

DESCRIPTION

Title of Invention

PRESSURE-SENSITIVE ADHESIVE LAYER AND PRESSURE-SENSITIVE
ADHESIVE SHEET

Technical Field

[0001]

The present invention generally relates to pressure-sensitive adhesive layers and pressure-sensitive adhesive sheets. More specifically, the present invention relates to a pressure-sensitive adhesive layer, and a pressure-sensitive adhesive sheet including the pressure-sensitive adhesive layer.

Background Art

[0002]

Input devices using an image display device and a touch screen in combination (touch screen-equipped devices) have been diffused into personal digital assistants such as cellular phones, portable music players, smartphones, and tablet computers. Such touch screens employ transparent conductive films, of which those including a transparent conductive thin film (such as an indium tin oxide (ITO) film) disposed on a transparent plastic base film or glass are widely known. The transparent conductive film is disposed on another member through an adhesive layer. Of

such adhesive layers for use in optical members, known exemplary pressure-sensitive adhesive layers include those disclosed in Patent Literature (PTL) 1 to 3.

Citation List

Patent Literature

[0003]

PTL 1: Japanese Unexamined Patent Application
Publication (JP-A) No. 2003-238915

PTL 2: JP-A No. 2003-342542

PTL 3: JP-A No. 2004-231723

Summary of Invention

Technical Problem

[0004]

During use, the touch screen is always touched with bare hands, from which sebum (or skin surface lipids) unavoidably moves to the touch screen. Unfortunately, the sebum moved to the touch screen surface gradually migrates into the adhesive layer inside the touch screen and swells the adhesive layer. The adhesive layer swelling causes adherends to separate from each other and/or causes a gap. The hand sebum varies in amount from a user to another, depending typically on the user's country and living environment. More and more users in the world use touch screen-equipped devices, and this requires pressure-

sensitive adhesive layers to less sebum-induced swelling from various users.

[0005]

In addition, the touch screen-equipped devices have remarkably slimmed in profile. This requires pressure-sensitive adhesive layers and other members constituting the touch screen-equipped devices to have low profiles. However, such low-profile pressure-sensitive adhesive layers tend to have lower level difference absorbency (conformability to level difference, bumps, or asperities) when applied typically to a member having level difference caused by printing (print level difference).

[0006]

Accordingly, the present invention has an object to provide a pressure-sensitive adhesive layer that has little sebum-induced swelling and satisfactorily level difference absorbency (conforms to level difference). The present invention has another object to provide a pressure-sensitive adhesive sheet that has little sebum-induced swelling and satisfactorily level difference absorbency.

Solution to Problem

[0007]

After intensive investigations to achieve the objects, the inventors of the present invention have found that a specific pressure-sensitive adhesive layer has little sebum-

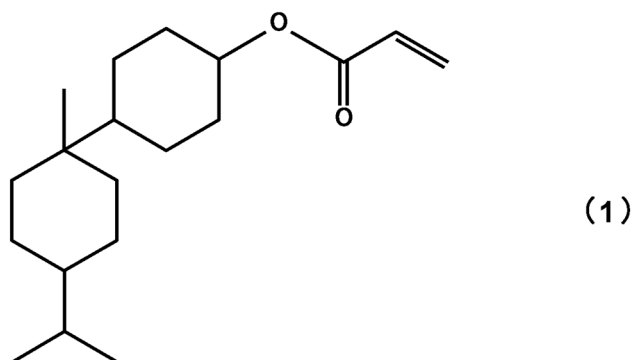
induced swelling and satisfactorily level difference absorbency. This pressure-sensitive adhesive layer is formed from a pressure-sensitive adhesive including an acrylic polymer and has a residual stress of 0.1 to 6 N/cm² after 300-percent tensile deformation, where the acrylic polymer is derived from monomer components including a (meth)acrylic alkyl ester having a C₁-C₅ alkyl group at the ester end, a hydroxy-containing monomer, and a specific alicyclic structure-containing monomer in specific proportions. The present invention has been made on the basis of these findings.

[0008]

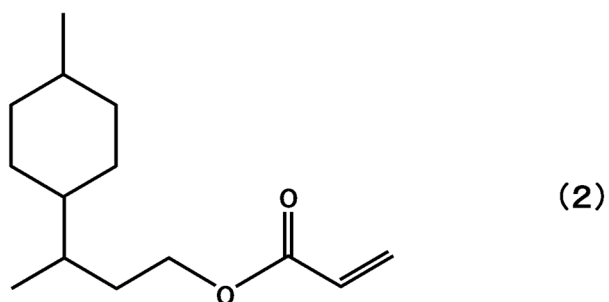
Specifically, the present invention provides a pressure-sensitive adhesive layer that is formed from a pressure-sensitive adhesive including an acrylic polymer and has a residual stress of 0.1 to 6 N/cm² after 300-percent tensile deformation. The acrylic polymer is derived from monomer components including a (meth)acrylic alkyl ester having a C₁-C₅ alkyl group at the ester end, a hydroxy-containing monomer, and an alicyclic structure-containing monomer. The alicyclic structure-containing monomer is at least one selected from the group consisting of cyclohexyl (meth)acrylate, a compound represented by Formula (1), a compound represented by Formula (2), and a compound represented by Formula (3), where Formulae (1), (2), and (3)

are expressed as follows:

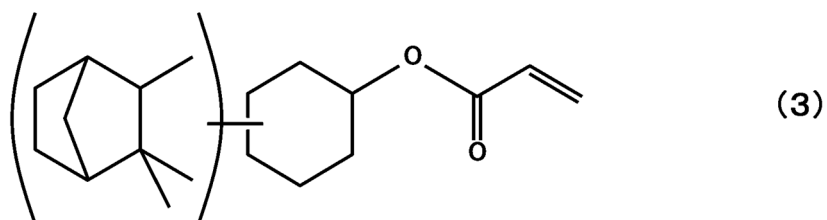
[Chem. 1]



[Chem. 2]



[Chem. 3]



The monomer components to form the acrylic polymer include, relative to the totality of the monomer components, 40 to 82 mass percent of the (meth)acrylic alkyl ester having a C₁-C₅ alkyl group at the ester end, 17 to 35 mass

percent of the hydroxy-containing monomer, and 42 mass percent or less of the alicyclic structure-containing monomer.

[0009]

The pressure-sensitive adhesive layer preferably has a storage modulus of 7.0×10^4 Pa or less at 70°C.

[0010]

The pressure-sensitive adhesive layer preferably has a gel fraction of 30 to 85 mass percent.

[0011]

The pressure-sensitive adhesive layer preferably has a b^* value of 2.0 or less after an ultraviolet irradiation test as follows.

