US 20080280538A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2008/0280538 A1

(43) Pub. Date: Nov. 13, 2008

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(54) **POLISHING COMPOSITION**

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(21) Appl. No.: **12/216,762**

(22) Filed: **Jul. 10, 2008**

Related U.S. Application Data

(62) Division of application No. 11/288,294, filed on Nov. 29, 2005.

(30) **Foreign Application Priority Data**

Nov. 10, 2004 (JP) 2004-347212

Publication Classification

(51) **Int. Cl.**
B24B 1/00 (2006.01)
B24B 29/00 (2006.01)

(52) **U.S. Cl.** **451/36**

(57) **ABSTRACT**

The present invention provides a polishing composition containing an organic nitrogen-containing compound, an organic polybasic acid, an abrasive, and water, wherein the organic nitrogen-containing compound has in the molecule two or more amino groups, two or more imino groups, or one or more amino groups and one or more imino groups; a method for manufacturing a substrate with the polishing composition; and a method for reducing surface stains of a substrate with the polishing composition. The polishing composition can be suitably used, for example, in the manufacturing step for a substrate for a hard disk such as a memory hard disk.

POLISHING COMPOSITION

[0001] This Application is a Divisional of co-pending U.S. application Ser. No. 11/288,294, which was filed Nov. 29, 2005, which claims priority to Japanese application JP2004-347212 filed in Japan on Nov. 30, 2004, the content of which is hereby incorporated by reference into this application.

FIELD OF THE INVENTION

[0002] The present invention relates to a polishing composition, a method for manufacturing a substrate with the polishing composition, and a method for reducing surface stains on a substrate with the polishing composition.

BACKGROUND OF THE INVENTION

[0003] In recent years, in order to progress in minimizing a unit recording area and increasing storage capacity, hard disks are demanded to have a smaller flying height of a magnetic head or be prevented from surface defects such as surface stains.

[0004] Therefore, conventionally, as disclosed in JP2002-164307 A, studies have been made on a polishing composition that enables smoother polishing of the surface of a substrate for a hard disk and that less likely causes surface defects. In addition, recently, in order to obtain a substrate having a desired surface quality in a given time period, studies have been made on the use of two or more stages of polishing steps.

[0005] When abrasive grains used in a first-stage polishing step and polishing debris remain on a substrate for a hard disk obtained in the first-stage polishing step, the majority of these abrasive grains and polishing debris are removed in the second-stage polishing step. However, those that undesirably remain unremoved lead to cause defects. Also, although the residual abrasive grains and polishing debris in the first stage are indeed removed in the second-stage polishing step, they have undesirably disadvantageous influences on the second-stage polishing step, leading to generate scratches or pits on the substrate. In addition, those residual abrasive grains and polishing debris are even more undesirable in a case where the polishing is carried out only in a single stage, or a case where the polishing is carried out in a finishing step.

[0006] In order to solve these disadvantages, it is important that the abrasive grains and the polishing debris are removed from the substrate at the termination of each stage of the polishing step. However, the studies on a polishing composition that gives a substrate having reduced surface stains have been hardly conducted, so that a technique of satisfactorily solving the disadvantage has not so far been known.

SUMMARY OF THE INVENTION

[0007] The present invention relates to:

[1] a polishing composition containing an organic nitrogen-containing compound, an organic polybasic acid, an abrasive, and water, wherein the organic nitrogen-containing compound has in the molecule two or more amino groups, two or more imino groups, or one or more amino groups and one or more imino groups;

[2] a method for manufacturing a substrate, including the step of feeding the polishing composition as defined in the above [α] to a substrate to be polished at a flow rate of from 0.01 to 0.5 mL/minute per 1 cm^2 of the substrate, and polishing the substrate with a polishing pad; and

[3] a method for reducing surface stains on a substrate, including the step of feeding the polishing composition as defined in the above [1] to a substrate to be polished at a flow rate of from 0.01 to 0.5 mL/minute per 1 cm^2 of the substrate, and polishing the substrate with a polishing pad.

DETAILED DESCRIPTION OF THE INVENTION

[0008] The present invention relates to a polishing composition giving fewer residual abrasive grains and polishing debris generated by polishing on a polished substrate after polishing, higher polishing rates, and being capable of maintaining smoothness of the substrate; a method for manufacturing a substrate with the polishing composition; and a method for reducing surface stains on a substrate with the polishing composition.

[0009] Since the polishing composition of the present invention is used, the effects that a substrate having excellent surface smoothness, including fewer surface defects such as surface stains, smaller waviness, or the like, can be efficiently manufactured are exhibited.

