

CONDUCTIVE CLEAR COATED STAINLESS STEEL SHEET

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a clear coated stainless steel sheet with a clear coating film having conductivity.

Description of the Related Art

Recently, a clear coated stainless steel sheet comprising a stainless steel sheet main body and a clear coating film formed on the surface of the stainless steel sheet main body has sometimes been used as a material of casings of electric household appliances and electronic equipments (see, for example, Japanese Unexamined Patent Application, First Publication No. 2001-149860, Japanese Unexamined Patent Application, First Publication No. 2001-316845, Japanese Unexamined Patent Application, First Publication No. 2003-154309, and Japanese Unexamined Patent Application, First Publication No. 2003-154309).

The casings of electric household appliances and electronic equipment are sometimes provided with antistatic properties so as to prevent the adhesion of dust. Usually, a method of providing a stainless steel sheet with conductivity is used so as to impart antistatic properties to the stainless steel sheet.

As the method of imparting conductivity to the stainless steel sheet, for example, a method of forming a clear coating film

containing a conductive filler composed of a metal powder on a stainless steel sheet main body (see, for example, Japanese Unexamined Patent Application, First Publication No. 2006-095709) and a method of coating a clear coating material containing a carbon material as a conductant agent to form a conductive clear coating film are known.

The conductive coating film described in Japanese Unexamined Patent Application, First Publication No. 2006-095709 has high conductivity enough to exhibit electromagnetic shielding properties. However, this conductive coating film has a problem that the clear coating film has low transparency and the stainless steel sheet main body has low visibility. Also, when the clear coating film contains a carbon material, since the carbon material has a black color, the clear coating film is colored and transparency decreases. Therefore, visibility of the stainless steel sheet main body deteriorates and appearance of the clear coated stainless steel sheet deteriorates. One of advantages of the stainless steel sheet is excellent appearance. Therefore, when appearance deteriorates, utility of the stainless steel sheet may decrease. Also, it becomes difficult to inspect the presence of flaws of the clear coating film, thus becoming uneasy to perform quality control.

SUMMARY OF THE INVENTION

Under these circumstances, the present invention has been

made and an object thereof is to provide a conductive clear coated stainless steel sheet having conductivity enough to exhibit antistatic properties wherein a decrease in visibility of the stainless steel sheet main body is prevented.

The present invention includes the following constitutions.

The first aspect of the present invention pertains to a conductive clear coated stainless steel sheet comprising a stainless steel sheet main body and a clear coating film formed on at least one surface side of the stainless steel sheet main body, the clear coating film containing a conductive pearl pigment in an amount of 3 to 30 parts by mass based on 100 parts by mass of the solid content of a thermosetting resin composition.

The second aspect of the present invention pertains to the conductive clear coated stainless steel sheet described in the first aspect, which further comprises a chemical conversion coating film between the stainless steel sheet main body and the clear coating film, wherein the chemical conversion coating film contains either or both of an aminosilane-based silane coupling agent and an epoxysilane-based silane coupling agent, the coating weight of the chemical conversion coating film is from 2 to 50 mg/m², and the clear coating film is made of a thermosetting resin composition in which an acrylic resin containing a crosslinking functional group and having a glass transition point of 30 to 90°C and a number average molecular weight of 3,000 to 50,000 is

crosslinked with a block isocyanate compound.

The third aspect of the present invention pertains to the conductive clear coated stainless steel sheet described in the second aspect, wherein the clear coating film contains a polyolefin-based wax in an amount of 0.25 to 10 parts by mass based on 100 parts by mass of the solid content of a thermosetting resin composition.

The fourth aspect of the present invention pertains to the conductive clear coated stainless steel sheet described in the second or third aspect, wherein an acrylic resin in the clear coating film is also crosslinked with an amino resin.

The fifth aspect of the present invention pertains to the conductive clear coated stainless steel sheet described in any one of the second to fourth aspects, wherein the clear coating film contains a silica sol in an amount of 2 to 10 parts by mass based on 100 parts by mass of the solid content of a thermosetting resin composition.

The sixth aspect of the present invention pertains to the conductive clear coated stainless steel sheet described in any one of the first to fifth aspects, which is used for a casing of a hard disk drive.

Effect of the invention

The conductive clear coated stainless steel sheet of the present invention has conductivity enough to exhibit antistatic properties, and a decrease in visibility of the stainless steel

sheet main body is prevented.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional view showing one embodiment of a conductive clear coated stainless steel sheet of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

One embodiment of a conductive clear coated stainless steel sheet according to the present invention will now be described.

