

DESCRIPTION

PRESSURE-SENSITIVE ADHESIVE COMPOSITION, PRESSURE-SENSITIVE ADHESIVE SHEET, AND OPTICAL MEMBER

Technical Field

[0001]

The present invention relates to a pressure-sensitive adhesive composition, a pressure-sensitive adhesive sheet, and an optical member. In particular, the pressure-sensitive adhesive sheet obtained from the pressure-sensitive adhesive composition is suitably used to be attached to a plastic product that easily generates static electricity or the like (for example, liquid crystal display panel, plasma display panel (PDP), organic electroluminescence (EL) display, etc.), and is particularly useful as a surface protective film used for the purpose of protecting the surfaces of optical members (for example, polarizing plates, wavelength plates, retardation plates, optical compensation films, reflection sheets, brightness enhancement films used for liquid crystal displays) and the like.

BACKGROUND ART

[0002]

A surface protective film (also referred to as a surface protective sheet) generally has a structure in which a pressure-sensitive adhesive layer is provided on a film-like substrate film (support). Such a protective film is bonded to an adherend (an object to be protected) with the pressure-sensitive adhesive layer interposed therebetween, and thereby is used for the purpose of protecting the adherend from being scratched and stained during processing, transportation and the like. For example, a liquid crystal display panel is formed by bonding an optical member such as a polarizing plate and a wavelength plate to a liquid crystal cell with a pressure-sensitive adhesive layer interposed therebetween. In the production of such a liquid crystal display panel, the polarizing plate to be bonded to the liquid crystal cell is once formed into a roll form, unwound from this roll, and cut to a desired size according to the shape of the liquid crystal cell before use. Here, in order to prevent the polarizing plate from rubbing against the conveying roll or the like in the intermediate step and preventing the polarizing plate from being scratched, measures are taken to attach a surface protective film to one side or both sides (typically, one side) of the polarizing plate. This surface protective film is peeled off and removed at the stage where such a film becomes unnecessary.

[0003]

Generally, since surface protective films and optical members are made of a plastic material, they have high electrical insulating property and generate static electricity by friction or peeling. For this reason, static electricity is liable to be generated also when the surface protective film is peeled off from an optical member such as a polarizing plate, and when voltage is applied to a liquid crystal while the static electricity remains, there is also concern that alignment of liquid crystal molecules is lost or the panel may be damaged. Moreover, the presence of static electricity can also be a factor of sucking dust and reducing workability. In view of such circumstances, antistatic treatment is performed on the surface protective film. For example, an antistatic function is imparted on a surface layer (top coat layer, back layer) of the surface protective film by forming an antistatic layer or applying an antistatic coating (see Patent Documents 1 and 2).

[0004]

In order to impart antistatic property to the pressure-sensitive adhesive layer itself constituting the surface protective film, an ionic compound such as an alkali metal salt and an ionic liquid which functions as an

antistatic agent is contained in the pressure-sensitive adhesive (see Patent Document 3).

[0005]

However, when an optical member is stored in a high temperature (warming) environment in a state where the surface of the pressure-sensitive adhesive layer containing an ionic compound is attached to the optical member such as a polarizing plate or the like, the ionic compound permeates from the surface of the optical member. Thereby, the antistatic ability of the ionic compound is lowered, and there arises a problem that the optical member cannot be sufficiently protected.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0006]

Patent Document 1: JP-A-2004-223923

Patent Document 2: JP-A-2008-255332

Patent Document 3: JP-A-9-165460

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0007]

Therefore, as a result of intensive studies in view of the above circumstances, the purpose of the present

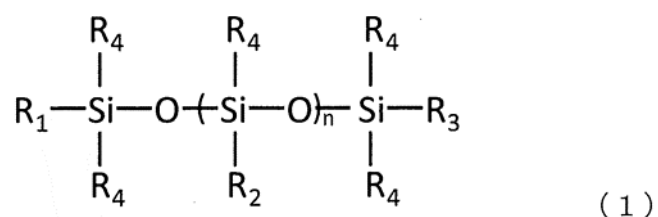
invention is to provide a pressure-sensitive adhesive composition capable of achieving antistatic property and stability over time of peeling voltage even after being adhered to an optical member such as a polarizing plate and stored in a high-temperature environment; a pressure-sensitive adhesive sheet formed from the pressure-sensitive adhesive composition; and an optical member to which the pressure-sensitive adhesive sheet is attached.

MEANS FOR SOLVING THE PROBLEMS

[0008]

That is, the pressure-sensitive adhesive composition of the present invention comprises a pressure-sensitive adhesive polymer and an ionic group-containing silicone represented by the following formula (1).

[Formula 1]



In the above formula (1), R₁ to R₄ may be the same or different and each includes any one of an alkyl group having 1 to 10 carbon atoms, an alkoxy group, an aryl group, an alicyclic group, a fluorine-substituted alkyl group, and an ionic group, provided that one or more of R₁

to R₄ includes an ionic group; and n is an integer of 0 to 100.

[0009]

The pressure-sensitive adhesive composition of the present invention preferably contains an oxyalkylene group-containing compound.

[0010]

The pressure-sensitive adhesive composition of the present invention preferably contains at least one selected from the group consisting of an acrylic pressure-sensitive adhesive, a urethane-based pressure-sensitive adhesive, and a silicone-based pressure-sensitive adhesive.

[0011]

It is preferable that the pressure-sensitive adhesive sheet of the present invention comprises a pressure-sensitive adhesive layer formed from the pressure-sensitive adhesive composition on at least one side of a substrate film, wherein the ionic group-containing silicone is present inside the pressure-sensitive adhesive layer and/or on the surface of the pressure-sensitive adhesive layer.

[0012]

In the pressure-sensitive adhesive sheet of the present invention, a separator is preferably attached to a surface of the pressure-sensitive adhesive layer opposite to the surface in contact with the substrate film.

[0013]

In the pressure-sensitive adhesive sheet of the present invention, it is preferable that the ionic group-containing silicone is present on the surface of the separator in contact with the pressure-sensitive adhesive layer.

[0014]

In the optical member of the present invention, it is preferable that the pressure-sensitive adhesive sheet or a pressure-sensitive adhesive sheet obtained by peeling off the separator from the pressure-sensitive adhesive sheet is attached.

EFFECT OF THE INVENTION

[0015]

The present invention is useful because by using a pressure-sensitive adhesive composition containing a specific ionic group-containing silicone, excellent antistatic property and stability over time of peeling electrification voltage even after a pressure-sensitive adhesive sheet having a pressure-sensitive adhesive layer formed from the pressure-sensitive adhesive composition has been applied to an optical member such as a polarizing plate and stored in a high-temperature environment, can be achieved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

Fig. 1 is a schematic cross-sectional view showing one constitution example of a pressure-sensitive adhesive sheet (surface protective film) according to the present invention.

Fig. 2 is an explanatory view showing a method of measuring a peeling electrification voltage.

MODE FOR CARRYING OUT THE INVENTION

[0017]

Embodiments of the present invention will be described in detail below.

[0018]

<Overall Structure of Pressure-Sensitive Adhesive Sheet (Surface Protective Film)>

The pressure-sensitive adhesive sheet disclosed herein is generally in the form of a pressure-sensitive adhesive tape, a pressure-sensitive adhesive label, a pressure-sensitive adhesive film or the like, and in particular, such a sheet is suitably used as a surface protective film for protecting the surface of optical members (for example, optical members used as a constituent element of a liquid crystal display panel such as a

polarizing plate and a wavelength plate) at the time of processing or transporting the optical members. Typically, the pressure-sensitive adhesive layer in the surface protective film is, but not limited thereto, formed continuously. For example, the pressure-sensitive adhesive layer may be formed in a regular or random pattern such as a dotted shape, a striped shape or the like. Further, the surface protective film disclosed herein may be in the form of a roll or a sheet.

[0019]

<Substrate Film>

The pressure-sensitive adhesive sheet (surface protective film) of the present invention is characterized by having a substrate film. In the technique disclosed herein, any resin material constituting a substrate film can be used without particular limitation, but it is preferable to use a material having excellent properties in transparency, mechanical strength, thermal stability, moisture shielding property, isotropy, flexibility, dimensional stability, and the like. In particular, with a substrate film having flexibility, it is possible to apply the pressure-sensitive adhesive composition with a roll coater or the like, and it is useful to wrap the substrate film in a roll form.

[0020]

It is preferable to use, as the substrate film (base material, support), a plastic film composed of a resin material having a main resin component (a main component in the resin component, typically a component occupying 50% by mass or more), such as polyester-based polymers such as polyethylene terephthalate (PET), polyethylene naphthalate (PEN), and polybutylene terephthalate; cellulose-based polymers such as diacetyl cellulose and triacetyl cellulose; polycarbonate-based polymers; and acrylic polymers such as polymethyl methacrylate. Other examples of the resin material include styrene-based polymers such as polystyrene and acrylonitrile-styrene copolymer; olefin-based polymers such as polyethylene, polypropylene, polyolefin having a cyclic or norbornene structure, and ethylene-propylene copolymer; vinyl chloride-based polymers; amide-based polymers such as nylon 6, nylon 6,6, and aromatic polyamide; and the like. Still other examples of the resin material include an imide-based polymer, a sulfone-based polymer, a polyether sulfone-based polymer, a polyether ether ketone-based polymer, a polyphenylene sulfide-based polymer, a vinyl alcohol-based polymer, a vinylidene chloride-based polymer, a vinyl butyral-based polymer, an acrylate-based polymer, a polyoxymethylene-based polymer, an epoxy-based polymer, and the like. A substrate

film comprising a blend of two or more kinds of the above-mentioned polymers may be used.

[0021]

As the substrate film, a plastic film made of a transparent thermoplastic resin material can be preferably adopted. Among the plastic films, it is a more preferable embodiment to use a polyester film. Here, the polyester film is a film made of a polymer material (polyester resin) having a main skeleton based on an ester bond such as polyethylene terephthalate (PET), polyethylene naphthalate (PEN), and polybutylene terephthalate as a main resin component. Such a polyester film has favorable characteristics as a substrate film of a surface protective film, such as excellent optical properties and dimensional stability, whereas the polyester film as it is has a property of becoming charged easily.

[0022]

Various additives such as an antioxidant, an ultraviolet absorber, a plasticizer, a coloring agent (a pigment, a dye, etc.), and the like may be blended in the resin material constituting the substrate film, if necessary. For example, known or conventional surface treatment such as corona discharge treatment, plasma treatment, ultraviolet irradiation treatment, acid treatment, alkali treatment, application of an undercoat

agent, etc. may be applied. Such a surface treatment can be, for example, a treatment for enhancing the tackiness between the substrate film and the pressure-sensitive adhesive layer (anchoring property of the pressure-sensitive adhesive layer).

[0023]

In the pressure-sensitive adhesive sheet (surface protective film) of the present invention, it is also possible to use a plastic film subjected to antistatic treatment as the substrate film. Use of the substrate film is preferable because the charging of the pressure-sensitive adhesive sheet itself upon peeling can be suppressed. In addition, when the substrate film is a plastic film, charging of the pressure-sensitive adhesive sheet itself can be reduced by applying an antistatic treatment to the plastic film, so that an adherend having an excellent antistatic ability can be obtained. The method of imparting the antistatic function is not particularly limited and conventionally known methods can be used for such purpose. For example, there are exemplified a method of coating the plastic film with an antistatic resin comprising an antistatic agent and a resin component, or a conductive resin containing a conductive polymer or a conductive substance, a method of vapor-depositing a conductive substance or plating the plastic

film with a conductive substance, and a method of kneading an antistatic agent into the plastic film and the like.

[0024]

The thickness of the substrate film is usually about 5 to 200 μm , preferably about 10 to 100 μm . The substrate film having a thickness within the above range is preferable since workability of bonding to an adherend as well as workability of peeling from an adherend is excellent.