[0010] These and other advantages of the present invention will be apparent from the following description.

[0011] The feature of the polishing composition of the present invention, as mentioned above, resides in that the polishing composition contains an organic nitrogen-containing compound, an organic polybasic acid, an abrasive, and water, wherein the organic nitrogen-containing compound has in the molecule two or more amino groups, two or more imino groups, or one or more amino groups and one or more imino groups. Since the polishing composition has the above feature, the effects that a substrate having excellent surface smoothness, including fewer surface defects such as surface stains, smaller waviness, or the like, can be efficiently manufactured are exhibited.

[0012] Here, the function mechanism in which the abrasive grains and polishing debris are prevented from remaining by the polishing composition of the present invention is yet unknown. Although not wanting to be limited by theory, the function is considered to be exhibited due to a synergistic effect of a combined use of a specified organic nitrogen-containing compound and an organic polybasic acid as explained below.

[0013] Also, while the function mechanism is yet unknown, it is deduced that an organic polybasic acid is adsorbed to the abrasive grains and the polishing debris, so that their surfaces are charged negatively and likely to deposit on the substrate, and an organic nitrogen-containing compound is adsorbed to the surfaces of abrasive grains and polishing debris adsorbed by the organic polybasic acid to electrically neutralize, thereby suppressing them to deposit or remain on the substrate.

[0014] The organic nitrogen-containing compound used in the present invention refers to a compound having a total of two or more groups selected from an amino group and an imino group in the molecule. Specifically, the organic nitrogen-containing compound used in the present invention has in the molecule two or more amino groups, two or more imino groups, or one or more amino groups and one or more imino groups. The total number of the amino groups and the imino groups in the molecule is not particularly limited. The total number of the amino groups and the imino groups in the molecule is preferably from 2 to 2000, more preferably from

2 to 1000, even more preferably from 2 to 200, and even more preferably from 2 to 50, from the viewpoint of increasing polishing rate and preventing surface stains on a substrate. Specific examples thereof include polyalkyleneimines, diethylenetriamine, triethylenetetramine, tetraethylenepentamine, bis(3-aminopropyl)amine, 1,3-propanediamine and the like.

[0015] Representative examples of the polyalkyleneimine include polyethyleneimine, polypropyleneimine, polybutadieneimine and the like, including those having a linear or branched structure, or those having a cyclic structure. Among them, the polyethyleneimine is preferable, from the viewpoint of increasing polishing rate and preventing surface stains on a substrate. The polyalkyleneimine has a molecular weight of preferably from 150 to 100000, more preferably from 200 to 30000, even more preferably from 200 to 10000, and even more preferably from 300 to 2000, from the viewpoint of increasing polishing rate and reducing surface stains on a substrate. The above-mentioned molecular weight can be determined as a number-average molecular weight according to ebulioscopy or viscosity method.

[0016] In addition, the organic nitrogen-containing compound is contained in an amount of preferably from 0.001 to 0.5% by weight, more preferably from 0.001 to 0.3% by weight, and even more preferably from 0.001 to 0.1% by weight, of the polishing composition, from the viewpoint of increasing polishing rate and preventing surface stains on a substrate.

[0017] The organic polybasic acid used in the present invention is preferably a sulfur-containing organic acid, a carboxylic acid, and a phosphorus-containing organic acid. Specific examples of the organic polybasic acid include organic sulfonic acids such as methanedisulfonic acid, ethanedisulfonic acid, phenoldisulfonic acid, and naphthalenedisulfonic acid; polycarboxylic acids such as oxalic acid, succinic acid, glutaric acid, adipic acid, maleic acid, fumaric acid, itaconic acid, malic acid, tartaric acid, citric acid, isocitric acid, phthalic acid, nitrilotriacetic acid, and ethylenediaminetetraacetic acid; phosphorus-containing organic acids such as hydroxyethylidene-1,1-diphosphonic acid, phosphonobutanetricarboxylic acid, and ethylenediaminetetramethylenephosphonic acid; and the like. Among them, succinic acid, citric acid, malic acid, tartaric acid, hydroxyethylidene-1,1-diphosphonic acid, and ethylenediaminetetramethylenephosphonic acid are preferable, citric acid, malic acid, and tartaric acid are more preferable, and citric acid is even more preferable, from the viewpoint of increasing polishing rate, reducing waviness and reducing roll-off. These compounds may be used alone or in admixture of two or more kinds.