Ultraviolet Irradiation Test

The pressure-sensitive adhesive layer is prepared as a 250- μm thick layer and placed between two plies of alkali glass to give a test specimen. The test specimen is irradiated with ultraviolet radiation from a xenon arc lamp at wavelengths from 300 to 400 nm, an illuminance of 110 W/m², and a black panel preset temperature of 83°C for 240 hours. The b^* value of the pressure-sensitive adhesive layer after the test is measured.

[0012]

The monomer components to form the acrylic polymer preferably further include a multifunctional monomer. The

monomer components to form the acrylic polymer preferably contains the multifunctional monomer in a content of 3 mass percent or less of the totality of the monomer components.

[0013]

The pressure-sensitive adhesive layer is preferably used in or for an optical member or members.

[0014]

In addition and advantageously, the present invention provides a pressure-sensitive adhesive sheet including a substrate, and the pressure-sensitive adhesive layer on at least one side of the substrate.

Advantageous Effects of Invention

[0015]

The pressure-sensitive adhesive layer according to the present invention has little sebum-induced swelling and satisfactorily level difference absorbency. The pressure-sensitive adhesive sheet according to the present invention has little sebum-induced swelling and satisfactorily level difference absorbency.

Brief Description of Drawings

[0016]

FIG. 1 is a view of an exemplary capacitive touch screen using a pressure-sensitive adhesive layer or pressure-sensitive adhesive sheet according to an embodiment

of the present invention.

Description of Embodiments

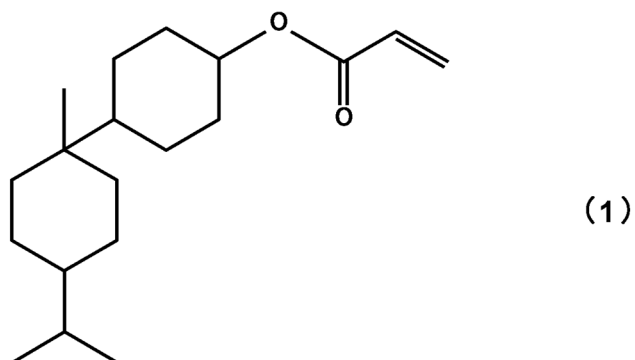
[0017]

The pressure-sensitive adhesive layer according to the present invention is formed from a pressure-sensitive adhesive including a specific acrylic polymer. This acrylic polymer is derived from (formed from) monomer components essentially including a (meth)acrylic alkyl ester having a C₁-C₅ alkyl group at the ester end, a hydroxy-containing monomer, and a monomer containing the specific alicyclic structure. Specifically, the pressure-sensitive adhesive layer according to the present invention is an acrylic pressure-sensitive adhesive layer formed from a pressure-sensitive adhesive containing the acrylic polymer (acrylic pressure-sensitive adhesive). The alicyclic structure-containing monomer is at least one selected from the group consisting of cyclohexyl (meth)acrylate, a compound represented by Formula (1), a compound represented by Formula (2), and a compound represented by Formula (3). Herein, the "alicyclic structure-containing monomer which is at least one selected from the group consisting of cyclohexyl (meth)acrylate, the compound represented by Formula (1), the compound represented by Formula (2), and the compound represented by Formula (3)" is also referred to

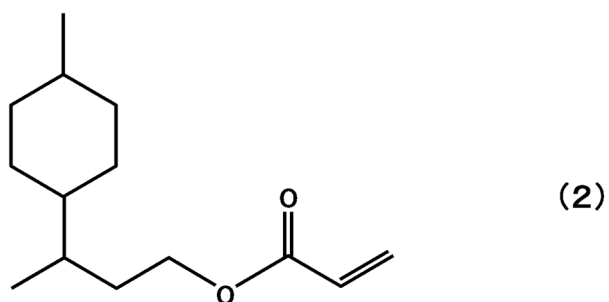
as a "specific alicyclic structure-containing monomer".

Formulae (1), (2), and (3) are expressed as follows:

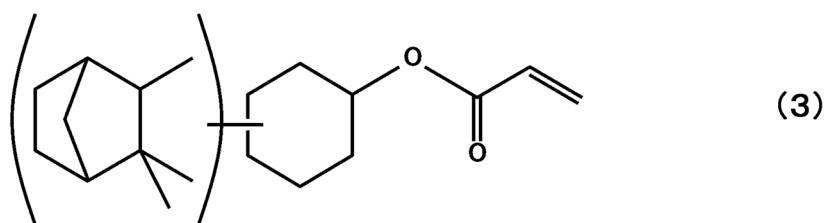
[Chem. 1]



[Chem. 2]



[Chem. 3]



[0018]

The acrylic polymer is a polymer derived from monomer components essentially including a (meth)acrylic alkyl ester

having a C₁-C₅ alkyl moiety at the ester end, a hydroxy-containing monomer, and the specific alicyclic structure-containing monomer. As used herein, the term "(meth)acryl(ic)" refers to "acryl(ic)" and/or "methacryl(ic)" (one or both of "acryl(ic)" and "methacryl(ic)"). This is also applied to other similar cases. The pressure-sensitive adhesive may include each of different acrylic polymers alone or in combination.

[0019]

Examples of the (meth)acrylic alkyl ester having a C₁-C₅ alkyl moiety at the ester end include methyl (meth)acrylate, ethyl (meth)acrylate, propyl (meth)acrylate, isopropyl (meth)acrylate, n-butyl (meth)acrylate, isobutyl (meth)acrylate, s-butyl (meth)acrylate, and t-butyl (meth)acrylate. Among them, (meth)acrylic alkyl esters having a C₂-C₄ alkyl moiety at the ester end are preferred. The monomer components to form the acrylic polymer may include each of different (meth)acrylic alkyl esters having a C₁-C₅ alkyl moiety at the ester end alone or in combination.

[0020]

The pressure-sensitive adhesive layer according to the present invention employs a (meth)acrylic alkyl ester including an alkyl moiety having 1 to 5 carbon atoms as a (meth)acrylic alkyl ester to form the acrylic polymer. Owing to the configuration employing such a small alkyl

group constituting the (meth)acrylic ester, the pressure-sensitive adhesive layer has relatively low lipophilicity, less absorbs sebum, and, as a result, less sebum-induced swelling. The configuration also protects the pressure-sensitive adhesive layer from being invaded by liquid sebum through a lamination end with an adherend and eliminates or minimizes gaps in the end. In addition, this pressure-sensitive adhesive layer tends to have a lower b^* value as described later.

