate has been used in an information recording medium (magnetic-disk information medium) to be used in a computer or the like. A magnetic thin film layer is formed on the substrate and magnetized with a magnetic head, and thus information is
15 recorded in the magnetic thin film layer.

[0003] In recent years, recording density has been increasingly improved in hard disk drive (HDD) devices. Due to the improvement of recording density, a gap (flying height) between an information recording medium (medium) and a head that reads/writes records while flying above the information recording
20 medium has decreased to about several nanometers.

[0004] As the flying height decreases, problems such as a read error and/or a write error when accessing data recorded in a medium, and a head crash in which the magnetic head collides with the surface of a medium in the case where an information recording medium is used in a hard disk drive device are
25 more likely to occur.

[0005] Therefore, significantly high cleanliness is required of glass substrates for an information recording medium, and reliably removing polishing agent, foreign matter, or the like has been dealt with by, for example, performing scrub cleaning after bringing the attached matter into contact with a liquid
30 after a polishing step in order to make the attached matter easier to remove.

[Citation List]

[Patent Literature]

[0006] [PLT1]: Japanese Patent No. 4623210

[Summary of Invention]

5 [Technical Problem]

[0007] However, with a next-generation glass substrate for an information recording medium capable of achieving a surface recording density of equal to or greater than 630 Gbit/inch², there was a problem in that the electromagnetic conversion characteristics (SNR) decreased and reading accuracy is reduced in the case where a magnetic thin film layer was formed thereon to provide an information recording medium, despite the glass substrate itself having no problems in terms of smoothness and cleanliness.

[0008] As a result of a close investigation of such problems, it was found that in a process that is performed by medium manufacturers for the purpose of further improving cleanliness in which the glass substrate for an information recording medium is cleaned with an alkaline solution to remove every last particle on the substrate before forming the magnetic film, a slight amount of a glass component was eluted and changed the surface state, and the conditions under which the magnetic thin film layer was subsequently formed by sputtering or the like thereby varied, causing the above-described problems.

[0009] The present invention was achieved in light of the aforementioned problems, and it is an object thereof to provide a method for manufacturing a glass substrate for an information recording medium that can suppress changes in the surface state even when the glass substrate for an information recording medium is cleaned with an alkaline solution in order to improve cleanliness before forming a magnetic film.

[Solution to Problem]

[0010] A method for manufacturing a glass substrate for an information recording medium according to the present invention is a method for manufacturing a glass substrate for an information recording medium to be

used in an information recording medium in which a magnetic thin film layer is formed on a main surface of the glass substrate and in which a recording density of a magnetic recording surface is equal to or greater than 630 Gbit per square inch. The method for manufacturing a glass substrate for an information recording medium includes a precision polishing step of performing precision polishing on a main surface of a glass member using an acidic polishing liquid at pH 4 or less that contains colloidal silica, a first immersing step of performing immersion in a solution for 5 minutes or more after the precision polishing step, and an ultrasonic cleaning step of performing ultrasonic cleaning on the glass member after the first immersing step. The glass member subjected to the precision polishing in the precision polishing step has a surface roughness Ra of 3.0 Å or less in a measurement area of 1 μm². The pH of the solution used in the first immersing step is 6.5 or more to 8.5 or less.

[0011] It is preferable that the method for manufacturing a glass substrate for an information recording medium further includes a second immersing step of immersing the glass member in a solution at pH 6.5 or more to 8.5 or less for 5 minutes or more after the ultrasonic cleaning step. It is preferable that the method for manufacturing a glass substrate for an information recording medium further includes a scrub cleaning step of performing scrub cleaning on the glass member after the ultrasonic cleaning step, and a third immersing step of performing immersion in a solution at pH 6.5 or more to 8.5 or less for 5 minutes or more after the scrub cleaning step.