[0018] The organic polybasic acid is contained in an amount of preferably 0.002% by weight or more, more preferably 0.005% by weight or more, even more preferably 0.007% by weight or more, and even more preferably 0.01% by weight or more, of the polishing composition, from the viewpoint of increasing polishing rate and reducing waviness. In addition, the organic polybasic acid is contained in an amount of preferably 20% by weight or less, more preferably 15% by weight or less, even more preferably 10% by weight or less, and even more preferably 5% by weight or less, of the polishing composition, from the viewpoint of surface quality and economic advantage. In other words, the organic polybasic acid is contained in an amount of preferably from 0.002 to 20% by weight, more preferably from 0.005 to 15% by weight, even more preferably from 0.007 to 10% by weight, and even more preferably from 0.01 to 5% by weight, of the polishing composition.

[0019] In addition, in the polishing composition of the present invention, the organic nitrogen-containing compound and the organic polybasic acid mentioned above are contained in a weight ratio, i.e. organic nitrogen-containing compound/organic polybasic acid, of preferably 1/1 or less, more preferably 1/2 or less, and even more preferably 1/5 or less, from the viewpoint of increasing the polishing rate. In addition, the weight ratio is preferably 1/10000 or more, more preferably 1/1000 or more, even more preferably 1/200 or more, and even more preferably 1/50 or more, from the viewpoint of preventing surface stains on a substrate. In other words, the weight ratio is preferably from 1/10000 to 1/1, more preferably from 1/1000 to 1/2, even more preferably from 1/500 to 1/5, even more preferably from 1/200 to 1/5, and even more preferably from 1/50 to 1/5, from the viewpoint of increasing polishing rate and preventing surface stains on a substrate.

[0020] As the abrasive to be used in the present invention, any abrasives generally employed for polishing can be used. Examples of the abrasive include, for instance, metals; carbides of metals or metalloids, nitrides of metals or metalloids, oxides of metals or metalloids, borides of metals or metalloids; diamond, and the like. The metals or metalloids include those elements belonging to the Groups 2A, 2B, 3A, 3B, 4A, 4B, 5A, 6A, 7A or 8 of the Periodic Table (long period form). Specific examples of the abrasive include aluminum oxide (hereinafter referred to as "alumina" in some cases) particles such as α-alumina particles and intermediate alumina particles, silicon carbide particles, diamond particles, magnesium oxide particles, zinc oxide particles, cerium oxide particles, titanium oxide particles, zirconium oxide particles, colloidal silica particles, fumed silica particles, and the like. Among them, α-alumina particles, intermediate alumina particles, cerium oxide particles, zirconium oxide particles, colloidal silica particles, fumed silica particles, and the like are preferable, and α-alumina particles, intermediate alumina particles, colloidal silica particles and fumed silica particles are more preferable, and α-alumina particles and intermediate alumina particles are even more preferable. In addition, aluminum oxide particles are preferable from the viewpoint of reducing abrasive grains and polishing debris. Further, effects of an even more increased polishing rate and reduction in waviness are obtained by a combined use of α-alumina and an intermediate alumina, or a combined use of α-alumina and colloidal silica or fumed silica.

[0021] Among the α-alumina and the intermediate alumina mentioned above, it is preferable that the alumina has a purity of 95% or more, more preferably 97% or more, and even more preferably 99% or more, from the viewpoint of reducing waviness, reducing surface roughness, increasing polishing rate, and preventing surface defects. In addition, α-alumina is preferable from the viewpoint of increasing polishing rate, and intermediate aluminas such as γ-alumina, δ-alumina, θ-alumina, η-alumina, and κ-alumina are preferable, from the viewpoint of surface properties and reduction in waviness. Here, the intermediate alumina used in the present invention is a generic term referring to alumina particles other than α-alumina particles. Specific examples thereof include γ-alumina, δ-alumina, θ-alumina, η-alumina, κ-alumina, and mixtures thereof. Among the intermediate aluminas, γ-alumina, δ-alumina, θ-alumina, and mixtures thereof are preferable,

and γ-alumina and θ-alumina are even more preferable, from the viewpoint of increasing polishing rate and reducing waviness.

[0022] Even more, in the case of the intermediate alumina, the intermediate alumina has a specific surface area as determined by BET method of preferably from 30 to 300 m^2/g, and more preferably from 50 to 200 m^2/g.