[0021]

The monomer components to form the acrylic polymer include the (meth)acrylic alkyl ester having a C_1 - C_5 alkyl moiety at the ester end in a proportion of 40 to 82 mass percent, preferably 45 to 75 mass percent, and more preferably 50 to 70 mass percent, of the totality (100 mass percent) of the monomer components. The (meth)acrylic alkyl ester, as used in a proportion within the range, readily allows the pressure-sensitive adhesive layer not only to less sebum-induced swelling, but also to satisfactorily level difference absorbency owing to balance with other monomer components.

[0022]

The hydroxy-containing monomer is not limited, as long as being a monomer that has at least one hydroxy (hydroxy group) in the molecule (in one molecule) and is

copolymerizable with the (meth)acrylic alkyl ester. Among such hydroxy-containing monomers, preferred examples include monomers that have (meth)acryloyl, vinyl, or another polymerizable functional group having an unsaturated double bond and have a hydroxy group. The monomer components to form the acrylic polymer may include each of different hydroxy-containing monomers alone or in combination.

[0023]

Non-limiting examples of the hydroxy-containing monomer include hydroxy-containing (meth)acrylic esters exemplified by hydroxyalkyl (meth)acrylates such as 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, 6-hydroxyhexyl (meth)acrylate, 8-hydroxyoctyl (meth)acrylate, 10-hydroxydecyl (meth)acrylate, and 12-hydroxylauryl (meth)acrylate; and alicyclic structure-containing hydroxyalkyl (meth)acrylates such as (4-hydroxymethylcyclohexyl)methyl (meth)acrylate. Non-limiting examples of the hydroxy-containing monomer also include vinyl alcohol, allyl alcohol, hydroxyethyl(meth)acrylamide, 2-hydroxyethyl vinyl ether, 4-hydroxybutyl vinyl ether, and diethylene glycol monovinyl ether. Among them, the hydroxy-containing monomer is preferably selected from hydroxy-containing (meth)acrylic esters, more preferably selected from hydroxyalkyl (meth)acrylates, still more preferably

selected from (meth)acrylic esters having a C₂-C₆ hydroxyalkyl group, and particularly preferably selected from 2-hydroxyethyl acrylate (HEA) and 4-hydroxybutyl acrylate (4HBA).

[0024]

The monomer components to form the acrylic polymer include the hydroxy-containing monomer in a proportion of 17 to 35 mass percent, preferably 20 to 33 mass percent, and more preferably 25 to 32 mass percent, of the totality (100 mass percent) of the monomer components. The hydroxy-containing monomer, as used in a proportion within the range, readily allows the pressure-sensitive adhesive layer not only to less sebum-induced swelling, but also to satisfactorily have level difference absorbency owing to balance with other monomer components. Such a hydroxy-containing monomer is usable as a polar monomer instead of a nitrogen-containing monomer and allows the pressure-sensitive adhesive layer to more resist discoloration (yellowing) as compared with one using an acrylic polymer derived from a nitrogen-containing monomer, where the discoloration will be caused by ultraviolet radiation.

[0025]

The specific alicyclic structure-containing monomer is at least one selected from the group consisting of cyclohexyl (meth)acrylate, the compound represented by

Formula (1), the compound represented by Formula (2), and the compound represented by Formula (3). The specific alicyclic structure-containing monomer is used as a monomer component to form the acrylic polymer, and readily allows the pressure-sensitive adhesive layer to less sebum-induced swelling, to have a readily controllable glass transition temperature (T_g), and to satisfactorily have level difference absorbency owing to balance with other monomer components. In particular, the specific alicyclic structure-containing monomer is preferably cyclohexyl (meth)acrylate. The monomer components to form the acrylic polymer may include each of different specific alicyclic structure-containing monomers alone or in combination.

[0026]

The monomer components to form the acrylic polymer include the specific alicyclic structure-containing monomer in a proportion of 42 mass percent or less (e.g., 1 to 42 mass percent), preferably 30 mass percent or less (e.g., 5 to 30 mass percent), and more preferably 15 mass percent or less (e.g., 8 to 15 mass percent), of the totality (100 mass percent) of the monomer components. The specific alicyclic structure-containing monomer, as contained in a proportion of 42 mass percent or less, readily allows the pressure-sensitive adhesive layer not only to less sebum-induced swelling, but also to satisfactorily have level difference

absorbency owing to balance with other monomer components.

[0027]

The acrylic polymer is derived from monomer components including the (meth)acrylic alkyl ester having a C₁-C₅ alkyl moiety at the ester end, the hydroxy-containing monomer, and the specific alicyclic structure-containing monomer and may be derived from monomer components further including one or more other copolymerizable monomers, which are monomer components copolymerizable with at least one of the monomers. Non-limiting examples of the other copolymerizable monomers include nitrogen-containing monomers, alicyclic structure-containing monomers other than the specific alicyclic structure-containing monomers, carboxy-containing monomers, cyclic ether-containing monomers, sulfonate-containing monomers, phosphate-containing monomers, (meth)acrylic esters containing an aromatic hydrocarbon group, vinyl esters, aromatic vinyl compounds, olefins or dienes, vinyl ethers, (meth)acrylic alkoxyalkyl esters, silicon-containing monomers, glycol monomers, vinyl chloride, tetrahydrofurfuryl (meth)acrylate, fluorinated (meth)acrylates, and silicone (meth)acrylates. However, the monomer components to form the acrylic polymer include the (meth)acrylic alkyl ester having a C₁-C₅ alkyl moiety at the ester end, the hydroxy-containing monomer, and the specific alicyclic structure-containing monomer in a total proportion

of preferably 70 mass percent or more, more preferably 80 mass percent or more, still more preferably 90 mass percent or more, and particularly preferably 95 mass percent or more, of the totality (100 mass percent) of the monomer components. The monomer components may include each of different other copolymerizable monomers alone or in combination.

[0028]

Non-limiting examples of the nitrogen-containing monomers include cyclic nitrogen-containing monomers and (meth)acrylamide. The cyclic nitrogen-containing monomers have (meth)acryloyl, vinyl, or another polymerizable functional group containing an unsaturated double bond and have a cyclic nitrogen structure. The cyclic nitrogen structure is preferably one having a nitrogen atom in the cyclic structure. Non-limiting examples of the cyclic nitrogen-containing monomers include cyclic N-vinylamides such as N-vinyl-2-pyrrolidone, N-vinyl-2-piperidone, N-vinyl-3-morpholinone, N-vinyl-2-caprolactam, N-vinyl-1,3-oxazin-2-one, and N-vinyl-3,5-morpholinedione.