[0012] It is preferable that the method for manufacturing a glass substrate for an information recording medium further includes a step of adding an adjusting agent to the solution such that the pH of the solution is adjusted to 6.5 or more to 8.5 or less when the pH falls below 6.5. It is preferable that the pH of the solution used in the first immersing step is 7 or more to 8 or less. It is preferable that the immersion time in the first immersing step is 120 minutes or less.

[Advantageous Effects of the Invention]

[0013] With a method for manufacturing a glass substrate for an information recording medium according to the present invention, it is possible to manufacture a glass substrate for an information recording medium that can suppress changes in the surface state even when the glass substrate for an information recording medium is cleaned with an alkaline solution in order to improve cleanliness before forming a magnetic film.

[Brief Description of Drawings]

[0014] FIG. 1 is a perspective view of a glass substrate for an information recording medium 1G.

FIG. 2 is a perspective view of an information recording medium.

FIG. 3 is a flowchart illustrating a method for manufacturing the glass substrate 1G and an information recording medium 1.

[Description of Embodiments]

[0015] Hereinafter, an embodiment and examples of the present invention will be described. Identical or equivalent parts are denoted by identical reference numerals and descriptions thereof may be omitted. When numbers, amounts, and so on are referred to in the following embodiment and examples, the scope of the present invention is not necessarily limited to those numbers, amounts, and so on, unless explicitly mentioned otherwise. Each component of the following embodiment is not necessarily essential for the present invention unless explicitly mentioned otherwise.

(Configuration of information recording medium 1)

Configurations of a glass substrate for an information recording medium 1G and an information recording medium 1 will be described with reference to FIGS. 1 and 2. FIG. 1 is a perspective view of the glass substrate for an information recording medium 1G, and FIG. 2 is a perspective view of the information recording medium.

[0016] As shown in FIG. 1, the glass substrate for an information recording medium 1G (referred to as "glass substrate 1G" hereinafter) to be used in the

information recording medium 1 has an annular disk shape in which a hole 11 is formed in the center. The glass substrate 1G has an outer circumferential end surface 12, an inner circumferential end surface 13, a front main surface 14, and a back main surface 15. The glass substrate 1G is made of amorphous glass or the like and has an outer diameter of about 65 mm, an inner diameter of about 20 mm, a thickness of about 0.8 mm, and a surface roughness of about 2.0 Å or less, for example.

[0017] The inch size of the glass substrate 1G is not particularly limited, and various glass substrates 1G including 0.8-inch, 1.0-inch, 1.8-inch, 2.5-inch, and 3.5-inch glass substrates may be manufactured as a disk for an information recording medium.

[0018] The thickness of the glass substrate 1G is preferably 0.30 to 2.2 mm because it is effective against breakage of the glass substrate 1G due to drop impact. The thickness of the glass substrate 1G here means an average value of the values measured at several arbitrary points on the substrate that have point symmetry.

[0019] As shown in FIG. 2, in the information recording medium 1, a magnetic thin film layer 23 is formed on the above-described front main surface 14 of the glass substrate 1G. In the diagram, the magnetic thin film layer 23 is formed on only the front main surface 14, but it is also possible to form a magnetic thin film layer 23 on the back main surface 15.

[0020] Conventionally known methods can be used as a method for forming the magnetic thin film layer 23. Examples thereof include a formation method that involves spin-coating a thermosetting resin in which magnetic particles are dispersed on the glass substrate 1G, a formation method that uses sputtering, and a formation method that uses electroless plating.

[0021] The thickness of the film obtained by the spin coat method is about 0.3 to 1.2 μm, the thickness of the film obtained by the sputtering method is about 0.04 to 0.08 μm, and the thickness of the film obtained by the electroless plating method is about 0.05 to 0.1 μm. From the viewpoint of making the film

thinner and denser, it is preferable to form the film by the sputtering method or the electroless plating method.