[0023] The primary particles of the above-mentioned abrasive have an average particle size of preferably from 0.001 to 2 μm, more preferably from 0.005 to 0.8 μm, and even more preferably from 0.01 to 0.5 μm, from the viewpoint of increasing polishing rate and reducing waviness. Further, when the primary particles are aggregated to form secondary particles, the secondary particles have an average particle size of preferably from 0.02 to 3 μm, more preferably from 0.05 to 1 μm, even more preferably from 0.1 to 0.8 μm, and even more preferably from 0.1 to 0.5 μm, from the viewpoint of increasing polishing rate, reducing waviness, and inhibiting surface defects. The average particle size of the primary particles of the abrasive is obtained by subjecting the abrasive to an image analysis by observing with a scanning electron microscope in a magnification of favorably from 3000 to 30000 times, or with a transmission electron microscope in a magnification of favorably from 10000 to 500000 times, and determining the particle size. In addition, the average particle size of the secondary particles can be determined as a volume-average particle size by using a laser diffraction method.

[0024] The specific gravity of the abrasive is preferably from 1.5 to 8, and more preferably from 1.5 to 5, from the viewpoints of dispersibility, feed ability to the polishing device and efficiency of recovery and reuse.

[0025] The abrasive is contained in an amount of preferably from 0.05 to 40% by weight, more preferably from 0.1 to 30% by weight, even more preferably from 0.5 to 25% by weight, even more preferably from 1 to 20% by weight, and even more preferably from 1 to 10% by weight, of the polishing composition, from the viewpoint of economic advantage and increase in polishing rate.

[0026] Water in the polishing composition of the present invention is used as a medium, and the water is contained in an amount of preferably from 55 to 99% by weight, more preferably from 60 to 97% by weight, and even more preferably from 70 to 95% by weight, of the polishing composition, from the viewpoint of efficiently polishing the object to be polished.

[0027] In addition, the polishing composition of the present invention can contain other components as occasion demands.

[0028] It is preferable that an inorganic acid is used together in the polishing composition of the present invention, from the viewpoint of further increasing the polishing rate and reducing the waviness. The inorganic acid is preferably nitric acid, nitrous acid, sulfuric acid, sulfurous acid and amide sulfuric acid, and sulfuric acid, sulfurous acid and amide sulfuric acid are more preferable, and sulfuric acid is even more preferable, from the viewpoint of increasing the polishing rate. The inorganic acid is contained in an amount of preferably from 0.002 to 20% by weight, more preferably from 0.005 to 15% by weight, even more preferably from 0.007 to 10% by weight, and even more preferably from 0.01 to 5% by weight, of the polishing composition, from the viewpoint of polishing rate, surface quality and economic advantage.

[0029] In addition, it is preferable that the polishing composition of the present invention contains an oxidizing agent, from the viewpoint of increasing the polishing rate. The oxidizing agent is roughly classified into inorganic oxidizing agents and organic oxidizing agents. As the inorganic oxidizing agent, there can be used hydrogen peroxide, a peroxide of an alkali metal or an alkaline earth metal, a peroxosulfuric acid or a salt thereof, peroxonitric acid or a salt thereof, a peroxophosphoric acid or a salt thereof, a peroxoborate, a peroxochromate, a permanganate, a halogeno-acid or a derivative thereof, a metal salt of an inorganic acid or the like. As the organic oxidizing agent, there can be used a percarboxylic acid, a peroxide, iron (III) citrate or the like. Among them, the inorganic oxidizing agent is preferable, when an increase of the polishing rate, availability, and easy handling, such as water-solubility are compared. Especially, in consideration of the environmental problems, an inorganic peroxide which does not contain a heavy metal is preferable. In addition, hydrogen peroxide, a peroxosulfate, a halogeno-acid or a derivative thereof are more preferable, and hydrogen peroxide is even more preferable, from the viewpoint of preventing the stains on the surface of the substrate to be polished. In addition, these oxidizing agents can be used alone or in admixture of two or more kinds.

[0030] The oxidizing agent is contained in an amount of preferably from 0.002 to 20% by weight, more preferably from 0.005 to 15% by weight, even more preferably from 0.007 to 10% by weight, and even more preferably from 0.01 to 5% by weight, of the polishing composition, from the viewpoint of increase in polishing rate, reduction in waviness, surface quality, and economic advantage.

[0031] In addition, other components for the polishing composition include celluloses such as cellulose, carboxymethyl cellulose, and hydroxyethyl cellulose; water-soluble alcohols such as ethanol, propanol, and ethylene glycol; and the like, and also include surfactants such as alkylbenzenesulfonates, formalin condensates of naphthalenesulfonic acid, polyacrylates, and ligninsulfonates; water-soluble polymers such as polyvinyl alcohol; and the like. These components can be used alone or in admixture of two or more kinds. The other components can be each contained in an amount of preferably from 0.001 to 20% by weight, more preferably from 0.01 to 5% by weight, and even more preferably from 0.01 to 2% by weight, of the polishing composition, from the viewpoint of exhibiting each of the functions and from the viewpoint of economic advantages.

