

CLEANING AGENT FOR ELECTRONIC MATERIAL

BACKGROUND OF THE INVENTION

5 1. Field of the Invention

[0001] The present invention generally relates to a cleaning agent for an electronic material, in particular, to a cleaning agent for an electronic material, such as, magnetic disk substrate, flat panel display substrate, and photomask substrate.

2. Description of Related Art

10 [0002] In the cleaning technique of electronic materials, such as, magnetic disk substrate, flat panel display substrate, and photomask substrate, trace impurities remained on the substrate during fabrication, such as, organic stains, glass cullets, and abrasive grains have great influence on the performance or yield of electronic materials, so impurity control becomes very important. Especially as the impurities as cleaning
15 object get more and more particlized, thus being more easily attached or remained on interfaces, such that a high-degree cleaning technique is required to be established urgently.

[0003] Therefore, in order to prevent the pollution caused by the particles, for example, in Japanese Patent Publication No. H11-43791, Japanese Patent Publication
20 No. 2001-276759, and Japanese Patent Publication No. 2002-212597, methods for improving particle removal effect with surfactants are disclosed.

[0004] However, the fabrication of magnetic disk substrate, especially, aluminum substrate, includes the following steps: plating Ni-P layer as non-magnetic layer on the

substrate surface; next polishing with alumina slurry and colloidal silica and mirror finishing; and then, optionally texturing the substrate surface with diamond slurry.

Thus, the following problem occurs: in the steps, the abrasive or polishing debris is attached on the substrate surface firmly and cannot be removed completely in the

5 cleaning step. Furthermore, the fabrication of magnetic disk substrate, especially glass substrate, includes the steps of polishing with ceria and mirror finishing, and the optional step of texturing the substrate surface with diamond slurry. Thus, the following problem occurs: in the steps, the abrasive or polishing debris is attached on the substrate surface firmly and cannot be removed completely in the cleaning step.

10 Furthermore, during the fabrication of flat panel display substrate or photomask substrate, the following problem occurs: the glass debris (generally called as glass cullet) generated on the mother glass when cutting into glass substrates of suitable size on demand, organic stains (such as processing oil) splashed in the clean room, or the abrasive or polishing debris used in the step of polishing the substrate surface or end
15 may be attached on the substrate surface firmly and cannot be removed completely in the cleaning step.

[0005] In order to completely remove the particles attached on the substrate surface firmly, represented with abrasive, polishing debris, and organic stains, it is necessary to etch the substrate surface or the abrasive surface slightly, such that the particles can be
20 dispersed into the liquid and will not be re-attached on the substrate surface as far as possible. In Japanese Patent Publication No. H11-43791, a method is disclosed, in which a cleaning agent composition containing a coagulant and a surfactant having an absorbing capacity to the abrasive of higher than or equal to 5 mg/m^2 and a number

average molecular weight of higher than or equal to 100,000 and having a surface tension of lower than or equal to 30 dyne/cm² in the form of 10 vol% aqueous solution is used to coagulate and coarsen the abrasive particulates as cleaning object, so as to prevent the particulates from being re-attached, but when a little coarsened particulates is attached on the substrate surface, some serious problems may be caused. Moreover, in Japanese Patent Publication No. H11-43791, the specific formulation of the ingredients of the cleaning agent composition is not described. Furthermore, the cleaning agent disclosed in Japanese Patent Publication No. 2001-276759 is a cleaning solution with hydrogen fluoride and ozone dissolved therein. Although the effect of removing the particles firmly attached on the substrate surface by etching with the cleaning agent can be realized, but the follow problems occur: great cost will be consumed in wastewater treatment due to fluoride ion contained in the cleaning solution; and the flatness of the substrate will be damaged during cleaning due to too strong etching capacity of the cleaning solution. Furthermore, the zeta potential of the glass substrate and the abrasive surface is made to be minus to prevent the particles from being re-attached, but the preventing effect is not adequate. Additionally, in the cleaning agent disclosed in Japanese Patent Publication No. 2002-212597, an anionic surfactant is used to improve the effect of preventing the particles from be re-attached to a certain degree, but as the cleaning agent almost doest not have etching capacity, the removal of the particles is not adequate, and the cleanliness is not adequate.

SUMMARY OF THE INVENTION

[0006] Accordingly, the present invention is directed to a cleaning agent for an

electronic material, such as, magnetic disk substrate, flat panel display substrate, and photomask substrate. The cleaning agent can appropriately etch the surface of the electronic material substrate, such as, magnetic disk substrate, flat panel display substrate, and photomask substrate without damaging the flatness of the substrate surfaces, and improves the dispersion of the particles departed from the substrate surface by using a surfactant, thus excellent particle removal effect is realized, thereby the manufacturing yield is improved, and high-degree cleaning with very high cleaning rate is achieved in a short time.

[0007] In order to solve the issues above, the inventors of the present invention conducted researches devotedly. As a result, the inventors found that, as the cleaning agent has different pH values when being used, desired oxidation reduction potential (ORP) exists, thus achieving the present invention.

[0008] The present invention includes the following contents:

[0009] (First Invention) A cleaning agent for an electronic material, contains a surfactant (A), and is characterized in that, at an active ingredient concentration when being used as cleaning solution and at 25°C, the pH value and the oxidation reduction potential (V) [in mV, vsSHE] meet Formula (1):

$$[0010] \quad V \leq -38.7 \times \text{pH value} + 550 \quad (1).$$

[0011] (Second Invention) A cleaning solution for an electronic material, contains a surfactant (A), and is characterized in that, at an active ingredient concentration of 0.01 wt% to 15 wt% (weight percentage) and at 25°C, the pH value and the oxidation reduction potential (V) [in mV, vsSHE] meet Formula (1):

$$[0012] \quad V \leq -38.7 \times \text{pH value} + 550 \quad (1).$$

[0013] (Third Invention) A method for cleaning an electronic material includes cleaning the electronic material in the cleaning solution above.

[0014] (Fourth Invention) A method for fabricating an electronic material includes cleaning the electronic material by the cleaning method above.

5 [0015] The cleaning agent of the present invention has the following advantages: having excellent cleanliness on the fine particles that cause problems during fabrication of an electronic material, such as, magnetic disk substrate (especially glass substrate for magnetic disk and aluminum substrate for magnetic disk after Ni-P plating), flat panel display substrate, and photomask substrate, and being capable of achieving
10 high-efficient cleaning in a short period of time without damaging the surface of the electronic material.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] No drawings.

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DESCRIPTION OF THE EMBODIMENTS

[0017] Reference will now be made in detail to the present embodiments of the invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to
20 refer to the same or like parts.

[0018] When the electronic material is a glass substrate for magnetic disk, a flat panel display substrate, or a photomask substrate, as for the cleaning agent of the First Invention of the present invention, at an active ingredient concentration when being

used cleaning solution and at 25°C, the pH value is preferably 1 to 13, more preferably 1 to 5 or 8 to 13, particularly preferably 1 to 4 or 9 to 13, and most preferably 1 to 3 or 10 to 13. When the pH value is in this range, the cleaning agent has suitable etching capacity and will not damage the flatness of the substrate, and exhibit excellent effect of preventing the fine particles from being re-attached. Similarly, in terms of the effect, when the electronic material is an aluminum substrate for magnetic disk substrate, the pH value is preferably 5 to 13, more preferably 6 to 12, particularly preferably 6.5 to 11, and most preferably 7 to 10.

[0019] Furthermore, especially when the material to be cleaned is ceria used in the grinding step or polishing step of the electronic material described hereinafter, the cleaning solution is preferably acidic, and when the material to be cleaned is alumina, colloidal silica, cerium oxide or diamond, the cleaning solution is preferably alkali.

[0020] The cleaning agent of the present invention contains a surfactant (A), and optionally contains water (preferably ion-exchange water or ultra-pure water, the water hereinafter is the same).

[0021] The active ingredient concentration of the cleaning agent of the present invention is generally 1 wt% to 100 wt%, preferably 2% to 50% (hereinafter, % presents wt% unless otherwise stated), and when the cleaning agent of the present invention is used as cleaning solution, it is generally diluted with water. Moreover, the active ingredient concentration of the cleaning agent of the present invention when being used as cleaning solution is preferably 0.01% to 15%, and more preferably 0.05% to 10%. Furthermore, when the active ingredient concentration of the cleaning agent is 1% to 15%, the cleaning agent can be directly used as cleaning solution at this concentration.

Additionally, the active ingredient in the present invention refers to the ingredients in addition to water.

[0022] In order to improve the cleanliness on electronic materials, the inventors of the present invention conducted researches devotedly on the relationship of various physical property values of the cleaning solution and the cleanliness. As a result, the inventors found that, the pH value and the oxidation reduction potential of the cleaning solution have great influence on the cleanliness. The inventors of the present invention accumulated a variety of data about the upper limit (upper limit to exert the effect) of the pH value and the oxidation reduction potential of the cleaning solution and analyzed.

As a result, the inventors found that, the cleaning agent provided with the following cleaning solution composition can exert significantly improved cleaning effect compared with the previous cleaning agents, that is, the cleaning solution exhibits the oxidation reduction potential (V) [at 25°C, in mV, vsSHE] meeting Formula (1):

$$[0023] \quad V \leq -38.7 \times \text{pH value} + 550 \quad (1).$$

[0024] For example, if the oxidation reduction potential (V) at pH value of 2 is lower than or equal to 472.6 mV, the (V) at pH value of 5 is lower than or equal to 356.5 mV, the (V) at pH value of 10 is lower than or equal to 163.0 mV, and the (V) at pH value of 13 is lower than or equal to 46.9 mV, the effect of the present invention can be exerted.

[0025] If the oxidation reduction potential (25°C) does not meet formula (1), the substrate surface will be etched significantly and the flatness of the surface is damaged, thus the particle removal effect is deteriorated, and the effect is undesired.

[0026] As for the suitable etching of the electronic material and the cleanliness on the particles, in the cleaning agent of the present invention, the cleaning agent meeting

Formula (2) is more preferable, and the cleaning agent meeting Formula (3) is particularly preferable.

[0027] $V \leq -38.7 \times \text{pH value} + 450$ (2)

[0028] $V \leq -38.7 \times \text{pH value} + 350$ (3)

5 [0029] According to the present invention, the oxidation reduction potential (V) can be determined by the following known methods.

[0030] <Determination of oxidation reduction potential>

[0031] An oxidation reduction potential composite electrode (for example, model: PST-5421C, TOA DKK Co., Ltd.) composed of a Pt electrode and a reference electrode
10 (AgCl electrode) is used to determine the potential of the cleaning solution at 25°C (V1). The potential (V1) and the unipolar potential difference of the reference electrode (AgCl electrode) (199 mV, 25°C) are added together to get the oxidation reduction potential (mV, vsSHE) of the cleaning solution. For example, when the potential (V1) is -100 mV, the oxidation reduction potential (mV, vsSHE) is $-100 + 199 = +99$ mV.

15 [0032] The necessary ingredient of the cleaning agent of the present invention is the surfactant (A), which includes, for example, nonionic surfactants (A-1), anionic surfactants (A-2), cationic surfactants (A-3), and amphoteric surfactants (A-4).

[0033] The nonionic surfactants (A-1) useful in the cleaning agent of the present invention include, for example, alkylene oxide addition nonionic surfactants (A-1a), and
20 polyol nonionic surfactants (A-1b).

[0034] The (A-1a) includes, for example, alkylene oxide (having 2-4 carbon atoms) (in which the addition mole number of each active hydrogen is 1-30) adducts of higher alcohols (having 8-18 carbon atoms), phenol ethylene oxide (in which the addition mole

number of each active hydrogen is 1-30) adducts of alkyls (having 1-12 carbon atoms), ethylene oxide (in which the addition mole number of each active hydrogen is 1-30) adducts of fatty acids (having 8-18 carbon atoms), alkylene oxide adducts (in which the addition mole number of each active hydrogen is 1-30) of aliphatic amines (having 6-24 carbon atoms), ethylene oxide (in which the addition mole number of each active hydrogen is 1-50) adducts of poly(propylene glycol) (having a molecular weight of 200-4000), and polyoxyethylene (in which the addition mole number of each active hydrogen is 1-30) alkyl (having 1-20 carbon atoms) allyl ethers, and ethylene oxide adducts (in which the addition mole number of each active hydrogen is 1-30) of fatty acid (having 8-24 carbon atoms) esters of polyols (having 2-8 or more hydroxyl groups and 2-30 carbon atoms), such as, ethylene oxide (in which the addition mole number is 1-30) adducts of sorbitan monolaurate, and ethylene oxide (in which the addition mole number is 1-30) adducts of sorbitan monooleate.

[0035] The (A-1b) includes, for example, fatty acid (having 8-24 carbon atoms) esters of polyols (having 2-8 or more hydroxyl groups and 2-30 carbon atoms), such as, glycerol monostearate, glycerol monooleate, sorbitan monolaurate, sorbitan monooleate, and fatty acid alkanolamides, such as, lauroyl monoethanolamide, and lauroyl diethanolamide.

[0036] In (A-1), in terms of cleanliness, (A-1a) is preferable, alkylene oxide (having 2-3 carbon atoms) (in which the addition mole number of each active hydrogen is 2-20) adducts of higher alcohols (having 10-16 carbon atoms), alkyl phenol ethylene oxide (in which the addition mole number of each active hydrogen is 2-20) adducts, and alkylene oxide adducts (in which the addition mole number of each active hydrogen is 2-20) of

aliphatic amines (having 8-18 carbon atoms) are more preferable.

[0037] The anionic surfactants (A-2) include, for example, polymer anionic surfactants (A-2a) and low-molecular anionic surfactants (A-2b).

[0038] The polymer anionic surfactants (A-2a) include, for example, polymer anionic
5 surfactants having at least one group selected from the group consisting of sulfonate group, sulfate group, phosphate group, phosphonate group, and carboxylate group and having a weight average molecular weight (Mw) of 1,000-800,000. The polymer anionic surfactant generally has at least two or more repeated units in one molecule. Examples of the polymer anionic surfactants (A-2a) include the following
10 (A-2a-1)-(A-2a-5).