[0029]

Non-limiting examples of the vinyl monomers having a nitrogen-containing heterocycle other than cyclic N-vinylamides include monomers that have (meth)acryloyl, vinyl, or another polymerizable functional group containing an unsaturated double bond and have a nitrogen-containing

heterocycle such as morpholine, piperidine, pyrrolidine, or piperazine ring. Non-limiting examples of the vinyl monomers having a nitrogen-containing heterocycle include (meth)acryloylmorpholine, N-vinylpiperazine, N-vinylpyrrole, N-vinylimidazole, N-vinylpyrazine, N-vinylmorpholine, N-vinylpyrazole, vinylpyridine, vinylpyrimidine, vinyloxazole, vinylisoxazole, vinylthiazole, vinylisothiazole, vinylpyridazine, (meth)acryloylpyrrolidone, (meth)acryloylpyrrolidine, and (meth)acryloylpiperidine.

[0030]

The monomer components to form the acrylic polymer include the nitrogen-containing monomers in a proportion of preferably 10 mass percent or less, more preferably 5 mass percent or less, and still more preferably 1 mass percent or less, of the totality (100 mass percent) of the monomer components, although the proportion is not limited. The monomer components to form the acrylic polymer, when having a proportion of the nitrogen-containing monomers of 10 mass percent or less, allows the pressure-sensitive adhesive layer to resist discoloration (yellowing) and to have a still lower b^* value, where the discoloration will be caused by ultraviolet radiation. The proportion of the cyclic nitrogen-containing monomers preferably falls within the range.

[0031]

Non-limiting examples of the carboxy-containing monomers include (meth)acrylic acid, itaconic acid, maleic acid, fumaric acid, crotonic acid, isocrotonic acid, carboxyethyl (meth)acrylate, and carboxypentyl (meth)acrylate. As used herein, the term "carboxy-containing monomers" also refers to and includes acid anhydride-containing monomers such as maleic anhydride and itaconic anhydride.

[0032]

The monomer components to form the acrylic polymer include the carboxy-containing monomers in a proportion of preferably 10 mass percent or less, more preferably 5 mass percent or less, and still more preferably 1 mass percent or less, of the totality (100 mass percent) of the monomer components, although the proportion is not limited. The monomer components to form the acrylic polymer, when having a proportion of the carboxy-containing monomers of 10 mass percent or less, allows the pressure-sensitive adhesive layer to less cause metal corrosion, where the metal corrosion will be caused by carboxy groups.

[0033]

Examples of the cyclic ether-containing monomers include monomers that have (meth)acryloyl, vinyl, or another polymerizable functional group containing an unsaturated double bond and have epoxy, oxetane, or another cyclic ether

group. Non-limiting examples of the epoxy-containing monomers include glycidyl (meth)acrylate, methylglycidyl (meth)acrylate, 3,4-epoxycyclohexylmethyl (meth)acrylate, and 4-hydroxybutyl (meth)acrylate glycidyl ether. Non-limiting examples of the oxetane-containing monomers include 3-oxetanylmethyl (meth)acrylate, 3-methyl-oxetanylmethyl (meth)acrylate, 3-ethyl-oxetanylmethyl (meth)acrylate, 3-butyl-oxetanylmethyl (meth)acrylate, and 3-hexyl-oxetanylmethyl (meth)acrylate.

[0034]

Non-limiting examples of the (meth)acrylic alkoxyalkyl esters include 2-methoxyethyl (meth)acrylate, 2-ethoxyethyl (meth)acrylate, methoxytriethylene glycol (meth)acrylate, 3-methoxypropyl (meth)acrylate, 3-ethoxypropyl (meth)acrylate, 4-methoxybutyl (meth)acrylate, and 4-ethoxybutyl (meth)acrylate.

[0035]

Non-limiting examples of the silicon-containing monomers include 3-acryloxypropyltriethoxysilane, vinyltrimethoxysilane, vinyltriethoxysilane, 4-vinylbutyltrimethoxysilane, 4-vinylbutyltriethoxysilane, 8-vinyloctyltrimethoxysilane, 8-vinyloctyltriethoxysilane, 10-methacryloyloxydecyltrimethoxysilane, 10-acryloyloxydecyltrimethoxysilane, 10-methacryloyloxydecyltriethoxysilane, and 10-

acryloyloxydecyltriethoxysilane.

[0036]

A non-limiting example of the sulfonate-containing monomers is sodium vinylsulfonate. Non-limiting examples of the (meth)acrylic esters containing an aromatic hydrocarbon group include phenyl (meth)acrylate, phenoxyethyl (meth)acrylate, and benzyl (meth)acrylate. Non-limiting examples of the vinyl esters include vinyl acetate and vinyl propionate. Non-limiting examples of the aromatic vinyl compounds include styrene, α -methylstyrene, and vinyltoluene. Non-limiting examples of the olefins or dienes include ethylene, propylene, butadiene, isoprene, and isobutylene. Non-limiting examples of the vinyl ethers include vinyl alkyl ethers. Non-limiting examples of the glycol monomers include polyethylene glycol (meth)acrylates, polypropylene glycol (meth)acrylates, methoxyethylene glycol (meth)acrylate, and methoxypoly(propylene glycol) (meth)acrylates.

[0037]

The monomer components to form the acrylic polymer may further include, as the other copolymerizable monomer, a (meth)acrylic alkyl ester having a C6 or higher alkyl moiety at the ester end. The monomer components to form the acrylic polymer include the (meth)acrylic alkyl ester having a C6 or higher alkyl moiety at the ester end in a proportion

of preferably 10 mass percent or less, more preferably 5 mass percent or less, and still more preferably 1 mass percent or less, of the totality (100 mass percent) of the monomer components, although the proportion is not limited. The monomer components, when having a proportion of the (meth)acrylic alkyl ester having a C6 or higher alkyl moiety at the ester end of 10 mass percent or less, allows the pressure-sensitive adhesive layer to less sebum-induced swelling. The total proportion of methyl (meth)acrylate and (meth)acrylic alkyl esters having a C5 or higher alkyl moiety at the ester end may fall within the range.

[0038]

The monomer components to form the acrylic polymer may further include a multifunctional monomer as the other copolymerizable monomer, to regulate the cohesive force of the pressure-sensitive adhesive and to allow the pressure-sensitive adhesive layer to more satisfactorily have level difference absorbency (absorb level difference). The multifunctional monomer is a monomer that has at least two polymerizable functional groups having (meth)acryloyl, vinyl, or another unsaturated double bond. The monomer components may include each of different multifunctional monomers alone or in combination.