[0025]

The pressure-sensitive adhesive sheet disclosed herein can also be put into practice in an embodiment including another layer in addition to the substrate film and the pressure-sensitive adhesive layer. Examples of the other layer include an undercoat layer (anchor layer) for enhancing the anchoring property of an antistatic layer and a pressure-sensitive adhesive layer.

[0026]

<Pressure-Sensitive Adhesive Composition>

The pressure-sensitive adhesive sheet of the present invention has the pressure-sensitive adhesive layer, the pressure-sensitive adhesive layer is formed from a pressure-sensitive adhesive composition, and any pressure-sensitive adhesive composition may be used without any limitation as long as it has an adherability. As the

pressure-sensitive adhesive composition, for example, acrylic pressure-sensitive adhesives, urethane-based pressure-sensitive adhesives, synthetic rubber-based pressure-sensitive adhesives, natural rubber-based pressure-sensitive adhesives, silicone-based pressure-sensitive adhesives and the like can be used. Among them, at least one selected from the group consisting of an acrylic pressure-sensitive adhesive, a urethane-based pressure-sensitive adhesive, and a silicone-based pressure-sensitive adhesive is preferable. In particular, an acrylic pressure-sensitive adhesive produced by using a (meth)acrylic polymer that is a pressure-sensitive adhesive polymer is preferred.

[0027]

In the case where the pressure-sensitive adhesive layer is produced by using an acrylic pressure-sensitive adhesive, the (meth)acrylic polymer that is a pressure-sensitive adhesive polymer constituting the acrylic pressure-sensitive adhesive can be produced by using a (meth)acrylic monomer having an alkyl group of 1 to 14 carbon atoms for forming the (meth)acrylic polymer as a main monomer. As the (meth)acrylic monomer, one or two or more types thereof can be used. By using the (meth)acrylic monomer having an alkyl group of 1 to 14 carbon atoms, it becomes easy to control the peeling strength (adhesive

strength) to an adherend (an object to be protected) at a low level, thereby to obtain a pressure-sensitive adhesive sheet (surface protective film) excellent in light peelability and removability. In the present invention, the (meth)acrylic polymer refers to an acrylic polymer and/or a methacrylic polymer, and the (meth)acrylate refers to an acrylate and/or a methacrylate.

[0028]

Specific examples of the (meth)acrylic monomer having an alkyl group of 1 to 14 carbon atoms include methyl (meth)acrylate, ethyl (meth)acrylate, n-butyl (meth)acrylate, s-butyl (meth)acrylate, t-butyl (meth)acrylate, isobutyl (meth)acrylate, hexyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, n-octyl (meth)acrylate, isooctyl (meth)acrylate, n-nonyl (meth)acrylate, isononyl (meth)acrylate, n-decyl (meth)acrylate, isodecyl (meth)acrylate, n-dodecyl (meth)acrylate, n-tridecyl (meth)acrylate, n-tetradecyl (meth)acrylate, and the like.

[0029]

Among them, in the case of a surface protective film as the pressure-sensitive adhesive sheet of the present invention, it is preferable to use a (meth)acrylic monomer having an alkyl group of 4 to 14 carbon atoms, such as n-butyl (meth)acrylate, hexyl (meth)acrylate, 2-ethylhexyl

(meth)acrylate, n-octyl (meth)acrylate, isooctyl (meth)acrylate, n-nonyl (meth)acrylate, isononyl (meth)acrylate, n-decyl (meth)acrylate, isodecyl (meth)acrylate, n-dodecyl (meth)acrylate, n-tridecyl (meth)acrylate, and n-tetradecyl (meth)acrylate. In particular, by using a (meth)acrylic monomer having an alkyl group of 4 to 14 carbon atoms, it becomes easy to control the peeling strength (adhesive strength) of the surface protective film to an adherend to a low level, and such protective film has excellent removability.

[0030]

In particular, it is preferable to contain 50% by mass or more of a (meth)acrylic monomer having an alkyl group of 1 to 14 carbon atoms, more preferably 80% by mass or more, even more preferably 85 to 99.9% by mass, and most preferably 90 to 99% by mass, with respect to 100% by mass of the total amount of monomer components constituting the (meth)acrylic polymer. If the amount of the (meth)acrylic monomer having an alkyl group of 1 to 14 carbon atoms is less than 50% by mass, appropriate wettability of the pressure-sensitive adhesive composition and cohesive strength of the pressure-sensitive adhesive layer are deteriorated, which is not preferable.

[0031]

In the pressure-sensitive adhesive composition of the

present invention, it is preferable that the (meth)acrylic polymer contains a hydroxyl group-containing (meth)acrylic monomer as a raw material monomer. As the hydroxyl group-containing (meth)acrylic monomer, one or two or more kinds of such monomers can be used. By using the hydroxyl group-containing (meth)acrylic monomer, it becomes easier to control the crosslinking of the pressure-sensitive adhesive composition and furthermore control the balance between improvement of wettability by flow and reduction of peeling strength (adhesive strength) in peeling. Moreover, unlike carboxyl groups and sulfonate groups which can generally act as a crosslinking site, the hydroxyl group can be suitably used also in terms of antistatic property because the hydroxyl group has moderate interaction with an ionic group-containing silicone which is an antistatic component (antistatic agent) and an oxyalkylene group-containing compound.

[0032]

Examples of the hydroxyl group-containing (meth)acrylic monomer include 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, 6-hydroxyhexyl (meth)acrylate, 8-hydroxyoctyl (meth)acrylate, 10-hydroxydecyl (meth)acrylate, 12-hydroxylauryl (meth)acrylate, (4-hydroxymethylcyclohexyl)methyl acrylate, N-methylol

(meth)acrylamide, and the like. In particular, the use of a hydroxyl group-containing (meth)acrylic monomer having an alkyl group of 4 or more carbon atoms is preferable because light peeling at high peel rate is facilitated.

[0033]

The content of the hydroxyl group-containing (meth)acrylic monomer is preferably 25% by mass or less, more preferably 20% by mass or less, even more preferably 0.1 to 15% by mass, most preferably 1 to 10% by mass, per 100% by mass of the total amount of monomer components constituting the (meth)acrylic polymer. If the content of the hydroxyl group-containing (meth)acrylic monomer is within the above range, the balance between the wettability of the pressure-sensitive adhesive composition and the cohesive strength of the pressure-sensitive adhesive layer to be obtained can be easily controlled, which is preferable.

[0034]

In addition, as other polymerizable monomer components, for the reason that it is easier to balance the adhesive performance so that T_g should be 0°C or less (usually -100°C or more), a polymerizable monomer or the like for adjusting the glass transition temperature and peelability can be used as long as the effect of the present invention is not impaired.

[0035]

A carboxyl group-containing (meth)acrylic monomer can be used in the (meth)acrylic polymer as the other polymerizable monomer other than the (meth)acrylic monomer having an alkyl group of 1 to 14 carbon atoms and the hydroxyl group-containing (meth)acrylic monomer. It is preferable to use the carboxyl group-containing (meth)acrylic monomer because the pressure-sensitive adhesive sheet (pressure-sensitive adhesive layer) can be prevented from increase in adhesive strength with time and thus is excellent in removability, prevention of increase in adhesive strength, and workability and the pressure-sensitive adhesive layer can be excellent in cohesive strength and shearing force.

[0036]

Examples of the carboxyl group-containing (meth)acrylic monomer include (meth)acrylic acid, carboxylethyl (meth)acrylate, carboxylpentyl (meth)acrylate and the like.

[0037]

The content of the carboxyl group-containing (meth)acrylic monomer is preferably 0 to 5% by mass, more preferably 0 to 3% by mass, even more preferably 0 to 2% by mass, most preferably 0 to 0.19% by mass, per 100% by mass of the total amount of monomer components constituting the

(meth)acrylic polymer. When the content of the carboxyl group-containing (meth)acrylic monomer exceeds 5% by mass, there are many acid functional groups such as carboxyl group having a high polar action, and when an antistatic component such as an ionic group-containing silicone or an oxyalkylene group-containing compound is blended, the antistatic component or the like interacts with the acid functional group such as a carboxyl group, so that ionic conduction is hindered to lower the conduction efficiency and thus antistatic property can be unsatisfactory, which is not preferable.

[0038]

When the hydroxyl group-containing (meth)acrylic monomer and the carboxyl group-containing (meth)acrylic monomer are used in combination, it is preferable that the carboxyl group-containing (meth)acrylic monomer is contained in an amount of 0.01 to 0.19% by mass per 100% by mass of the total amount of the monomer components constituting the (meth)acrylic polymer. Adjustment of such content within the above range is effective for obtaining a pressure-sensitive adhesive composition excellent in removability and in prevention of increase in adhesive strength while maintaining antistatic properties.

[0039]

Further, as the other polymerizable monomer other

than the (meth)acrylic monomer having an alkyl group of 1 to 14 carbon atoms, the hydroxyl group-containing (meth)acrylic monomer, and the carboxyl group-containing (meth)acrylic monomer used in the (meth)acrylic polymer, any polymerizable monomer may be used without particular limitation as long as such a monomer does not impair the properties of the present invention. For example, cohesive strength/heat resistance improving components such as cyano group-containing monomers, vinyl ester monomers and aromatic vinyl monomers, and components having a functional group capable of improving the peeling strength (adhesive strength) and acting as a crosslinking base point, such as amide group-containing monomers, imide group-containing monomers, amino group-containing monomers, epoxy group-containing monomers, N-acryloyl morpholine, and vinyl ether monomers, can be appropriately used. Among them, it is preferable to use a nitrogen-containing monomer such as a cyano group-containing monomer, an amide group-containing monomer, an imide group-containing monomer, an amino group-containing monomer, and N-acryloyl morpholine. By using a nitrogen-containing monomer, it is possible to obtain an appropriate peeling strength (adhesive strength) without causing lifting or peeling, and further it is possible to obtain a pressure-sensitive adhesive sheet (surface protective film) excellent in shearing force, which is

useful. These polymerizable monomers may be used singly or in combination of two or more thereof.

[0040]

Examples of the cyano group-containing monomer include acrylonitrile and methacrylonitrile.

[0041]

Examples of the amide group-containing monomer include acrylamide, methacrylamide, diethylacrylamide, N-vinylpyrrolidone, N,N-dimethylacrylamide, N,N-dimethylmethacrylamide, N,N-diethylacrylamide, N,N-diethylmethacrylamide, N,N'-methylenebisacrylamide, N,N-dimethylaminopropylacrylamide, N,N-dimethylaminopropylmethacrylamide, diacetone acrylamide, and the like.

[0042]

Examples of the imide group-containing monomer include cyclohexyl maleimide, isopropyl maleimide, N-cyclohexyl maleimide, itaconimide, and the like.

[0043]

Examples of the amino group-containing monomer include aminoethyl (meth)acrylate, N,N-dimethylaminoethyl (meth)acrylate, and N,N-dimethylaminopropyl (meth)acrylate.

[0044]

Examples of the vinyl ester monomer include vinyl acetate, vinyl propionate, vinyl laurate, and the like.

[0045]

Examples of the aromatic vinyl monomer include styrene, chlorostyrene, chloromethylstyrene, α -methylstyrene, and other substituted styrenes.

[0046]

Examples of the epoxy group-containing monomer include glycidyl (meth)acrylate, methylglycidyl (meth)acrylate, allyl glycidyl ether, and the like.

[0047]

Examples of the vinyl ether monomer include methyl vinyl ether, ethyl vinyl ether, isobutyl vinyl ether, and the like.

[0048]

In the present invention, the content of other polymerizable monomer other than the (meth)acrylic monomer having an alkyl group of 1 to 14 carbon atoms, the hydroxyl group-containing (meth)acrylic monomer, and the carboxyl group-containing (meth)acrylic monomer is preferably from 0 to 50% by mass, more preferably from 0 to 20% by mass, per 100% by mass of the total amount of monomer components constituting the (meth)acrylic polymer. The other polymerizable monomer can be appropriately adjusted in order to obtain desired characteristics.