[0039] (A-2a-1) is polymer anionic surfactants having a sulfonate group, and includes:

[0040] poly(styrene sulfonic acid), styrene/styrene sulfonic acid copolymer, poly{2-(meth)acryloyl amino-2,2-dimethylethanesulfonic acid}, 2-(meth)acryloyl
15 amino-2,2-dimethylethanesulfonic acid/styrene copolymer, 2-(meth)acryloyl amino-2,2-dimethylethanesulfonic acid/acrylamide copolymer, 2-(meth)acryloyl amino-2,2-dimethylethanesulfonic acid/(meth)acrylic acid copolymer, 2-(meth)acryloyl amino-2,2-dimethylethanesulfonic acid/(meth)acrylic acid/acrylamide copolymer, 2-(meth)acryloyl amino-2,2-dimethylethanesulfonic acid/styrene/acrylamide copolymer,
20 2-(meth)acryloyl amino-2,2-dimethylethanesulfonic acid/styrene/(meth)acrylic acid copolymer, naphthalenesulfonic acid and formaldehyde condensate, methylnaphthalenesulfonic acid and formaldehyde condensate, dimethylnaphthalenesulfonic acid and formaldehyde condensate, anthracene sulfonic

acid and formaldehyde condensate, melamine sulfonic acid and formaldehyde condensate, and aniline acid-phenol-formaldehyde condensate.

[0041] (A-2a-2) is polymer anionic surfactants having a sulfate group, and includes:

[0042] poly{2-hydroxyethyl (meth)acrylate sulfate}, 2-hydroxyethyl
5 acrylate/2-hydroxyethyl acrylate sulfate copolymer, and 2-hydroxyethyl
methacrylate/2-hydroxyethyl methacrylate sulfate copolymer, sulfate of
poly{2-hydroxyethyl (meth)acrylate}, poly{(meth)acryloxy polyoxyalkylene sulfate},
(meth)acryloxy polyoxyalkylene sulfate/acrylic acid copolymer, and sulfates of cellulose,
methyl cellulose, or ethyl cellulose.

10 [0043] (A-2a-3) is polymer anionic surfactant having a phosphate group, and
includes:

[0044] poly{2-hydroxyethyl (meth)acrylate phosphate}, 2-hydroxyethyl
acrylate/2-hydroxyethyl acrylate phosphate copolymer, and 2-hydroxyethyl
methacrylate/2-hydroxyethyl methacrylate phosphate copolymer, phosphate of
15 poly{2-hydroxyethyl (meth)acrylate}, poly{(meth)acryloxy polyoxyalkylene phosphate},
(meth)acryloxy polyoxyalkylene phosphate/acrylic acid copolymer, and phosphate of
cellulose, methyl cellulose, or ethyl cellulose.

[0045] (A-2a-4) is polymer anionic surfactant having a phosphonate group, and
includes:

20 [0046] poly{(meth)acryloxyethyl phosphonate}, 2-hydroxyethyl
acrylate/acryloxyethyl phosphonate copolymer, and 2-hydroxyethyl
methacrylate/methacryloxyethyl phosphonate copolymer, naphthalenephosphonic acid
formaldehyde condensate, methylnaphthalenephosphonic acid formaldehyde condensate,

dimethylnaphthalenephosphonic acid formaldehyde condensate, anthracenephosphonic acid formaldehyde condensate, and anilinephosphonic acid-phenol-formaldehyde condensate.

[0047] (A-2a-5) is polymer anionic surfactant having a carboxylate group, and
5 includes:

[0048] poly(meth)acrylic acid, (meth)acrylic acid-cis-butenedioic acid copolymer, (meth)acrylic acid-methylene succinic acid copolymer, (meth)acrylic acid-trans-butenedioic acid copolymer, (meth)acrylic acid/vinyl acetate copolymer, and 2-hydroxyethyl methacrylate/(meth)acrylic acid copolymer, carboxymethylate of
10 poly{2-hydroxyethyl (meth)acrylate}, carboxymethyl cellulose, carboxymethyl methyl cellulose, carboxymethyl ethyl cellulose, benzoic acid formaldehyde condensate, and benzoic acid-phenol-formaldehyde condensate.

[0049] In terms of preventing the particles from being re-attached and low foaming, the Mw of the polymer anionic surfactants (A-2a) is preferably 1,000-800,000, more
15 preferably 1,200-400,000, particularly preferably 1,500-80,000, and most preferably 2,000-40,000. The Mw of the present invention is determined with a gel-permeation chromatography (GPC) at 40°C with poly(ethylene oxide) as standard material. Particularly, for example, the following equipment is used to perform the determination, that is, equipment: HLC-8120 (manufactured by Tosoh Co., Ltd.); column: TSKgel
20 α 6000, G3000 PWXL, manufactured by Tosoh Co., Ltd.; detector: differential refraction detector, installed in the equipment; eluate: 0.5% sodium acetate-water/methanol (volume ratio of 70/30); eluate flowing rate: 1.0 ml/min; column temperature: 40°C; sample: 0.25% eluate solution; injection volume: 200 μ l; standard material: TSK

STANDARD POLYETHYLENE OXIDE, manufactured by Tosoh Co., Ltd.; data processing software: GPC-8020 model II (manufactured by Tosoh Co., Ltd.).

[0050] The low-molecular anionic surfactants (A-2b) include, for example, anionic surfactants having a molecular weight (Mw or molecular weight calculated based on the structure) lower than 1,000, such as, low-molecular sulfonate surfactants (A-2b-1),
5 low-molecular sulfurate surfactants (A-2b-2), low-molecular fatty acid surfactants (A-2b-3), and low-molecular phosphate surfactants (A-2b-4).

[0051] The sulfonate surfactants (A-2b-1) in the anionic surfactant include, for example, sulfosuccinate (mono-, di-) ester (salt) of alcohols having 6-24 carbon atoms,
10 sulfonate of α -olefins having 8-24 carbon atoms, alkylbenzenesulfonate of alkyls having 8-14 carbon atoms, petroleum sulfonate, toluenesulfonate, xylenesulfonate, and isopropylbenzenesulfonate. The sulfonate surfactants (A-2b-1) in the anionic surfactant include, for example, dioctylsulfosuccinic acid (salt), p-toluenesulfonic acid (salt), o-toluenesulfonic acid (salt), m-xylenesulfonic acid (salt), and p-xylenesulfonic
15 acid (salt).

[0052] The low-molecular sulfurate surfactants (A-2b-2) include, for example, sulfate of aliphatic alcohols having 8-18 carbon atoms, sulfate of ethylene oxide 1 mole-10moles adduct of aliphatic alcohols having 8-18 carbon atoms, sulfonated oil (salt), sulfated fatty acid ester (salt), and sulfated olefin (salt). The low-molecular
20 sulfurate surfactants (A-2b-2) include, for example, 2-ethyl hexanol sulfate, octanol sulfate, 1,10-decanediol disulfate, and disulfate of ethylene oxide (5 mole) adduct of lauryl alcohol.

[0053] The low-molecular fatty acid surfactants (A-2b-3) include, for example, salts

of fatty acids having 8-18 carbon atoms, and ether carboxylate of aliphatic alcohols having 8-18 carbon atoms. The low-molecular fatty acid surfactants (A-2b-3) include, for example, n-octanoate, 2-ethyl hexanoate, n-nonanoate, iso-nonanoate, oleate, and stearate.

5 [0054] The low-molecular phosphate surfactants (A-2b-4) include, for example, phosphate (mono-, di-) ester (salt) of higher alcohols having 8-24 carbon atoms, and phosphate (mono-, di-) ester (salt) of ethylene oxide adducts of higher alcohols having 8-24 carbon atoms. The low-molecular phosphate surfactants (A-2b-4) include, for example, lauryl alcohol monophosphate, phosphate monoester (salt) of ethylene oxide
10 (5 mole) adduct of lauryl alcohol, and octanol diphosphate.

[0055] The counter ion is not particularly limited when forming salt with (A-2), and general includes: alkali metal (sodium and potassium) salts, ammonium salts, salts of primary amines (alkyl amines, such as, methylamine, ethylamine, and butylamine, monoethanolamine, and guanidine, salts of secondary amine (dialkyl amines, such as,
15 dimethylamine, diethylamine, and dibutylamine, and diethanolamine, salts of tertiary amines {trialkylamines, such as, trimethylamine, triethylamine, and tributylamine, triethanolamine, N-methyldiethanolamine, and 1,8-diazabicyclo[5,4,0]-7-undecene (DBU), 1,5-diazabicyclo[4.3.0]-5-nonene (DBN), or 1,4-diazabicyclo[2,2,2]octane (DABCO), 1H-imidazole, 2-methyl-1H-imidazole, 2-ethyl-1H-imidazole,
20 4,5-dihydro-1H-imidazole, 2-methyl-4,5-dihydro-1H-imidazole, 1,4,5,6-tetrahydropyrimidine, 1,6(4)-dihydropyrimidine}, and quaternary ammonium salts (tetraalkyl ammonium). Among the salts, in terms of the metal pollution on the substrate, ammonium salts, primary ammonium salts, secondary ammonium salts,

tertiary ammonium salts, and quaternary ammonium salts are preferable, tertiary ammonium salts and quaternary ammonium salts are particularly preferable, and salts of DBU, DBN, DABCO, N-methdiethanolamine, 1H-imidazole, 2-methyl-1H-imidazole, and 2-ethyl-1H-imidazole are the most preferable.

5 [0056] In terms of preventing the particles from being re-attached, among the anionic surfactants (A-2), polymer anionic surfactants (A-2a), low-molecular sulfonate surfactants (A-2b-1), low-molecular sulfurate surfactants (A-2b-2), and low-molecular fatty acid surfactants (A-2b-3) are preferable, (A-2a), (A-2b-1), and (A-2b-2) are more preferable, and polyacrylate, poly(styrene sulfonic acid) (salt), salt of
10 naphthalenesulfonic acid formalin condensate, salt of acrylamide-2-methylpropanesulfonic acid/acrylic acid copolymer, salt of methacryloxy polyoxyethylene sulfate/acrylic acid copolymer, octylbenzenesulfonic acid (salt), p-toluenesulfonate, m-xylenesulfonate, and 2-ethylhexanol sulfate are particularly preferable.

15 [0057] (A-2) can be used alone, and can also be used in combination of two or more. In terms of the dispersion of the particles, more preferably two or more are used in combination.

[0058] The cationic surfactants (A-3) include, for example, quaternary ammonium salt-type surfactants (A-3a) {such as, alkyl (having 1-30 carbon atoms)
20 trimethylammonium salts, dialkyl (having 1-30 carbon atoms) dimethylammonium salts, nitrogen ring-containing quaternary ammonium salts, quaternary ammonium salt containing poly(in which the addition mole number is 2-15)oxyethylene (having 2-4 carbon atoms) chain, alkyl (having 1-30 carbon atoms) amide alkyl (having 1-10 carbon

atoms) dialkyl (having 1-4 carbon atoms) methylammonium salt}, and amine-based surfactants (A-3b) {such as, inorganic salts or organic salts of aliphatic tertiary amine having 3-90 carbon atom, alicyclic (containing nitrogen-containing heterocycle) tertiary amine having 3-90 carbon atoms, and hydroxylalkyl-containing tertiary amine having
5 3-90 carbon atoms}.

[0059] The amphoteric surfactants (A-4) include, for example, betaine type amphoteric surfactants (A-4a) {such as, alkyl (having 1-30 carbon atoms) dimethylbetaine type, alkyl (having 1-30 carbon atoms)amide alkyl (having 1-4 carbon atoms)dimethylbetaine type, alkyl (having 1-30 carbon atoms) dihydroxylalkyl (having
10 1-30 carbon atoms) betaine type, sulfo betaine type}; amino acid type amphoteric surfactants (A-4b) {such as, alanine type [alkyl (having 1-30 carbon atoms)aminopropanoic acid type, alkyl (having 1-30 carbon atoms) iminodipropionic acid type], glycine type [alkyl (having 1-30 carbon atoms) amino acetic acid type]}; and aminosulfonate type amphoteric surfactants (A-4c) {such as, alkyl (having 1-30 carbon
15 atoms) taurine type amphoteric surfactants.

[0060] In terms of preventing the particles from being re-attached, as for the surfactant (A), the anionic surfactants (A-2), and nonionic surfactants (A-1) and (A-2) in combination are preferably, and (A-1) and (A-2) in combination are more preferably. In terms of the cleanliness and foaming property, the containing ratio of (A-1) and (A-2)
20 $[(A-1)/(A-2)]$ when being used in combination is preferably lower than or equal to 6, more preferably 0.1 to 5, and particularly preferably 0.2 to 0.8.

[0061] Based on the weight of the active ingredient of the cleaning agent of the present invention, the content of the surfactant (A) in the cleaning agent of the present

invention is preferably 1.5% to 100%, more preferably 2 to 90%, and particularly preferably 3 to 80%.

[0062] In addition to surfactant (A), the cleaning agent of the present invention can further contain one or more ingredients selected from the group consisting of chelating agent (B), reductant (C), and alkaline ingredient (D).

[0063] When the cleaning agent of the present invention contains a chelating agent (B), the cleanliness on the surface of the electronic material is improved, and the etching is controllable, thus being more preferable. Furthermore, by containing a reductant (C), the cleaning agent of the present invention can control the etching on the surface of the electronic material, thus more preferably containing the reductant (C). The cleaning agent of the present invention can further improve the cleanliness on particles by containing an alkaline ingredient (D).

[0064] The chelating agent (B) includes, for example, amino-polycarboxylic acid (salt) (B-1) {such as, ethylenediaminetetraacetic acid (EDTA) (salt), diethylenetriaminepentaacetic acid (DTPA) (salt), triethylenetetraaminehexaacetic acid (TTHA) (salt), hydroxyethylethylenediaminetriacetic acid (HEDTA) (salt), dihydroxyethyl ethylenediaminetetraacetic acid (DHEDDA) (salt), nitrilotriacetic acid (NTA) (salt), hydroxyethyliminodiacetic acid (HIDA) (salt), β -propylamine acid diacetic acid (salt), aspartic acid diacetic acid (salt), methylglycine diacetic acid (salt), iminodisuccinic acid (salt), serine diacetic acid (salt), hydroxyl iminodisuccinic acid (salt), dihydroxyethyl glycine (salt), aspartic acid (salt), and glutamic acid (salt)};

[0065] hydroxycarboxylic acid (salt) (B-2) {such as, hydroxyacetic acid (salt), tartaric acid (salt), citric acid (salt), and gluconic acid (salt)};

[0066] cyclocarboxylic acid (salt) (B-3) {such as, pyromellitic acid (salt) benzopoly-carboxylic acid (salt), and cyclopentanetetracarboxylic acid (salt)};

[0067] ether carboxylic acid (salt) (B-4) (such as, carboxymethyl tartronate, carboxymethoxy succinate, oxy disuccinate, tartaric acid monosuccinate, and tartaric
5 acid disuccinate;

[0068] other carboxylic acid (salt) (B-5) {such as, maleic acid derivative, and oxalic acid (salt)};

[0069] phosphonic acid (salt) (B-6) {such as, methyldiphosphonic acid (salt), aminotri(methylenephosphonic acid) (salt), 1-hydroxyethylene-1,1-diphosphonic acid
10 (salt), ethylenediaminetetra(methylenephosphonic acid) (salt), 1,6-hexanediaminetetra(methylenephosphonic acid) (salt), propanediaminetetra(methylenephosphonic acid) (salt), diethylenetriaminepenta(methylenephosphonic acid) (salt), triethylenetetraaminehexa(methylenephosphonic acid) (salt),
15 triaminotriethyleneaminehexa(methylenephosphonic acid) (salt), trans-1,2-cyclohexanediaminetetra(methylenephosphonic acid) (salt), ethylenebis(oxyethylenenitrilo)tetra(methylenephosphonic) (salt), and tetraethylenepentaaminehepta(methylenephosphonic acid) (salt)}; and

[0070] condensed phosphoric acid (salt) (B-7) {such as, metaphosphoric acid (salt),
20 triphosphoric acid (salt), hexametaphosphoric acid (salt)}.