[0032] The concentration of each component mentioned above in the polishing composition is a preferred concentration upon use. The concentration upon the preparation of the polishing composition may be in a concentration higher than those defined above. In many cases, the polishing composition is usually prepared as a concentrate, which is diluted upon use.

[0033] The polishing composition of the present invention can be preferably used in polishing a substrate for a hard disk as a substrate to be polished. The substrate for a hard disk is not particularly limited as long as usually known ones are used, and includes, for example, a substrate having a metal layer formed on a surface layer such as a Ni—P plated aluminum alloy substrate, a Ni—P plated glass substrate, and an aluminum disk, a substrate made of a glassy substance or a ceramic material, such as a carbon disk and a glass substrate, a substrate composed of composites of the above substances and materials, and the like. Among them, when the polishing

composition of the present invention is used for a substrate having a metal layer formed on a surface layer such as a Ni—P plated aluminum alloy substrate, a Ni—P plated glass substrate, and an aluminum disk, it is preferable because the abrasive grains and the polishing debris can be remarkably reduced.

[0034] It is preferable that the pH of the polishing composition is properly determined depending upon the kinds of the substrate to be polished. For example, it is preferable that the pH of the polishing composition is preferably from 1 to 12, from the viewpoint of rinsability of the substrate, corrosion inhibition of the processing machine, and safety of an operator. When the main subject for a substrate to be rinsed is a substrate having a metal layer formed on a surface layer such as a Ni—P plated aluminum alloy substrate, a Ni—P plated glass substrate, and an aluminum disk, the pH is preferably from 1 to 7, more preferably from 1 to 5, even more preferably from 1 to 4, even more preferably from 2 to 4, and even more preferably 2 or more and less than 3, from the viewpoint of increasing the polishing rate. The pH can be adjusted by properly formulating an inorganic acid, an organic acid, or a salt thereof, or a basic substance such as ammonia, sodium hydroxide, potassium hydroxide, or amine as occasion demands.

[0035] In the present invention, the effects of preventing residual abrasive grains and polishing debris by the polishing composition can be evaluated by, for example, an observation with a microscope, an observation with a scanning electron microscope, or the like of the surface of the substrate after polishing. Among them, in the substrate for a hard disk, the effect can be evaluated by observing an edge portion of its inner diameter which is less likely to be cleaned off with these equipments. In addition, the surface of the substrate after polishing can be further evaluated by glow discharge optical emission spectrometry (GDOES) or the like.

[0036] By using the polishing composition of the present invention having the constitution mentioned above, in the step of polishing in the method for manufacturing a substrate, such as a substrate for a hard disk, the residual abrasive grains and polishing debris generated by polishing on the substrate, in other words, surface stains are prevented, so that the substrate has less surface defects such as scratches and pits on its surface, whereby a substrate having less abrasive grains and polishing debris can be manufactured. Therefore, the present invention relates to a method for manufacturing a substrate, and a method for reducing surface stains of a substrate.

[0037] Each of the method for manufacturing a substrate and the method for reducing surface stains of the present invention includes the step of polishing a substrate to be polished with the above-mentioned polishing composition. In this step, the substrate to be polished can be polished by feeding the polishing composition to the polishing side of the substrate pressed against platens to which a porous organic polymer-based polishing pad is attached, and moving the platens and/or the substrate, while applying a pressure. Therefore, the present invention also relates to a method for polishing a substrate using the above-mentioned polishing composition.

[0038] In the method for manufacturing a substrate and the method for reducing surface stains of a substrate of the present invention, it is preferable that each method includes the step of feeding the polishing composition to a substrate at a flow rate of preferably from 0.01 to 0.5 mL/min, more preferably from 0.02 to 0.3 mL/min, even more preferably from 0.03 to 0.2 mL/min, per 1 cm^2 of the substrate to be polished, and polishing the substrate with a polishing pad, from the viewpoint of increase in polishing rate and economic advantage. Therefore, an example of the method for manufacturing a substrate or the method for reducing surface stains of a substrate of the present invention includes a method including the step of feeding the polishing composition of the present invention to a substrate to be polished at a flow rate of from 0.01 to 0.5 mL/minute per 1 cm^2 of the substrate, and polishing the substrate with a polishing pad

[0039] In addition, in the method for manufacturing a substrate of the present invention, it is desired that the polishing pressure upon polishing the substrate is adjusted to a range of from 2 to 30 kPa, preferably from 2 to 20 kPa, and more preferably from 4 to 15 kPa, from the viewpoint of increasing polishing rate and reducing waviness.