[0049]

The (meth)acrylic polymer may further contain an

alkylene oxide group-containing reactive monomer as a monomer component.

[0050]

The average addition molar number of the oxyalkylene unit of the alkylene oxide group-containing reactive monomer is preferably from 1 to 40, more preferably from 3 to 40, even more preferably from 4 to 35, particularly preferably from 5 to 30, from the viewpoint of compatibility with an antistatic component such as the ionic group-containing silicone and the oxyalkylene group-containing compound. When the average addition molar number is 1 or more, there is a tendency to efficiently obtain a contamination reducing effect on an adherend (an object to be protected). When the average addition molar number is more than 40, there is a tendency that the interaction with the ionic group-containing silicone or the oxyalkylene group-containing compound is large and the viscosity of the pressure-sensitive adhesive composition increases to make coating difficult. Thus, such an average addition molar number of more than 40 is not preferable. The terminal of the oxyalkylene chain may be the hydroxyl group as it is or may be substituted with other functional groups.

[0051]

The alkylene oxide group-containing reactive monomer

may be used alone or two or more kinds thereof may be used by mixing, and the total content of the alkylene oxide group-containing reactive monomer is preferably 0 to 20% by mass, more preferably 0 to 10% by mass, based on the total amount of monomer components of the (meth)acrylic polymer. When the content of the alkylene oxide group-containing reactive monomer exceeds 20% by mass, the interaction with the ionic group-containing silicone or the oxyalkylene group-containing compound becomes larger, so that the ionic conduction is hindered to result in reduction of the antistatic property. Thus, such a content of the reactive monomer exceeding 20% by mass is not preferable.

[0052]

The oxyalkylene unit of the alkylene oxide group-containing reactive monomer includes those having an alkylene group of 1 to 6 carbon atoms, and examples thereof include an oxymethylene group, an oxyethylene group, an oxypropylene group, an oxybutylene group, and the like. The hydrocarbon group of the oxyalkylene chain may be linear or branched.

[0053]

Further, it is more preferable that the alkylene oxide group-containing reactive monomer is a reactive monomer having an ethylene oxide group. By using a reactive monomer-containing (meth)acrylic polymer having an

ethylene oxide group as the base polymer, the compatibility between the base polymer and the ionic group-containing silicone or the oxyalkylene group-containing compound is improved, so that bleeding to an adherend is suitably suppressed, and as a result, a low-fouling pressure-sensitive adhesive composition can be obtained.

[0054]

Examples of the alkylene oxide group-containing reactive monomer include a (meth)acrylic acid alkylene oxide adduct and a reactive surfactant having, in the molecule, a reactive substituent such as acryloyl group, methacryloyl group or allyl group.

[0055]

Specific examples of the (meth)acrylic acid alkylene oxide adduct include polyethylene glycol (meth)acrylate, polypropylene glycol (meth)acrylate, polyethylene glycol-polypropylene glycol (meth)acrylate, polyethylene glycol-polybutylene glycol (meth)acrylate, polypropylene glycol-polybutylene glycol (meth)acrylate, methoxypolyethylene glycol (meth)acrylate, ethoxypolyethylene glycol (meth)acrylate, butoxypolyethylene glycol (meth)acrylate, octoxypolyethylene glycol (meth)acrylate, lauroxypolyethylene glycol (meth)acrylate, stearo xypolyethylene glycol (meth)acrylate, phenoxypolyethylene glycol (meth)acrylate,

methoxypolypropylene glycol (meth)acrylate,
octoxypolyethylene glycol-polypropylene glycol
(meth)acrylate, and the like.

[0056]

Also, specific examples of the reactive surfactant include an anionic reactive surfactant, a nonionic reactive surfactant, and a cationic reactive surfactant, having a (meth) acryloyl group or an allyl group.

[0057]

The weight average molecular weight (Mw) of the (meth)acrylic polymer is preferably from 100,000 to 5,000,000, more preferably from 200,000 to 4,000,000, even more preferably from 300,000 to 3,000,000, most preferably from 300,000 to 950,000. If the weight average molecular weight of the (meth)acrylic polymer is less than 100,000, the cohesive strength of the pressure-sensitive adhesive layer is reduced to cause an adhesive residue. On the other hand, when such weight average molecular weight exceeds 5,000,000, the fluidity of the polymer is lowered and the wetting on the adherend (for example, a polarizing plate) becomes insufficient, resulting in a tendency to cause blistering which occurs between the adherend and the pressure-sensitive adhesive layer of the pressure-sensitive adhesive sheet (surface protective film). The weight

average molecular weight refers to a value obtained by measurement by GPC (gel permeation chromatography).

[0058]

The glass transition temperature (T_g) of the (meth)acrylic polymer is preferably 0°C or less, more preferably -10°C or less (usually -100°C or more). When the glass transition temperature is higher than 0°C , the polymer hardly flows, for example, the wetting to the polarizing plate which is an optical member becomes insufficient, and there is a tendency to cause blistering that occurs between the polarizing plate and the pressure-sensitive adhesive layer of the pressure-sensitive adhesive sheet (surface protective film). Especially, a pressure-sensitive adhesive layer excellent in wettability to a polarizing plate and in light peelability is easily obtained when the glass transition temperature is set to -61°C or less. Incidentally, the glass transition temperature of the (meth)acrylic polymer can be adjusted within the above range by suitably changing the monomer component and the composition ratio to be used.

[0059]

The polymerization method for obtaining the (meth)acrylic polymer is not particularly limited, and the (meth)acrylic polymer can be obtained by polymerization using a known method such as solution polymerization,

emulsion polymerization, bulk polymerization, suspension polymerization, etc. In particular, from the viewpoints of workability and characteristics such as low staining property to an adherend (an object to be protected), solution polymerization is a more preferable embodiment. Further, the obtained polymer may be any of a random copolymer, a block copolymer, an alternate copolymer, a graft copolymer, and the like.

[0060]

When a urethane-based pressure-sensitive adhesive is used for the pressure-sensitive adhesive layer, any suitable urethane-based pressure-sensitive adhesive can be adopted. As such a urethane-based pressure-sensitive adhesive, an adhesive comprising a urethane-based polymer which is a pressure-sensitive adhesive polymer obtained by reacting a polyol with a polyisocyanate compound can be mentioned. As the polyol, for example, polyether polyol, polyester polyol, polycarbonate polyol, polycaprolactone polyol and the like can be mentioned. Examples of the polyisocyanate compound include diphenylmethane diisocyanate, tolylene diisocyanate, hexamethylene diisocyanate, and the like.

[0061]

When a silicone-based pressure-sensitive adhesive is used for the pressure-sensitive adhesive layer, any

appropriate silicone-based pressure-sensitive adhesive can be adopted. As such a silicone-based pressure-sensitive adhesive, an adhesive obtained by blending or coagulating a silicone-based polymer that is a pressure-sensitive adhesive polymer can be adopted.

[0062]

Examples of the silicone-based pressure-sensitive adhesive include an addition reaction-curable silicone-based pressure-sensitive adhesive and a peroxide-curable silicone-based pressure-sensitive adhesive. Among these silicone-based pressure-sensitive adhesives, an addition reaction-curable silicone-based pressure-sensitive adhesive is preferable because no peroxide (such as benzoyl peroxide) is used and no decomposition products are generated.

[0063]

As a curing reaction of the addition reaction-curable silicone-based pressure-sensitive adhesive, for example, in the case of obtaining a polyalkylsilicone-based pressure-sensitive adhesive, a method of curing a polyalkylhydrogensiloxane composition with a platinum catalyst is generally exemplified.

[0064]

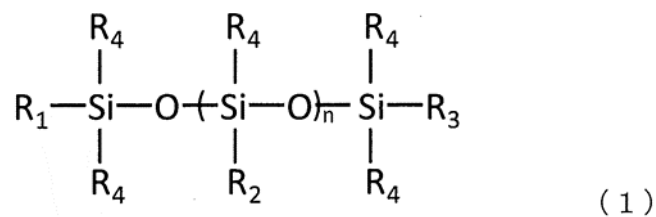
<Ionic Group-Containing Silicone>

The pressure-sensitive adhesive composition of the

present invention comprises a pressure-sensitive adhesive polymer and an ionic group-containing silicone represented by the following formula (1). By including the ionic group-containing silicone in the pressure-sensitive adhesive composition, it is possible to obtain a preferred embodiment such that even when the pressure-sensitive adhesive layer is stored in a high-temperature environment in a state of being adhered to the surface of an adherend (for example, a polarizing plate), the ionic group-containing silicone does not permeate (from the surface of the adherend to the inside of the adherend) into the adherend due to low surface free energy of the silicone chain, and tends to stay on the surface of the pressure-sensitive adhesive layer, so that even with the lapse of time, the peeling electrification characteristics are stabilized, and the antistatic performance is maintained for a long period of time. Note that the "inside" of the pressure-sensitive adhesive layer means, for example, a case where when the pressure-sensitive adhesive layer is formed using the pressure-sensitive adhesive composition blended with the ionic group-containing silicone, such ionic group-containing silicone is contained in the pressure-sensitive adhesive layer. Further, the "surface" of the pressure-sensitive adhesive layer means, for example, a case where when a pressure-sensitive adhesive

layer is formed using the pressure-sensitive adhesive composition blended with or without the ionic group-containing silicone, the ionic group-containing silicone is applied (laminated) in advance on the surface of the separator affixed for protecting the surface of the pressure-sensitive adhesive layer, and at the time of attaching the separator to the pressure-sensitive adhesive layer, the ionic group-containing silicone is transferred (shifted) from the surface of the separator to the surface of the pressure-sensitive adhesive layer.

[Formula 2]



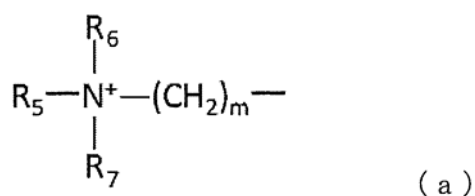
R₁ to R₄ in the above formula (1) may be the same or different and each includes any one of an alkyl group having 1 to 10 carbon atoms, an alkoxy group, an aryl group, an alicyclic group, a fluorine-substituted alkyl group, and an ionic group, provided that one or more of R₁ to R₄ includes an ionic group; and n is an integer of 0 to 100.

[0065]

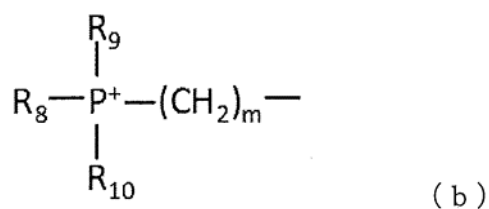
The ionic group included in one or more of R₁ to R₄

has preferably an ammonium cationic group or a phosphonium cationic group. Among them, it is preferable that at least one of R₁ to R₄ is composed of a cation structure represented by the following formula (a) or (b) and an anion component or is composed of a zwitterionic structure represented by (c) or (d).