[0022] The magnetic materials used for the magnetic thin film layer 23 are not particularly limited, and conventionally known materials can be used. In order to provide high adhesion strength, it is preferable to use a Co-based alloy that contains Co, which has high crystal anisotropy, as a main component and to which Ni and Cr are added to adjust the residual magnetic flux density, and the like. In recent years, FePt-based materials have been used as materials for a magnetic layer that are preferable for thermally assisted recording.

[0023] In order to allow the magnetic head to slide smoothly, the surface of the magnetic thin film layer 23 may be thinly coated with a lubricant. One example of the lubricant is a lubricant obtained by diluting perfluoropolyether (PFPE), which is a liquid lubricant, with a Freon-based solvent or the like.

[0024] A base layer and a protecting layer may be provided as needed. The base layer in the information recording medium 1 is selected according to the magnetic film. For example, at least one selected from non-magnetic metals such as Cr, Mo, Ta, Ti, W, V, B, Al, and Ni can be used as a material for the base layer.

[0025] The base layer is not limited to a single layer, and may have a multilayer structure in which the same type or different types of layers are laminated. For example, the base layer may be a multilayer base layer made of Cr/Cr, Cr/CrMo, Cr/CrV, NiAl/Cr, NiAl/CrMo, NiAl/CrV, or the like.

[0026] Examples of the protecting layer for preventing wear and corrosion of the magnetic thin film layer 23 include a Cr layer, a Cr alloy layer, a carbon layer, a hydrogenated carbon layer, a zirconia layer, and a silica layer. Similarly to the base layer, the magnetic film, and the like, the protecting layer can be continuously formed using an inline-type sputtering device. The protecting layer may be a single layer or have a multilayer configuration constituted by the same type or different types of layers.

[0027] Another protecting layer may be formed on the above protecting layer

or instead of the above protecting layer. For example, instead of the above protecting layer, a silicon oxide (SiO_2) layer may be formed by applying a solution obtained by diluting tetraalkoxysilane with an alcohol-based solvent and dispersing colloidal silica microparticles therein on a Cr layer, and by firing the Cr layer.

[0028] As described above, a glass substrate 1G for an information recording medium is packed and sealed in a packing material after being manufactured. Then, after being distributed, the glass substrate is taken out from the packing material and is provided with a magnetic thin film layer 23 and the like. In order to remove minute particles that have attached thereto during packing and transportation and to eliminate the nonuniformity of the surface state due to the difference in conditions, the glass substrate is cleaned with an alkaline solution or the like just before the magnetic thin film layer 23 and the like are provided.

[0029] Even when such alkali treatment is performed, it is possible to sufficiently suppress a reduction in the signal-to-noise ratio (S/N ratio) in the case of a glass substrate for an information recording medium with respect to which the average value of the SiOH/Si values of the main surfaces 14 and 15 of the glass substrate after being subjected to alkali treatment in which the glass substrate for an information recording medium is immersed in a sodium hydroxide solution at pH 11 at 40°C for 30 minutes is 0.20 or more to 0.50 or less, even when the glass substrate is used in an information recording medium in which the magnetic recording surface has a very high recording density of equal to or greater than 630 Gbit per square inch, for example.

[0030] Next, a method for manufacturing a glass substrate will be described that can suppress a decrease in the S/N ratio even if the alkali treatment is performed before forming a magnetic thin film layer.

[0031] (Steps of manufacturing glass substrate 1G)

Next, a method for manufacturing the glass substrate 1G and the information recording medium 1 according to this embodiment will be

described with reference to FIG. 3. FIG. 3 is a flowchart illustrating a method for manufacturing the glass substrate 1G and the information recording medium 1.

[0032] First, in "a glass melting step" of step 10 (abbreviated as "S10" hereinafter; the same applies to step 11 onward), a glass material constituting a glass substrate was melted.