In Fig. 1, a conductive clear coated stainless steel sheet of the present embodiment is shown. A conductive clear coated stainless steel sheet 10 of the present embodiment comprises a stainless steel sheet main body 11, a chemical conversion coating film 12 formed on one surface side of the stainless steel sheet main body 11, and a clear coating film 13 formed on the surface of the chemical conversion coating film 12.

As the stainless steel sheet main body 11 in the conductive clear coated stainless steel sheet 10, a sheet made of any of known stainless steel materials can be used.

Chemical conversion coating film

The chemical conversion coating film 12 is preferably a coating film containing either or both of an aminosilane-based silane coupling agent and an epoxysilane-based silane coupling agent. If the chemical conversion coating film 12 containing

these silane coupling agents is formed between the stainless steel sheet main body 11 and the clear coating film 13, a non-polluting chromate-free conductive clear coated stainless steel sheet can be obtained and also adhesion between the stainless steel sheet main body 11 and the clear coating film 13 can be enhanced.

The aminosilane-based coupling agent includes, for example, N-2-(aminoethyl)-3-aminopropylmethyldimethoxysilane, N-2-(aminoethyl)-3-aminopropyltriethoxysilane, and 3-aminopropyltrimethoxysilane.

The epoxy-based silane coupling agent includes, for example, 2-(3,4-epoxycyclohexyl)ethyltrimethoxysilane, 3-glycidoxypropyltrimethoxysilane, and 3-glycidoxypropylmethyldiethoxysilane.

The coating weight of the chemical conversion coating film 12 is preferably from 2 to 50 mg/m². When the coating weight of the chemical conversion coating film 12 is less than 2 mg/m², luster and corrosion resistance are likely to decrease. In contrast, when the coating weight is more than 50 mg/m², blistering sometimes occurs on the surface of the coating film after a boiling water test. The upper limit of the coating weight of the chemical conversion coating film 12 is preferably 30 mg/m², and more preferably 10 mg/m².

The coating weight of the chemical conversion coating film 12 can be determined by measuring the amount of SiO₂ by X-ray fluorescence analysis.

Clear Coating Film

The clear coating film 13 in the present embodiment is a coating film containing a conductive pearl pigment and a thermosetting resin composition.

Conductive Pearl Pigment

It is known that the volume resistivity (volume resistivity of the entire layers in a multi-layered structure material) of the material must be $10^7 \Omega \cdot \text{cm}$ or less (10^4 to $10^7 \Omega \cdot \text{cm}$) so as to prevent electrification characteristic (Synthetic Resin, 28 (2), page 14, 1982).

The conductive pearl pigment contained in the clear coating film 13 is a pearl pigment in which mica is coated with a metal oxide having excellent conductivity and excellent transparency. Usually, the pearl pigment has a structure in which mica (composed of an aluminum oxide, a magnesium oxide, a silicon dioxide, a fluorine compound, or the like) as sheet-shaped mica particles is coated with a metal oxide. Such a pearl pigment has high transparency and also has conductivity.

The metal oxide is not specifically limited. As the metal oxide, for example, one or more kinds of metal oxides selected from the group consisting of tin oxide, antimony oxide, indium oxide and zinc oxide are preferred. When the above metal oxides are used, high conductivity and high transparency can be obtained.

The content of the metal oxide in the conductive pearl pigment is preferably 40% by mass or more. When the content of

the metal oxide is less than 40% by mass, it is difficult to ensure conductivity.

The content of the metal oxide in the conductive pearl pigment is preferably 60% by mass or less. When the content of the metal oxide is more than 60% by mass, it becomes disadvantageous in view of cost because the coverage of mica is saturated.

The content of the metal oxide in the conductive pearl pigment may be 100% by mass. When the content of the metal oxide is 100% by mass, it means the conductive metal oxide itself.

As the conductive pearl pigment, commercially available conductive pearl pigments can be used. For example, a conductive pearl pigment such as Minatec 40CM (manufactured by Merck Japan Ltd.) is commercially available. As a conductive oxide having high transparency, for example, a tin/antimony-based oxide such as TWU-1 (manufactured by Mitsubishi Materials Corporation) is commercially available.

The content of the conductive pearl pigment in the clear coating film 13 is from 3 to 30 parts by mass, and more preferably from 5 to 15 parts by mass, based on 100 parts by mass of the solid content of a thermosetting resin composition. When the content of the conductive pearl pigment is less than 3 parts by mass, conductivity is not improved because of insufficient contact between conductive pearl particles. In contrast, when the content of the conductive pearl pigment is more than 30 parts by

mass, conductivity of the clear coating film 13 is saturated and also coatability deteriorates and workability of the conductive clear coated stainless steel sheet 10 deteriorates.