[0039]

Non-limiting examples of the multifunctional monomer

include hexanediol di(meth)acrylate, dodecanediol di(meth)acrylate, butanediol di(meth)acrylate, (poly)ethylene glycol di(meth)acrylate, (poly)propylene glycol di(meth)acrylate, neopentyl glycol di(meth)acrylate, pentaerythritol di(meth)acrylate, pentaerythritol tri(meth)acrylate, dipentaerythritol hexa(meth)acrylate, trimethylolpropane tri(meth)acrylate, tetramethylolmethane tri(meth)acrylate, allyl (meth)acrylate, vinyl (meth)acrylate, divinylbenzene, epoxy acrylates, polyester acrylates, urethane acrylates, butyl di(meth)acrylate, and hexyl di(meth)acrylate. Among them, preferred are trimethylolpropane tri(meth)acrylate, hexanediol di(meth)acrylate, and dipentaerythritol hexa(meth)acrylate. [0040]

The monomer components to form the acrylic polymer may include the multifunctional monomer in a proportion of preferably 3 mass percent or less (e.g., 0.001 to 3 mass percent), more preferably 0.5 mass percent or less (e.g., 0.002 to 0.5 mass percent), and still more preferably 0.1 mass percent or less (e.g., 0.005 to 0.1 mass percent), of the totality (100 mass percent) of the monomer components, although the proportion is not limited. The monomer components, when having a proportion of the multifunctional monomer within the range, can provide an adequately higher crosslinking density. This configuration readily allows the

pressure-sensitive adhesive layer to have an adequately lower tensile residual stress and to satisfactorily have level difference absorbency.

[0041]

The pressure-sensitive adhesive layer according to the present invention contains the acrylic polymer in a content of preferably 50 mass percent or more (e.g., 50 to 100 mass percent), more preferably 80 mass percent or more (e.g., 80 to 100 mass percent), and still more preferably 90 mass percent or more (e.g., 90 to 100 mass percent), of the totality (100 mass percent) of the pressure-sensitive adhesive layer, although the content is not limited.

[0042]

The acrylic polymer results from polymerization of the monomer components. The polymerization can be performed by any technique, such as solution polymerization, emulsion polymerization, bulk polymerization, or polymerization with actinic radiation irradiation (actinic radiation polymerization). The resulting acrylic polymer may be any polymer such as random copolymer, block copolymer, or graft copolymer.

[0043]

The polymerization of the monomer components may employ any of various common solvents. Non-limiting examples of the solvents include organic solvents exemplified by esters

such as ethyl acetate and n-butyl acetate; aromatic hydrocarbons such as toluene and benzene; aliphatic hydrocarbons such as n-hexane and n-heptane; alicyclic hydrocarbons such as cyclohexane and methylcyclohexane; and ketones such as methyl ethyl ketone and methyl isobutyl ketone. The polymerization may employ each of different solvents alone or in combination.

[0044]

The polymerization of the monomer components, when performed as radical polymerization, may employ any agent or agents such as a polymerization initiator, a chain-transfer agent, and an emulsifier, which can be selected appropriately. The amounts of the polymerization initiator and the chain-transfer agent, as well as reaction conditions, can control the weight-average molecular weight of the acrylic polymer. The amounts of these agents are regulated appropriately according to their types. Specifically, when the polymerization is performed as solution polymerization, for example, the reaction is performed generally at about 50°C to about 70°C for about 5 to about 30 hours, after adding a polymerization initiator in a stream of nitrogen or another inert gas.

[0045]

The polymerization initiator usable in polymerization of the monomer components may be selected from thermal

initiators and photoinitiators according to the type of the polymerization reaction. Each of different polymerization initiators may be used alone or in combination.

[0046]

Non-limiting examples of the thermal initiators include azo polymerization initiators, peroxide polymerization initiators, and redox polymerization initiators.

[0047]

Examples of the azo polymerization initiators include 2,2'-azobisisobutyronitrile (hereinafter also referred to as "AIBN"), 2,2'-azobis-2-methylbutyronitrile (hereinafter also referred to as "AMBN"), dimethyl 2,2'-azobis(2-methylpropionate), 4,4'-azobis-4-cyanovaleric acid, azobisisovaleronitrile, 2,2'-azobis(2-amidinopropane) dihydrochloride, 2,2'-azobis[2-(5-methyl-2-imidazolin-2-yl)propane] dihydrochloride, 2,2'-azobis(2-methylpropionamidine) disulfate, 2,2'-azobis(N,N'-dimethyleneisobutylamidine), and 2,2'-azobis[N-(2-carboxyethyl)-2-methylpropionamidine] hydrate (available typically under the trade name of VA-057 from FUJIFILM Wako Pure Chemical Corporation).

[0048]

Non-limiting examples of the peroxide polymerization initiators include persulfates such as potassium persulfate and ammonium persulfate; as well as t-butyl permaleate,

di(2-ethylhexyl)peroxydicarbonate, di(4-t-butylcyclohexyl)peroxydicarbonate, di-sec-butylperoxydicarbonate, t-butyl peroxyneodecanoate, t-hexyl peroxy-pivalate, t-butyl peroxy-pivalate, dilauroyl peroxide, di-n-octanoyl peroxide, 1,1,3,3-tetramethylbutylperoxy-2-ethylhexanoate, di(4-methylbenzoyl) peroxide, dibenzoyl peroxide, t-butylperoxyisobutyrate, 1,1-di(t-hexylperoxy)cyclohexane, t-butyl hydroperoxide, and hydrogen peroxide.

[0049]

Examples of the redox polymerization initiators include combinations of a peroxide and a reducing agent, such as the combination of a persulfate and sodium hydrogensulfite, and the combination of a peroxide and sodium ascorbate.

[0050]

The thermal initiator is used in an amount of preferably 1 part by mass or less, more preferably 0.005 to 1 part by mass, and still more preferably 0.02 to 0.5 part by mass, per 100 parts by mass of the totality of the monomer components to form the acrylic polymer. The thermal initiator, when used in an amount of 0.005 part by mass or more, tends to readily control the acrylic polymer to have a low molecular weight and to allow the pressure-sensitive adhesive layer to have a higher residual stress and more satisfactorily have level difference absorbency.

[0051]

Non-limiting examples of the photoinitiators include benzoin ether photoinitiators, acetophenone photoinitiators, α -ketol photoinitiators, aromatic sulfonyl chloride photoinitiators, photoactive oxime photoinitiators, benzoin photoinitiators, benzil photoinitiators, benzophenone photoinitiators, ketal photoinitiators, thioxanthone photoinitiators, acylphosphine oxide photoinitiators, and titanocene photoinitiators. Among them, preferred are benzoin ether photoinitiators and acetophenone photoinitiators.