[0071] Furthermore, the salt of the acids include, for example, the salts exemplified in anionic surfactants (A-2). Moreover, the chelating agents (B) can be used alone, or used in combination of two or more.

[0072] Among the chelating agents (B), in terms of etching control of the substrate and cleanliness, (B-1), (B-2), (B-6), (B-7) and salts thereof are preferable, (B-1), (B-6), (B-7) and salts thereof are more preferably, ethylenediaminetetraacetic acid (salt) (EDTA), diethylenetriaminepentaacetic acid (salt) (DTPA), dihydroxyethyl
5 ethylenediaminetetraacetic acid (salt) (DHEDDA), aspartic acid diacetic acid (salt), aspartic acid (salt), glutamic acid (salt), 1-hydroxyethylene-1,1-diphosphonic acid (salt), ethylenediaminetetra(methylenephosphonic acid) (salt), metaphosphoric acid (salt), hexametaphosphoric acid (salt), and most preferably ethylenediaminetetraacetic acid (salt) (EDTA), 1-hydroxyethylene-1,1-diphosphonic acid (salt), and
10 hexametaphosphoric acid (salt) are particularly preferable.

[0073] When using a chelating agent (B), in terms of etching control of the substrate and cleanliness, based on the weight of the active ingredient of the cleaning agent of the present invention, the content of the chelating agent (B) is preferably lower than or equal to 30%, more preferably 0.1% to 20%, and particularly preferably 0.3% to 20%.

15 [0074] The reductant (C) includes, for example, organic reductant (C-1) and inorganic reductant (C-2). The organic reductant (C-1) includes, for example, aliphatic organic reductants (C-1a), aromatic organic reductants (C-1b), and other organic reductants (C-1c), and can be exemplified by the following reductants.

[0075] The aliphatic organic reductants (C-1a) include, for example, organic acids
20 having 1-12 carbon atoms, aldehydes having 1-12 carbon atoms, reductones having 6-9 carbon atoms, and aliphatic amines having 1-30 carbon atoms.

[0076] The organic acids having 1-12 carbon atoms include, for example, formic acid, acetic acid, succinic acid, lactic acid, malic acid, butyric acid, maleic acid,

2-oxo-propionic acid, malonic acid, gallic acid, and salts thereof. Furthermore, the (B-2) and (B-5) also have the effect of reductant.

[0077] The aldehydes having 1-12 carbon atoms include, for example, formaldehyde, acetaldehyde, propionaldehyde, and ethylene aldehyde.

5 [0078] The reductones having 6-9 carbon atoms include, for example, L-ascorbic acid, isoascorbic acid, L-ascorbyl sulfate, L-ascorbyl phosphate, L-ascorbyl 2-glucoside, L-ascorbyl palmitate, L-ascorbyl tetraisopalmitate, ascorbyl isopalmitate, erythorbic acid, erythorbyl phosphate, erythorbyl palmitate, erythorbyl tetraisopalmitate, and salts thereof.

10 [0079] The aliphatic amines having 1-30 carbon atoms include, for example, alkylamines having 1-6 carbon atoms, alkanol amines having 2-6 carbon atoms, alkyldiamines having 2-5 carbon atoms, cycloamines having 4-10 carbon atoms, amidine compounds having 3-15 carbon atoms, and poly(n-2-5)alkylene(having 2-6 carbon atoms)poly(n-3-6)amines having 4-30 carbon atoms.

15 [0080] The alkylamines having 1-6 carbon atoms include, for example, monoalkylamine {methylamine, ethylamine, propylamine, isopropylamine, butylamine, and hexylamine}, and dialkylamine having 2-6 carbon atoms {dimethylamine, ethylmethylamine, propylmethylamine, butylmethylamine, diethylamine, propylethylamine, and diisopropylamine}.

20 [0081] The alkanol amines having 2-6 carbon atoms include, for example, monoethanolamine, diethanolamine, triethanolamine, dimethylaminoethanol, diethylaminoethanol, N-methyl-diethanolamine, 2-amino-2-methyl-1-propanol, N-(aminoethyl)ethanolamine, N,N-dimethyl-2-aminoethanol, and

2-(2-aminoethoxy)ethanol.

[0082] The alkyldiamines having 2-5 carbon atoms include, for example, ethylenediamine, 1,3-propanediamine, 1,4-butanediamine, and 1,6-hexanediamine.

[0083] The cycloamines having 4-10 carbon atoms include, for example, piperidine,
5 piperazine, and 1,4-diazabicyclo[2.2.2]octane (DABCO).

[0084] The amidine compounds having 3-15 carbon atoms include, for example, 1,8-diazabicyclo[5.4.0]-7-undecene (DBU), 1,5-diazabicyclo[4.3.0]-5-nonene (DBN).

[0085] The poly(n-2-5)alkylene(having 2-6 carbon atoms)poly(n-3-6)amines having 4-30 carbon atoms include, for example, diethylenetriamine, triethylenetetraamine,
10 tetraethylenepentaamine, hexamethylheptaamine, iminobispropylamine, bis(hexamethylene)triamine, and pentaethylhexaamine.

[0086] The aromatic organic reductants (C-1b) include, for example, aromatic aldehydes having 7-12 carbon atoms, aromatic amines having 6-9 carbon atoms, and phenolic compounds having 6-30 carbon atoms.

15 [0087] The aromatic aldehydes having 7-12 carbon atoms include, for example, benzaldehyde and cinnamaldehyde.

[0088] The aromatic amines having 6-9 carbon atoms include, for example, p-phenylenediamine and p-aminophenol.

[0089] The phenolic compounds having 6-30 carbon atoms include, for example,
20 monohydric phenol and polyphenol. The monohydric phenol includes, for example, 3-hydroxy flavone, and tocopherol (α -, β -, γ -, δ -, ϵ -, or η -tocopherol). The polyphenol includes, for example, 3,4,5-trihydroxybenzoic acid, pyrocatechol, resorcinol, hydroquinone, naphthoresorcinol, pyrogallol, and phloroglucinol.

[0090] The other organic reductants (C-1c) include, for example, phosphorus-containing reductant (such as, tri-2-carboxylethylphosphine), borane complexes (such as, borane-tert-butylamine complex, borane-N,N-diethyl aniline complex, and borane-trimethylamine complex), thiol reductants (such as, L-cysteine and
5 aminoethanethiol), and hydroxylamine reductants {such as, hydroxylamine and diethylhydroxylamine). Furthermore, saccharides and saccharide alcohols exemplified hereinafter as (F3) and (F4) also have the effect of organic reductants.

[0091] The inorganic reductants (C-2) include, for example, oxo acids of sulfur {such as, sulfurous acid (salt), disulfurous acid (salt), dithionous acid (salt), thiosulfuric acid
10 (salt), dithionic acid (salt), and polythionic acid (salt)}, oxo acids of phosphorus {such as, phosphoric acid (salt), hydro-phosphoric acid (salt), and hypophosphorous acid (salt)}, and other inorganic reductants (ferrous sulfate, tin chloride, sodium cyanoborohydride, and sodium borohydride).

[0092] The salt for forming the reductants (C) can be the same as those exemplified in
15 (A-2).

[0093] In terms of controlling the etching of the cleaning agent and preventing the ions in the cleaning agent from causing re-pollution of the substrate, among the reductants (C), aldehydes having 1-12 carbon atoms, reductones having 6-9 carbon atoms, aliphatic amines having 1-30 carbon atoms, thiol reductant, oxo acids of sulfur, and oxo acids of phosphorus are preferable, formaldehyde, L-ascorbic acid (salt),
20 isoascorbic acid (salt), erythorbic acid (salt), monoethanolamine, diethanolamine, N-methyl-diethanolamine, L-cysteine, aminoethanethiol, sulfurous acid (salt), disulfurous acid (salt), dithionous acid (salt), thiosulfuric acid (salt), phosphoric acid

(salt), hydro-phosphoric acid (salt), and hypophosphorous acid (salt) are more preferable, and L-ascorbic acid (salt), L-cysteine, sulfurous acid (salt), dithionous acid (salt), phosphoric acid (salt), hydro-phosphoric acid (salt), and hypophosphorous acid (salt) are particularly preferable.

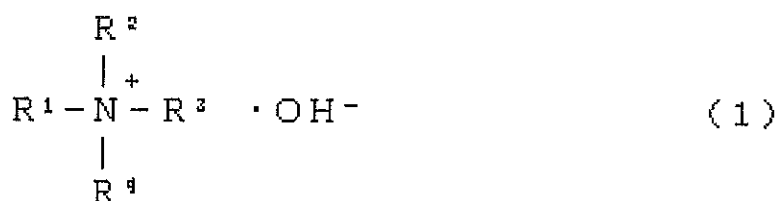
5 [0094] The counter ion is not particularly limited when forming salts with (C), and the counter ions exemplified in (A-2) can be used.

[0095] Moreover, (C) can be used alone, and can also be used in combination of two or more.

[0096] When the cleaning agent of the present invention contains a reductant (C),
10 based on the weight of the active ingredients of the cleaning agent, the content of the reductant (C) is preferably lower than or equal to 60%, more preferably 1% to 50%, and particularly preferably 2% to 40%.

[0097] The content in the range is desired, in terms of controlling the etching of the substrate.

15 [0098] The alkaline ingredients (D) include, for example, quaternary ammonium salts (D-1) represented by Formula (1), ammonia (D-2), aliphatic amines (D-3) having 1-30 carbon atoms exemplified in the aliphatic organic reductant (C-1a), inorganic bases (D-4), and mixtures thereof. Furthermore, the aliphatic amines (D-3) having 1-10 carbon atoms has two effects, that is, the effect of reductant and the effect of alkaline
20 ingredient.



[0099]

[00100] in which, R^1 , R^2 , R^3 , and R^4 individually represents alkyl having 1-24 carbon atoms or a group expressed by $-(R^5O)r-H$, R^5 represents alkylene having 2-4 carbon atoms, and r represents an integer of 1-6.

5 [00101] The alkyl having 1-24 carbon atoms includes, for example, methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, octadecyl, nonadecyl, eicosyl, heneicosyl, docosyl, tricosyl, and tetracosyl. The alkylene having 2-4 carbon atoms includes, for example, ethylene, propylene, and butylene. The r is preferably 1-3.

10 [00102] The quaternary ammonium salts (D-1) include, for example, tetramethyl ammonium hydroxide, trimethylethyl ammonium hydroxide, tetraethyl ammonium hydroxide, triethylmethyl ammonium hydroxide, tetrapropyl ammonium hydroxide, tetrabutyl ammonium hydroxide, tetrapentyl ammonium hydroxide, tetrahexyl ammonium hydroxide, trimethylethyl ammonium hydroxide, and tetraethyl ammonium
 15 hydroxide, hydroxyethyltrimethyl ammonium hydroxide, hydroxyethyltriethyl ammonium hydroxide, dihydroxyethyldimethyl ammonium hydroxide, and trihydroxyethylmethyl ammonium hydroxide.

[00103] The inorganic bases (D-4) include, for example, lithium hydroxide, sodium hydroxide, and potassium hydroxide.

20 [00104] In terms of cleanliness, among (D), quaternary ammonium salts (D-1) and

aliphatic amines having 1-30 carbon atoms (D-3) are preferable, and tetramethyl ammonium hydroxide, trimethylethyl ammonium hydroxide, tetraethyl ammonium hydroxide, triethylmethyl ammonium hydroxide, monoethanolamine, diethanolamine, triethanolamine, N-methyl-diethanolamine, DBU, DBN, and combinations thereof are
5 more preferable.

[00105] When the cleaning agent of the present invention contains an alkaline ingredient (D), in terms of the cleanliness, based on the weight of the active ingredient of the cleaning agent of the present invention, the content of (D) is preferably lower than or equal to 40%, more preferably 2% to 30%, and particularly preferably 3% to 25%.

10 [00106] The cleaning agent of the present invention preferably contains one or more compounds selected from the group consisting of chelating agent (B), reductant (C), and alkaline ingredient (D), more preferably (B) and (C) together, or (B), (C), and (D) together.

[00107] When the cleaning agent of the present invention contains the chelating agent (B) and the reductant (C), the content of the chelating agent (B) and the reductant (C) is
15 preferably in the following range, based on the weight of surfactant (A), the chelating agent (B) is 0.1% to 60%, and the reductant (C) is 0.1% to 20%, more preferably, the chelating agent (B) is 1% to 33%, and the reductant (C) is 0.5% to 13%, and particularly preferably, the chelating agent (B) is 3% to 27%, and the reductant (C) is 1% to 8%.

20 [00108] In addition to surfactant (A), water, chelating agent (B), reductant (C), and alkaline ingredient (D), the cleaning agent of the present invention can further contain one or more ingredients selected from the group consisting of dispersant (E), polyol of triol or higher (F), water-soluble organic solvent (G), and other additives (H) in the

range of having no damage on the effect of the cleaning agent of the present invention.

[00109] The dispersant (E) includes, for example, particulate dispersant used in previous, such as, polysaccharide and derivatives thereof (hydroxyethyl cellulose, cationized cellulose, hydroxymethyl cellulose, hydroxypropyl cellulose, guar gum, cationized guar gum, xanthan gum, alginate, cationized starch); poval and phosphate [phytic acid, di(polyoxyethylene)alkyl ether phosphate, tri(polyoxyethylene)alkyl ether phosphate]. Furthermore, the polymer anionic surfactants (A-2a) also have the effect of dispersant.