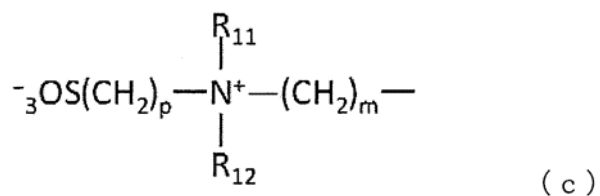
[Formula 3]



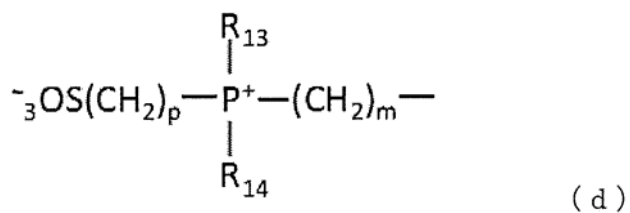
[Formula 4]



[Formula 5]

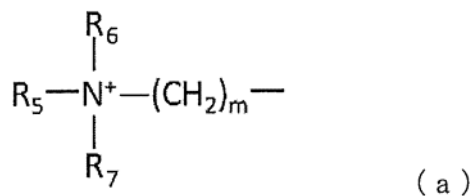


[Formula 6]



[0066]

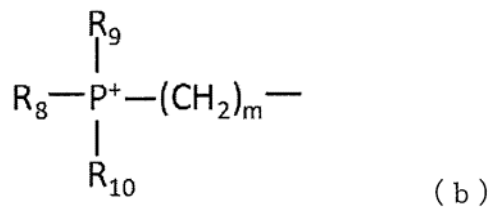
[Formula 7]



R₅ to R₇ in the above formula (a) may be the same or different and each represents any one of an alkyl group of 1 to 10 carbon atoms, an aryl group, and a fluorine-substituted alkyl group; and m is an integer of 1 to 10.

[0067]

[Formula 8]



R₈ to R₁₀ in the above formula (b) may be the same or different and each represents any one of an alkyl group of

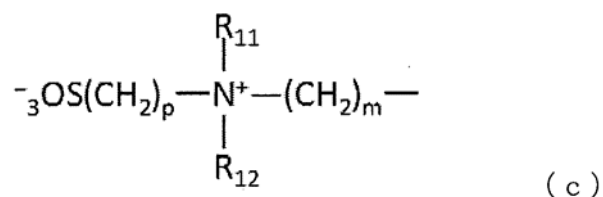
1 to 10 carbon atoms, an aryl group, and a fluorine-substituted alkyl group; and m is an integer of 1 to 10.

[0068]

On the other hand, the anion component is not particularly limited, and the following is used: Cl^- , Br^- , I^- , AlCl_4^- , Al_2Cl_7^- , BF_4^- , PF_6^- , ClO_4^- , NO_3^- , CH_3COO^- , CF_3COO^- , CH_3SO_3^- , CF_3SO_3^- , $\text{C}_4\text{F}_9\text{SO}_3^-$, $(\text{CF}_3\text{SO}_2)_2\text{N}^-$, $(\text{C}_2\text{F}_5\text{SO}_2)_2\text{N}^-$, $(\text{C}_3\text{F}_7\text{SO}_2)_2\text{N}^-$, $(\text{C}_4\text{F}_9\text{SO}_2)_2\text{N}^-$, $(\text{CF}_3\text{SO}_2)_3\text{C}^-$, AsF_6^- , SbF_6^- , NbF_6^- , TaF_6^- , $\text{F}(\text{HF})_n^-$, $(\text{CN})_2\text{N}^-$, $\text{C}_4\text{F}_9\text{SO}_3^-$, $(\text{C}_2\text{F}_5\text{SO}_2)_2\text{N}^-$, $\text{C}_3\text{F}_7\text{COO}^-$, $(\text{CF}_3\text{SO}_2)(\text{CF}_3\text{CO})\text{N}^-$, $\text{C}_9\text{H}_{19}\text{COO}^-$, $(\text{CH}_3)_2\text{PO}_4^-$, $(\text{C}_2\text{H}_5)_2\text{PO}_4^-$, $\text{C}_2\text{H}_5\text{OSO}_3^-$, $\text{C}_6\text{H}_{13}\text{OSO}_3^-$, $\text{C}_8\text{H}_{17}\text{OSO}_3^-$, $\text{CH}_3(\text{OC}_2\text{H}_4)_2\text{OSO}_3^-$, $\text{C}_6\text{H}_4(\text{CH}_3)\text{SO}_3^-$, $(\text{C}_2\text{F}_5)_3\text{PF}_3^-$, $\text{CH}_3\text{CH}(\text{OH})\text{COO}^-$, and $(\text{FSO}_2)_2\text{N}^-$.

[0069]

[Formula 9]

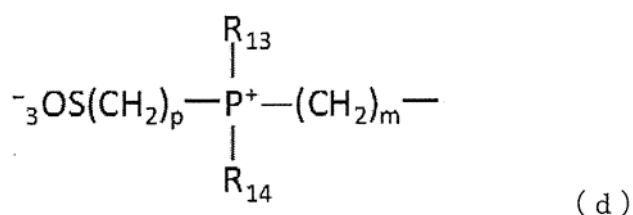


R_{11} and R_{12} in the above formula (c) may be the same or different and each represents any one of an alkyl group having 1 to 10 carbon atoms, an aryl group, and a fluorine-substituted alkyl group, and each of R_{11} and R_{12} may form a

ring and, if forming a ring, represents an alkylene group;
m is an integer of 1 to 10; and p is an integer of 1 to 6.

[0070]

[Formula 10]



R₁₃ and R₁₄ in the above formula (d) may be the same or different and each represents any one of an alkyl group having 1 to 10 carbon atoms, an aryl group, and a fluorine-substituted alkyl group, and each of R₁₃ and R₁₄ may form a ring and, if forming a ring, represents an alkylene group;
m is an integer of 1 to 10; and p is an integer of 1 to 6.

[0071]

Since such an ionic group-containing silicone contains a silicone chain,
it is possible to suitably use the ionic group-containing silicone as an antistatic agent even when the pressure-sensitive adhesive layer is stored in a high-temperature environment in a state of being adhered to the surface of an adherend (for example, a polarizing plate). At that time, the ionic group-containing silicone does not permeate (from the surface of the adherend to the inside of the

adherend) into the adherend due to low surface free energy of the silicone chain, and tends to stay on the surface of the pressure-sensitive adhesive layer, so that even with the lapse of time, the peeling electrification characteristics are stabilized and the antistatic performance is maintained for a long period of time.

[0072]

Specific examples of the ionic group-containing silicone include commercially available products such as X-40-2450 (trade name) and X-40-2750 (trade name) (all manufactured by Shin-Etsu Chemical Co., Ltd.), and the like. These compounds may be used alone or in the form of a mixture of two or more kinds thereof.

[0073]

The content of the ionic group-containing silicone is preferably in the range of 0.01 to 10 parts by mass, more preferably 0.02 to 7.5 parts by mass, even more preferably 0.03 to 5.5 parts by mass, and most preferably 0.04 to 4.8 parts by mass, per 100 parts by mass of a pressure-sensitive adhesive polymer (a main polymer, for example, (meth)acrylic polymer, urethane polymer, silicone polymer) constituting the pressure-sensitive adhesive composition. If the content of the ionic group-containing silicone is within the above range, even when the pressure-sensitive adhesive sheet of the present invention is attached to an

optical member or the like and stored in a high-temperature environment, the antistatic property, the stability over time of peeling electrification voltage, and the light peelability (removability) can be satisfied, which is preferable. In order to satisfy stain resistance, the content of the ionic group-containing silicone is preferably 0.01 to 5.5 parts by mass with respect to 100 parts by mass of the pressure-sensitive adhesive polymer.

[0074]

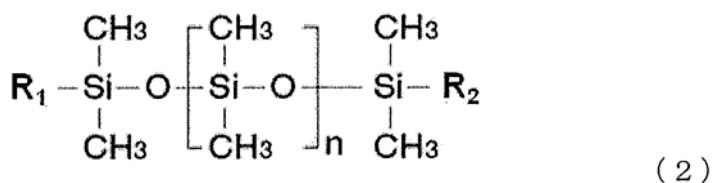
<Oxyalkylene Group-Containing Compound>

The pressure-sensitive adhesive composition of the present invention preferably contains an oxyalkylene group-containing compound, more preferably an organopolysiloxane having an oxyalkylene chain, even more preferably an organopolysiloxane having an oxyalkylene main chain. It is presumed that by using the organopolysiloxane, a surface free energy on the surface of the pressure-sensitive adhesive is lowered and light peelability is achieved.

[0075]

As the organopolysiloxane, an organopolysiloxane having a known polyoxyalkylene main chain can be appropriately used but is preferably represented by the following formula (2).

[Formula 11]



In the above formula (2), R₁ and/or R₂ has an oxyalkylene chain having 1 to 6 carbon atoms, and the alkylene group in the oxyalkylene chain may be linear or branched. The terminal of the oxyalkylene chain may be an alkoxy group or a hydroxyl group. Either R₁ or R₂ may be a hydroxyl group or may be an alkyl group or an alkoxy group, or a functional group being an alkyl group or an alkoxy group partially substituted with a hetero atom. The symbol n is an integer of 1 to 300.

[0076]

As the organopolysiloxane, an organopolysiloxane having a siloxane-containing moiety (siloxane moiety) as the main chain, and containing an oxyalkylene chain bonded to the main chain terminus is used. By using the organosiloxane having the oxyalkylene chain, it is presumed that the compatibility with the (meth)acrylic polymer or the antistatic component can be balanced to realize light peelability.

[0077]

Further, as the organopolysiloxane in the present invention, for example, the following constitution can be

used. Specifically, R_1 and/or R_2 in the formula has an oxyalkylene chain containing a hydrocarbon group having 1 to 6 carbon atoms, and as the oxyalkylene chain, there are exemplified an oxymethylene group, an oxyethylene group, an oxypropylene group, an oxybutylene group and the like, among which the oxyethylene group and oxypropylene group are preferable. When R_1 and R_2 each have an oxyalkylene chain, they may be the same or different.

[0078]

The hydrocarbon group of the oxyalkylene chain may be linear or branched.

[0079]

Further, the terminal of the oxyalkylene chain may be an alkoxy group or a hydroxyl group, and more preferably an alkoxy group. In the case of attaching a separator to the surface of a pressure-sensitive adhesive layer for the purpose of protecting the pressure-sensitive adhesive surface, interaction with the separator occurs in the organopolysiloxane having a terminal hydroxyl group, and the adhesive (peeling) strength when peeling the separator from the surface of the pressure-sensitive adhesive layer may be increased in some cases.

[0080]

n is an integer of 1 to 300 and is preferably from 10 to 200, and more preferably from 20 to 150. If n is within

the above range, balanced compatibility with a base polymer is achieved, resulting in preferred aspect. It is also possible to have a reactive substituent such as a (meth)acryloyl group, an allyl group or a hydroxyl group in the molecule. The organopolysiloxane may be used alone or in a mixture of two or more.

[0081]

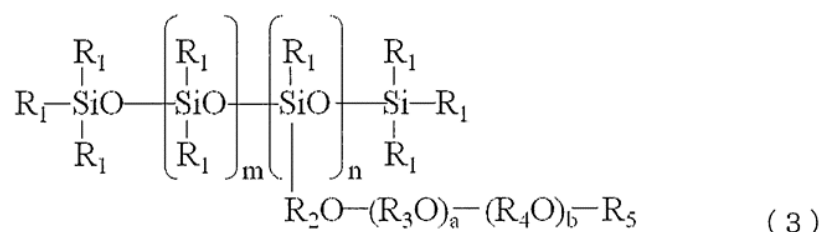
Specific examples of the organopolysiloxane having the oxyalkylene chain include commercially available products such as X-22-4952, X-22-4272, X-22-6266, KF-6004 and KF-889 (all manufactured by Shin-Etsu Chemical Co., Ltd.); BY16-201 and SF8427 (all manufactured by Dow Corning Toray Co., Ltd.); and IM22 (all manufactured by Wacker Asahikasei Silicone Co., Ltd.). These compounds may be used alone or in a mixture of two or more.

[0082]

It is also possible to use an organosiloxane having an oxyalkylene chain (organosiloxane to which oxyalkylene chain is bonded) at a side chain other than the organosiloxane having an oxyalkylene chain (organosiloxane to which oxyalkylene chain is bonded) as a main chain, and the use of the organosiloxane having an oxyalkylene chain at a side chain rather than that having an oxyalkylene chain in a main chain is a more preferable embodiment. A publicly-known polyorganosiloxane having a polyoxyalkylene

side chain may be used properly as the organopolysiloxane, and a polyorganosiloxane represented by the following formula (3) are preferable.