[0033] In "a press molding step" of S11, a glass substrate was manufactured by pressing the molten glass material using an upper mold and a lower mold. The glass used had the same composition as that of common aluminosilicate glass. The method for manufacturing a glass substrate is not limited to molding, and cutting out from plate glass, which is a known method, or the like may be performed. Also, the glass composition is not limited to the above composition.

[0034] In "a first lapping step (first grinding step)" of S12, two main surfaces of the glass substrate was lapped. This first lapping step was performed using a double-side lapping device utilizing a planetary gear mechanism. Specifically, lapping was performed by pressing lapping surface plates onto the two surfaces of the glass substrate from the upper and lower sides, supplying a grinding liquid to the main surfaces of the glass substrate, and moving them relative to each other. The glass substrate having substantially flat main surfaces was obtained by this lapping processing.

[0035] In "a coring step" of S13, a hole was formed in the center portion of the glass substrate using a tubular diamond drill to produce an annular glass substrate. The inner circumferential end surface and the outer circumferential end surface of the glass substrate were ground using a diamond grindstone to perform predetermined chamfering.

[0036] In "a second lapping step (second grinding step)" of S14, the two main surfaces of the glass substrate were lapped as in the first lapping step (S12). By performing this second lapping step, it is possible to eliminate in advance the minute unevenness formed on the main surfaces by the coring processing

and the end surface processing in the previous steps. As a result, it is possible to reduce the time required for polishing the main surfaces in later steps.

[0037] In "an inner and outer circumference polishing step" of S15, mirror polishing was performed on the outer circumferential end surface of the glass substrate by brushing. In this case, a slurry containing common cerium oxide abrasive particles was used as polishing abrasive particles.

[0038] In "a first polishing step (rough polishing step)" of S16, the main surfaces were polished. This first polishing step is performed mainly to eliminate scratches and/or warping that remain in the main surfaces in the above-described first and second lapping steps (S12 and S14). In this first polishing step, the main surfaces were polished using a double-side polishing device having a planetary gear mechanism. Common cerium oxide abrasive particles were used as an abrasive.

[0039] In "a chemical strengthening step" of S17, surface strengthening layers were formed on the main surfaces of the glass substrate 1G. Specifically, chemical strengthening was performed by bringing the glass substrate 1G into contact with a mixed solution of potassium nitrate (70%) and sodium nitrate (30%) that had been heated to 300°C, for about 30 minutes. As a result, lithium ions and sodium ions of the inner circumferential end surface and the outer circumferential end surface of the glass substrate were respectively substituted for sodium ions and potassium ions in the chemical strengthening solution and a compressive stress layer was formed, thus chemically strengthening the main surfaces and the end surfaces of the glass substrate.

[0040] In "a second polishing step (precision polishing step)" of S18, precision polishing was performed on the main surfaces. This second polishing step is performed to mirror-finish the main surfaces by eliminating any small defects or the like that have occurred in the above-described steps and remain on the main surfaces and to finish the main surfaces to a desired smoothness by eliminating warping. In this second polishing step, polishing was performed using a double-side polishing device having a planetary gear mechanism. An

acidic polishing liquid at pH 4 or less that contained colloidal silica was used as an abrasive in order to obtain smooth surfaces. When the main surfaces of the glass substrate 1G after being polished are measured using an atomic force microscope (AFM), the surface roughness Ra (measurement area: 1 μm square) is 3.0 $\text{\AA}$ or less in a measurement area of 1 μm square (1 μm^2).

[0041] If the glass substrate 1G is brought into contact with an acidic solution, alkaline components are eluted from the glass substrate 1G, and thus the skeleton is bent and bondings are very likely to be cleaved. The surface state of the glass substrate 1G in such a state is changed by the alkali cleaning performed before forming the magnetic thin film layer. Immediately after being polished, the glass substrate 1G is significantly activated, and bondings are likely to be elongated and cleaved. If the glass substrate 1G is brought into contact with an acidic solution in this state, the resistance to the alkali cleaning before forming the magnetic film significantly decreases.