Thermosetting Resin Composition

The thermosetting resin composition is preferably a resin in which an acrylic resin having a crosslinking functional group (hereinafter abbreviated to acrylic resin) is crosslinked with a block isocyanate compound. When the thermosetting resin composition is the above resin, the conductive clear coated stainless steel sheet 10 can be made free of chromate and also flaw resistance, weathering resistance and chemical resistance can be improved.

The crosslinking functional groups are one or more kinds of functional groups selected from a hydroxyl group, a carboxy group and an alkoxysilane group or the like. The acrylic resin preferably has two or more crosslinking functional groups per one molecule.

The acrylic resin is a copolymer of at least one kind of a nonfunctional acryl monomer and at least one kind of functional monomer.

The nonfunctional acryl monomer includes, for example, an aliphatic acrylate or a cyclic acryte, such as methyl acrylate, ethyl acrylate, isopropyl acrylate, n-butyl acrylate, 2-ethylhexyl acrylate, methyl methacrylate, ethyl methacrylate, isopropyl methacrylate, n-butyl methacrylate, n-hexyl

methacrylate, cyclohexyl acrylate, cyclohexyl methacrylate, or lauryl methacrylate.

Examples of the functional monomer include a monomer having a hydroxyl group, a monomer having a carboxy group, and a monomer having an alkoxysilane group.

The monomer having a hydroxyl group includes, for example, a hydroxyalkyl ester such as 2-hydroxyethyl acrylate, 2-hydroxyethyl methacrylate, hydroxypropyl acrylate, and hydroxypropyl methacrylate, and a lactone-modified hydroxyl group-containing acryl monomer (for example, manufactured by Daicel Chemical Industries, Ltd. under the trade names of PLACSEL FM1 to FM5 and FA-1 to FA-5).

The monomer having a carboxy group includes, for example, acrylic acid, methacrylic acid, itaconic acid, maleic acid, and fumaric acid.

The monomer having an alkoxysilane group includes, for example, vinyltrimethoxysilane, vinyltriethoxysilane, and methacryloxypropyltrimethoxysilane.

The acrylic resin may be copolymerized with another monomer other than the nonfunctional acryl monomer and the functional monomer. The other monomer includes, for example, methyl vinyl ether; ethyl vinyl ether; n-propyl vinyl ether; n-butyl vinyl ethers; styrenes such as styrene and α -methylstyrene; and acrylamide-based monomers such as acrylamide, N-methylolacrylamide, and diacetoneacrylamide.

The glass transition point of the acrylic resin is preferably from 30 to 90°C, and more preferably from 50 to 90°C. In the case of continuously pressing the conductive clear coated stainless steel sheet 10, friction occurs and the temperature of the surface increases to a temperature within the range from 80 to 100°C due to heat generated upon working. When the glass transition point of the acrylic resin is lower than 30°C, the clear coating film 13 sometimes adheres to a mold as a result of softening. When the glass transition point of the acrylic resin is higher than 90°C, pinholes and lack of leveling tend to occur.

The composition of the acrylic resin may be appropriately selected so as to adjust the glass transition temperature of the acrylic resin within the above range.

The number average molecular weight of the acrylic resin is preferably from 3,000 to 50,000, and more preferably from 4,000 to 10,000. When the number average molecular weight of the acrylic resin is less than 3,000, reactivity with the block isocyanate compound decreases and it becomes uneasy to form the clear coating film 13. When the number average molecular weight is more than 50,000, solvent solubility decreases and thus it becomes difficult to obtain the clear coating material.

The number average molecular weight of the acrylic resin can be adjusted by the conditions when producing the acrylic resin (for example, the polymerization temperature, and the kind and the amount of the polymerization initiator).

A block isocyanate compound as a crosslinking agent capable of crosslinking the acrylic resin is a compound having two or more isocyanate groups in a molecule. Specific examples thereof include aromatic diisocyanates such as tolylene diisocyanate, diphenylmethane diisocyanate, xylylene diisocyanate, and naphthalene diisocyanate; aliphatic diisocyanates such as hexamethylene diisocyanate and dimer acid diisocyanate; alicyclic diisocyanates such as isophorone diisocyanate and cyclohexane diisocyanate; and burette-type adducts and isocyanule ring-type adducts of the polyisocyanates, which are blocked with block agents such as phenols, oximes, active methylenes, ϵ -caprolactams, triazoles, and pyrazoles. An organic tin catalyst such as dibutyltin dilaurate is used as a dissociation enhancing agent of the block agent.