[Formula 12]



In the above formula (3), R_1 is a monovalent organic group; R_2 , R_3 and R_4 are each an alkylene group; R_5 is hydrogen or an organic group; and m and n are each an integer of from 0 to 1000, provided that m and n are not 0 at the same time. The symbols a and b are each an integer of from 0 to 100, provided that a and b are not 0 at the same time.

[0083]

The organopolysiloxane that can be used in the present invention are those with the following constitution. Specifically, R_1 in the above formula is a monovalent organic group, e.g., an alkyl group such as a methyl group, an ethyl group, or a propyl group; an aryl group such as a phenyl group or a tolyl group; or an aralkyl group such as a benzyl group or a phenethyl group,

all of which may respectively have a substituent group such as a hydroxyl group. R_2 , R_3 , and R_4 each may be an alkylene group of 1 to 8 carbon atoms such as a methylene group, an ethylene group, or a propylene group. Herein, R_3 and R_4 are each a different alkylene group and R_2 may be the same as or different from R_3 or R_4 . Either R_3 or R_4 is preferably an ethylene group or a propylene group in order to increase the concentration of an ionic compound soluble in the polyoxyalkylene side chain. R_5 may be a monovalent organic group, e.g., an alkyl group such as a methyl group, an ethyl group, or a propyl group; or an acyl group such as an acetyl group or a propionyl group, all of which may respectively have a substituent group such as a hydroxyl group. These compounds may be used singly or in the form of a mixture of two or more of them. These compounds may have a reactive substituent group such as a (meth)acryloyl group, an allyl group, or a hydroxyl group in the molecule. The organosiloxane having a polyoxyalkylene side chain containing a hydroxyl group at the terminal is preferable among the organosiloxanes having a polyoxyalkylene side chain since it is supposed that the compatibility can be easily balanced.

[0084]

Specific examples of the organosiloxane having an oxyalkylene chain in the side chain include commercially

available products including trade names KF-351A, KF-352A, KF-353, KF-354L, KF-355A, KF-615A, KF-945, KF-640, KF-642, KF-643, KF-6022, X-22-6191, X-22-4515, KF-6011, KF-6012, KF-6015, KF-6017, and X-22-2516 (all manufactured by Shin-Etsu Chemical Co., Ltd.); SF8428, FZ-2162, SH3749, FZ-77, L-7001, FZ-2104, FZ-2110, L-7002, FZ-2122, FZ-2164, FZ-2203, FZ-7001, SH8400, SH8700, SF8410, and SF8422 (all manufactured by Dow Corning Toray Co., Ltd.); TSF-4440, TSF-4441, TSF-4445, TSF-4450, TSF-4446, TSF-4452, TSF-4460 (manufactured by Momentive Performance Materials Inc.); and BYK-333, BYK-307, BYK-377, BYK-UV3500, and BYK-UV3570 (manufactured by BYK Japan KK). These compounds may be used singly or in the form of a mixture of two or more kinds of them.

[0085]

The organosiloxane to be used in the present invention has a HLB (Hydrophile-Lipophile Balance) value of preferably 1 to 16, and more preferably 3 to 14. If the HLB value is out of the range, the staining property to the adherend are worsened, and thus it is not preferable.

[0086]

The pressure-sensitive adhesive composition may contain an oxyalkylene group-containing compound that does not contain an organopolysiloxane. The addition of the compound to the pressure-sensitive adhesive composition can

provide a pressure-sensitive adhesive composition with more excellent wettability to an adherend.

[0087]

Specific examples of the polyoxyalkylene chain-containing compound containing no organopolysiloxane include nonionic surfactants such as polyoxyalkylenealkylamine, polyoxyalkylenediamine, polyoxyalkylene fatty acid ester, polyoxyalkylenesorbitan fatty acid ester, polyoxyalkylene alkyl phenyl ether, polyoxyalkylene alkyl ether, polyoxyalkylene alkyl allyl ether and polyoxyalkylene alkyl phenyl allyl ether; anionic surfactants such as polyoxyalkylene alkyl ether sulfuric acid ester, polyoxyalkylene alkyl ether phosphoric acid ester salt, polyoxyalkylene alkyl phenyl ether sulfuric acid ester salt and polyoxyalkylene alkyl phenyl ether phosphoric acid ester salt; cationic surfactants and amphoteric surfactants, having a polyoxyalkylene chain (polyalkyleneoxide chain); polyether compound having a polyoxyalkylene chain (including derivatives thereof), acryl compounds having a polyoxyalkylene chain (including derivatives thereof); and the like. Further, a polyoxyalkylene chain-containing monomer may be added as the polyoxyalkylene chain-containing compound to an acryl-based polymer. These polyoxyalkylene chain-containing

compounds may be used singly or in combination of two or more of them.

[0088]

Specific examples of the polyether-based compound having a polyoxyalkylene chain include a polypropylene glycol (PPG)-polyethylene glycol (PEG) block copolymer, a PPG-PEG-PPG block copolymer, and a PEG-PPG-PEG block copolymer. Examples of the polyether compound derivative having a polyoxyalkylene chain include a terminal-etherified oxypropylene group-containing compound (PPG monoalkyl ether, PEG-PPG monoalkyl ether, etc.) and a terminal-acetylated oxypropylene group-containing compound (terminal-acetylated PPG, etc.).

[0089]

Specific examples of the acrylic compound having a polyoxyalkylene chain include a (meth)acrylate polymer having an oxyalkylene group. For the oxyalkylene group, the number of addition moles of the oxyalkylene unit is preferably from 1 to 50, more preferably from 2 to 30, and even more preferably from 2 to 20, from the viewpoint of the coordination of the ionic group-containing silicone. The terminal of the oxyalkylene chain may be a hydroxyl group as it is, or may be substituted with an alkyl group, a phenyl group or the like.

[0090]

The (meth)acrylate polymer containing an oxyalkylene group is preferably a polymer containing (meth)acrylic acid alkylene oxide as a monomer unit (component), and specific examples of the (meth)acrylic acid alkylene oxide, as ethylene glycol group-containing (meth)acrylate, include methoxy-polyethylene glycol (meth)acrylate type such as methoxy-diethylene glycol (meth)acrylate and methoxy-triethylene glycol (meth)acrylate; ethoxy-polyethylene glycol (meth)acrylate type such as ethoxy-diethylene glycol (meth)acrylate and ethoxy-triethylene glycol (meth)acrylate; butoxy-polyethylene glycol (meth)acrylate type such as butoxy-diethylene glycol (meth)acrylate and butoxy-triethylene glycol (meth)acrylate; phenoxy-polyethylene glycol (meth)acrylate type such as phenoxy-diethylene glycol (meth)acrylate and phenoxy-triethylene glycol (meth)acrylate; 2-ethylhexyl-polyethylene glycol (meth)acrylate; nonylphenol-polyethylene glycol (meth)acrylate type; and methoxy-polypropylene glycol (meth)acrylate type such as methoxydipropylene glycol (meth)acrylate.

[0091]

Other monomer units (components) other than the (meth)acrylic acid alkylene oxide may be used as the monomer unit (component). Specific examples of the other monomer components include acrylates and/or methacrylates

each containing an alkyl group of 1 to 14 carbon atoms such as methyl (meth)acrylate, ethyl (meth)acrylate, n-butyl (meth)acrylate, sec-butyl (meth)acrylate, tert-butyl (meth)acrylate, isobutyl (meth)acrylate, hexyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, n-octyl (meth)acrylate, isooctyl (meth)acrylate, n-nonyl (meth)acrylate, isononyl (meth)acrylate, n-decyl (meth)acrylate, isodecyl (meth)acrylate, n-dodecyl (meth)acrylate, n-tridecyl (meth)acrylate, and n-tetradecyl (meth)acrylate.

[0092]

Further, it is also possible to properly use a carboxyl group-containing (meth)acrylate, a phosphoric acid group-containing (meth)acrylate, a cyano group-containing (meth)acrylate, vinyl esters, an aromatic vinyl compound, an acid anhydride group-containing (meth)acrylate, a hydroxyl group-containing (meth)acrylate, an amide group-containing (meth)acrylate, an amino group-containing (meth)acrylate, an epoxy group-containing (meth)acrylate, N-acryloylmorpholine, and vinyl ethers as the other monomer units (components) other than the (meth)acrylic acid alkylene oxide.

[0093]

In a preferred embodiment, the polyoxyalkylene chain-containing compound containing no organopolysiloxane is a

compound which has a (poly)ethylene oxide chain at least in a portion. The addition of the (poly)ethylene oxide chain-containing compound improves compatibility between the base polymer and the antistatic component, and preferably suppresses bleeding to an adherend, and thus gives a pressure-sensitive adhesive composition with less-staining property. In particular, in the case of using a PPG-PEG-PPG block copolymer, a pressure-sensitive adhesive composition with excellent less-staining property is obtained. In the polyethylene oxide chain-containing compound, the weight ratio of the (poly)ethylene oxide chain to the total weight of the polyoxyalkylene chain-containing compound containing no organopolysiloxane is preferably 5 to 90% by weight, more preferably 5 to 85% by weight, furthermore preferably 5 to 80% by weight, and even more preferably 5 to 75% by weight.

[0094]

The polyoxyalkylene chain-containing compound containing no organopolysiloxane has a number average molecular weight (M_n) of suitably 50,000 or less, preferably 200 to 3,0000, and more preferably 200 to 10,000, but usually, one having a number average molecular weight of 200 to 5,000 is preferably used. If M_n is too much higher than 50,000, compatibility with the acryl-based polymer tends to be lowered, which results in whitening of

the pressure-sensitive adhesive layer. If Mn is too much less than 200, staining with the polyoxyalkylene compound may be likely to occur. Herein, Mn refers to a value in terms of polystyrene measured by GPC (gel permeation chromatography).

[0095]

Specific examples of the polyoxyalkylene chain-containing compounds as commercially available products not containing an organopolysiloxane include ADEKA Pluronic 17R-4 and ADEKA Pluronic 25R-2 (both manufactured by ADEKA CORPORATION); LATEMUL PD-420, LATEMUL PD-450, EMULGEN 120 (manufactured by Kao Corporation), AQUALON HS-10, KH-10, NOIGEN EA-87, EA-137, EA-157, EA-167, EA-177 (all manufactured by Dai-ichi Kogyo Seiyaku Co., Ltd.).

[0096]

The content of the oxyalkylene group-containing compound is preferably 0.01 to 5.0 parts by mass, more preferably 0.02 to 2 parts by mass, even more preferably 0.03 to 1.6 parts by mass, most preferably 0.1 to 0.8 parts by mass, with respect to 100 parts by mass of a pressure-sensitive adhesive polymer constituting the pressure-sensitive adhesive composition (main polymer, for example, (meth)acrylic polymer, urethane-based polymer, silicone-based polymer, etc.). When the content of the oxyalkylene group-containing compound is within the above range, such a

range is preferable because both the antistatic property and the light peelability (removability) of the pressure-sensitive adhesive sheet of the present invention are easily satisfied.

[0097]

<Crosslinking Agent>

In the pressure-sensitive adhesive sheet (surface protective film) of the present invention, it is preferable that the pressure-sensitive adhesive composition contains a crosslinking agent. Further, in the present invention, a pressure-sensitive adhesive layer can be formed by using the pressure-sensitive adhesive composition. For example, when the pressure-sensitive adhesive composition is an acrylic pressure-sensitive adhesive containing the (meth)acrylic polymer, the constitutional unit and constitutional ratio of the (meth)acrylic polymer, and the selection and addition ratio of the crosslinking agent are appropriately adjusted to form crosslinking, thereby making it possible to obtain a pressure-sensitive adhesive sheet (pressure-sensitive adhesive layer) having more excellent heat resistance.