[00110] When the cleaning agent of the present invention contains the dispersants (E), based on the weight of the active ingredient of the cleaning agent of the present invention, the content of the dispersants (E) is preferably lower than or equal to 10%, more preferably lower than or equal to 8%, and particularly preferably lower than or equal to 5%.

[00111] The polyol of triol or higher (F) includes, for example, the following (F1)-(F5);

[00112] (F1) aliphatic polyols (such as, glycerol, trimethylol ethane, trimethylol propane, and pentaerythritol);

[00113] (F2) dehydration condensates of (F1) (such as, diglycerol, triglycerol, tetraglycerol, and pentaglycerol);

[00114] (F3) saccharides, such as, mono-saccharides {pentose (arabinose, xylose, ribose, xylulose, ribulose), hexose (glucose, mannose, galactose, fructose, sorbose, tagatose), and heptose (sedoheptulose)}, disaccharides (trehalose, saccharose, maltose, cellobiose, gentiobiose, lactose), and trisaccharides (raffinose, maltotriose);

[00115] (F4) saccharide alcohols (such as, arabitol, adonitol, xylitol, sorbitol, mannitol, dulcitol);

[00116] (F5) triphenol (such as, triphenol PA); and

[00117] alkylene oxide (having 2-4 carbon atoms) adducts (in which the addition mole
5 number is 1 mole to 7 moles) thereof.

[00118] Furthermore, polyol of triol or higher (F) can be used alone, and can also be used in combination of two or more.

[00119] In terms of the effect of preventing the substrate from being eroded, among the polyols of triol or higher (F), (F1), (F2), (F3), and (F4) are preferable, glycerol,
10 saccharose and sorbitol are more preferable.

[00120] When the cleaning agent of the present invention contains a polyol of triol or higher (F), based on the weight of the active ingredients of the cleaning agent, the content of the polyol of triol or higher (F) is preferably lower than or equal to 30%, more preferably lower than or equal to 20%, particularly preferably lower than or equal
15 to 10%.

[00121] The water-soluble organic solvents (G) include, for example, organic solvents having a solubility in water at 20°C (g/100 g H₂O) of higher than or equal to 3, and preferably higher than or equal to 10.

[00122] The organic solvents include, for example, sulfoxides {dimethylsulfoxide, sulfolane, butyl sulfone, 3-methyl cyclobutyl sulfone, 2,4-dimethyl sulfolane}; sulfones {dimethyl sulfone, diethyl sulfone, bis(2-hydroxyethyl)sulfone}; amide
20 {N,N-dimethylformamide, N-methylformamide, N,N-dimethylacetamide, N,N-dimethylpropanamide}; lactams {N-methyl-2-pyrrolidone, N-ethyl-2-pyrrolidone,

N-hydroxymethyl-2-pyrrolidone}; lactones { β -propiolactone, β -butyrolactone, γ -butyrolactone, γ -valerolactone, δ -valerolactone}; alcohols {methanol, ethanol, isopropanol}; glycols and glycol ethers {ethylene glycol, ethylene glycol monomethyl ether, triethylene glycol monomethyl ether, ethylene glycol monoethyl ether, diethylene glycol, diethylene glycol monomethyl ether, diethylene glycol monoethyl ether, diethylene glycol butyl ether, diethylene glycolmonohexyl ether, propylene glycol, propylene glycol monomethyl ether, dipropylene glycol monomethyl ether, 1,3-butylene glycol, diethylene glycol dimethyl ether, diethylene glycol diethyl ether, triethylene glycol dimethyl ether, triethylene glycol diethyl ether}; oxazolidinone (N-methyl-2-oxazolidinone), 3,5-dimethyl-2-oxazolidinone}; nitriles (acetonitrile, propionitrile, butyronitrile, acrylonitrile, methyl acrylonitrile, benzonitrile); carbonate (ethylene carbonate, propylene carbonate); ketones (acetone, diethyl ketone, acetophenone, methyl ethyl ketone, cyclohexanone, cyclopentanone, di acetone alcohol); cyclic ether (tetrahydrofuran, tetrahydropyran).

[00123] Furthermore, the water-soluble organic solvents (G) can be used alone, and can also be used in combination of two or more.

[00124] In terms of cleanliness and preventing the ingredients in the cleaning agent from being remained on the surface of the electronic material, among the water-soluble organic solvents (G), glycols and glycol ethers are preferable, and ethylene glycolmonomethyl ether, diethylene glycolmonomethyl ether, triethylene glycolmonomethyl ether, diethylene glycol butyl ether, and diethylene glycolmonohexyl ether are more preferable.

[00125] When the cleaning agent of the present invention contains a water-soluble

organic solvent (G), based on the weight of the active ingredients of the cleaning agent, the content of the water-soluble organic solvent (G) is preferably lower than or equal to 80%, more preferably lower than or equal to 50%, and particularly preferably lower than or equal to 20%.

5 [00126] The other additives (H) include, for example, anti-oxidant, corrosion resistant, pH value regulator, buffer, defoamer, preservative, and hydrotropic agent.

[00127] The anti-oxidant includes, for example, phenol anti-oxidant {2,6-di-tert-butyl phenol, 2-tert-butyl-4-methoxy phenol, 2,4-dimethyl-6-tert-butyl phenol}; amine anti-oxidant {monoalkyldiphenylamine, such as, monooctyldiphenylamine, 10 monononyldiphenylamine; dialkyldiphenylamine, such as, 4,4'-dibutyldiphenylamine, 4,4'-dipentyldiphenylamine; polyalkyldiphenylamine, such as tetrabutyl diphenylamine, tetrahexyldiphenylamine; and naphthylamine, such as, α -naphthylamine, phenyl- α -naphthylamine}; sulfur-containing compounds {phenothiazine, pentaerythritol-tetra(3-laurylthiopropionate), bis(3,5-tert-butyl-4-hydroxybenzyl)sulfur 15 ether}; phosphorus-containing anti-oxidant {bis(2,4-di-tert-butylphenyl)pentaerythritol diphosphite, phenyldiisodecyl phosphite, diphenyldiisooctyl phosphite, triphenyl phosphite}.

[00128] The anti-oxidants can be used alone, and can also be used in combination of two or more.

20 [00129] The corrosion resistant includes, for example, nitrogen-containing organic corrosion resistant, such as, benzotriazole, tolyltriazole, alkyl (having 2-10 carbon atoms) benzotriazole, benzimidazole, alkyl (having 2-20 carbon atoms) imidazole, alkyl (having 2-20 carbon atoms) thiazole, 2-mercaptobenzothiazole; alkyl or alkenyl

succinate, such as, dodecenyl succinate half-ester, octadecenyl succinic anhydride, dodecenyl succinamic acid amide; polyol partial ester, such as, sorbitan monooleate, glycerol monooleate, pentaerythritol monooleate.

[00130] The corrosion resistant can be used alone, and can also be used in combination
5 of two or more.

[00131] The pH value modifier includes, for example, inorganic acid (hydrochloric acid, sulfuric acid, nitric acid, sulfamic acid, and phosphoric acid), and the inorganic bases (D-4) exemplified above. The pH value modifiers can be used alone, and can also be used in combination of two or more.

10 [00132] As for the buffer, organic acids or inorganic acids having buffering effect and salts thereof can be used.

[00133] The organic acids include, for example, the organic acids having 1-12 carbon atoms exemplified in the aliphatic organic reductant (C-1a), and the inorganic acids include, for example, phosphoric acid and boric acid. Furthermore, the salts of the
15 acids include, for example, the salts as the same as those exemplified in the anionic surfactants (A-2).

[00134] The buffers can be used alone, and can also be used in combination of two or more.

[00135] The defoamer includes, for example, silicone defoamers {the defoamers with
20 dimethylsilicone, fluorosilicone, polyethersilicone as composition}. The defoamers can be used alone, and can also be used in combination of two or more.

[00136] The preservative includes, for example, triazine derivatives {such as, hexahydro-1,3,5-tris(2-hydroxyethyl)-s-triazine}, isothiazoline derivatives {such as,

1,2-benzisothiazoline-3-one, 2-methyl-4-isothiazoline-3-one,
5-chloro-2-methyl-4-isothiazoline-3-one}, pyridine derivatives {such as, pyridine,
2-pyridinethiol-1-oxide (salt)}, morpholine derivatives {such as, 4-(2-nitrobutyl)
morpholine, 4,4-(2-ethyl-2-nitrotrimethylene)dimorpholine}, benzoimidazole
5 derivatives {such as, 2-(4-thiazolyl)benzoimidazole}, and other preservatives {such as,
poly[oxyethylene(dimethyl imino)ethylene(dimethyl imino) ethylene]dichloride,
p-cholo-m-xlenol, phenoxy ethanol, phenoxy propanol, acetoxymethyldioxane,
isopropylmethphenol, tetrachloroisophthalonitrile, bisbromoacetoxymethane,
3-iodo-2-propynylbutylcarbamate, 2-bromo-2-nitropropane-1,3-diol}.

10 [00137] The preservatives can be used alone, and can also be used in combination of
two or more.

[00138] The hydrotropic agent includes, for example, resorcinol and salicylic acid (salt).
Furthermore, the salts of the salts include, for example, the salts as the same as those
exemplified in the anionic surfactants (A-2). The hydrotropic agent can be used alone,
15 and can also be used in combination of two or more. Moreover, toluenesulfonic acid
(salt), xylenesulfonic acid (salt), and isopropylbenzenesulfonic acid (salt) exemplified as
sulfonate surfactants (A-2b-1) also have the effect of hydrotropic agent.

[00139] When the cleaning agent of the present invention contains other additives (H),
based on the weight of the active ingredients of the cleaning agent, the content of the
20 additive, such as, anti-oxidant, corrosion resistant, buffer, preservative, and hydrotropic
agent is preferably lower than or equal to 10%, more preferably lower than or equal to
8%, particularly preferably lower than or equal to 5%. Moreover, the content of the
added defoamer is preferably lower than or equal to 2%, more preferably lower than or

equal to 1.5%, and particularly preferably lower than or equal to 1%. Furthermore, based on the weight of the active ingredients of the cleaning agent, the content of the pH value modifier is preferably lower than or equal to 90%, more preferably lower than or equal to 85%, and particularly preferably lower than or equal to 80%. Furthermore, 5 based on the weight of the active ingredients of the cleaning agent, the total content of the other additives (H) is preferably lower than or equal to 90%, more preferably lower than or equal to 85%, particularly preferably lower than or equal to 80%.

[00140] Furthermore, when the same composition appears in the chelating agents (B) to other additives (H) and repeated, not the amount having the corresponding addition 10 effect of each ingredients is used without considering the effect of the ingredient as other ingredients, but the effect of the ingredient as other ingredients should be considered, and the amount of the ingredient is adjusted according to the purpose.

[00141] In terms of operation or transportation efficiency during use, the concentration of the active ingredients of the cleaning agent of the present invention is as described 15 above, and generally is 1% to 100%, and preferably 2% to 50%. Therefore, the content of water in the cleaning agent of the present invention is generally lower than or equal to 99%, and preferably 50% to 98%.

[00142] Except of the case of merely composed of a surfactant (A), the cleaning agent of the present invention is fabricated by mixing a surfactant (A) with at least one 20 ingredient selected from the group consisting of chelating agent (B) to other additives (H), and water. In order to get a cleaning agent meeting Formula (1), the fabrication method is preferably as follows.

[00143] (1) The surfactant (A), or a mixture formed by mixing the surfactant (A) with

at least one ingredient selected from the group consisting of chelating agent (B) to other additives (H), and water as required at room temperature to 80°C is sampled, and diluted with water to the active ingredient concentration when being used as cleaning solution. The pH value and the oxidation reduction potential at 25°C of the diluent is determined,
5 to confirm whether the pH value and the oxidation reduction potential (V) meet Formula (1).

[00144] (2) When the oxidation reduction potential does not meet Formula (1), an ingredient for decreasing the oxidation reduction potential, such as, chelating agent (B), reductant (C), and/or alkaline ingredient (D) is added, to adjust the oxidation reduction
10 potential, such that the pH value and the oxidation reduction potential meet Formula (1).

[00145] Furthermore, for a cleaning solution having a pH value in a specific range, besides the operation described above, the pH value can be adjusted by the following methods.

[00146] When the pH value during Operation (1) or (2) is lower than the desired pH
15 value range, an ingredients for raising the pH value, such as, alkaline ingredient (D), pH value modifier in other additives (H), and/or surfactant (A-2) is added, to adjust the pH value into the desired range.

[00147] When the pH value during Operation (1) or (2) is higher than the desired pH value range, an ingredients for decreasing the pH value, such as, chelating agent (B),
20 reductant (C), pH value modifier in other additives (H), and/or buffer is added, to adjust the pH value into the desired range.

[00148] The mixing and dissolving equipment when fabricating the cleaning agent of the present invention is not particularly limited, and stirring and mixing equipment

equipped with mixing blades or spiral-shaped blades can be used.

[00149] In terms of preventing metal pollution, based on the weight of the active ingredients of the cleaning agent, the content of metals, such as, Na, K, Ca, Fe, Cu, Al, Pb, Ni, Zn in the cleaning agent of the present invention is preferably lower than or
5 equal to 20 ppm, more preferably lower than or equal to 10 ppm, and particularly preferably lower than or equal to 5 ppm.

[00150] The content of the metal atoms can be determined by known methods, such as, atomic absorption method, inductively-coupled plasma atomic emission spectrometry (ICP-AES), and inductively-coupled plasma mass spectrometry (ICP-MS).

10 [00151] The second invention of the present invention is a cleaning solution for an electronic material, which is a cleaning solution for a cleaning step and formed by diluting the cleaning agent with water as required, and is characterized in that, at an active ingredient concentration of 0.01 wt% to 15 wt% and at 25°C, the pH value and the oxidation reduction potential (V) [in mV, vs SHE (standard hydrogen electrode)]
15 meet Formula (1):

[00152] $V \leq -38.7 \times \text{pH value} + 550$ (1).

[00153] The methods for determining the ingredients in the cleaning solution and the oxidation reduction potential are as described above.

[00154] The cleaning solution for an electronic material is especially suitable to be
20 used as cleansing solution of magnetic disk substrate, flat panel display substrate, and photomask substrate, and as described above, as for each electronic material, the cleaning solution for an electronic material has preferred pH value range.

[00155] In terms of the wettability of the cleaning agent to the electronic material, the

surface tension (25°C) of the cleaning agent of the present invention is preferably lower than or equal to 65 mN/m, more preferably lower than or equal to 50 mN/m, and particularly preferably lower than or equal to 40 mN/m. According to the present invention, the surface tension can be determined according to ISO 304 using the ring
5 method in JIS K3362:1998.