[0042] In the manufacturing method according to this embodiment, the precision polishing using colloidal silica is performed in an acidic state in order to aggregate the colloidal silica to have a particle size suitable for use in the polishing. On the other hand, since the old surface portion is continually ground by the polishing and a fresh surface is continually exposed, the old surface layer portion from which alkaline components have been eluted is removed by the polishing and a fresh surface layer portion is sequentially exposed. Therefore, in the manufacturing method according to this embodiment, alkaline components in a surface layer being eluted and bonding strength thus decreasing is not particularly a problem.

[0043] In "a first immersing step" of S19, the glass substrate 1G on which the precision polishing has been performed is immersed in a solution at pH 6.5 or more to 8.5 or less for 5 minutes or more. The pH of the solution is preferably 7 or more to 8 or less. The immersion time for which the glass substrate 1G is immersed in the solution is 120 minutes or less. The pH of the solution used in the first immersing step is measured, and when the pH of the solution falls

below 6.5, an adjusting agent is added to the solution such that the pH is adjusted to 6.5 or more to 8.5 or less. An alkaline adjusting agent is supplied to the solution as the adjusting agent.

5 [0044] In "an ultrasonic cleaning step" of S20, high-frequency waves are used to perform ultrasonic cleaning on the glass substrate 1G after the first immersing step.

[0045] In "a second immersing step" of S21, the glass substrate 1G on which the ultrasonic cleaning has been performed is immersed in a solution at pH 6.5 or more to 8.5 or less for 5 minutes or more. The pH of the solution is preferably 7 or more to 8 or less. The immersion time for which the glass substrate 1G is immersed in the solution is 120 minutes or less. The pH of the solution used in the second immersing step is measured, and when the pH of the solution falls below 6.5, an adjusting agent is added to the solution such that the pH is adjusted to 6.5 or more to 8.5 or less. An alkaline adjusting agent is supplied to the solution as the adjusting agent.

[0046] In "a scrub cleaning step" of S22, a scrub cleaning device is used to perform scrub cleaning on the glass substrate 1G on which the second immersing step has been performed.

20 [0047] In "a third immersing step" of S23, the glass substrate 1G on which the scrub cleaning has been performed is immersed in a solution at pH 6.5 or more to 8.5 or less for 5 minutes or more. The pH of the solution is preferably 7 or more to 8 or less. The immersion time for which the glass substrate 1G is immersed in the solution is 120 minutes or less. The pH of the solution used in the third immersing step is measured, and when the pH of the solution falls below 6.5, an adjusting agent is added to the solution such that the pH is adjusted to 6.5 or more to 8.5 or less. An alkaline adjusting agent is supplied to the solution as the adjusting agent.

30 [0048] In "a final cleaning step" of S24, final cleaning is performed on the main surfaces and the end surfaces of the glass substrate. Thus, attached matter remaining on the glass substrate is removed. The final cleaning step is

performed as the last step of the steps of manufacturing the glass substrate and includes a drying step as appropriate.

[0049] The method for manufacturing a glass substrate according to this embodiment is configured as described above. It is possible to obtain the glass substrate 1G shown in FIG. 1 by this method for manufacturing a glass substrate. Thereafter, alkali cleaning is performed on the glass substrate 1G obtained in this manner, and then a magnetic thin film layer is formed.

[0050] With the glass substrate 1G configured as described above, it is possible to obtain a glass substrate for an information recording medium in which a decrease in the signal-to-noise ratio (S/N ratio) is sufficiently suppressed even if alkali treatment is performed.

[Working Example 1]

[0051] Working examples of this application were examined using a glass composition containing SiO₂ in an amount of 60 to 65 (mol%), Al₂O₃ in an amount of 8 to 12 (mol%), Na₂O in an amount of 5 to 12 (mol%), K₂O in an amount of 0 to 3 (mol%), MgO in an amount of 6 to 10 (mol%), and CaO in an amount of 0 to 5 (mol%). It should be noted that the glass composition is not limited thereto, and all compositions usable in glass substrates for an information recording medium can be used.