[0040] In addition, other conditions when the polishing is carried out, such as kinds of polishing machine, kinds of polishing pads, polishing temperature, and polishing rate, are not particularly limited. When a Ni—P plated aluminum alloy substrate is polished with an abrasive containing aluminum oxide particles, the polishing rate is preferably from 0.05 to 8 μm/min, more preferably from 0.1 to 6 μm/min, even more preferably from 0.2 to 5 μm/min, and even more preferably from 0.4 to 4 μm/min, from the viewpoint of productivity and operability.

[0041] The polishing composition of the present invention is especially effective in the polishing step, and the polishing composition can be similarly applied to grinding steps other than this, for example, lapping step, and the like.

EXAMPLES

[0042] The following examples further describe and demonstrate embodiments of the present invention. The examples are given solely for the purposes of illustration and are not to be construed as limitations of the present invention.

Examples 1 to 13, Comparative Examples 1 to 5

[0043] There were mixed together given amounts of α-alumina (average particle size of primary particles: 0.07 μm, average particle size of secondary particles: 0.3 μm, specific surface area: 15 m^2/g, purity: 99.9%), θ-alumina (average particle size of secondary particles: 0.2 μm, specific surface area: 120 m^2/g, purity: 99.9%), an organic polybasic acid, an organic nitrogen-containing compound, and other additives as listed in Table 1, and balance ion-exchanged water, while stirring, to give a polishing composition.

1. Polishing Process

[0044] Surfaces of a Ni—P plated aluminum alloy substrate having a thickness of 1.27 mm, and a diameter of 3.5 inch (95 mm) (short-wavelength waviness: 3.8 nm and long-wavelength waviness: 1.6 nm, as determined by "Zygo New View 5032") were polished, using a double-sided processing machine under the following setting conditions with each of the polishing compositions obtained in the Examples and Comparative Examples, to give a polished object, a Ni—P plated aluminum alloy substrate usable as a substrate for a magnetic recording medium.

[0045] The setting conditions for the double-sided processing machine are as follows.

<Setting Conditions for Double-Sided Processing Machine]

[0046] Double-sided processing machine: Model 9B, commercially available from SPEEDFAM CO., LTD.
Processing pressure: 9.8 kPa
Polishing pad: a polishing pad for a substrate for hard disk, commercially available from FUJIBO
Rotational speed of a platen: 50 r/min.
Flow rate for a polishing composition: 100 mL/min (0.076 mL/min per 1 cm^2 of a substrate to be polished)
Polishing time period: 4 min.
Number of substrates introduced: 10

3. Evaluation Methods

(1) Polishing Rate

[0047] Weights of each substrate before and after polishing were measured using a device commercially available from Sartorius under the trade name of BP-210S. Change in weight of each substrate was obtained, and an average of the change of 10 substrates was referred to as an amount reduced, and a value obtained by dividing the amount reduced by the polishing time is referred to as a rate of weight reduced. The rate of weight reduced is introduced into the following equation and converted to a polishing rate (μm/min).

Rate of Weight Reduced (g/min)=[Weight Before Polishing (g)−Weight After Polishing (g)]/Polishing Time (min)

Polishing Rate (μm/min)=Rate of Weight Reduced (g/min)/Area of One Side of Substrate (mm^2)/Ni—P Plating Density (g/cm^3)×1000000

[0048] Here, a relative value of a polishing rate (relative rate) for each of the Examples and Comparative Examples is shown in Table 1, assuming that the polishing rate of Comparative Example 1 (1.2 μm/min) takes a standard value of 1.

(2) Surface Stains

[0049] The surface of each of the substrates after polishing was observed with a scanning electron microscope S-4000 commercially available from Hitachi, Ltd. in a magnification of 10,000, and the following 5-rank evaluations were made. Here, those ranked in 1 and 2 are failures from the viewpoint of practical purposes.

[0050] 5: no alumina residue, polishing debris or the like is observed on the surface at all on the surface;

[0051] 4: alumina residue, polishing debris or the like is observed but in less amounts on the surface;

[0052] 3: alumina residue, polishing debris or the like is observed but in slight amounts on the surface;

[0053] 2: alumina residue, polishing debris or the like is observed but in large amounts on the surface; and

[0054] 1: alumina residue, polishing debris or the like is observed but in much amounts on the surface.

(3) Waviness

[0055] The waviness of each substrate after the polishing was determined for two kinds, short-wavelength waviness and long-wavelength waviness in accordance with the following conditions. A relative value of waviness for each of the Examples and Comparative Examples is shown in Table 1, assuming that each waviness of Comparative Example 1 (short-wavelength waviness: 0.40 nm, long-wavelength waviness: 0.42 nm) takes a standard value of 1. The lower the numerical value, the more the waviness being reduced.