Commercially available products of the block isocyanate compound include, for example, DESMODUR BL1100, DESMODUR BL1265MPA/X, DESMODUR VPLS2253, DESMODUR BL3475BS/SN, DESMODUR BL3272MPA, DESMODUR BL3370MPA, DESMODUR BL4265SN, DESMORSUM 2170, and SUMIDUR 3175 (all of which are manufactured by Sumika Bayer Urethane Co., Ltd.); DULANATE 17B-60PX, DULANATE TPA-B80X, DULANATE MF-B60X, and DULANATE MF-K60X (all of which are manufactured by Asahi Kasei Chemicals Corporation); BURNOCK DB-980K, BURNOCK D-550, BURNOCK B3-867, and BURNOCK B7-887-60 (all of which are manufactured by Dainippon Ink and Chemicals, Incorporated); and CORONATE 2515, CORONATE 2507, and CORONATE

2513 (all of which are manufactured by Nippon Polyurethane Industry Co., Ltd.). These block isocyanate compounds may be used alone or in combination.

Since the clear coating film 13 becomes hard and flaw resistance is more improved, the acrylic resin is preferably crosslinked using, as the crosslinking agent, not only the block isocyanate compound, but also an amino resin (a melamine resin).

The amino resin is a generic name for a resin obtained by an addition reaction of an amino compound (melamine, guanamine, urea) and formaldehyde (formalin) and modification of the reaction product with an alcohol. Specific examples thereof include a melamine resin, a benzoguanamine resin, a urea resin, a butylated urea resin, a butylated ureamelamine resin, a glycol uril resin, an acetoguanamine resin, and a cyclohexylguanamine resin. Of these resins, a melamine resin is preferred in view of fingerprint staining resistance, flaw resistance and chemical resistance.

The melamine resin is classified into a methylated melamine resin, an n-butylated melamine resin, an isobutylated melamine resin and a mixed alkylated melamine resin according to the kind of alcohol used for modification.

Specific examples of the methylated melamine resin include CYMEL 300, CYMEL 301, CYMEL 303, CYMEL 350, CYMEL 370, CYMEL 771, CYMEL 325, CYMEL 327, CYMEL 703, CYMEL 712, CYMEL 715, CYMEL 701, CYMEL 267, CYMEL 285, CYMEL 232, CYMEL 235, CYMEL 236, CYMEL 238,

CYMEL 211, CYMEL 254, CYMEL 204, CYMEL 212, CYMEL 202, and CYMEL 207 (all of which are manufactured by Mitsui Cytec, Ltd.); LUWIPAL 063, LUWIPAL 066, LUWIPAL 068, LUWIPAL 069, LUWIPAL 072, and LUWIPAL 073 (all of which are manufactured by BASF Corp.); SUPERBECKAMIN L-105 (manufactured by Dainippon Ink and Chemicals, Incorporated); and MELAN 522, MELAN 523, MELAN 620, MELAN 622, and MELAN 623 (all of which are manufactured by Hitachi Chemical Co., Ltd.).

Specific examples of the n-butylation melamine resin include MYCOAT 506 and MYCOAT 508 (all of which are manufactured by Mitsui Cytec, Ltd.); U-VAN 20SB, U-VAN 20SE, U-VAN 21R, U-VAN 22R, U-VAN 122, U-VAN 125, U-VAN 128, U-VAN 220, U-VAN 225, U-VAN 228, U-VAN 28-60, U-VAN 20HS, U-VAN 2020, U-VAN 2021, U-VAN 2028, and U-VAN 120 (all of which are manufactured by Mitsui Chemicals, Inc.); PLASTOPAL EBS 100A, PLASTOPAL 100B, PLASTOPAL 400B, PLASTOPAL 600B, and PLASTOPAL CB (all of which are manufactured by BASF Corp.);, SUPERBECKAMIN J-820, SUPERBECKAMIN L-109, SUPERBECKAMIN L-117, SUPERBECKAMIN L-127, and SUPERBECKAMIN L-164 (all of which are manufactured by Dainippon Ink and Chemicals, Incorporated); MELAN 21A, MELAN 22, MELAN 220, MELAN 2000, and MELAN 8000 (all of which are manufactured by Hitachi Chemical Co., Ltd.); and TESAZINE 3020, TESAZINE 3021, and TESAZINE 3036 (all of which are manufactured by Hitachi Kasei Polymer Co., Ltd.).