[00156] In terms of preventing particles from being re-attached and etching, the conductivity (mS/cm) of the cleaning solution is preferably 0.2 to 10.0, more preferably 0.5 to 5.0, and particularly preferably 1.0 to 3.5.

[00157] The third invention of the present invention is a method for cleaning an
10 electronic material, which is a method for cleaning the electronic material in the cleaning solution described above, and is suitable to be used as the cleaning method for magnetic disk substrate (especially aluminum substrate after Ni-P plating), flat panel display substrate, and photomask substrate. The cleaning object (stain) includes, for example, organics, such as, oils (e.g., coolant), stains from human body (e.g.,
15 fingerprints and sebum), plasticizer (e.g., dioctyl phthalate), organic particles, and inorganics, such as, inorganic particles [such as, abrasive (e.g., alumina, colloidal silica, cerium oxide or diamond), and polishing debris (e.g., glass cullet)].

[00158] As the cleaning method of the present invention has excellent particle removal effect, thus preferably, during the fabrication of magnetic disk substrate (particularly
20 preferably glass substrate for magnetic disk, and aluminum substrate for magnetic disk after Ni-P plating), flat panel display substrate, and photomask substrate, a cleaning step for removing particles, such as, abrasive, polishing debris, and grinding dust, more particularly, the cleaning method of the present invention is preferably used as the

cleaning method in the cleaning step after the grinding step, the cleaning step after the polishing step, and/or the cleaning step after the texturing step.

[00159] Additionally, in order to prevent stains floating in the air (such as, particles and organic stains) from attached on the substrate surface firmly, the substrate can be dipped
5 in the cleaning solution of the present invention before or after the cleaning step.

[00160] When any one of alumina, colloidal silica, cerium oxide or diamond is used as abrasive in the polishing step, the effect of the cleaning method of the present invention can be easily exerted.

[00161] The cleaning manner of the cleaning method of the present invention can be at
10 least one selected from the group consisting of ultrasonic cleaning, shower cleaning, spray cleaning, scrub cleaning, dipping cleaning, dipping and shaking cleaning, and single substrate cleaning, and the effect of the cleaning method of the present invention can be easily exerted by any manner.

[00162] In terms of cleanliness, the cleaning temperature (°C) when cleaning with the
15 cleaning agent of the present invention is preferably 10°C to 80°C, more preferably 15°C to 70°C, and particularly preferably 20°C to 60°C.

[00163] Furthermore, the contact angle (25°C) of water with respect to the electronic material to be cleaned by the cleaning method of the present invention is preferably lower than or equal to 20°, more preferably 1° to 15°, and particularly preferably 2° to
20 10°. If the contact angle is in this range, when forming a magnetic film by sputtering, a uniform film can be formed, thus being desired, as for magnetic properties. Furthermore, the contact angle can be determined, for example, with an automatic contact angle meter [manufactured by Kyowa Interface Science Co., Ltd., PD-W].

[00164] In terms of surface flatness of the electronic material, the surface roughness (Ra) of the surface of the electronic material cleaned by the cleaning method of the present invention is preferably lower than or equal to 0.5 nm, more preferably 0.001 nm to 0.3 nm, and particularly preferably 0.05 nm to 0.25 nm.

- 5 [00165] Additionally, the surface roughness (Ra) can be determined with E-sweep (manufactured by SII Nano Technology Inc.) under the following conditions.

[00166] Determine mode: DFM (tapping mode)

[00167] Scanning area: 10 μm x 10 μm

[00168] Number of scanning lines: 256 (scanning in Y direction)

- 10 [00169] Correction: flat correction in X,Y direction

[00170] The fourth invention of the present invention is a method for fabricating an electronic material, which includes cleaning the electronic material by the cleaning method described above, and particularly suitable to be used as the method for fabricating magnetic disk substrate, flat panel display substrate, and photomask
15 substrate.

[00171] [Embodiment]

- [00172] Hereinafter, the present invention is explained with embodiments in detail, but not limited thereto. Moreover, unless otherwise limited, the following parts represent weight parts. Under the determination conditions of the method above, the molecular
20 weight of the polymers is determined with GPC. Furthermore, the resistivity of the ultra-pure water used in the embodiments and comparative examples is higher than or equal to 18 M Ω .

[00173] [Fabrication Example 1]

[00174] 200 parts (1.1 molar part) lauryl alcohol, and 10 parts (0.027 molar part) 25% aqueous solution of tetramethyl ammonium hydroxide (TMAH) were added into a 1 L stainless steel autoclave equipped with a stirrer and a temperature control device, and dehydrated at 100°C and reduced pressure of lower than or equal to 4 kPa for 30 min.

5 Next, the reaction temperature was controlled at 100°C, and at the same time, 430 parts (9.8 molar parts) ethylene oxide (EO) were added dropwise. Then, the mixture was cured at 100°C for 3 hr, to get a crude product. The crude product was maintained at reduced pressure of lower than or equal to 2.6 kPa at 150°C for 2 hrs., to decompose and remove the remained TMAH, to get a nonionic surfactant, that is, 630 parts 9 mole EO
10 adduct (A-1-1) of lauryl alcohol.

[00175] [Fabrication Example 2]

[00176] 185 parts (1.0 molar part) lauryl amine, and 3.6 parts (0.01 molar part) 25% aqueous solution of TMAH were added into a 1 L stainless steel autoclave equipped with a stirrer and a temperature control device, and dehydrated at 100°C and reduced
15 pressure of lower than or equal to 4 kPa for 30 min. Next, the reaction temperature was controlled at 100°C, and at the same time, 264 parts (9.8 molar parts) EO were added dropwise. Then, the mixture was cured at 100°C for 3 hrs., to get a crude product. The crude product was maintained at a reduced pressure of lower than or equal to 2.6 kPa at 150°C for 2 hrs., to decompose and remove the remained TMAH, to
20 get a nonionic surfactant, that is, 445 parts 6 mole EO adduct (A-1-2) of lauryl amine.

[00177] [Fabrication Example 3]

[00178] 212 parts (1.0 molar part) cumylphenol, and 2.9 parts (0.008 molar part) 25% aqueous solution of TMAH were added into a 1 L stainless steel autoclave equipped

with a stirrer and a temperature control device, and dehydrated at 100°C and reduced pressure of lower than or equal to 4 kPa for 30 min. Next, the reaction temperature was controlled at 100°C, and at the same time, 352 parts (8.0 molar parts) EO were added dropwise. Then, the mixture was cured at 100°C for 3 hrs., to get a crude
5 product. The crude product was maintained at a reduced pressure of lower than or equal to 2.6 kPa at 150°C for 2 hrs., to decompose and remove the remained TMAH, to get a nonionic surfactant, 560 parts 8 mole EO adduct (A-1-3) of cumylphenol.

[00179] [Fabrication Example 4]

[00180] 300 parts isopropanol and 100 parts ultra-pure water were added into a reactor
10 capable of adjusting temperature and stirring, and the temperature was raised to 75°C after nitrogen replacement. Next, with stirring, 407 parts 75% aqueous solution of acrylic acid and 95 parts 15% isopropanol solution of dimethyl-2,2'-azo-bis-isobutyrate were added into the reactor simultaneously within 3.5 hrs.. After addition, the mixture was stirred at 75°C for 5 hrs., and then ultra-pure water was added into the system
15 intermittently, such that the system will not be solidified and the stirring process will be conducted smoothly. The mixture of water and isopropanol was distilled out, till no isopropanol was detected. The obtained aqueous solution of polyacrylic acid was neutralized with DBU (about 450 parts), till the pH value was 7, and then, the concentration was adjusted with ultra-pure water, to get 40% aqueous solution of
20 anionic surfactant polyacrylic acid DBU salt (A-2-1). Furthermore, the Mw of the polyacrylic acid DBU salt (A-2-1) is 10,000.

[00181] [Fabrication Example 5]

[00182] 100 parts 1,2-dichloroethane was added into a reactor capable of adjusting

temperature and refluxing and equipped with a stirrer, and the temperature was raised to 90°C after nitrogen replacement with stirring, to reflux 1,2-dichloroethane. Next, 120 parts styrene 120 and an initiator solution formed by dissolving 1.7 parts 2,2'-azobisisobutyronitrile in 20 parts 1,2-dichloroethane in advance were added into the reactor simultaneously within 6 hrs.. After addition, the mixture was polymerized for 1 hr.. After polymerization, the mixture was cooled to 20°C under nitrogen sealing. Then, the temperature was controlled at 20°C, and at the same time, 105 parts anhydrous sulfuric acid was added dropwise within 10 hrs.. After addition, sulfone reaction was performed for 3 hrs.. After reaction, the solvent was distilled out, and the mixture was cured, and then 345 parts ultra-pure water was added for dissolving, to get an aqueous solution of poly(styrene sulfonic acid). Next, the obtained aqueous solution of poly(styrene sulfonic acid) was neutralized with 25% aqueous solution of TMAH (about 400 parts), till the pH value was 7, and then, the concentration was adjusted with ultra-pure water, to get 40% aqueous solution of anionic surfactant poly(styrene sulfonic acid) TMAH salt (A-2-2). Furthermore, the Mw of the poly(styrene sulfonic acid) TMAH salt (A-2-2) is 40,000, and the sulfonation yield is 97%.

[00183] [Fabrication Example 6]

[00184] Into a reactor equipped with a stirrer, 21 parts naphthalene sulfonic acid and 10 parts ultra-pure water were added, and 8 parts 37% formaldehyde were added dropwise at 80°C within 3 hrs.. After addition, the temperature was raised to 105°C for reaction for 25 hrs., cooled to room temperature (about 25°C), and then adjusted to 25°C in water bath, and at the same time, DBU was added slowly to adjust the pH value to be 6.5 (about 15 parts DBU were used). Ultra-pure water was added to adjust the solid

content to be 40%, to get 40% aqueous solution of anionic surfactant DBU salt (A-2-3) of naphthalene sulfonic acid formalin condensate. Furthermore, the Mw of the DBU salt (A-2-3) of naphthalene sulfonic acid formalin condensate is 5,000.

[00185] [Fabrication Example 7]

5 [00186] Except that 407 parts 75% aqueous solution of acrylic acid was replaced by 436 parts 70% aqueous solution of monomer formed by 227 parts acrylamide-2-methylpropanesulfonic acid, 78 parts acrylic acid, and 131 parts ultra-pure water, the fabrication process was the same as that of Fabrication Example 4, and the mixture of water and isopropanol was distilled out after polymerization, till no
10 isopropanol was detected, to get an aqueous solution of acrylamide-2-methylpropanesulfonic acid/acrylic acid copolymer. Next, the temperature of the obtained aqueous solution of acrylamide-2-methylpropanesulfonic acid/acrylic acid copolymer was adjusted to be 25°C, and at the same time, DBU was added slowly, to adjust the pH value to be 6.5 (about 280 parts DBU were used), and
15 then the concentration was adjusted with ultra-pure water, to get 40% aqueous solution of anionic surfactant acrylamide-2-methylpropanesulfonic acid/acrylic acid copolymer DBU salt (A-2-4). Furthermore, the Mw of the copolymer DBU salt (A-2-4) is 8,000.

[00187] [Fabrication Example 8]

[00188] Except that 407 parts 75% aqueous solution of acrylic acid was replaced by
20 465 parts 65% aqueous solution of monomer formed by 320 parts 50% aqueous solution of sodium methacryloxy polyoxyalkylene sulfate [manufactured by Sanyo Chemical Industries, Ltd., ELEMNOL RS-30] and 145 parts acrylic acid, the fabrication process was the same as that of Fabrication Example 4, and the mixture of water and

isopropanol was distilled out after polymerization, till no isopropanol was detected, to get an aqueous solution of sodium methacryloxy polyoxyalkylene sulfate/acrylic acid copolymer. Next, the obtained aqueous solution of the copolymer was diluted with ultra-pure water, such that the solid content got to be 10%, and then, sodium ions in the solution was removed with a cation exchange resin (Amberlite IR-120B, manufactured by Organo Co., Ltd.), till the sodium ion in the solution is lower than or equal to 1 ppm. Furthermore, the sodium content was determined with an ICP-AES analysis equipment (manufactured by VARIAN Company, Varian 730-ES). Then, the temperature of the obtained methacryloxy polyoxyethylene sulfate/acrylic acid copolymer was adjusted to be 25°C, and at the same time, the methacryloxy polyoxyethylene sulfate/acrylic acid copolymer was neutralized with 25% aqueous solution of TMAH (about 600 parts), till the pH value got to be 7, and then the concentration was adjusted with ultra-pure water, to get 10% aqueous solution of anionic surfactant methacryloxy polyoxyethylene sulfate/acrylic acid copolymer TMAH salt (A-2-5). Furthermore, the Mw of the copolymer TMAH salt (A-2-5) is 9,000.

[00189] [Fabrication Example 9]

[00190] 136 parts octylbenzenesulfonic acid and 245 parts ultra-pure water were added into a 1 L beaker, to dissolve octylbenzenesulfonic acid, till the solution got uniform. Next, the obtained aqueous solution of octylbenzenesulfonic acid was neutralized with DBN (about 65 parts), till the pH value got to be 7, and then the concentration was adjusted with ultra-pure water, to get 40% aqueous solution of anionic surfactant octylbenzenesulfonic acid DBN salt (A-2-6).

[00191] [Fabrication Example 10]

[00192] 144 parts 2-ethylhexanoic acid 144 and 300 parts ultra-pure water were added into a 1 L beaker, to dissolve 2-ethylhexanoic acid, till the solution got uniform. Next, the obtained aqueous solution of 2-ethylhexanoic acid was neutralized with diethanolamine (about 105 parts), till the pH value got to be 7, and then the concentration was adjusted with ultra-pure water, to get 40% aqueous solution of anionic surfactant 2-ethylhexanoic acid diethanolamine salt (A-2-7).

[00193] [Fabrication Example 11]

[00194] 256 parts 2-ethyl hexanol was added into a glass reactor equipped with a stirrer and temperature control device, and cooled to 0°C with stirring. Next, the temperature in the system was maintained at 0°C, and at the same time, 229 parts chlorosulfonic acid were added dropwise, to get sulfate. Then, the solution was neutralized with 48% aqueous solution of potassium hydroxide (about 230 parts), till the pH value got to be 7, and then the concentration was adjusted with ultra-pure water, to get 40% aqueous solution of anionic surfactant potassium 2-ethyl hexanol sulfate (A-2-8).