Device:	Zygo New View 5032
Object Lens:	Magnification, 2.5 times, Michelson
Zooming Ratio:	0.5
Remove:	Cylinder
Filter type:	FFT Fixed Band Pass
Short-Wavelength Waviness:	50 to 500 μm
Long-Wavelength Waviness:	0.5 to 5 mm
Area:	4.33 mm × 5.77 mm

TABLE 1

	α-Alumina	θ-Alumina	Organic Polybasic Acid		Organic Nitrogen-Containing Compound	
	(% by wt.)	(% by wt.)	Name of Compound	(% by wt.)	Name of Compound	(% by wt.)
Ex. No.						
1	3	2	Citric Acid	1	Polyethyleneimine Molecular Weight 300	0.05
2	3	2	Citric Acid	1	Polyethyleneimine Molecular Weight 600	0.003
3	3	2	Citric Acid	1	Polyethyleneimine Molecular Weight 600	0.01
4	3	2	Citric Acid	1	Polyethyleneimine Molecular Weight 600	0.05
5	3	2	Citric Acid	1	Polyethyleneimine Molecular Weight 2000	0.05
6	3	2	Citric Acid	1	Triethylenetetramine	0.05
7	3	2	Citric Acid	1	Bis(3-aminopropyl)amine	0.05
8	3	2	Citric Acid	1	1,3-Propanediamine	0.05
9	3	2	Citric Acid	1	Polyethyleneimine Molecular Weight 600	0.05
10	3	2	Citric Acid	1	Polyethyleneimine Molecular Weight 600	0.05

TABLE 1-continued

11	3	2	Citric Acid/ Succinic Acid	0.5/0.5	Polyethyleneimine Molecular Weight 600	0.05
12	3	2	Succinic Acid	1	Polyethyleneimine Molecular Weight 600	0.05
13	3	2	Malic Acid	1	Polyethyleneimine Molecular Weight 600	0.05
Comp. Ex. No.						
1	3	2	Citric Acid	1	—	—
2	3	2	Citric Acid	1	—	—
3	3	2	Citric Acid	1	Laurylamine Acetate	0.05
4	3	2	Citric Acid	1	N-(2-Hydroxypropyl)-N,N,N-trimethylammonium formate	0.05
5	3	2	—	—	Polyethyleneimine Molecular Weight 600	0.05

	Other Component(s)			Evaluation Results			
	Name of Compound	(% by wt.)	pH	Polishing Rate	Surface Stains	Short-Wavelength Waviness	Long-Wavelength Waviness
Ex. No.							
1	Hydrogen Peroxide/ Sulfuric Acid	0.6/0.6	2	2.5	5	0.98	0.70
2	Hydrogen Peroxide/ Sulfuric Acid	0.6/0.6	2	2.3	4	0.94	0.73
3	Hydrogen Peroxide/ Sulfuric Acid	0.6/0.6	2	2.2	4	0.94	0.75
4	Hydrogen Peroxide/ Sulfuric Acid	0.6/0.6	2	2.1	5	0.93	0.77
5	Hydrogen Peroxide/ Sulfuric Acid	0.6/0.6	2	1.8	4	0.93	0.80
6	Hydrogen Peroxide/ Sulfuric Acid	0.6/0.6	2	2.2	4	0.95	0.88
7	Hydrogen Peroxide/ Sulfuric Acid	0.6/0.6	2	2.2	4	0.96	0.82
8	Hydrogen Peroxide/ Sulfuric Acid	0.6/0.6	2	2.2	4	0.97	0.83
9	Polyphosphoric Acid	0.04	2.5	1.0	5	0.96	1.0
10	Ammonium Sulfate	0.1	2.5	1.0	4	0.97	1.0
11	—	—	2.5	1.1	5	0.95	0.98
12	—	—	2.5	1.1	5	1.0	0.98
13	—	—	2.5	1.0	5	1.0	1.0
Comp. Ex. No.							
1	—	—	2.5	1	1	1	1
2	Hydrogen Peroxide/ Sulfuric Acid	0.6/0.6	2	2.4	1	0.97	0.75
3	—	—	2.5	0.7	2	0.95	1.2
4	—	—	2.5	0.9	1	0.98	1.1
5	Glycolic Acid/ Polyphosphoric Acid	1/0.04	3	0.6	4	1.1	1.1

[0056] It can be seen from the above results shown in Table 1 that the polishing compositions obtained in Examples 1 to 13 give significantly reduced surface stains of the substrate after polishing, and are less likely to generate waviness on the substrate.