Specific examples of the isobutylation melamine resin

include U-VAN 60R, U-VAN 62, U-VAN 62E, U-VAN 360, U-VAN 361, U-VAN 165, U-VAN 166-60, U-VAN 169, and U-VAN 2061 (all of which are manufactured by Mitsui Chemicals, Inc.); SUPERBECKAMIN G-821, SUPERBECKAMIN L-145, SUPERBECKAMIN L-110, and SUPERBECKAMIN L-125 (all of which are manufactured by Dainippon Ink and Chemicals, Incorporated); PLASTOPAL EBS 4001, PLASTOPAL FIB, PLASTOPAL H731B, and PLASTOPAL LR8824 (all of which are manufactured by BASF Corp.); MELAN 27, MELAN 28, MELAN 28D, MELAN 245, MELAN 265, MELAN 269, and MELAN 289 (all of which are manufactured by Hitachi Chemical Co., Ltd.); and TESAZINE 3027, TESAZINE 3028, TESAZINE 3029, TESAZINE 3030, and TESAZINE 3037 (all of which are manufactured by Hitachi Kasei Polymer Co., Ltd.).

Specific examples of the mixed alkylated melamine resin include CYMEL 267, CYMEL 285, CYMEL 232, CYMEL 235, CYMEL 236, CYMEL 238, CYMEL 211, CYMEL 254, CYMEL 204, CYMEL 212, CYMEL 202, and CYMEL 207 (all of which are manufactured by Mitsui Cytec, Ltd.).

These amino resins may be used alone or in combination.

Lubricating Wax

The clear coating film 13 preferably contains a polyolefin-based wax. When the clear coating film 13 contains the polyolefin-based wax, lubricity increases as compared with the case of using an oily lubricant and the resulting conductive clear coated stainless steel sheet 10 is excellent in workability.

The polyolefin-based wax includes, for example, hydrocarbon-based waxes such as paraffin, microcrystalline, polyethylene, and polyethylenefluorine.

When the conductive clear coated stainless steel sheet 10 is worked, the temperature of the coating film increases due to heat generated upon working and frictional heat. Therefore, the melting point of the polyolefin-based wax is preferably from 70 to 160°C. When the melting point of the polyolefin-based wax is lower than 70°C, excellent characteristics as a solid lubricating additive sometimes cannot be exhibited when the polyolefin-based wax is softened or melted upon working. When the melting point of the polyolefin-based wax is higher than 160°C, hard particles exist on the surface and friction characteristics deteriorate, and thus high workability sometimes cannot be obtained.

The acid value of the polyolefin-based wax is preferably from 0 to 30. When the acid value of the polyolefin-based wax is more than 30, compatibility with the thermosetting resin composition increases and it becomes uneasy for the polyolefin-based wax to uniformly float on the surface of the coating film, and thus workability of the conductive clear coated stainless steel sheet 10 sometimes becomes insufficient.

The content of the polyolefin-based wax in the clear coating film 13 is preferably from 0.25 to 10 parts by mass based on 100 parts by mass of the solid content of a thermosetting resin composition. When the content of the polyolefin-based wax is less

than 0.25 parts by mass, workability sometimes becomes insufficient. When the content is more than 10 parts by mass, unevenness occurs on the surface of the coating film and the appearance of the conductive clear coated stainless steel sheet 10 sometimes deteriorates.

Silica Sol

The clear coating film 13 can contain a silica sol in which silica particles have a particle size of nanometer (nm) level. If the clear coating film 13 contains the silica sol, hardness, flaw resistance and fingerprint staining resistance of the coating film are improved.

The content of the silica sol is preferably from 2.0 to 10 parts by mass, and more preferably from 3.0 to 8.0 parts by mass, based on 100 parts by mass of the solid content of a thermosetting resin composition. When the content of the silica sol is less than 2.0 parts by mass, flaw resistance and hardness are insufficient. When the content is more than 10 parts by mass, workability tends to deteriorate.

The clear coating film 13 may further contain additives such as leveling agents, defoamers, antioxidants, ultraviolet absorbers, delustering agents, and silane coupling agents. It may also contain an epoxy resin, a silicone resin, a fluorine resin, a polyester, and the like.

The thickness of the clear coating film 13 is preferably from 1 to 10 μm . When the thickness of the clear coating film

13 is less than 1 μm , a lubricating function of the clear coating film 13 is not sufficiently exerted and workability of the conductive clear coated stainless steel sheet 10 deteriorates. Also, the conductivity sometimes cannot be improved. When the thickness of the clear coating film 13 is more than 10 μm , the lubricating function of the clear coating film 13 is saturated and it may become difficult to form the clear coating film.

Method for Production

An example of a method for production of the above conductive clear coated stainless steel sheet will now be described. The method for production of the conductive clear coated stainless steel sheet 10 is not limited to the following example.

In the method for production of this example, first, the stainless steel sheet main body 11 is subjected to a known pretreatment such as alkali degreasing, or etching with an acid or an alkali.

Next, a chemical conversion solution containing either or both of an aminosilane-based coupling agent and an epoxysilane-based coupling agent is coated on the stainless steel sheet main body 11, and dried to form a chemical conversion coating film 12.