[0052] When "the first immersing step" was performed on the glass substrates on which "the second polishing step (precision polishing step)" of S18 shown in FIG. 3 had been performed, the glass substrates were immersed in various solutions at different pH for 10 minutes and then glass substrates according to working examples 1 to 3 and comparative examples 1 to 3 shown in Table 1 below were produced by performing "the ultrasonic cleaning step" of S20, "the scrub cleaning step" of S22 and "the final cleaning step" of S24.

[0053] Ten glass substrates were extracted from one hundred glass substrates produced in each of the working examples 1 to 3 and comparative examples 1 to 3, and Ra measurement (measurement area: 1 μm×1 μm) was performed thereon using an atomic force microscope (AFM). Thereafter, the glass

substrates were treated using an NaOH solution (40°C) at pH 11 for 30 minutes, and Ra measurement (measurement area: 1 μm ×1 μm) was performed thereon, again using an atomic force microscope (AFM). Table 1 below shows the results of evaluation of changes in Ra before and after the treatment.

- 5 [0054] Magnetic thin film layers were formed on twenty glass substrates out of the remaining ninety glass substrates produced in each of the working examples 1 to 3 and comparative examples 1 to 3, and the electromagnetic conversion characteristics thereof were evaluated. Table 1 below shows the results of comparing change values of SNR with that of a reference substrate.
- 10 [0055] Since one hundred glass substrates were manufactured at a time (one hundred per batch) and there was little variation in glass substrates in the same batch, the glass substrates were evaluated as described above.
- [0056] In the case where the electromagnetic conversion characteristics were evaluated, first, an information recording medium was produced by cleaning
- 15 each of the obtained glass substrates using an alkaline solution and then forming a magnetic film. The obtained information recording media were evaluated by investigating the recording and reproducing characteristics of the magnetic head using a spin stand. Specifically, the characteristics were investigated by recording signals with recording density changed by changing
- 20 recording frequencies, and by reading the reproduction output of these signals. A merge type head for perpendicular recording in which a single magnetic pole head for perpendicular recording (for recording) and a GMR head (for reproduction) were integrated was used as the magnetic head.

[0057] [Table 1]

	pH of solution	Change in Ra (Å)	Change in SNR (db)	Evaluation
Work. Ex. 1	6.5	0.45	−0.17	B
Work. Ex. 2	7	0.24	−0.10	A
Work. Ex. 3	8.5	0.33	−0.14	B
Comp. Ex. 1	9	0.48	−0.33	D
Comp. Ex. 2	6	0.81	−0.37	D
Comp. Ex. 3	10.5	0.65	−0.41	D

[0058] "A", "B", "C", and "D" described below were used as evaluation criteria for Table 1 above. "A" shows that the change in SNR is −0.1 db or less. "B" shows that the change in SNR is −0.11 to −0.20 db. "C" shows that the change in SNR is −0.21 to −0.30 db. "D" shows that the change in SNR is −0.31 db or less.

[0059] Regarding the comparative example 1, the change in Ra was small, but Ra after the immersing step increased, and some nonstandard glass substrates were produced. Regarding the comparative example 3 as well, Ra after the immersing step was similarly deteriorated. It is understood from Table 1 that the pH of the solution used in the first immersing step is preferably 6.5 or more to 8.5 or less. It is understood that the pH of the solution used in the first immersing step is preferably 7 or more to 8 or less.

[0060] Next, the relationship of the pH of the solution used in "the second immersing step" of S21 described above with the change in SNR and the change in Ra was examined. Specifically, after the ultrasonic cleaning of S20 was performed on the glass substrate that had been immersed in a solution at pH 7 for 10 minutes in "the first immersing step" of S19, the glass substrates were immersed in solutions at various pH ("the second immersing step" of S21). Thereafter, glass substrates according to working examples A, B, and C described below were produced by performing "the scrub cleaning step" of S22 and "the final cleaning step" of S24.