[0052]

Non-limiting examples of the benzoin ether photoinitiators include benzoin methyl ether, benzoin ethyl ether, benzoin propyl ether, benzoin isopropyl ether, benzoin isobutyl ether, 2,2-dimethoxy-1,2-diphenylethan-1-one, and anisole methyl ether. Non-limiting examples of the acetophenone photoinitiators include 2,2-diethoxyacetophenone, 2,2-dimethoxy-2-phenylacetophenone, 1-hydroxycyclohexyl phenyl ketone, 4-phenoxydichloroacetophenone, 4-(t-butyl)dichloroacetophenone, 1-[4-(2-hydroxyethoxy)-phenyl]-2-hydroxy-2-methyl-1-propan-1-one, 2-hydroxy-2-methyl-1-phenyl-propan-1-one, and methoxyacetophenone. Non-limiting examples of the α -ketol photoinitiators include 2-methyl-2-hydroxypropiophenone and

1-[4-(2-hydroxyethyl)phenyl]-2-methylpropan-1-one. A non-limiting example of the aromatic sulfonyl chloride photoinitiators is 2-naphthalenesulfonyl chloride. A non-limiting example of the photoactive oxime photoinitiators is 1-phenyl-1,1-propanedione-2-(O-ethoxycarbonyl)oxime.

[0053]

A non-limiting example of the benzoin photoinitiators is benzoin. A non-limiting example of the benzil photoinitiators is benzil. Non-limiting examples of the benzophenone photoinitiators include benzophenone, benzoylbenzoic acid, 3,3'-dimethyl-4-methoxybenzophenone, and polyvinylbenzophenones. A non-limiting example of the ketal photoinitiators is benzil dimethyl ketal. Non-limiting examples of the thioxanthone photoinitiators include thioxanthone, 2-chlorothioxanthone, 2-methylthioxanthone, 2,4-dimethylthioxanthone, 2,4-dichlorothioxanthone, 2,4-diethylthioxanthone, isopropylthioxanthone, 2,4-diisopropylthioxanthone, and dodecylthioxanthone.

[0054]

Non-limiting examples of the acylphosphine oxide photoinitiators include bis(2,6-dimethoxybenzoyl)phenylphosphine oxide, bis(2,6-dimethoxybenzoyl)(2,4,4-trimethylpentyl)phosphine oxide, bis(2,6-dimethoxybenzoyl)-n-butylphosphine oxide, bis(2,6-

dimethoxybenzoyl)-(2-methylprop-1-yl)phosphine oxide,
bis(2,6-dimethoxybenzoyl)-(1-methylprop-1-yl)phosphine oxide,
bis(2,6-dimethoxybenzoyl)-t-butylphosphine oxide, bis(2,6-
dimethoxybenzoyl)cyclohexylphosphine oxide, bis(2,6-
dimethoxybenzoyl)octylphosphine oxide, bis(2-
methoxybenzoyl)(2-methylprop-1-yl)phosphine oxide, bis(2-
methoxybenzoyl)(1-methylprop-1-yl)phosphine oxide, bis(2,6-
diethoxybenzoyl)(2-methylprop-1-yl)phosphine oxide, bis(2,6-
diethoxybenzoyl)(1-methylprop-1-yl)phosphine oxide, bis(2,6-
dibutoxybenzoyl)(2-methylprop-1-yl)phosphine oxide, bis(2,4-
dimethoxybenzoyl)(2-methylprop-1-yl)phosphine oxide,
bis(2,4,6-trimethylbenzoyl)(2,4-dipentoxyphenyl)phosphine
oxide, bis(2,6-dimethoxybenzoyl)benzylphosphine oxide,
bis(2,6-dimethoxybenzoyl)-2-phenylpropylphosphine oxide,
bis(2,6-dimethoxybenzoyl)-2-phenylethylphosphine oxide,
bis(2,6-dimethoxybenzoyl)benzylphosphine oxide, bis(2,6-
dimethoxybenzoyl)-2-phenylpropylphosphine oxide, bis(2,6-
dimethoxybenzoyl)-2-phenylethylphosphine oxide, 2,6-
dimethoxybenzoylbenzylbutylphosphine oxide, 2,6-
dimethoxybenzoylbenzyloctylphosphine oxide, bis(2,4,6-
trimethylbenzoyl)-2,5-diisopropylphenylphosphine oxide,
bis(2,4,6-trimethylbenzoyl)-2-methylphenylphosphine oxide,
bis(2,4,6-trimethylbenzoyl)-4-methylphenylphosphine oxide,
bis(2,4,6-trimethylbenzoyl)-2,5-diethylphenylphosphine oxide,
bis(2,4,6-trimethylbenzoyl)-2,3,5,6-

tetramethylphenylphosphine oxide, bis(2,4,6-trimethylbenzoyl)-2,4-di-n-butoxyphenylphosphine oxide, 2,4,6-trimethylbenzoyldiphenylphosphine oxide, bis(2,6-dimethoxybenzoyl)-2,4,4-trimethylpentylphosphine oxide, bis(2,4,6-trimethylbenzoyl)isobutylphosphine oxide, 2,6-dimethoxybenzoyl-2,4,6-trimethylbenzoyl-n-butylphosphine oxide, bis(2,4,6-trimethylbenzoyl)phenylphosphine oxide, bis(2,4,6-trimethylbenzoyl)-2,4-dibutoxyphenylphosphine oxide, 1,10-bis[bis(2,4,6-trimethylbenzoyl)phosphine oxide]decane, and tri(2-methylbenzoyl)phosphine oxide.

[0055]

A non-limiting example of the titanocene photoinitiators is bis(η^5 -2,4-cyclopentadien-1-yl)-bis(2,6-difluoro-3-(1H-pyrrol-1-yl)-phenyl)titanium.

[0056]

The photoinitiator is used in an amount of preferably 0.005 to 1 part by mass, more preferably 0.01 to 0.7 part by mass, and still more preferably 0.18 to 0.5 part by mass, per 100 parts by mass of the totality of the monomer components to form the acrylic polymer. The photoinitiator, when used in an amount of 0.005 part by mass or more (in particular, 0.18 part by mass or more), tends to readily control the acrylic polymer to have a low molecular weight and to allow the pressure-sensitive adhesive layer to have a higher residual stress and to more satisfactorily have level

difference absorbency.

[0057]

Non-limiting examples of the chain-transfer agent include lauryl mercaptan, glycidyl mercaptan, mercaptoacetic acid, 2-mercaptoethanol, thioglycolic acid, 2-ethylhexyl thioglycolate, and 2,3-dimercapto-1-propanol. The chain-transfer agent is used in an amount of typically about 0.1 part by mass or less per 100 parts by mass of the totality of the monomer components to form the acrylic polymer.