[0098]

The crosslinking agent to be used in the present invention may be an isocyanate compound, an epoxy compound, a melamine-based resin, an aziridine derivative, a metal

chelate compound, etc., and particularly, the use of an isocyanate compound is a preferable embodiment. These compounds may be used singly or in the form of a mixture of two or more of them.

[0099]

Examples of the isocyanate compound include aliphatic polyisocyanates such as trimethylene diisocyanate, butylene diisocyanate, hexamethylene diisocyanate (HDI), and dimer acid diisocyanate; alicyclic isocyanates such as cyclopentylene diisocyanate, cyclohexylene diisocyanate, isophorone diisocyanate (IPDI), and 1,3-bis(isocyanatomethyl)cyclohexane; aromatic isocyanates such as 2,4-tolylene diisocyanate, 4,4'-diphenylmethane diisocyanate, and xylylene diisocyanate (XDI); and modified polyisocyanates obtained by modifying the isocyanate compounds with allophanate bonding, biuret bonding, isocyanurate bonding, uretdione bonding, urea bonding, carbodiimide bonding, uretonimine bonding, oxadiazinetriene bonding, etc. Examples of such isocyanate compounds as commercially available products include trade names TAKENATE 300S, TAKENATE 500, TAKENATE 600, TAKENATE D165N, and TAKENATE D178N (all manufactured by Takeda Pharmaceutical Co., Ltd.), SUMIDUR T80, SUMIDUR L, and DESMODUR N3400 (all manufactured by Sumitomo Bayer Urethane Co., Ltd.); and MILLIONATE MR, MILLIONATE MT, CORONATE L,

CORONATE HL, and CORONATE HX (all manufactured by Nippon Polyurethane Industry Co., Ltd.). These isocyanate compounds may be used singly or in the form of a mixture of two or more of them, and it is also possible to use a bifunctional isocyanate compound and a tri or higher functional isocyanate compound in combination. The combination use of the crosslinking agents makes it possible to satisfy both adherability and repulsion resistance (adhesion to a curved surface) and to obtain a pressure-sensitive adhesive sheet more excellent in adhesion reliability.

[0100]

In the case of using a bifunctional isocyanate compound and a tri or higher functional isocyanate compound in combination as the isocyanate compound, the mixing ratio (mass ratio) of the two compounds: [bifunctional isocyanate compound]/[tri or higher functional isocyanate compound] (mass ratio) is preferably 0.1/99.9 to 50/50, more preferably 0.1/99.9 to 20/80, even more preferably 0.1/99.9 to 10/90, still even more preferably 0.1/99.9 to 5/95, and most preferably 0.1/99.9 to 1/99. Mixing the two compounds at a ratio within the above range is a preferable embodiment since such mixing gives a pressure-sensitive adhesive layer excellent in adherability and repulsion resistance.

[0101]

Examples of the epoxy compound include N,N,N',N'-tetraglycidyl-m-xylenediamine (trade name TETRAD-X manufactured by Mitsubishi Gas Chemical Company, Inc.) and 1,3-bis(N,N-diglycidylaminomethyl)cyclohexane (trade name TETRAD-C manufactured by Mitsubishi Gas Chemical Company Inc.).

[0102]

Examples of the melamine-based resin include hexamethylolmelamine. Examples of the aziridine derivative as commercially available products include trade names HDU, TAZM, and TAZO (all manufactured by Sogo Pharmaceutical Co., Ltd.).

[0103]

Metal chelate compounds include a metal component such as aluminum, iron, tin, titanium, or nickel, and a chelate component such as acetylene, methyl acetoacetate, or ethyl lactate.

[0104]

The content of the crosslinking agent to be used in the present invention is preferably 0.01 to 20 parts by mass, more preferably 0.1 to 15 parts by mass, even more preferably 0.5 to 10 parts by mass, most preferably 1 to 6 parts by mass, with respect to 100 parts by mass of the (meth)acrylic polymer. If the content of the crosslinking

agent is less than 0.01 parts by mass, the crosslinking agent may insufficiently form crosslinking, so that the cohesive strength of the obtained pressure-sensitive adhesive layer may be low and sufficient heat resistance may not be obtained, which tends to cause adhesive residues. On the other hand, when the content of the crosslinking agent exceeds 20 parts by mass, the cohesive strength of the polymer is high and the fluidity is reduced, so that the wettability to an adherend (for example, a polarizing plate) becomes insufficient, which tends to cause blisters between the adherend and the pressure-sensitive adhesive layer (pressure-sensitive adhesive composition layer). In addition, the crosslinking agent in a large amount tends to lower the peeling electrification characteristics. These crosslinking agents may be used singly or in combination of two or more of them.

[0105]

The pressure-sensitive adhesive composition may further contain a crosslinking catalyst for more effectively progressing any of the crosslinking reactions described above. Examples of such crosslinking catalysts that can be used include tin catalysts such as dibutyltin dilaurate and dioctyltin dilaurate; and iron catalysts such as tris(acetylacetonato)iron, tris(hexane-2,4-dionato)iron,

tris(heptane-2,4-dionato)iron, tris(heptane-3,5-dionato)iron, tris(5-methylhexane-2,4-dionato)iron, tris(octane-2,4-dionato)iron, tris(6-methylheptane-2,4-dionato)iron, tris(2,6-dimethylheptane-3,5-dionato)iron, tris(nonane-2,4-dionato)iron, tris(nonane-4,6-dionato)iron, tris(2,2,6,6-tetramethylheptane-3,5-dionato)iron, tris(tridecane-6,8-dionato)iron, tris(1-phenylbutane-1,3-dionato)iron, tris(hexafluoroacetylacetonato)iron, tris(ethyl acetoacetate)iron, tris(n-propyl acetoacetate)iron, tris(isopropyl acetoacetate)iron, tris(n-butyl acetoacetate)iron, tris(sec-butyl acetoacetate)iron, tris(tert-butyl acetoacetate)iron, tris(methyl propionylacetate)iron, tris(ethyl propionylacetate)iron, tris(n-propyl propionylacetate)iron, tris(isopropyl propionylacetate)iron, tris(n-butyl propionylacetate)iron, tris(sec-butyl propionylacetate)iron, tris(tert-butyl propionylacetate)iron, tris(benzyl acetoacetate)iron, tris(dimethyl malonate)iron, tris(diethyl malonate)iron, trimethoxyiron, triethoxyiron, tri-isopropoxyiron, and ferric chloride. These crosslinking catalysts may be used singly or in combination of two or more of them.

[0106]

The content of the crosslinking catalyst is not particularly limited but is preferably about 0.0001 to 1

part by mass, more preferably about 0.001 to 0.5 parts by mass, with respect to 100 parts by mass of the (meth)acrylic polymer. If the content of the crosslinking catalyst is within the above range, the speed of the crosslinking reaction is high when forming the pressure-sensitive adhesive layer, and the pot life of the pressure-sensitive adhesive composition also becomes longer, which is a preferable embodiment.

[0107]

The pressure-sensitive adhesive composition may include a compound that exhibits keto-enol tautomerism. An embodiment can be preferably adopted, in which, for example, a pressure-sensitive adhesive composition including a crosslinking agent, or a pressure-sensitive adhesive composition that can be used by blending a crosslinking agent, includes the compound exhibiting keto-enol tautomerism. Thereby, it is possible to realize an effect of suppressing excessive increase in viscosity and gelation of the pressure-sensitive adhesive composition after blending the crosslinking agent and of prolonging the pot life of the pressure-sensitive adhesive composition. When at least an isocyanate compound is used as the crosslinking agent, it is particularly significant to contain the compound exhibiting keto-enol tautomerism. This technique can be preferably applied when the pressure-

sensitive adhesive composition is, for example, in the form of an organic solvent solution or in a solvent-free state.

[0108]

Various types of β -dicarbonyl compounds can be used as the compound exhibiting keto-enol tautomerism. Specific examples of the β -dicarbonyl compounds include β -diketones, such as acetylacetone, 2,4-hexanedione, 3,5-heptanedione, 2-methylhexane-3,5-dione, 6-methylheptane-2,4-dione, and 2,6-dimethylheptane-3,5-dione; acetoacetates, such as methyl acetoacetate, ethyl acetoacetate, isopropyl acetoacetate, and tert-butyl acetoacetate; propionylacetates, such as ethyl propionylacetate, ethyl propionylacetate, isopropyl propionylacetate, and tert-butyl propionylacetate; isobutyrylacetates, such as ethyl isobutyrylacetate, ethyl isobutyrylacetate, isopropyl isobutyrylacetate, and tert-butyl isobutyrylacetate; malonic acid esters, such as methyl malonate and ethyl malonate; and the like. Among them, acetylacetone and acetoacetates are used as preferred compounds. The compounds exhibiting keto-enol tautomerism may be used alone or in combination of two or more thereof.

[0109]

It is appropriate that the content of the keto-enol tautomerism-exhibiting compound is, for example, 0.1 to 20 parts by mass, usually 0.5 to 15 parts by mass (for

example, 1 to 10 parts by mass), with respect to 100 parts by mass of the (meth)acrylic polymer. When the amount of the compound is too small, sufficient use effect may not be exerted in some cases. On the other hand, if the compound is used more than necessary, the compound may remain in the pressure-sensitive adhesive layer, resulting in reduction of the cohesive strength in some cases.

[0110]

Further, the pressure-sensitive adhesive composition may contain other known additives. For example, powders such as lubricants, colorants and pigments, plasticizers, tackifiers, low molecular weight polymers, surface lubricants, leveling agents, antioxidants, corrosion inhibitors, light stabilizers, ultraviolet absorbers, polymerization inhibitors, silane coupling agents, inorganic or organic fillers, metal powders, particulate-like or foil-like materials may be added as appropriate depending on the intended use.

[0111]

<Pressure-Sensitive Adhesive Layer and Pressure-Sensitive Adhesive Sheet (Surface Protective Film)>

In the pressure-sensitive adhesive sheet of the present invention, the pressure-sensitive adhesive layer is formed on at least one side of the substrate film. In this case, it is preferable that crosslinking of the pressure-

sensitive adhesive composition is generally performed after application of the pressure-sensitive adhesive composition. However, it is also possible to transfer a pressure-sensitive adhesive layer comprising a pressure-sensitive adhesive composition after crosslinking to a substrate film or the like.

[0112]

The method for forming a pressure-sensitive adhesive layer on a substrate film is not particularly limited. For example, the pressure-sensitive adhesive composition (solution) is applied to a substrate film, and a polymerization solvent and the like are dried and removed to prepare a pressure-sensitive adhesive layer on the substrate film. After that, curing may be performed for the purpose of adjusting the component transfer of the pressure-sensitive adhesive layer or adjusting the crosslinking reaction and the like. When preparing a pressure-sensitive adhesive sheet by applying a pressure-sensitive adhesive composition onto a substrate film, one or more solvents other than the polymerization solvent may be newly added into the pressure-sensitive adhesive composition so that the substrate film can be uniformly coated with the pressure-sensitive adhesive composition.

[0113]

At the time of producing the pressure-sensitive adhesive sheet of the present invention, publicly-known methods employed for producing pressure-sensitive adhesive tapes are used to form the pressure-sensitive adhesive layer. Specific examples include roll coating, gravure coating, reverse coating, roll blush, spray coating, air knife coating, and extrusion coating using a die coater.

[0114]

The pressure-sensitive adhesive sheet of the present invention is usually prepared so that the thickness of the pressure-sensitive adhesive layer is about 3 to 100 μm , preferably about 5 to 50 μm . The pressure-sensitive adhesive layer having a thickness within the above range is preferable because a proper balance of removability and adhesion property can be easily obtained.