As the chemical conversion solution, commercially available products can be used. The commercially available chemical conversion solution includes, for example, PARCOAT E305, PARCOAT 3750, PARCOAT 3751, PARCOAT 3753, PARCOAT 3756, PARCOAT

3757, and PARCOAT 3970 (all of which are manufactured by Nihon Parkerizing Co., Ltd.), and ALSURF 440 (manufactured by Nippon Paint Co., Ltd.).

As a method of coating the chemical conversion solution, for example, a spray coating method, a roll coating method, a bar coating method, a curtain flow coating method and an electrostatic coating method can be employed.

The drying temperature (the surface temperature) of the chemical conversion solution is preferably adjusted within a range from 60 to 140°C.

Next, a clear coating material is coated on the surface of the chemical conversion coating film 12 and dried (baked). In the case of drying, an acrylic resin is crosslinked with a block isocyanate compound to form a thermosetting resin composition. Consequently, a clear coating film 13 containing a conductive pearl pigment and a thermosetting resin composition is formed to obtain a conductive clear coated stainless steel sheet 10.

The clear coating material is a coating material which contains a conductive pearl pigment, an acrylic resin, a block isocyanate compound and a solvent as essential components, and also contains a curing catalyst of the block isocyanate compound or an amino resin, a polyolefin-based wax and a silica sol or the like as optional components.

With respect to the proportion of the acrylic resin and the block isocyanate in the clear coating material, the proportion

of the isocyanate group is preferably from 0.1 to 2.0 mol, more preferably from 0.1 to 1.0 mol, and particularly preferably from 0.2 to 0.8 mol, based on 1 mol of the crosslinking functional group of the acrylic resin.

The clear coating material can contain the curing catalyst of the block isocyanate compound so as to shorten the time required to form the clear coating film 13.

Examples of the curing catalyst of the block isocyanate include di-n-butyltin oxide, n-dibutyltin chloride, di-n-butyltin dilaurate, di-n-butyltin diacetate, di-n-octyltin oxide, di-n-octyltin dilaurate, and tetra n-butyltin.

When the clear coating material contains, as the crosslinking agent, the amino resin in addition to the block isocyanate compound, the content of the amino resin in the clear coating material is preferably from 10 to 40 parts by mass, and more preferably from 15 to 30 parts by mass, based on 100 parts by mass of the solid content of the acrylic resin. When the content of the amino resin in the clear coating material is less than 10 parts by mass, flaw resistance cannot be sufficiently improved. When the content is more than 40 parts by mass, it sometimes becomes difficult to form the clear coating film 13.

When the clear coating material contains the amino resin, since the curing time (the baking time) of the acrylic resin tends to be lengthened, a curing catalyst of the amino resin can be mixed. If the clear coating material contains the curing catalyst of the

amino resin, the curing time can be shortened.

As the curing catalyst of the amino resin, for example, a sulfonic acid-based catalyst and an amine-based catalyst are used. Of these catalysts, a p-toluenesulfonic acid-based catalyst is preferred because the effect of shortening the baking time is particularly exerted.

The amount of the curing catalyst of the amino resin is preferably from 0.5 to 5 parts by mass, and more preferably from 1 to 2 parts by mass, based on 100 parts by mass of the total amount of the acrylic resin, the block isocyanate compound and the amino resin.

When the amount of the curing catalyst of the amino resin is less than 0.5 parts by mass when the total amount of the acrylic resin, the block isocyanate compound and the amino resin is 100 parts by mass, the curing time sometimes cannot be shortened. When the amount is more than 5 parts by mass, workability of the resulting conductive clear coated stainless steel sheet 10 tends to deteriorate.

When the clear coating material contains the polyolefin-based wax, the average particle size of the polyolefin-based wax is preferably from 0.1 to 7.0 μm . When the average particle size of the polyolefin-based wax is more than 7.0 μm , dispersibility of the polyolefin-based wax in the clear coating film 13 deteriorates. When the average particle size of the polyolefin-based wax is less than 0.1 μm , workability of the

resulting conductive clear coated stainless steel sheet 10 deteriorates.

When the clear coating material contains the silica sol, the clear coating material may be prepared by adding an organosilica sol.

The organosilica sol is a colloid solution in which a nanometer-sized colloidal silica is stably dispersed in an organic solvent.

Examples of the organosilica sol include MA-ST-M, IPA-ST, EG-ST, EG-ZL, NPC-ST, DMAC-ST, DMAC-ST-ZL, XBA-ST, and MIBK-ST (all of which are manufactured by Nissan Chemical Industries, Ltd.). These organosilica sols may be used alone or in combination.