[0057] The polishing composition of the present invention can be suitably used, for example, in the manufacturing step for a substrate for a hard disk such as a memory hard disk.

[0058] The present invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

What is claimed is:

1. A method for manufacturing a polished substrate for a hard disk, comprising the step of:

feeding a polishing composition comprising an organic nitrogen-containing compound, an organic polybasic acid, an abrasive, and water, wherein the organic nitrogen-containing compound has in the molecule two or more amino groups, two or more imino groups, or one or more amino groups and one or more imino groups to a substrate for a hard disk, and polishing the substrate with a polishing pad.

2. The method according to claim **1**, wherein the abrasive is an alumina.

3. The method according to claim **1**, wherein the organic nitrogen-containing compound has a molecular weight of from 150 to 100000.

4. The method according to claim **1**, wherein the organic nitrogen-containing compound is contained in an amount of from 0.001 to 0.5% by weight of the polishing composition.

5. The method according to claim **1**, wherein the organic nitrogen-containing compound and the organic polybasic acid are contained in a weight ratio of the organic nitrogen-containing compound/the organic polybasic acid of from 1/10000 to 1/1.

6. The method according to claim **1**, further comprising an oxidizing agent.

7. The method according to claim **1**, wherein the polishing composition has a pH of from 1 to 7.

8. The method according to claim **1**, wherein a flow rate of the polishing composition is from 0.01 to 0.5 mL/minute per 1 cm^2 of the substrate.

9. The method according to claim **1**, wherein a polishing pressure is from 2 to 30 kPa.

10. A method for manufacturing a polished substrate, comprising the steps of:

feeding a polishing composition comprising an organic nitrogen-containing compound, an organic polybasic acid, an abrasive, an oxidizing agent consisting essentially of hydrogen peroxide and water, wherein the organic nitrogen-containing compound is one or more members selected from the group consisting of polyalkyleneimines having a molecular weight of from 300 to 2000, diethylenetriamine, triethylenetetramine, tetraethylenepentamine, bis(3-aminopropyl)amine, and 1,3-propanediamine, and wherein the polishing composition has a pH of from 1 to 4 to a substrate to be polished at a flow rate of from 0.01 to 0.5 mL/minute per 1 cm^2 of the substrate, and

polishing the substrate with a polishing pad.

11. The method according to claim **10**, wherein a polishing pressure is from 2 to 30 kPa.

12. A method for reducing surface stains on a substrate for a hard disk, comprising the steps of:

feeding a polishing composition comprising an organic nitrogen-containing compound, an organic polybasic acid, an abrasive, and water, wherein the organic nitrogen-containing compound has in the molecule two or more amino groups, two or more imino groups, or one or more amino groups and one or more imino groups to a substrate for a hard disk, and polishing the substrate with a polishing pad.

13. The method according to claim **12**, wherein the abrasive is an alumina.

14. The method according to claim **12**, wherein the organic nitrogen-containing compound has a molecular weight of from 150 to 100000.

15. The method according to claim **12**, wherein the organic nitrogen-containing compound is contained in an amount of from 0.001 to 0.5% by weight of the polishing composition.

16. The method according to claim **12**, wherein the organic nitrogen-containing compound and the organic polybasic acid are contained in a weight ratio of the organic nitrogen-containing compound/the organic polybasic acid of from 1/10000 to 1/1.

17. The method according to claim **12**, further comprising an oxidizing agent.

18. The method according to claim **12**, wherein the polishing composition has a pH of from 1 to 7.

19. The method according to claim **12**, wherein a flow rate of the polishing composition is from 0.01 to 0.5 mL/minute per 1 cm^2 of the substrate.

20. The method according to claim **12**, wherein a polishing pressure is from 2 to 30 kPa.

21. A method for reducing surface stains on a substrate, comprising the steps of:

feeding a polishing composition comprising an organic nitrogen-containing compound, an organic polybasic acid, an abrasive, an oxidizing agent consisting essentially of hydrogen peroxide and water, wherein the organic nitrogen-containing compound is one or more members selected from the group consisting of polyalkyleneimines having a molecular weight of from 300 to 2000, diethylenetriamine, triethylenetetramine, tetraethylenepentamine, bis(3-aminopropyl)amine, and 1,3-propanediamine, and wherein the polishing composition has a pH of from 1 to 4 to a substrate to be polished at a flow rate of from 0.01 to 0.5 mL/minute per 1 cm^2 of the substrate, and

polishing the substrate with a polishing pad.

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