[0061] [Table 2]

	pH of solution	Change in Ra (Å)	Change in SNR (db)	Evaluation
Work. Ex. A	6.5	0.2	−0.07	AA
Work. Ex. B	7	0.15	−0.04	AA
Work. Ex. C	8.5	0.17	−0.08	AA

[0062] Table 2 above shows the results of measuring the changes in SNR (db) and the changes in Ra of the glass substrates according to the working examples A, B, and C in the same manner as in the above-described working examples 1 to 3 and comparative examples 1 to 3. "AA", "BB", "CC", and "DD" described below were used as evaluation criteria. "AA" shows that the change in SNR is −0.1 db or less. "BB" shows that the change in SNR is −0.11 to −0.20 db. "CC" shows that the change in SNR is −0.21 to −0.30 db. "DD" shows that the change in SNR is −0.31 db or less.

[0063] As is also clear from Table 2 above, it is understood that, with the glass substrate obtained by performing the ultrasonic cleaning of S20 on a glass substrate that has been immersed in a solution at pH 7 for 10 minutes in "the first immersing step" of S19, immersing the glass substrate in a solution at pH 6.5 or more to 8.5 or less for 10 minutes, and performing "scrub cleaning step" of S22 and "the final cleaning step" of S24 thereon, an information recording medium having favorable electromagnetic conversion characteristics can be obtained.

[0064] Next, the relationship of the pH of the solution used in "the third immersing step" with the change in NR and the change in Ra was examined. Specifically, after "the first immersing step (S19)" in which immersion in a solution at pH 7 for 10 minutes is performed, "the ultrasonic cleaning step (S20)", "the second immersing step (S21)" in which immersion in a solution at pH 7 for 10 minutes is performed, and "the scrub cleaning step (S22)" were performed, the glass substrates were immersed in solutions at various pH ("the third immersing step (S23)". Thereafter, glass substrates according to

working examples a, b, and c described below were produced by performing "the final cleaning step (S24)". Table 3 below shows the results of measuring the changes in SNR (db) and the changes in Ra of the glass substrates according to the working examples a, b, and c in the same manner as in the above-described working examples 1 to 3 and comparative examples 1 to 3.

[0065] [Table 3]

	pH of solution	Change in Ra (Å)	Change in SNR (db)	Evaluation
Work. Ex. a	6.5	0.2	0.01	AAA
Work. Ex. b	7	0.1	0.03	AAA
Work. Ex. c	8.5	0.14	0.01	AAA

[0066] "AAA", "BBB", "CCC", "DDD" and "EEE" were used as evaluation criteria. "AAA" shows that the change in SNR is positive. "BBB" shows that the change in SNR is 0 to -0.1 db. "CCC" shows that the change in SNR is -0.1 to -0.20 db. "DDD" shows that the change in SNR is -0.21 to -0.30 db. "EEE" shows that the change in SNR is -0.31 db or less. The term "positive" means that the S/N ratio was improved compared with that of the reference.

[0067] As is also clear from Table 3 above, it is understood that an information recording medium having favorable electromagnetic conversion characteristics can be obtained from all of the working examples a, b, and c.

[0068] As shown in Tables 1 to 3 above, by providing an immersing step using a solution at predetermined pH, it is possible to suppress a decrease in SNR. In particular, in the case where an immersing step is provided after a step in which physical stimulation is applied, such as a polishing step and/or a scrub cleaning step, a greater effect is exhibited.

[0069] Next, the relationship of the length of time of immersion in a solution with the change in Ra (Å) and the change in SNR (db) was examined.