[00195] [Embodiment 1-Embodiment 56], [Comparative Example 1-Comparative Example 8]

[00196] The ingredients listed in Table 1-Table 8 were stirred uniformly with the formulation parts listed in Table 1-Table 8 in a 1 L beaker at room temperature (about 20°C), so as to fabricate cleaning agents of Embodiment 1-Embodiment 56 and Comparative Example 1-Comparative Example 8, and the cleaning agents of Embodiment 1-Embodiment 26 and Comparative Example 1-Comparative Example 5 were directly evaluated with this concentration (dilution factor of 1) as cleaning solution, and the cleanse of Embodiment 27-Embodiment 56 and Comparative Example

6-Comparative Example 8 were diluted to 10 times with ultra-pure water and evaluated as cleaning solution according to the following evaluation method. The results are shown in Table 1-Table 8.

[00197] Furthermore, the formulation parts of ingredients listed in the tables except
5 ultra-pure water are values obtained through active ingredient conversion. Moreover, the volume of ultra-pure water listed in the tables includes ultra-pure water in the surfactant obtained in Fabrication Example 1-Fabrication Example 11 and the TMAH aqueous solution.

[00198] Furthermore, the abbreviation forms of the chelating agent (B), the reductant
10 (C), the alkaline ingredient (D), and the water-soluble organic solvent (G) in Table 1-Table 8 are as follows.

[00199] EDTA: ethylenediaminetetraacetic acid

[00200] HEDP: 1-hydroxyethylene-1,1-diphosphonic acid

[00201] HMP: sodium hexametaphosphate

15 [00202] AA: ascorbic acid

[00203] Cys: L-cystein

[00204] Sodium hypophosphite: hypophosphite monosodium salt

[00205] MDEA: N-methyldiethanolamine

[00206] TMAH: tetramethyl ammonium hydroxide

20 [00207] DEA: diethanolamine

[00208] DBU: 1,8-diazabicyclo[5,4,0]-7-undecene

[00209] DEG-B: diethylene glycol butyl ether

[00210] At 25°C, the pH value of the obtained cleaning solution is determined with a

pH value meter (manufactured by Horiba Ltd., M-12). The oxidation reduction potential and the surface tension are determined by the methods described above. Moreover, cleanliness-1-cleanliness-6, surface flatness-1-surface flatness-3, etching-1-etching-3, contact angle-1-contact angle-3, and dispersion are evaluated by the following methods.

[00211] <Cleanliness Evaluation-1>

[00212] After polishing a 3.5 inch magnetic disk substrate after Ni-P plating with a commercial colloidal silica slurry (having a particle size of about 30 nm) as abrasive and a polishing cloth, the surface was washed with ultra-pure water, and blown with nitrogen gas, to get a polluted substrate. 1,000 parts cleaning solution prepared above were taken and placed in a 1 L glass beaker, and then the polluted substrate was dipped in the cleaning solution, and cleaned in an ultrasonic cleaning agent (200 kHz) at 30°C for 5 min. After cleaning, the substrate was taken out and washed with ultra-pure water fully, and then blown with nitrogen gas to dry. According to the following evaluation standard, the cleanliness on the substrate surface was evaluated with a differential interference microscope (manufactured by Nikon Corporation, OPTIPHOT-2, having a magnification of 400 times). Furthermore, in order to avoid the pollution from the air, the evaluation is implemented in a clean room of class 1,000 (FED-STD-209D, USA Federal Standard, 1988).

[00213] ◎: Almost completely removed.

[00214] ○: Substantially cleaned.

[00215] △: A little particles remained.

[00216] ×: Almost impossible to be cleaned.

[00217] <Cleanliness Evaluation-2>

[00218] Except that commercial alumina slurry (having a particle size of about 0.4 μm) was used as abrasive, the evaluation was performed as the same as Cleanliness Evaluation-1.

5 [00219] <Cleanliness Evaluation-3>

[00220] After polishing a 2.5 inch glass substrate for magnetic disk with a commercial ceria slurry (having a particle size of about 100 nm) as abrasive and a polishing cloth, the surface was washed with ultra-pure water, and blown with nitrogen gas, to get a polluted substrate. The evaluation was performed as the same as Cleanliness
10 Evaluation-1.

[00221] <Cleanliness Evaluation-4>

[00222] Except that commercial colloidal silica slurry (having a particle size of about 30 nm) was used as abrasive, the evaluation was performed as the same as Cleanliness Evaluation-3.

15 [00223] <Cleanliness Evaluation-5>

[00224] On commercial glass substrate (manufactured by Corning Inc., glass plate # 1737, 10 cm x 10 cm), 5 mg glass powder obtained by cutting off (breaking) the glass plate was spread, and the glass substrate was heated on a hot plate (manufactured by PMC Industries Inc., digital hot plate series 730) at 105°C for 1 hour. The substrate
20 thus obtained was used as the polluted substrate, and the evaluation was performed as the same as Cleanliness Evaluation-1.

[00225] <Cleanliness Evaluation-6>

[00226] On a hot plate (manufactured by PMC Industries Inc., digital hot plate series

730), 10 mg n-triacontane (manufactured by Tokyo Chemical Industry Co., Ltd) was melt on a comer glass substrate (manufactured by Corning Inc., glass plate #1737, 10 cm x 10 cm) within 1 min as sample pollutant, to get a polluted substrate. Next, 100 g cleaning solution was taken and placed in a 200 ml glass beaker, and the polluted substrate was dipped in the cleaning solution and cleaned in an ultrasonic cleaning agent (200 kHz) at 30°C for 5 min. After cleaning, the substrate was taken out and washed with ultra-pure water fully, and then blown with nitrogen gas to dry. According to the same evaluation standard as that of Cleanliness Evaluation-1, the cleanliness on the substrate surface was evaluated with a differential interference microscope (manufactured by Nikon Corporation, OPTIPHOT-2, having a magnification of 400 times). Furthermore, in order to avoid the pollution from the air, the evaluation is implemented in a clean room of class 1,000 (FED-STD-209D, USA Federal Standard, 1988).

[00227] <Surface Flatness-1>

[00228] 10 ml cleaning solution was taken and placed in a 20 ml glass container, and the temperature was adjusted to 30°C, then a substrate having a size of 2 cm x 2 cm obtained by cutting a aluminum substrate for magnetic disk after Ni-P plating was placed in the container and dipped in the cleaning solution at 30°C for 20 min for cleaning. After cleaning, the substrate was taken out with a pincette, and washed with ultra-pure water fully to remove the cleaning solution, and then blown with nitrogen gas at room temperature (25°C) to dry. Next, the surface roughness (Ra) of the dried substrate surface was determined with an atomic force microscope (manufactured by SII Nano Technology Co., Ltd., E-Sweep), to evaluate the surface flatness. Furthermore,

the surface roughness (Ra) of the substrate before the test was 0.25 nm.

[00229] <Surface Flatness-2>

[00230] 10 ml cleaning solution was taken and placed in a 20 ml glass container, and the temperature was adjusted to 30°C, then a substrate having a size of 1 cm x 1 cm
5 obtained by cutting a glass substrate for magnetic disk was placed in the container and dipped in the cleaning solution at 30°C for 20 min for cleaning. After cleaning, the substrate was taken out with a pincette, and washed with ultra-pure water fully to remove the cleaning solution, and then blown with nitrogen gas at room temperature (25°C) to dry. Next, the surface roughness (Ra) of the dried substrate surface was
10 determined with an atomic force microscope (manufactured by SII Nano Technology Co., Ltd., E-Sweep), to evaluate the surface flatness. Furthermore, the surface roughness (Ra) of the substrate before the test was 0.20 nm.

[00231] <Surface Flatness-3>

[00232] 10 ml cleaning solution was taken and placed in a 20 ml glass container, and
15 the temperature was adjusted to 30°C, then a substrate having a size of 1 cm x 1 cm obtained by cutting a commercial glass substrate (manufactured by Corning Inc., glass plate #1737, 10 cm x 10 cm) was placed in the container and dipped in the cleaning solution at 30°C for 20 min for cleaning. After cleaning, the substrate was taken out with a pincette, and washed with ultra-pure water fully to remove the cleaning solution,
20 and then blown with nitrogen gas at room temperature (25°C) to dry. Next, the surface roughness (Ra) of the dried substrate surface was determined with an atomic force microscope (manufactured by SII Nano Technology Co., Ltd., E-Sweep), to evaluate the surface flatness. Furthermore, the surface roughness (Ra) of the substrate before the

test was 0.50 nm.

[00233] <Etching-1>

[00234] 100 parts cleaning solution were taken and placed in a 1 L container made of polypropylene, and a piece of 3.5 inch aluminum substrate for magnetic disk after Ni-P
5 plating was placed in the container. A film made of poly(vinylidene dichloride) was covered at the top of the container to seal the container, so as to prevent moisture from evaporating, and stood still for 12 hrs. in a room in which the temperature was adjusted to be 23°C. After standing still, the cleaning solution was sampled, and the Ni content in the cleaning solution was determined with an ICP-AES analysis equipment
10 (manufactured by VARIAN Company, Varian 730-ES). Furthermore, the Ni content of the cleaning solution was determined in the same manner before the test, and the difference between the Ni content before and after the test was calculated, so as to get the Ni content (ppm) dissolved during the test. The higher the dissolved Ni content is, the higher the etching is.

15 [00235] <Etching-2>

[00236] 100 parts cleaning solution were taken and placed in a 1 L container made of polypropylene, and a piece of 2.5 inch glass substrate for magnetic disk was placed in the container. A film made of poly(vinylidene dichloride) was covered at the top of the container to seal the container, so as to prevent moisture from evaporating, and stood
20 still for 12 hrs. in a room in which the temperature was adjusted to be 23°C. After standing still, the cleaning solution was sampled, and the Si content in the cleaning solution was determined with an ICP-AES analysis equipment (manufactured by VARIAN Company, Varian 730-ES). Furthermore, the Si content of the cleaning

solution before the test was determined in the same manner, and the difference between the Si content before and after the test was calculated, so as to get the Si content (ppb) dissolved during the test. The higher the dissolved Si content is, the higher the etching is.

5 [00237] <Etching-3>

[00238] 10 parts cleaning solution was taken and placed in a 50 ml container made of polypropylene, and the temperature was adjusted to be 50°C, then a substrate having a size of 2 cm x 2 cm obtained by cutting a commercial glass substrate (manufactured by Corning Inc., glass plate #1737, 10 cm x 10 cm) was placed in the container and
10 dipped in the cleaning solution at 50°C and stood still for 24 hrs.. The cleaning solution was sampled, and the Si content in the cleaning solution was determined with an ICP-AES analysis equipment (manufactured by VARIAN Company, Varian 730-ES). Furthermore, the Si content of the cleaning solution before the test was determined in the same manner, and the difference between the Si content before and after the test was
15 calculated, so as to get the Si content (ppb) dissolved during the test. The higher the dissolved Si content is, the higher the etching is.

[00239] <Determination of Contact Angle-1>

[00240] As for the substrate evaluated in cleanliness test-1, the contact angle of the substrate with respect to water was determined immediately with an automatic contact
20 angle meter [manufactured by Kyowa Interface Science Co., Ltd., PD-W] (25°C, after 1 s).

[00241] <Determination of Contact Angle-2>

[00242] As for the substrate evaluated in cleanliness test-3, the contact angle of the

substrate with respect to water was determined immediately with an automatic contact angle meter [manufactured by Kyowa Interface Science Co., Ltd., PD-W] (25°C, after 1 s).

[00243] <Determination of Contact Angle-3>

- 5 [00244] As for the substrate evaluated in cleanliness test-5, the contact angle of the substrate with respect to water was determined immediately with an automatic contact angle meter [manufactured by Kyowa Interface Science Co., Ltd., PD-W] (25°C, after 1 s).

[00245] <Dispersion Evaluation>

- 10 [00246] 30 parts cleaning solution was taken and placed in a 50 ml glass container, and 0.3 part commercial colloidal silica slurry (having a particle size of about 30 nm) used in Cleanliness Evaluation-4 was added into the container, and stirred with a magnetic stirrer for 1 min. After standing still for 5 min, the particle size (median size) was determined with a dynamic light scattering particle size analyzer [manufactured by
- 15 Horiba Ltd., LB-550V]. The smaller the particle size is, the more excellent the dispersion is.

[00247] [Table 1]

			Embodiment									
			1	2	3	4	5	6	7	8	9	10
Formulation Volume (part)	nonionic surfactants (A-1)	(A-1-1)	0.4	-	1	-	-	0.2	0.2	-	-	-
		(A-1-2)	-	0.4	-	0.7	-	-	-	-	-	-
		(A-1-3)	-	-	-	-	0.5	-	-	0.5	-	-
	anionic surfactants (A-2)	(A-2-1)	1	-	-	-	-	0.5	-	-	1	-
		(A-2-2)	-	1	-	-	-	-	-	-	-	-
		(A-2-3)	-	-	1	-	-	-	1	-	-	-
		(A-2-4)	-	-	-	1	-	-	-	1	-	1
		(A-2-5)	-	-	-	-	1	-	-	-	-	-
		(A-2-6)	-	-	-	-	-	0.2	-	0.2	0.2	-
		(A-2-7)	-	-	-	-	-	-	0.2	-	-	-
		(A-2-8)	-	-	-	-	-	-	-	-	-	-
		p-toluenesulfonic acid	-	-	-	-	-	-	-	-	-	-
	chelating agent (B)	EDTA	0.2	0.2	-	-	-	-	-	0.2	-	-
		HEDP	-	-	0.2	-	-	-	0.2	-	-	0.2
		HMP	-	-	-	0.2	-	0.2	-	-	0.2	-
	reductant (C)	AA	0.05	-	0.05	-	-	-	-	0.05	-	-
		Cys	-	0.05	-	-	0.05	0.05	-	-	-	0.05
		formaldehyde	-	-	-	-	-	-	-	-	-	-
		sulfurous acid	-	-	-	-	-	-	-	-	-	-
		dithionous acid	-	-	-	-	-	-	-	-	-	-
		phosphoric acid	-	-	-	-	-	-	-	-	-	-
		sodium hypophosphite	-	-	-	0.05	-	-	0.05	-	0.05	-
		MDEA	-	-	-	-	-	-	-	-	-	-
	alkaline ingredient (D)	TMAH	0.2	-	-	-	-	-	-	0.2	-	-
		DEA	-	-	0.3	-	-	-	0.2	-	-	-
		DBU	-	0.3	-	-	-	-	-	-	-	-
	Water-soluble organic solvent(G)	DEG-B	-	-	-	-	-	-	-	-	-	-
	water	ultra-pure water	98.2	98.1	97.5	98.1	98.5	98.9	98.1	97.9	98.6	98.8
Dilution factor			1	1	1	1	1	1	1	1	1	1
Evaluation Results	pH value		6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
	value of the right part of Formula (1)		298	298	298	298	298	298	298	298	298	298
	oxidation reduction potential (mV)		231	116	229	277	120	125	280	240	272	120
	surface tension (mN/m)		27	26	25	25	34	30	30	30	32	65
	cleanliness-1		◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
	cleanliness-2		◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
	surface flatness-1[surface roughness Ra(nm)]		0.25	0.25	0.26	0.28	0.25	0.27	0.26	0.26	0.28	0.25
	etching-1 [Ni content (ppm)]		11.3	11.8	12.0	14.0	12.1	14.5	13.6	13.0	14.2	12.2
	contact angle-1(°)		8.1	7.3	6.5	6.8	8.5	9.0	9.1	8.6	9.2	7.5
	dispersion (nm)		46	48	47	48	46	33	32	34	36	43