As a method of coating the clear coating material, the same method as that of coating the chemical conversion solution is applied.

The conductive clear coated stainless steel sheet 10 described above has conductivity enough to exhibit antistatic properties, an electrostatic charge can be sufficiently dissipated and the adhesion of dust can be prevented. The clear coating film 13 is a film containing a specific amount of a conductive pearl pigment and is therefore excellent in transparency and thus a decrease in visibility of the stainless steel sheet main body 11 is prevented. Therefore, this conductive clear coated stainless steel sheet 10 is excellent in appearance.

Such a conductive clear coated stainless steel sheet 10 is suited for use as a casing of electronic equipment in which the adhesion of dust may cause failures. The conductive clear coated stainless steel sheet 10 is more suited for use as a casing of hard disk drives.

The present invention is not limited to the above embodiments. For example, in the above embodiments, while a chemical conversion coating film and a clear coating film were formed on one surface of a stainless steel sheet main body, a chemical conversion coating film and a clear coating film may be formed on both surfaces of the stainless steel sheet main body.

In the embodiments described above, the conductive clear coated stainless steel sheet has the chemical conversion coating film formed between the stainless steel sheet main body and the clear coating film, but may not have the chemical conversion coating film.

EXAMPLES

Example 1

In a four-necked flask equipped with a thermometer, a reflux condenser, a stirrer, a dropping funnel and a nitrogen gas-introducing tube, toluene and butyl acetate were charged in each amount shown in Table 1 and, after heating to 110°C and stirring while bubbling a nitrogen gas, a mixture of methyl methacrylate, styrene, n-butyl methacrylate, 2-hydroxyethyl methacrylate, methyl acrylate and azobisisobutyronitrile (AIBN)

was added dropwise over 3 hours. After the completion of dropwise addition, AIBN was further added and the reaction was performed at the same temperature for 3 hours to obtain a solution of an acrylic resin containing 50% of a non-volatile component.

Furthermore, a block isocyanate "DESMODUR VPLS2253" (manufactured by Sumika Bayer Urethane Co., Ltd., NCO content: 10.5% by mass) as a curing agent was mixed to obtain a clear coating material.

Then, 5.0 parts by mass of MINATEC 40CM (manufactured by Merck Japan Ltd., a pigment in which a flake-shaped mica (main component: SiO_2) is coated with tin oxide and antimony oxide, the total of the content of tin oxide and the content of antimony oxide is about 43% by mass) as a conductive pearl pigment and 2.0 parts by mass of a polyolefin-based wax (a polyethylene wax having a melting point of 120°C and a particle size of $2\ \mu\text{m}$) were mixed and included in the clear coating material in each amount described above based on 100 parts by mass of the entire solid content of a thermosetting resin composition.

Table 1

Acrylic resin	Toluene	25.0 Parts by mass
	Butyl acetate	24.0 Parts by mass
	Methyl acrylate	16.0 Parts by mass
	Styrene	5.0 Parts by mass
	n-butyl methacrylate	19.5 Parts by mass
	2-hydroxyethyl methacrylate	9.0 Parts by mass
	Methyl acrylate	0.5 Parts by mass
	Azoisobutyronitrile (AIBN)	1.0 Parts by mass
	Number average molecular weight	5,000
Crosslinking agent	Glass transition point	60°C
	Block isocyanate (DESMODUR VPLS2253)	20.0 Parts by mass

A chemical conversion solution containing an aminosilane-based coupling agent was coated on one surface of a stainless steel sheet main body (made of No. 4 polish-finished SUS304) using a roll coater and then dried so as to adjust the surface temperature to 100°C to form a chemical conversion coating film having a coating weight of 10 g/m².

Then, the clear coating material was coated on the surface of the chemical conversion coating film using a bar coater and baked so as to adjust the surface temperature to 193°C to form a 3 µm thick clear coating film, and thus a clear coated stainless steel sheet was obtained.

With respect to the resulting clear coated stainless steel sheet, the resistance was measured by a double ring method under the environment of a temperature of 23°C and a relative humidity of 50%, and then the surface resistivity was determined based on equation (1) and the volume resistivity was determined based on equation (2). The volume resistivity was determined with respect to the entire clear coated stainless steel sheet and only the clear coating film. The volume resistivity of the entire clear coated stainless steel sheet is the value calculated assuming that the thickness is 0.4 mm. The volume resistivity of only the clear coating film is the value calculated assuming that the resistivity of the stainless steel sheet main body is 0 and the thickness of the clear coating film is 5 μ m. The results are shown in Table 2.