[0115]

Further, the pressure-sensitive adhesive sheet of the present invention preferably has a total thickness of 8 to 300 μm , more preferably 10 to 200 μm , most preferably 20 to 100 μm . If the thickness of the pressure-sensitive adhesive sheet is within the above range, a preferred embodiment is obtained such that the sheet is excellent in adhesive properties (removability, adhesion property, etc.), workability and appearance characteristics. The total thickness means the sum of the thicknesses including

all the layers such as the substrate film, the pressure-sensitive adhesive layer, and other layers.

[0116]

<Separator>

In the pressure-sensitive adhesive sheet of the present invention, it is preferable that a separator is attached to the surface of the pressure-sensitive adhesive layer opposite to the surface in contact with the substrate film. The separator may be laminated on the surface of the pressure-sensitive adhesive layer for the purpose of protecting the adhesive surface as necessary.

[0117]

A material for constituting the separator may be paper or a plastic film, and in terms of excellent surface smoothness, a plastic film is preferably used. The plastic film is not particularly limited as long as the film is a film capable of protecting the pressure-sensitive adhesive layer, and examples include a polyethylene film, a polypropylene film, a polybutene film, a polybutadiene film, a polymethylpentene film, a polyvinyl chloride film, a polyvinyl chloride copolymer film, a polyethylene terephthalate film, a polybutylene terephthalate film, a polyurethane film, and an ethylene-vinyl acetate copolymer film.

[0118]

The separator has a thickness of usually 5 to 200 μm and preferably about 10 to 100 μm . If the thickness falls within the range, the workability of bonding to the pressure-sensitive adhesive layer and the peeling workability from the pressure-sensitive adhesive layer are excellent, and thus it is preferable. The separator may be subjected to a release and anti-staining treatment by a silicone-based, a fluorine-based, a long chain alkyl-based, or an aliphatic acid amide-based releasing agent and a silica powder; and an application type, a kneading type, or a deposition type antistatic treatment, if necessary.

[0119]

In the pressure-sensitive adhesive sheet of the present invention, it is preferable that the ionic group-containing silicone is present (applied) on the surface of the separator in contact with the pressure-sensitive adhesive layer (see Fig. 1). In the case where the ionic group-containing silicone is present (applied or formed as a coating film) on the surface of the separator in contact with the pressure-sensitive adhesive layer, when the separator is attached to the pressure-sensitive adhesive layer, the ionic group-containing silicone is transferred (shifted) from the surface of the separator to the surface of the pressure-sensitive adhesive layer, and even when the pressure-sensitive adhesive layer is stored in a high-

temperature environment in a state of being adhered to the surface of an adherend (for example, a polarizing plate), the ionic group-containing silicone does not penetrate (from the surface of the adherend to the inside of the adherend) in the adherend, so that the peeling electrification characteristics are stabilized even with time, and the antistatic performance is maintained for a long period, which is a preferred embodiment.

[0120]

<Optical Member>

The optical member of the present invention is preferably attached to (protected with) the pressure-sensitive adhesive sheet. Since the pressure-sensitive adhesive sheet is excellent in antistatic property and stability over time of peeling electrification voltage, such a sheet can be used for surface protection application (as a surface protective film) such as processing, transporting, shipping, etc. Thus, the pressure-sensitive adhesive sheet is useful for protecting the surface of the optical member (polarizing plate, etc.). In particular, since such sheet can be used as a plastic product which is prone to generate static electricity, the sheet is extremely useful for antistatic applications in technical fields related to optical and electronic parts where charging is a particularly serious problem.

EXAMPLES

[0121]

Several Examples relating to the present invention will be described below, but the present invention is not intended to be limited to the specific Examples. In the following description, "parts" and "%" are on a mass basis unless otherwise specified. Also, the blending amount (adding amount) is shown in the table.

[0122]

In addition, each characteristic in the following explanation was measured or evaluated as follows.

[0123]

<Measurement of Weight Average Molecular Weight (Mw)>

The weight average molecular weight (Mw) was measured using a GPC apparatus (HLC-8220 GPC) manufactured by Tosoh Corporation. The measurement conditions are as follows.

Sample concentration: 0.2wt% (THF solution)

Sample injection amount: 10 μ l

Eluent: THF

Flow rate: 0.6ml/min

Measuring temperature: 40°C

Column:

Sample column; TSKguard column SuperHZ-H(1 column)+TSK gel Super HZM-H(2 columns)

Reference column; TSK gel SuperH-RC(1 column)

Detector: Refractive index detector (RI)

A molecular weight was obtained in terms of polystyrene.

[0124]

<Measurement of Initial Peeling electrification voltage>

A pressure-sensitive adhesive sheet according to each Example was cut to a size of 70 mm in width and 130 mm in length and after releasing a release liner, the pressure-sensitive adhesive sheet was pressure-bonded to the surface of a polarizing plate (SEG1423 DU polarizing plate, manufactured by Nitto Denko Corporation, width: 70 mm, length: 100 mm) attached to a glass plate, by a hand roller such that one end portion of the pressure-sensitive adhesive sheet protruded by 30 mm from the end of the polarizing plate.

The sample was allowed to stand in an environment of 23°C × 50% RH for 1 day and then set at a predetermined position of a sample fixing table 30 having a height of 20 mm as shown in Fig. 2. The end portion of a pressure-sensitive adhesive sheet (surface protective film) 1 protruding from a polarizing plate 20 by 30 mm was fixed to an automatic winder (not shown) and peeled off at a peel angle of 150° and a peel rate of 30 m/min. The electric potential generated at this time on the surface of the

adherend (polarizing plate) was measured with a potential measuring instrument 40 (model "STATIRON DZ-4" manufactured by Shishido Electrostatic, Ltd.) fixed at a height of 30 mm from the center of the polarizing plate 20, thereby to measure "an initial peeling electrification voltage". The measurement was carried out in an environment of 23°C and 50% RH.

[0125]

<Measurement of Peeling electrification voltage After Storage at 70°C>

A pressure-sensitive adhesive sheet according to each Example was cut to a size of 70 mm in width and 130 mm in length and after releasing a release liner, the pressure-sensitive adhesive sheet was pressure-bonded to the surface of a polarizing plate (SEG1423 DU polarizing plate, manufactured by Nitto Denko Corporation, width: 70 mm, length: 100 mm) attached to a glass plate, by a hand roller such that one end portion of the pressure-sensitive adhesive sheet protruded by 30 mm from the end of the polarizing plate.

This sample was allowed to stand in an environment of 70°C for 120 hours and then set at a predetermined position of a sample fixing table 30 having a height of 20 mm as shown in Fig. 2. The end portion of the pressure-sensitive adhesive sheet (surface protective film) 1 protruding from

the polarizing plate 20 by 30 mm was fixed to an automatic winder (not shown) and peeled off at a peel angle of 150° and a peel rate of 30 m/min. The electric potential generated at this time on the surface of the adherend (polarizing plate) was measured with a potential measuring instrument 40 (model "STATIRON DZ-4" manufactured by Shishido Electrostatic, Ltd.) fixed at a height of 30 mm from the center of the polarizing plate 20, thereby to measure "a peeling electrification voltage after storage at 70°C". The measurement was carried out in an environment of 23°C and 50% RH.

[0126]

Incidentally, the initial peeling electrification voltage and the peeling electrification voltage after storage at 70°C (kV) (absolute value) in the present invention are preferably 0.55 or less, more preferably 0.5 or less, even more preferably 0.45 or less. When such a peeling electrification voltage is within the above range, the pressure-sensitive adhesive sheet peeled off at an initial stage or after storage at 70°C for 120 hours is not charged and is excellent in antistatic properties, peeling electrification characteristic over time, and workability. This is a preferred embodiment.

[0127]

<Presence/Absence of Contamination (Stain Resistance)>

The pressure-sensitive adhesive sheet according to each Example was cut into a size of 50 mm in width and 80 mm in length, and after peeling off the separator, such adhesive sheet was pressure-bonded to a TAC polarizing plate (SEG1423 DU polarizing plate, width: 70 mm, length: 100 mm, manufactured by Nitto Denko Corporation) by a hand roller while introducing air bubbles, thereby to prepare evaluation samples. After leaving the evaluation sample in an environment of 70°C for 120 hours, the pressure-sensitive adhesive sheet was peeled off from the adherend by hand, and bubble traces on the adherend surface at that time were visually observed. In the evaluation, the case where bubble traces were not observed was evaluated as ○, and the case where bubble traces were observed was evaluated as ×.

[0128]

<Preparation of Acrylic Polymer (1)>

A four-neck flask equipped with a stirring blade, a thermometer, a nitrogen gas-introducing tube, and a condenser was charged with 96 parts by mass of 2-ethylhexyl acrylate (2EHA), 4 parts by mass of 2-hydroxyethyl acrylate (HEA), 0.2 parts by mass of 2,2'-azobisisobutyronitrile as a polymerization initiator, and 150 parts by mass of ethyl acetate. Nitrogen gas was introduced into the flask while

the mixture was gently stirred, and polymerization reaction was performed for 6 hours while the temperature of the liquid in the flask was kept at about 65°C, thereby to prepare a solution (40% by mass) of an acrylic polymer (1). The acrylic polymer (1) had a weight average molecular weight (Mw) of 540,000.

[0129]

<Preparation of Acrylic Polymer (2)>

A four-neck flask equipped with a stirring blade, a thermometer, a nitrogen gas-introducing tube, and a condenser was charged with 91 parts by mass of 2-ethylhexyl acrylate (2EHA), 9 parts by mass of 4-hydroxybutyl acrylate (4HBA), 0.02 parts by mass of acrylic acid (AA), 0.2 parts by mass of 2,2'-azobisisobutyronitrile as a polymerization initiator, and 150 parts by mass of ethyl acetate.

Nitrogen gas was introduced into the flask while the mixture was gently stirred, and polymerization reaction was performed for 6 hours while the temperature of the liquid in the flask was kept at about 65°C, thereby to prepare a solution (40% by mass) of an acrylic polymer (2). The acrylic polymer (2) had a weight average molecular weight (Mw) of 540,000.

[0130]

<Example 1>

[Preparation of Acrylic Pressure-Sensitive Adhesive Solution]

The acrylic polymer (1) solution (40% by mass) was diluted to 20% by mass with ethyl acetate, and 500 parts by mass (solid content: 100 parts by mass) of this solution were mixed with 5 parts by mass (solid content: 0.5 parts by mass) of a solution obtained by diluting an ionic group-containing silicone (X-40-2450, manufactured by Shin-Etsu Chemical Co., Ltd.) with ethyl acetate to 10%, 2 parts by mass (solid content: 2 parts by mass) of an isocyanurate form of hexamethylene diisocyanate (CORONATE HX, manufactured by Tosoh Corp.) which is a trifunctional isocyanate compound as a crosslinking agent, and 3 parts by mass (solid content: 0.03 parts by mass) of dibutyltin dilaurate (1% by mass ethyl acetate solution) as a crosslinking catalyst. The resulting mixture was stirred to prepare an acrylic pressure-sensitive adhesive solution.

[0131]

[Preparation of Antistatic-Treated Film]

An antistatic solution was prepared by diluting 10 parts by mass of an antistatic agent (MICRO-SOLVER RMD-142 containing tin oxide and a polyester resin as main components, manufactured by Solvex Inc.) with a mixed solvent consisting of 30 parts by mass of water and 70 parts by mass of methanol.

The obtained antistatic solution was applied onto a polyethylene terephthalate (PET) film (thickness: 38 μm) using a Meyer bar and dried at 130°C for 1 minute to remove the solvent to form an antistatic layer (thickness: 0.2 μm). Thus, an antistatic-treated film was prepared.

[0132]

[Preparation of Pressure-Sensitive Adhesive Sheet (Surface Protective Film)]

The acrylic pressure-sensitive adhesive solution was applied to the surface opposite to the antistatic-treated surface of the antistatic-treated film and heated at 130°C for 2 minutes to form a pressure-sensitive adhesive layer having a thickness of 15 μm . Subsequently, a silicone-treated surface of a polyethylene terephthalate film (thickness: 25 μm) which had been subjected to a silicone treatment on one side was bonded to the surface of the pressure-sensitive adhesive layer to prepare a pressure-sensitive adhesive sheet.