[00248] [Table 2]

			Embodiment									
			11	12	13	14	15	16	17	18	19	20
Formulation Volume (part)	nonionic surfactants (A-1)	(A-1-1)	0.2	0.2	0.2	0.2	-	0.2	0.2	0.2	0.2	0.2
		(A-1-2)	-	-	-	-	0.2	-	-	-	-	-
		(A-1-3)	-	-	-	-	-	-	-	-	-	-
	anionic surfactants (A-2)	(A-2-1)	1	-	-	1	-	-	-	-	-	-
		(A-2-2)	-	-	-	-	-	-	-	-	-	-
		(A-2-3)	-	1	-	-	1	1	1	-	1	1
		(A-2-4)	-	-	1	-	-	-	-	-	-	-
		(A-2-5)	-	-	-	-	-	-	-	-	-	-
		(A-2-6)	-	-	-	-	-	-	-	-	-	-
		(A-2-7)	-	-	-	-	-	-	-	-	-	-
		(A-2-8)	-	-	-	-	-	0.2	-	-	-	-
		p-toluenesulfonic acid	-	-	-	-	-	-	0.2	1	0.2	0.2
	chelating agent (B)	EDTA	-	0.2	-	-	0.2	-	-	-	-	-
		HEDP	-	-	-	0.2	-	0.2	0.2	0.2	0.2	0.2
		HMP	0.2	-	-	-	-	-	-	-	-	-
	reductant (C)	AA	0.05	-	-	-	0.05	-	-	-	-	-
		Cys	-	0.05	-	0.05	-	-	-	-	0.05	-
		formaldehyde	-	-	-	-	-	-	-	-	-	0.05
		sulfurous acid	-	-	-	-	-	-	-	-	-	-
		dithionous acid	-	-	-	-	-	-	-	-	-	-
		phosphoric acid	-	-	-	-	-	-	-	-	-	-
		sodium hypophosphite	-	-	0.05	-	-	0.05	0.05	0.05	-	-
		MDEA	-	-	-	-	-	-	-	-	-	-
	alkaline ingredient (D)	TMAH	-	0.2	-	-	0.6	-	-	-	-	-
		DEA	-	-	0.01	-	-	0.25	0.4	0.3	0.4	0.4
		DBU	0.08	-	-	0.3	-	-	-	1	-	-
	Water-soluble organic solvent(G)	DEG-B	-	-	-	-	-	-	-	-	-	-
	water	ultra-pure water	98.5	98.3	98.7	98.2	98.0	98.1	98.0	97.3	98.0	98.0
Dilution factor			1	1	1	1	1	1	1	1	1	1
Evaluation Results	pH value		8.5	8.5	8.5	5.0	13.0	6.5	6.5	6.5	6.5	6.5
	value of the right part of Formula (1)		221	221	221	357	47	298	298	298	298	298
	oxidation reduction potential (mV)		162	43	213	171	5	280	278	273	128	223
	surface tension (mN/m)		30	30	30	30	34	24	30	31	30	31
	cleanliness-1		◎	◎	◎	◎	○	◎	◎	◎	◎	◎
	cleanliness-2		◎	◎	◎	○	○	◎	◎	◎	◎	◎
	surface flatness-1 [surface roughness Ra(nm)]		0.25	0.26	0.25	0.32	0.25	0.25	0.25	0.29	0.24	0.25
	etching-1 [Ni content (ppm)]		11.9	13.8	12.4	15.0	9.8	14.0	14.2	12.8	14.1	14.0
	contact angle-1(°)		8.7	8.7	8.9	8.5	10.5	8.7	8.6	9.2	6.8	8.0
	dispersion (nm)		46	48	47	47	46	34	33	55	33	34

[00249] [Table 3]

			Embodiment					
			21	22	23	24	25	26
Formulation Volume (part)	nonionic surfactants (A-1)	(A-1-1)	0.2	0.2	0.2	0.2	0.2	0.2
		(A-1-2)	-	-	-	-	-	-
		(A-1-3)	-	-	-	-	-	-
	anionic surfactants (A-2)	(A-2-1)	-	-	-	-	-	-
		(A-2-2)	-	-	-	-	-	-
		(A-2-3)	1	1	1	1	1	1
		(A-2-4)	-	-	-	-	-	-
		(A-2-5)	-	-	-	-	-	-
		(A-2-6)	-	-	-	-	-	-
		(A-2-7)	-	-	-	-	-	-
		(A-2-8)	-	-	-	-	-	-
		p-toluenesulfonic acid	0.2	0.2	0.2	0.2	0.2	0.2
	chelating agent (B)	EDTA	-	-	-	-	-	-
		HEDP	0.2	0.2	0.2	0.2	0.2	0.2
		HMP	-	-	-	-	-	0.2
	reductant (C)	AA	-	-	-	-	-	-
		Cys	-	-	-	-	0.05	0.05
		formaldehyde	-	-	-	-	-	-
		sulfurous acid	0.05	-	-	-	-	-
		dithionous acid	-	0.05	-	-	-	-
		phosphoric acid	-	-	0.05	-	-	-
		sodium hypophosphite	-	-	-	-	-	-
		MDEA	-	-	-	0.05	-	-
	alkaline ingredient (D)	TMAH	-	-	-	-	-	-
		DEA	0.45	0.45	0.45	0.45	0.4	0.4
		DBU	-	-	-	-	-	-
	Water-soluble organic solvent(G)	DEG-B	-	-	-	-	0.5	-
	water	ultra-pure water	97.9	97.9	97.9	97.9	97.5	97.8
Dilution factor			1	1	1	1	1	1
Evaluation Results	pH value		6.5	6.5	6.5	6.5	6.5	6.0
	value of the right part of Formula (1)		298	298	298	298	298	318
	oxidation reduction potential (mV)		270	268	278	284	123	134
	surface tension (mN/m)		30	30	30	29	26	32
	cleanliness-1		◎	◎	◎	◎	◎	◎
	cleanliness-2		◎	◎	◎	◎	◎	◎
	surface flatness-1 [surface roughness Ra(nm)]		0.25	0.25	0.25	0.26	0.24	0.25
	etching-1 [Ni content (ppm)]		13.8	13.9	14.0	13.3	13.6	15.6
	contact angle-1(°)		7.8	7.9	8.4	8.8	6.3	6.1
	dispersion (nm)		33	33	34	33	30	34

[00250] [Table 4]

			Comparative Example				
			1	2	3	4	5
Formulation Volume (part)	nonionic surfactants (A-1)	(A-1-1)	0.2	-	0.2	0.2	0.2
		(A-1-2)	-	0.2	-	-	-
		(A-1-3)	-	-	-	-	-
	anionic surfactants (A-2)	(A-2-1)	1	-	1	-	1
		(A-2-2)	-	-	-	-	-
		(A-2-3)	-	1	-	1	-
		(A-2-4)	-	-	-	-	-
		(A-2-5)	-	-	-	-	-
		(A-2-6)	-	-	-	-	-
		(A-2-7)	-	-	-	-	-
		(A-2-8)	-	-	-	-	-
		p-toluenesulfonic acid	-	-	-	-	-
	chelating agent (B)	EDTA	-	-	0.2	-	-
		HEDP	0.2	0.2	-	-	-
		HMP	-	-	-	0.2	0.2
	reductant (C)	AA	-	-	-	-	-
		Cys	-	-	-	-	-
		formaldehyde	-	-	-	-	-
		sulfurous acid	-	-	-	-	-
		dithionous acid	-	-	-	-	-
		phosphoric acid	-	-	-	-	-
		sodium hypophosphite	-	-	-	-	-
		MDEA	-	-	-	-	-
	alkaline ingredient (D)	TMAH	0.2	-	0.2	-	-
		DEA	-	-	-	-	-
		DBU	-	2.0	-	-	-
	Water-soluble organic solvent(G)	DEG-B	-	-	-	-	-
	water	ultra-pure water	98.4	96.6	98.4	98.6	98.6
Dilution factor			1	1	1	1	1
Evaluation Results	pH value		4.0	13.5	6.5	6.5	8.5
	value of the right part of Formula (1)		395	28	298	298	221
	oxidation reduction potential (mV)		441	74	350	344	267
	surface tension (mN/m)		30	28	30	30	32
	cleanliness-1		△	△	△	△	○
	cleanliness-2		×	△	×	×	△
	surface flatness-1[surface roughness Ra(nm)]		0.42	0.26	0.32	0.35	0.31
	etching-1 [Ni content (ppm)]		20.5	9.4	15.5	16.3	15.1
	contact angle-1(°)		20.1	19.5	20.3	20.5	22.0
	dispersion (nm)		576	1012	489	815	460

[00251] [Table 5]

	Embodiment
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		27	28	29	30	31	32	33	34	35	36
Formulation Volume (part)	nonionic surfactants (A-1)	(A-1-1)	0.2	-	0.1	-	0.1	0.1	-	-	0.01
		(A-1-2)	-	0.2	-	0.05	-	-	-	-	-
		(A-1-3)	-	-	-	0.5	-	-	-	-	-
	anionic surfactants (A-2)	(A-2-1)	0.1	-	-	-	0.5	-	-	0.1	-
		(A-2-2)	-	0.1	-	-	-	-	-	-	-
		(A-2-3)	-	-	0.1	-	-	0.1	-	-	0.05
		(A-2-4)	-	-	-	0.1	-	-	0.1	-	-
		(A-2-5)	-	-	-	0.1	-	-	-	-	-
		(A-2-6)	-	-	-	-	0.1	-	0.1	0.1	-
		(A-2-7)	-	-	-	-	-	0.1	-	-	-
		(A-2-8)	-	-	-	-	-	-	-	-	-
		m-xylenesulfonic acid	-	-	-	-	-	-	-	-	-
	chelating agent (B)	citric acid	0.1	0.1	-	-	-	-	0.1	-	-
		HEDP	-	-	0.1	-	-	0.1	-	-	-
		HMP	-	-	-	0.2	0.2	-	-	0.2	0.2
	reductant (C)	AA	0.5	-	0.5	-	-	-	0.5	-	0.5
		Cys	-	0.5	-	-	0.5	0.5	-	-	-
		formaldehyde	-	-	-	-	-	-	-	-	-
		sulfurous acid	-	-	-	-	-	-	-	-	-
		dithionous acid	-	-	-	-	-	-	-	-	-
		phosphoric acid	-	-	-	-	-	-	-	-	-
		sodium hypophosphite	-	-	-	0.5	-	0.5	-	0.5	-
		MDEA	-	-	-	-	-	-	-	-	-
	alkaline ingredient (D)	DBU	-	-	-	-	-	-	-	-	-
		sodium hydroxide	-	-	-	-	-	-	-	-	-
	Water-soluble organic solvent(G)	DEG-B	-	-	-	-	-	-	-	-	-
	other additives (H) [pH value modifier]	sulfamic acid	1.0	-	-	7.0	-	3.5	-	0.8	0.5
		phosphatic acid	-	-	-	-	1.5	-	0.4	-	1.5
	water	ultra-pure water	98.1	99.1	99.2	92.2	97.4	95.1	98.7	98.4	97.6
Dilution factor		10	10	10	10	10	10	10	10	10	10
Evaluation Results	pH value	2.0	4.5	3.0	1.5	2.0	1.8	2.5	2.2	2.0	2.3
	value of the right part of Formula (1)	473	376	434	492	473	480	453	465	473	461
	oxidation reduction potential (mV)	395	214	360	444	323	294	412	388	428	392
	surface tension (mN/m)	40	35	45	52	42	34	38	32	33	60
	cleanliness-3	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙
	cleanliness-4	⊙	⊙	⊙	○	⊙	○	⊙	⊙	⊙	⊙
	cleanliness-5	⊙	⊙	⊙	○	⊙	⊙	⊙	⊙	⊙	⊙
	cleanliness-6	⊙	⊙	⊙	○	⊙	⊙	⊙	⊙	⊙	⊙
	surface flatness-2[surface roughness Ra(nm)]	0.21	0.20	0.20	0.22	0.23	0.21	0.22	0.20	0.21	0.20
	surface flatness-3[surface roughness Ra(nm)]	0.79	0.75	0.77	0.76	0.77	0.79	0.82	0.83	0.83	0.86
	etching-2[Si content (ppb)]	1400	1050	1100	1600	1350	1550	1150	1200	1400	1200
	etching-3[Si content (ppb)]	720	580	600	760	710	730	630	690	720	670
	contact angle-2(°)	5.1	6.4	6.0	5.5	4.8	6.2	5.7	5.6	5.5	6.0
	contact angle-3(°)	8.0	7.8	7.6	8.5	8.0	8.3	7.9	7.7	8.1	7.9
	dispersion (nm)	46	46	48	47	46	47	48	48	48	51

[00252] [Table 6]