The surface resistivity and the volume resistivity were measured by a measuring apparatus composed of a tester (digital multimeter R6441D manufactured by ADVANTEST CORPORATION) and electrodes (P-616 manufactured by Kawaguchi Electric Works Co., Ltd., main electrode diameter: 50 mm, area of main electrode: 19.63 cm², inner diameter of outside electrode: 70 mm, outer diameter of inside electrode: 50 mm). The surface resistivity of Comparative Example 1 is the value obtained by using a super insulation tester (R-503 manufactured by Kawaguchi Electric Works Co., Ltd.).

$$(\text{Surface Resistivity}) = \{\pi(D + d)/(D - d)\} \times R \quad (1)$$

$$(\text{Volume Resistivity}) = (R \times A)/t \quad (2)$$

(D: inner diameter of outside electrode, d: outer diameter of inside electrode, R: measured value of resistance, A: main electrode area, t: thickness of sample)

Table 2

	Example 1	Example 2	Example 3	Comparative Example 1	Comparative Example 1	Comparative Example 3
Content of conductive pearl pigment in clear coating film (Parts by mass)	5	10	20	0	2	40
Surface resistivity (Ω)	1.09×10^6	6.22×10^5	2.12×10^5	$>1.9 \times 10^9$	1.51×10^6	—
Volume resistivity ($\Omega \cdot \text{cm}$)	6.13×10^6	5.64×10^6	4.55×10^6	1.27×10^8	1.28×10^7	—
	Entire steel sheet					
	4.91×10^8	4.52×10^8	3.64×10^8	1.02×10^{10}	1.02×10^9	—
Only clear coating film						

(Note) Symbol in parenthesis "—" means not measure

Examples 2 to 3 and Comparative Examples 1 to 3

In the same manner as in Example 1, except that the content of the conductive pearl pigment in the clear coating film is as shown in Table 2 in the clear coating material, a clear coated stainless steel sheet was obtained. In the same manner as in Example 1, the surface resistivity and the volume resistivity were measured. The results are shown in Table 2.

The clear coated stainless steel sheets of Examples 1 to 3 wherein the clear coating film contains a specific amount of the conductive pearl pigment were excellent in conductivity. Also, the clear coating film had high transparency and the visibility of the stainless steel sheet main body was satisfactory.

In contrast, the clear coated stainless steel sheets of Comparative Examples 1 and 2 wherein the content of the conductive pearl pigment in the clear coating film is less than 3 parts by mass had low conductivity.

The clear coated stainless steel sheet of Comparative Example 3 wherein the content of the conductive pearl pigment in the clear coating film is 40 parts by mass had low coatability and the coating material could not be uniformly coated, resulting in unevenness. Therefore, the test was terminated.

Preferable examples of the present invention have been described. It is understood, however, that the present invention is not limited to these examples. Additions, omissions,

substitutions, and other modifications can be made without departing from the spirit or scope of the present invention. Accordingly, the invention is not to be considered as limited by the foregoing description but is only limited by the scope of the appended claims.

What is claimed is:

1. A conductive clear coated stainless steel sheet comprising:
a stainless steel sheet main body and a clear coating film
formed on at least one surface side of the stainless steel sheet
main body,

the clear coating film containing a conductive pearl
pigment in an amount of 3 to 30 parts by mass based on 100 parts
by mass of the solid content of a thermosetting resin composition.

2. The conductive clear coated stainless steel sheet according
to claim 1, further comprising a chemical conversion coating film
between the stainless steel sheet main body and the clear coating
film, wherein

the chemical conversion coating film contains either or
both of an aminosilane-based silane coupling agent and an
epoxysilane-based silane coupling agent,

a coating weight of the chemical conversion coating film
is from 2 to 50 mg/m²,

the clear coating film is made of a thermosetting resin
composition in which an acrylic resin containing a crosslinking
functional group and having a glass transition point of 30 to 90°C
and a number average molecular weight of 3,000 to 50,000 is
crosslinked with a block isocyanate compound.

3. The conductive clear coated stainless steel sheet according to claim 2, wherein the clear coating film contains a polyolefin-based wax in an amount of 0.25 to 10 parts by mass based on 100 parts by mass of the solid content of a thermosetting resin composition.
4. The conductive clear coated stainless steel sheet according to claim 2 or 3, wherein an acrylic resin in the clear coating film is also crosslinked with an amino resin.
5. The conductive clear coated stainless steel sheet according to any one of claims 2 to 4, wherein the clear coating film contains a silica sol in an amount of 2 to 10 parts by mass based on 100 parts by mass of the solid content of a thermosetting resin composition.
6. The conductive clear coated stainless steel sheet according to any one of claims 1 to 5, which is used for a casing of a hard disk drive.