[0058]

When the polymerization is performed as emulsion polymerization, non-limiting examples of the emulsifier for use therein include anionic emulsifiers such as sodium lauryl sulfate, ammonium lauryl sulfate, sodium dodecylbenzenesulfonate, ammonium polyoxyethylene alkyl ether sulfates, and sodium polyoxyethylene alkyl phenyl ether sulfates; and nonionic emulsifiers such as polyoxyethylene alkyl ethers, polyoxyethylene alkyl phenyl ethers, polyoxyethylene fatty acid esters, and polyoxyethylene-polyoxypropylene block polymers.

[0059]

The reaction may employ, as a reactive emulsifier, an emulsifier into which propenyl, allyl ether group, or another radically polymerizable functional group is introduced. Non-limiting examples of such emulsifiers

usable herein include commercial products available under the trade names of AQUALON HS-10, HS-20, KH-10, BC-05, BC-10, and BC-20 (each from Dai-ichi Kogyo Seiyaku Co., Ltd.) and under the trade name of ADEKA REASOAP SE10N (from ADEKA CORPORATION). Such a reactive emulsifier is taken into the polymer chain after polymerization and desirably allows the pressure-sensitive adhesive layer to have better water resistance. The emulsifier may be used in an amount of 5 parts by mass or less and more preferably 0.3 to 5 parts by mass, per 100 parts by mass of the totality of the monomer components to form the acrylic polymer, and still more preferably used in an amount of 0.5 to 1 part by mass from the viewpoints of polymerization stability and mechanical stability.

[0060]

The acrylic polymer has a glass transition temperature (T_g) of preferably -70°C to 30°C , more preferably -60°C to 20°C , and still more preferably -50°C to 20°C . The acrylic polymer, when having a T_g within the range, allows the pressure-sensitive adhesive layer to have higher adhesive strength. The glass transition temperature T_g of the acrylic polymer is a theoretical value calculated according to the Fox equation.

[0061]

Herein, the glass transition temperatures T_g of

homopolymers derived from various monomer components for use in the Fox equation are numerical values listed in "Polymer Handbook" (3rd Ed., John Wiley & Sons, Inc., 1989). For a monomer listed in the literature with two or more different glass transition temperatures, the highest value is defined as its glass transition temperature. For a monomer whose homopolymer's glass transition temperature is not listed even in "Polymer Handbook" (3rd Ed., John Wiley & Sons, Inc., 1989), the glass transition temperature for use herein is defined as a value determined by the following measuring method (see JP-A No. 2007-51271).

[0062]

Specifically, into a reactor equipped with a thermometer, a stirrer, a nitrogen inlet tube, and a reflux condenser, 100 parts by mass of a tested monomer, 0.2 part by mass of azobisisobutyronitrile, and 200 parts by mass of ethyl acetate polymerization solvent are charged, followed by stirring for one hour under a nitrogen gas stream. After removing oxygen from the polymerization system in the above manner, the temperature is raised to 63°C, followed by reaction for 10 hours. Next, the mixture cools down to room temperature to give a homopolymer solution having a solids concentration of 33 mass percent. Next, the homopolymer solution is applied onto a release liner by flow casting and dried to give a test sample (sheet homopolymer) having a

thickness of about 2 mm. The test sample is blanked (die-cut) into a disc having a diameter of 7.9 mm, placed between parallel plates, and whose viscoelasticity is measured at temperatures in the range of -70°C to 150°C and a rate of temperature rise of 5°C/min in a shearing mode, using a viscoelasticity tester ARES (trade name, TA Instruments) with a shear strain at a frequency of 1 Hz. On the basis of the measured viscoelasticity, the peak top temperature at $\tan \delta$ (loss tangent) is defined as the glass transition temperature T_g of the homopolymer.

[0063]

The acrylic polymer has a weight-average molecular weight of preferably 40×10^4 to 250×10^4 , and more preferably 60×10^4 to 220×10^4 . The acrylic polymer, when having a weight-average molecular weight within the range, tends to allow the pressure-sensitive adhesive layer to have lower tensile residual stress and to more satisfactorily have level difference absorbency. The weight-average molecular weight herein refers to a value measured by gel permeation chromatography (GPC) and calibrated with a polystyrene standard.

[0064]

The pressure-sensitive adhesive to form the pressure-sensitive adhesive layer according to the present invention may include a crosslinker, or not. The crosslinker can, for

example, crosslink the acrylic polymer in the acrylic pressure-sensitive adhesive layer and control the gel fraction of the acrylic polymer. The pressure-sensitive adhesive may include each of different crosslinkers alone or in combination.

[0065]

Non-limiting examples of the crosslinker include isocyanate crosslinkers, epoxy crosslinkers, melamine crosslinkers, peroxide crosslinkers, urea crosslinkers, metal alkoxide crosslinkers, metal chelate crosslinkers, metal salt crosslinkers, carbodiimide crosslinkers, oxazoline crosslinkers, aziridine crosslinkers, amine crosslinkers, silicone crosslinkers, and silane crosslinkers.

[0066]

The pressure-sensitive adhesive may contain the crosslinker in a content of preferably 5 parts by mass or less, more preferably 0.001 to 5 parts by mass, still more preferably 0.001 to 4 parts by mass, and particularly preferably 0.001 to 3 parts by mass, per 100 parts by mass of the acrylic polymer, although the content is not limited.

[0067]

Non-limiting examples of the isocyanate crosslinkers (multifunctional isocyanate compounds) include lower aliphatic polyisocyanates such as 1,2-ethylene diisocyanate, 1,4-butylene diisocyanate, and 1,6-hexamethylene

diisocyanate; alicyclic polyisocyanates such as cyclopentylene diisocyanate, cyclohexylene diisocyanate, isophorone diisocyanate, hydrogenated tolylene diisocyanate, and hydrogenated xylene diisocyanate; and aromatic polyisocyanates such as 2,4-tolylene diisocyanate, 2,6-tolylene diisocyanate, 4,4'-diphenylmethane diisocyanate, and xylylene diisocyanate. Non-limiting examples of the isocyanate crosslinkers also include commercial products available typically as a trimethylolpropane/tolylene diisocyanate adduct (trade name CORONATE L, from Tosoh Corporation), a trimethylolpropane/hexamethylene diisocyanate adduct (trade name CORONATE HL, from Tosoh Corporation), and a trimethylolpropane/xylylene diisocyanate adduct (trade name TAKENATE D-110N, from Mitsui Chemicals Inc.).

[0068]

Such an isocyanate crosslinker, when used as the crosslinker, may be present in a content of preferably 5 parts by mass or less, more preferably 0.01 to 5 parts by mass, still more preferably 0.01 to 4 parts by mass, and particularly preferably 0.02 to 3 parts by mass, per 100 parts by mass of the acrylic polymer, although the content is not limited.