	Embodiment
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			37	38	39	40	41	42	43	44	45	46
Formulation Volume (part)	nonionic surfactants (A-1)	(A-1-1)	-	0.1	0.1	0.1	-	-	0.01	0.1	0.1	0.1
		(A-1-2)	-	-	-	-	-	-	-	-	-	-
		(A-1-3)	-	-	-	-	-	-	-	-	-	-
	anionic surfactants (A-2)	(A-2-1)	-	0.1	0.1	0.1	0.1	0.1	-	0.1	-	0.1
		(A-2-2)	-	-	-	-	-	-	-	-	-	-
		(A-2-3)	-	-	-	-	-	-	-	-	-	-
		(A-2-4)	0.1	-	-	-	-	-	-	-	-	-
		(A-2-5)	-	-	-	-	-	-	-	-	-	-
		(A-2-6)	-	-	-	-	-	-	-	-	-	-
		(A-2-7)	-	-	-	-	-	-	-	-	-	-
		(A-2-8)	-	0.3	0.3	0.3	-	-	0.05	-	-	-
		m-xylenesulfonic acid	-	-	-	-	0.3	0.3	-	-	0.3	0.1
		chelating agent (B)	citric acid	0.1	-	-	-	-	-	-	-	-
	HEDP		-	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	HMP		-	-	-	-	-	-	-	-	-	-
	reductant (C)	AA	0.5	-	-	-	-	-	-	-	-	-
		Cys	-	-	-	-	-	-	-	-	-	0.5
		formaldehyde	-	-	-	-	-	-	-	-	-	-
		sulfurous acid	-	-	-	-	-	-	-	-	-	-
		dithionous acid	-	-	-	-	-	-	-	-	-	-
		phosphoric acid	-	-	-	-	-	-	-	-	-	-
		sodium hypophosphite	-	-	-	-	-	-	-	-	-	-
		MDEA	-	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-
		DBU	-	-	0.1	0.10	-	0.4	0.10	-	-	0.2
	sodium hydroxide	-	0.35	-	-	0.7	-	-	0.35	0.55	-	
	Water-soluble organic solvent(G)	DEG-B	-	-	-	-	-	-	-	-	-	
	other additives (H) [pH value modifier]	sulfamic acid	0.5	-	-	-	-	-	-	-	-	
		phosphatic acid	-	-	-	-	-	-	-	-	-	0.4
	water	ultra-pure water	98.8	98.6	98.8	98.8	98.3	98.6	99.2	98.9	98.5	98.5
Dilution factor			10	10	10	10	10	10	10	10	10	
Evaluation Results	pH value		2.3	12.5	10.0	8.5	12.5	10.0	8.0	12.5	12.5	2.5
	value of the right part of Formula (1)		461	66	163	221	66	163	240	66	66	453
	oxidation reduction potential (mV)		390	40	106	161	39	97	158	54	58	270
	surface tension (mN/m)		65	32	33	35	48	49	58	38	35	39
	cleanliness-3		◎	○	○	◎	○	○	◎	○	○	◎
	cleanliness-4		◎	◎	◎	◎	◎	◎	○	◎	◎	◎
	cleanliness-5		◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
	cleanliness-6		◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
	surface flatness-2[surface roughness Ra(nm)]		0.21	0.25	0.24	0.22	0.24	0.23	0.22	0.27	0.29	0.20
	surface flatness-3[surface roughness Ra(nm)]		0.84	0.64	0.60	0.53	0.61	0.56	0.77	0.67	0.78	0.60
	etching-2[Si content (ppb)]		1200	1550	1450	1300	1500	1450	1200	1550	1550	1200
	etching-3[Si content (ppb)]		660	800	760	700	780	750	680	680	620	640
	contact angle-2(°)		6.2	6.1	6.3	6.8	6.1	6.4	7.2	6.9	7.1	4.7
	contact angle-3(°)		7.7	6.8	7.2	7.8	6.7	7.3	7.8	8.7	8.9	6.5
	dispersion (nm)		46	34	33	35	34	34	60	55	58	32

[00253] [Table 7]

	Embodiment										
	47	48	49	50	51	52	53	54	55	56	

Formulation Volume (part)	nonionic surfactants (A-1)	(A-1-1)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		(A-1-2)	-	-	-	-	-	-	-	-	-	-
		(A-1-3)	-	-	-	-	-	-	-	-	-	-
	anionic surfactants (A-2)	(A-2-1)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		(A-2-2)	-	-	-	-	-	-	-	-	-	-
		(A-2-3)	-	-	-	-	-	-	-	-	-	-
		(A-2-4)	-	-	-	-	-	-	-	-	-	-
		(A-2-5)	-	-	-	-	-	-	-	-	-	-
		(A-2-6)	-	-	-	-	-	-	-	-	-	-
		(A-2-7)	-	-	-	-	-	-	-	-	-	-
		(A-2-8)	-	-	-	-	-	-	-	-	-	-
		m-xylenesulfonic acid	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	chelating agent (B)	citric acid	-	-	-	-	-	-	-	-	-	-
		HEDP	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		HMP	-	-	-	-	-	-	-	-	0.1	0.1
	reductant (C)	AA	-	-	-	-	-	-	-	-	-	-
		Cys	-	-	-	-	-	-	0.5	0.5	0.5	0.5
		formaldehyde	0.5	-	-	-	-	-	-	-	-	-
		sulfurous acid	-	0.5	-	-	-	-	-	-	-	-
		dithionous acid	-	-	0.5	-	-	-	-	-	-	-
		phosphoric acid	-	-	-	0.5	-	-	-	-	-	-
		sodium hypophosphite	-	-	-	-	0.5	-	-	-	-	-
		MDEA	-	-	-	-	-	0.5	-	-	-	-
	alkaline ingredient (D)	DBU	0.2	0.7	0.7	0.7	0.7	0.2	0.2	-	0.2	-
		sodium hydroxide	-	-	-	-	-	-	-	0.45	-	0.45
	Water-soluble organic solvent(G)	DEG-B	-	-	-	-	-	-	0.5	0.5	-	-
	other additives (H) [pH value modifier]	sulfamic acid	-	-	-	-	-	-	-	-	-	-
		phosphatic acid	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-	0.4	-
	water	ultra-pure water	98.5	98.0	98.0	98.0	98.0	98.5	98.0	98.2	98.4	98.6
Dilution factor			10	10	10	10	10	10	10	10	10	10
Evaluation Results	pH value		2.5	2.5	2.5	2.5	2.5	2.5	2.5	12.5	2.5	12.0
	value of the right part of Formula (1)		453	453	453	453	453	453	453	66	453	86
	oxidation reduction potential (mV)		396	409	410	403	401	427	266	35	274	43
	surface tension (mN/m)		38	37	38	37	36	38	30	28	36	34
	cleanliness-3		⊙	⊙	⊙	⊙	⊙	⊙	⊙	○	⊙	○
	cleanliness-4		⊙	⊙	⊙	⊙	⊙	○	⊙	⊙	⊙	⊙
	cleanliness-5		⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙
	cleanliness-6		⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙
	surface flatness-2[surface roughness Ra(nm)]		0.20	0.21	0.21	0.22	0.22	0.22	0.19	0.20	0.20	0.21
	surface flatness-3[surface roughness Ra(nm)]		0.64	0.68	0.68	0.67	0.67	0.70	0.55	0.53	0.58	0.55
	etching-2[Si content (ppb)]		1250	1250	1250	1250	1250	1100	1200	1500	1500	1650
	etching-3[Si content (ppb)]		650	640	640	650	640	640	620	630	680	660
	contact angle-2(°)		5.8	6.4	6.5	6.5	6.6	6.7	4.5	6.8	4.3	6.9
	contact angle-3(°)		6.8	7.0	6.9	7.0	7.1	7.4	6.0	6.1	6.4	6.2
	dispersion (nm)		31	32	33	33	32	34	30	30	36	35

[00254] [Table 8]

			Comparative Example		
			6	7	8
me Volu n atio form	nonionic surfactants (A-1)	(A-1-1)	0.2	0.2	0.1
		(A-1-2)	-	-	-

		(A-1-3)	-	-	-
	anionic surfactants (A-2)	(A-2-1)	0.1	-	0.1
		(A-2-2)	-	-	-
		(A-2-3)	-	0.1	-
		(A-2-4)	-	-	-
		(A-2-5)	-	-	-
		(A-2-6)	-	-	-
		(A-2-7)	-	-	-
		(A-2-8)	-	-	0.3
	chelating agent (B)	m-xylenesulfonic acid	-	-	-
		citric acid	0.1	-	-
		HEDP	-	-	0.1
		HMP	-	0.2	-
	reductant (C)	AA	-	-	-
		Cys	-	-	-
		formaldehyde	-	-	-
		sulfurous acid	-	-	-
		dithionous acid	-	-	-
		phosphoric acid	-	-	-
		sodium hypophosphite	-	-	-
		MDEA	-	-	-
	alkaline ingredient (D)	DBU	-	-	-
		sodium hydroxide	-	-	0.45
	Water-soluble organic solvent(G)	DEG-B	-	-	-
	other additives (H) [pH value modifier]	sulfamic acid	-	1.0	-
		phosphatic acid	-	-	-
	water	ultra-pure water	99.6	98.5	99.0
Dilution factor			10	10	10
Evaluation Results	pH value		5.5	2.0	12.3
	value of the right part of Formula (1)		337	473	74
	oxidation reduction potential (mV)		394	565	167
	surface tension (mN/m)		40	40	42
	cleanliness-3		△	○	×
	cleanliness-4		○	×	○
	cleanliness-5		△	×	△
	cleanliness-6		×	×	○
	surface flatness-2[surface roughness Ra(nm)]		0.20	0.28	0.34
	surface flatness-3[surface roughness Ra(nm)]		1.12	1.34	1.05
	etching-2[Si content (ppb)]		500	800	300
	etching-3[Si content (ppb)]		350	650	550
	contact angle--2(°)		10.2	8.5	15.6
	contact angle-3(°)		18.6	13.2	9.4
	dispersion (nm)		422	1007	576

[00255] It can be known from the results of Table 1-Table 8 that, the cleaning agent of the present invention has excellent removal effect on various substrate surface particles. Moreover, it can be known from the etching text results that, the cleaning agent of the present invention has suitable etching capacity, and almost will not change the flatness of the substrate surface after cleaning, thus it does not need to worry that the substrate

surface becomes rough during cleaning, it even is effective on particles attached on the substrate surface firmly. Furthermore, as the cleaning agent of the present invention can reduce the contact angle of water with respect to the substrate surface after cleaning, the effect of realizing high-degree cleaning can be exerted.

5 [00256] Due to excellent particle cleanliness, the cleaning agent of the present invention can be used as cleaning agent for the following electronic materials: magnetic disk substrate (substrate, magnetic disk, and magnetic head), flat panel display substrate (such as, substrate for liquid crystal panel, color filter substrate, array substrate, substrate for plasma display, and substrate for organic electroluminescence (EL) display),
10 photomask substrate, silicon wafer, optical lens, printed circuit board, optical communication cable, light-emitting diode (LED), substrate for solar cell, and crystal oscillator.

[00257] It will be apparent to those skilled in the art that various modifications and variations can be made to the structure of the present invention without departing from
15 the scope or spirit of the invention. In view of the foregoing, it is intended that the present invention cover modifications and variations of this invention provided they fall within the scope of the following claims and their equivalents.

WHAT IS CLAIMED IS:

1. A cleaning agent for an electronic material, comprising a surfactant (A), wherein at an active ingredient concentration when being used as cleaning solution and at 25°C, the pH value and the oxidation reduction potential (V) [in mV, vsSHE] meet

5 Formula (1):

$$V \leq -38.7 \times \text{pH value} + 550 \quad (1).$$

2. The cleaning agent for an electronic material according to claim 1, wherein at the active ingredient concentration when the cleaning agent is used as cleaning solution and at 25°C, the pH value is in a range of 1 to 13, and the electronic
10 material is a glass substrate for magnetic disk, a flat panel display substrate, or a photomask substrate.

3. The cleaning agent for an electronic material according to claim 1, wherein at the active ingredient concentration when the cleaning agent is used as cleaning solution and at 25°C, the pH value is in a range of 5 to 13, and the electronic
15 material is an aluminum substrate for magnetic disk.

4. The cleaning agent for an electronic material according to any one of claims 1 to 3, wherein the active ingredient concentration when being used as cleaning solution is in a range of 0.01 wt% to 15 wt%.

5. The cleaning agent for an electronic material according to claim 4,
20 wherein the surfactant (A) is an anionic surfactant (A-2) or a mixture of an anionic surfactant (A-2) and a nonionic surfactant (A-1).

6. The cleaning agent for an electronic material according to claim 2 or claim 3, further comprising one or more selected from a group consisting of a chelating agent

(B), a reductant (C), and an alkaline ingredient (D).

7. The cleaning agent for an electronic material according to claim 6,
wherein the chelating agent (B) is one or more selected from a group consisting of
amino-polycarboxylic acid (B-1), hydroxycarboxylic acid (B-2), phosphonic acid (B-6),
5 condensed phosphoric acid (B-7), and salts thereof.

8. The cleaning agent for an electronic material according to claim 6,
wherein the reductant (C) is one or more selected from a group consisting of aldehydes
having 1 to 12 carbon atoms, reductones having 6 to 9 carbon atoms, aliphatic amines
having 1 to 30 carbon atoms, thiol reductants, oxo acids of sulfur, and oxo acids of
10 phosphorus.

9. A cleaning solution for an electronic material, comprising a surfactant (A),
wherein at an active ingredient concentration of 0.01 wt% to 15 wt% and at 25°C, the
pH value and the oxidation reduction potential (V) [in mV, vs SHE] meet Formula (1):

$$V \leq -38.7 \times \text{pH value} + 550 \quad (1).$$

15 10. The cleaning solution for an electronic material according to claim 9,
wherein the pH value is in a range of 1 to 13, and the electronic material is glass
substrate for magnetic disk, flat panel display substrate, or photomask substrate.

11. The cleaning solution for an electronic material according to claim 9,
wherein the pH value is in a range of 5 to 13, and the electronic material is aluminum
20 substrate for magnetic disk.

12. A method for cleaning an electronic material, comprising cleaning an
electronic material in the cleaning solution according to any one of claims 9 to 11.

13. The method for cleaning an electronic material according to claim 12,

comprising cleaning a magnetic disk substrate, a flat panel display substrate, or a photomask substrate by a cleaning step after a grinding step, by a cleaning step after a polishing step, or by a cleaning step after a texturing step.

14. The method for cleaning an electronic material according to claim 13,
5 wherein the polishing step is a polishing step and/or texturing step using any one of alumina, colloidal silica, cerium oxide or diamond as abrasive.

15. The method for cleaning an electronic material according to claim 12,
wherein the cleaning is performed by using at least one cleaning method selected from a group consisting of ultrasonic cleaning, shower cleaning, spray cleaning, scrub cleaning,
10 dipping cleaning, dipping and shaking cleaning, and single substrate cleaning.

16. The method for cleaning an electronic material according to claim 12,
wherein a contact angle (25°C) of water with respect to the substrate is lower than or equal to 20°.

17. A method for fabricating an electronic material, comprising cleaning an
15 electronic material by the cleaning method according to claim 12.