[0133]

<Example 2>

A pressure-sensitive adhesive sheet was prepared in the same manner as in Example 1 except that an acrylic polymer (2) was used in place of the acrylic polymer (1) used in Example 1 and an ionic group-containing silicone X-

40-2750 was used in place of the ionic group-containing silicone X-40-2450.

[0134]

<Example 3>

A pressure-sensitive adhesive sheet was prepared in the same manner as in Example 1 except that an acrylic polymer (2) was used in place of the acrylic polymer (1) used in Example 1 and 0.5 parts by mass of an oxyalkylene group-containing compound containing an organopolysiloxane KF353 (manufactured by Shin-Etsu Chemical Co., Ltd.) was further added.

[0135]

<Example 4>

A pressure-sensitive adhesive sheet was prepared in the same manner as in Example 1 except that an acrylic polymer (2) was used in place of the acrylic polymer (1) used in Example 1 and 0.2 parts of an organopolysiloxane-free oxyalkylene group-containing compound LATEMUL PD-420 (manufactured by Kao Corporation) was further added.

[0136]

<Examples 5 to 7>

A pressure-sensitive adhesive sheet was prepared in the same manner as in Example 1 except that an acrylic polymer (2) was used in place of the acrylic polymer (1)

used in Example 1 and X-40-2450 was added in an amount shown in the table.

[0137]

<Example 8>

[Preparation of Urethane-Based Pressure-Sensitive Adhesive Solution]

A urethane-based pressure-sensitive adhesive solution was obtained by blending 85 parts by mass of PREMINOL S3011 (Mn = 10,000, manufactured by AGC Inc.) as a polyol having three hydroxyl groups, 13 parts by mass of SANNIX GP 3000 (Mn = 3,000, manufactured by Sanyo Chemical Industries, Ltd.) as a polyol having three hydroxyl groups, 2 parts by mass of SANNIX GP 1000 (Mn = 1,000, manufactured by Sanyo Chemical Industries, Ltd.) as a polyol having three hydroxyl groups, 18 parts by mass of an isocyanate compound (CORONATE HX: C/HX, manufactured by Nippon Polyurethane Industry Co., Ltd.) as a crosslinking agent, 0.04 parts by mass of iron(III) acetylacetonate (manufactured by Tokyo Chemical Industry Co., Ltd.) as a catalyst, 0.5 parts by mass of an ionic group-containing silicone X-40-2450 (manufactured by Shin-Etsu Chemical Co., Ltd.), and 210 parts by mass of ethyl acetate as a dilution solvent. Then, in the same manner as in Example 1, a pressure-sensitive adhesive sheet in which the heating conditions

and the like and the thickness of the obtained pressure-sensitive adhesive layer were adjusted was prepared.

[0138]

<Example 9>

[Preparation of Silicone-Based Pressure-Sensitive Adhesive Solution]

A silicone-based pressure-sensitive adhesive solution was obtained by blending 100 parts by mass of "X-40-3229" (solid content 60% by mass, manufactured by Shin-Etsu Chemical Co., Ltd.) as a silicone-based pressure-sensitive adhesive, 0.5 parts by mass of "CAT-PL-50T" (manufactured by Shin-Etsu Chemical Co., Ltd.) as a platinum catalyst, 0.5 parts by mass of an ionic group-containing silicone X-40-2450 (manufactured by Shin-Etsu Chemical Co., Ltd.), and 100 parts by mass of toluene as a solvent. Then, in the same manner as in Example 1, a pressure-sensitive adhesive sheet in which the heating conditions and the like and the thickness of the obtained pressure-sensitive adhesive layer were adjusted was prepared.

[0139]

<Comparative Examples 1 to 4>

A pressure-sensitive adhesive sheet was prepared in the same manner as in Example 2 except that an ionic compound described in Table 1 was used in place of the ionic group-containing silicone used in Example 2.

[0140]

<Comparative Example 5>

A pressure-sensitive adhesive sheet was prepared in the same manner as in Example 3 except that EMIFSI was used in place of the ionic group-containing silicone used in Example 3.

[0141]

The blending contents and the results of various measurements and evaluations with respect to the pressure-sensitive adhesive sheets of Examples and Comparative Examples are shown in Table 1. The abbreviations in Table 1 are explained below.

[0142]

[Oxyalkylene Group-Containing Compound]

KF 353: an organopolysiloxane having an oxyalkylene chain (HLB value: 10), trade name: KF-353, manufactured by Shin-Etsu Chemical Co., Ltd.

PD 420: an oxyalkylene group-containing compound not containing an organopolysiloxane (HLB value: 12.6), trade name: LATEMUL PD-420, manufactured by Kao Corporation.

[0143]

[Ionic Compound (Antistatic component)]

X-40-2450: an ionic group-containing silicone, active ingredient 55%, manufactured by Shin-Etsu Chemical Co., Ltd.

X-40-2750: an ionic group-containing silicone, active ingredient 100%, manufactured by Shin-Etsu Chemical Co., Ltd.

LiTFSI: lithium bis(trifluoromethanesulfonyl)imide, alkali metal salt, active ingredient 100%, manufactured by Tokyo Chemical Industry Co., Ltd.

EMIFSI: 1-ethyl-3-methylimidazolium bis(fluorosulfonyl)imide, ionic liquid, active ingredient 100%, manufactured by Dai-ichi Kogyo Seiyaku Co., Ltd.

BMPTFSI: 1-butyl-3-methylpyridinium bis(trifluoromethanesulfonyl)imide, ionic liquid, active ingredient 100%, manufactured by Aldrich.

MTOATFSI: methyltrioctylammonium bis(trifluoromethanesulfonyl)imide, active ingredient 100%, manufactured by Wako Pure Chemical Industries, Ltd.

[0144]

[Table 1]

Content s of blending and evaluation results	Polymer or pressure- sensitive adhesive used	Ionic compound (including ionic group- containing silicone)		Oxyalkylene group- containing compound		Peeling electrifica tion voltage [kV]		Stain resist ance
		Kind	Adde d amou nt	Kind	Adde d amou nt	Polarizing plate		
						Initia l stage	70°C	
Example 1	Acrylic (1)	X-40- 2450	0.5	—	—	0.04	0.18	○

Example 2	Acrylic (2)	X-40-2750	0.5	–	–	0.31	0.18	○
Example 3	Acrylic (2)	X-40-2450	0.5	KF353	0.5	0.40	0.42	○
Example 4	Acrylic (2)	X-40-2450	0.5	PD420	0.2	0.38	0.39	○
Example 5	Acrylic (2)	X-40-2450	0.05	–	–	0.48	0.45	○
Example 6	Acrylic (2)	X-40-2450	4.5	–	–	0.03	0.07	○
Example 7	Acrylic (2)	X-40-2450	6	–	–	0.02	0.03	×
Example 8	Urethane-based	X-40-2450	0.5	–	–	0.10	0.15	○
Example 9	Silicone-based	X-40-2450	0.5	–	–	0.03	0.03	○
Comparative example 1	Acrylic (2)	LiTFSI	0.5	–	–	0.94	1.00	○
Comparative example 2	Acrylic (2)	EMIFSI	0.5	–	–	0.48	0.83	○
Comparative example 3	Acrylic (2)	BMPTFSI	0.5	–	–	0.18	0.60	○
Comparative example 4	Acrylic (2)	MTOATFSI	0.5	–	–	1.09	1.15	○
Comparative example 5	Acrylic (2)	EMIFSI	0.5	KF353	0.5	0.01	1.02	○

[0145]

From Table 1, it was confirmed that in the pressure-

sensitive adhesive sheets of all Examples, the antistatic property and the stability over time of peeling electrification voltage are excellent. In addition, it was confirmed that when the blending amount of the ionic group-containing silicone was adjusted within a desired range, stain resistance (low staining property) was also excellent in the pressure-sensitive adhesive sheets.

[0146]

On the other hand, as shown in Table 1, in all Comparative Examples, since an antistatic agent such as an ionic liquid was used instead of the ionic group-containing silicone, the antistatic property and the stability over time of peeling electrification voltage were confirmed to be inferior to those in Examples. Particularly, since no ionic group-containing silicone was used, there was a case where a large increase in peeling electrification voltage was observed over time, and it is inferred that the ionic compound contained in the pressure-sensitive adhesive layer penetrated the surface of the polarizing plate with time.

INDUSTRIAL APPLICABILITY

[0147]

The pressure-sensitive adhesive sheet disclosed herein is suitable as a surface protective film for protecting optical members at the time of manufacturing or

transporting the optical member used as a constituent element of a liquid crystal display panel, a plasma display panel (PDP), an organic electroluminescence (EL) display, etc. In particular, the pressure-sensitive adhesive sheet is useful as a surface protective film (optical surface protective film) applied to optical members such as a polarizing plate (polarizing film), a wavelength plate, a retardation plate, an optical compensation film, a brightness enhancement film, a light diffusion sheet, a reflection sheet, and the like for a liquid crystal display panel.

DESCRIPTION OF REFERENCE SIGNS

[0148]

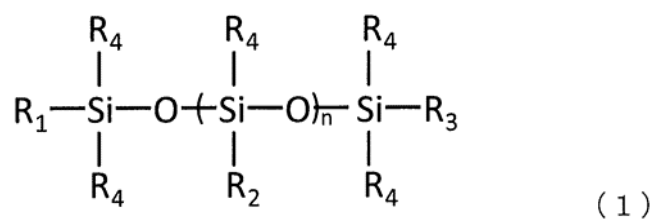
- 1 Pressure-sensitive adhesive sheet (surface protective film)
- 1' Separator attached pressure-sensitive adhesive sheet (surface protective film)
- 10 Acrylic plate
- 11 Separator
- 12 Ionic group-containing silicone coating film
- 13 Pressure-sensitive adhesive layer
- 14 Substrate film
- 20 Polarizing plate
- 30 Sample fixing table

40 Potential measuring instrument

CLAIMS

1. A pressure-sensitive adhesive composition comprising a pressure-sensitive adhesive polymer and an ionic group-containing silicone represented by the following formula (1):

[Formula 1]



wherein R₁ to R₄ is the same or different and each includes any one of an alkyl group having 1 to 10 carbon atoms, an alkoxy group, an aryl group, an alicyclic group, a fluorine-substituted alkyl group, and an ionic group, provided that one or more of R₁ to R₄ includes an ionic group; and n is an integer of 0 to 100.

2. The pressure-sensitive adhesive composition according to claim 1, which contains an oxyalkylene group-containing compound.

3. The pressure-sensitive adhesive composition according to claim 1 or 2, which contains at least one selected from the group consisting of an acrylic pressure-sensitive adhesive, a urethane-based pressure-sensitive adhesive, and a silicone-based pressure-sensitive adhesive.

4. A pressure-sensitive adhesive sheet comprising a pressure-sensitive adhesive layer formed from the pressure-sensitive adhesive composition according to any one of claims 1 to 3 on at least one side of a substrate film, wherein the ionic group-containing silicone is present inside the pressure-sensitive adhesive layer and/or on the surface of the pressure-sensitive adhesive layer.

5. The pressure-sensitive adhesive sheet according to claim 4, wherein a separator is attached to a surface of the pressure-sensitive adhesive layer opposite to the surface in contact with the substrate film.

6. The pressure-sensitive adhesive sheet according to claim 5, wherein the ionic group-containing silicone is present on the surface of the separator in contact with the pressure-sensitive adhesive layer.

7. An optical member to which the pressure-sensitive adhesive sheet according to claim 4, or a pressure-sensitive adhesive sheet obtained by peeling off the separator from the pressure-sensitive adhesive sheet according to claim 5 or 6 is attached.