[0070] Specifically, the glass substrate on which "the second polishing step (precision polishing step)" of S18 shown in FIG. 3 had been performed was immersed in a solution at pH 7 ("the first immersing step") with the period of

time of immersion being varied. Thereafter, glass substrates according to working examples i to iv shown in Table 4 below were produced by performing "the ultrasonic cleaning step" of S20, "the scrub cleaning step" of S22 and "the final cleaning step" of S24.

5 [0071] [Table 4]

	Immersion time (min)	Change in Ra (Å)	Change in SNR (db)	Evaluation
Work. Ex. i	5	0.27	-0.08	A2
Work. Ex. ii	60	0.24	-0.09	A2
Work. Ex. iii	120	0.25	-0.07	A2
Work. Ex. iv	150	0.30	-0.22	A3

[0072] "A1", "A2", "A3", "A4" and "A5" were used as evaluation criteria. "A1" shows that the change in SNR is positive. "A2" shows that the change in SNR is 0 to -0.1 db. "A3" shows that the change in SNR is -0.11 to -0.20 db. "A4" shows that the change in SNR is -0.21 to -0.30 db. "A5" shows that the change in SNR is -0.31 db or less.

[0073] As is clear from Table 4, it is understood that the immersion time in the first immersing step is preferably set to 120 minutes or less.

[0074] While an embodiment and examples of the present invention have been described above, the disclosed embodiment and examples are to be understood as being exemplary in all respects and in no way limiting. The scope of the present invention is defined by the scope of the appended claims, and all changes that fall within the same essential spirit as the scope of the claims are intended to be included therein.

20 [Industrial Applicability]

[0075] The present invention can be applied to a method for manufacturing a glass substrate for an information recording medium.

[List of Reference Numerals]

[0076] 1 Information recording medium
 25 1G Glass substrate for an information recording medium
 12 Outer circumferential end surface

- 13 Inner circumferential end surface
- 14, 15 Main surface
- 23 Magnetic thin film layer

CLAIMS

1. A method for manufacturing a glass substrate for an information recording medium to be used in an information recording medium in which a magnetic thin film layer is formed on a main surface of the glass substrate and in which a recording density of a magnetic recording surface is equal to or greater than 630 Gbit per square inch, the method comprising:

a precision polishing step of performing precision polishing on a main surface of a glass member using an acidic polishing liquid at pH 4 or less that contains colloidal silica;

a first immersing step of performing immersion in a solution for 5 minutes or more after the precision polishing step; and

an ultrasonic cleaning step of performing ultrasonic cleaning on the glass member after the first immersing step,

wherein the glass member subjected to the precision polishing in the precision polishing step has a surface roughness Ra of 3.0 Å or less in a measurement area of 1 μm^2 , and

a pH of the solution used in the first immersing step is 6.5 or more to 8.5 or less.

2. The method for manufacturing a glass substrate for an information recording medium according to claim 1, further comprising a second immersing step of immersing the glass member in a solution at pH 6.5 or more to 8.5 or less for 5 minutes or more after the ultrasonic cleaning step.

3. The method for manufacturing a glass substrate for an information recording medium according to claim 1 or 2, further comprising:

a scrub cleaning step of performing scrub cleaning on the glass member after the ultrasonic cleaning step; and

a third immersing step of performing immersion in a solution at pH 6.5

or more to 8.5 or less for 5 minutes or more after the scrub cleaning step.

4. The method for manufacturing a glass substrate for an information recording medium according to any one of claims 1 to 3, further comprising a
5 step of adding an adjusting agent to the solution such that a pH of the solution is adjusted to 6.5 or more to 8.5 or less when the pH falls below 6.5.

5. The method for manufacturing a glass substrate for an information recording medium according to any one of claims 1 to 4, wherein the pH of the
10 solution used in the first immersing step is 7 or more to 8 or less.

6. The method for manufacturing a glass substrate for an information recording medium according to any one of claims 1 to 5, wherein an immersion time in the first immersing step is 120 minutes or less.

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