[0069]

When the acrylic polymer is prepared by emulsion

polymerization as a modified acrylic polymer in an aqueous dispersion, the polymerization may employ no isocyanate crosslinker. However, where necessary, the polymerization may employ a blocked isocyanate crosslinker, which readily reacts with water.

[0070]

Non-limiting examples of the epoxy crosslinkers (multifunctional epoxy compounds) include N,N,N',N'-tetraglycidyl-m-xylenediamine, diglycidylaniline, 1,3-bis(N,N-diglycidylaminomethyl)cyclohexane, 1,6-hexanediol diglycidyl ether, neopentyl glycol diglycidyl ether, ethylene glycol diglycidyl ether, propylene glycol diglycidyl ether, polyethylene glycol diglycidyl ethers, polypropylene glycol diglycidyl ethers, sorbitol polyglycidyl ethers, glycerol polyglycidyl ethers, pentaerythritol polyglycidyl ethers, polyglycerol polyglycidyl ethers, sorbitan polyglycidyl ethers, trimethylolpropane polyglycidyl ethers, diglycidyl adipate, diglycidyl o-phthalate, triglycidyl-tris(2-hydroxyethyl)isocyanurate, resorcinol diglycidyl ether, and bisphenol-S diglycidyl ether, as well as epoxy resins each having two or more epoxy groups in the molecule. Non-limiting examples of the epoxy crosslinkers also include commercial products available typically under the trade name of TETRAD C (from MITSUBISHI GAS CHEMICAL COMPANY, INC.).

[0071]

Such an epoxy crosslinker, when used as the crosslinker, may be present in a content of preferably 5 parts by mass or less, more preferably 0.01 to 5 parts by mass, still more preferably 0.01 to 4 parts by mass, and particularly preferably 0.02 to 3 parts by mass, per 100 parts by mass of the acrylic polymer, although the content is not limited.

[0072]

As the peroxide crosslinkers, any of peroxide crosslinkers that generate active radical species upon application of heat to cause the acrylic polymer to crosslink is appropriately usable, of which peroxides having a half-life temperature for 1 minute of 80°C to 160°C are preferred, and peroxides having a half-life temperature for 1 minute of 90°C to 140°C are more preferred.

[0073]

Non-limiting examples of the peroxide crosslinkers include di(2-ethylhexyl)peroxydicarbonate (half-life temperature for 1 minute: 90.6°C), di(4-t-butylcyclohexyl)peroxydicarbonate (half-life temperature for 1 minute: 92.1°C), di-sec-butyl peroxydicarbonate (half-life temperature for 1 minute: 92.4°C), t-butyl peroxyneodecanoate (half-life temperature for 1 minute: 103.5°C), t-hexyl peroxy-pivalate (half-life temperature for 1 minute: 109.1°C), t-butyl peroxy-pivalate (half-life

temperature for 1 minute: 110.3°C), dilauroyl peroxide (half-life temperature for 1 minute: 116.4°C), di-n-octanoyl peroxide (half-life temperature for 1 minute: 117.4°C), 1,1,3,3-tetramethylbutyl peroxy-2-ethylhexanoate (half-life temperature for 1 minute: 124.3°C), di(4-methylbenzoyl) peroxide (half-life temperature for 1 minute: 128.2°C), dibenzoyl peroxide (half-life temperature for 1 minute: 130.0°C), t-butyl peroxyisobutyrate (half-life temperature for 1 minute: 136.1°C), and 1,1-di(t-hexylperoxy)cyclohexane (half-life temperature for 1 minute: 149.2°C).

[0074]

The "half-life" of such a peroxide crosslinker is an index that indicates the decomposition rate of the peroxide and refers to a time at which a half of the peroxide remains. Decomposition temperatures for any (arbitrary) half lives, and half lives at any temperatures are described typically in manufactures' catalogs, such as "Organic Peroxides Catalog" 9th Ed. (May, 2003) available from NOF Corporation. The amount of the residual peroxide after the reaction treatment can be measured by a technique such as high-performance liquid chromatography (HPLC). More specifically, the peroxide amount after the reaction treatment can be measured typically in the following manner. About 0.2 g of a tested pressure-sensitive adhesive after the reaction

treatment is sampled, immersed in 10 ml of ethyl acetate, extracted with shaking in a shaker at 25°C, 120 rpm for 3 hours, and left stand at room temperature for 3 days. Next, the resulting article is combined with 10 ml of acetonitrile, shaken at 25°C, 120 rpm for 30 minutes, and filtered through a membrane filter (0.45 µm) to give an extract. About 10 µl of the extract is charged into a HPLC system, analyzed, and the analyzed amount is defined as the residual amount of the peroxide after the reaction treatment.

[0075]

Such a peroxide crosslinker, when used as the crosslinker, may be present in a content of preferably 2 parts by mass or less, more preferably 0.02 to 2 parts by mass, and still more preferably 0.05 to 1 part by mass, per 100 parts by mass of the acrylic polymer, although the content is not limited.

[0076]

The crosslinker for use herein may further include an organic crosslinker and/or a multifunctional metal chelate. The multifunctional metal chelate is a chelate including a multifunctional metal covalently or coordinately bonded to an organic compound. Non-limiting examples of the multifunctional metal atom include Al, Cr, Zr, Co, Cu, Fe, Ni, V, Zn, In, Ca, Mg, Mn, Y, Ce, Sr, Ba, Mo, La, Sn, and Ti. A non-limiting example of the atom in the organic compound

to which the multifunctional metal is covalently or coordinately bonded is oxygen atom, and non-limiting examples of the organic compound include alkyl esters, alcohol compounds, carboxylic acid compounds, ether compounds, and ketone compounds.

[0077]

The acrylic pressure-sensitive adhesive (pressure-sensitive adhesive to form the pressure-sensitive adhesive layer according to the present invention) may contain an acrylic oligomer, to have higher bond strength. The acrylic oligomer is preferably a polymer having a smaller weight-average molecular weight as compared with the acrylic polymer. Advantageously, the acrylic oligomer functions as a tackifier resin and allows the pressure-sensitive adhesive to have higher bond strength without increase in dielectric constant. The pressure-sensitive adhesive, when having a low proportion of the acrylic oligomer, can have sebum-induced swelling (resist sebum-induced swelling). The acrylic pressure-sensitive adhesive may contain the acrylic oligomer in an amount of typically preferably 10 parts by mass or less, more preferably 5 parts by mass or less, and still more preferably 3 parts by mass or less, per 100 parts by mass of the acrylic polymer.

[0078]

The acrylic oligomer preferably has a higher glass

transition temperature T_g as compared with the acrylic polymer and has a T_g of typically 0°C to 200°C , preferably 20°C to 150°C , and more preferably 40°C to 120°C . The acrylic oligomer, when having a T_g within the range, contributes to higher bond strength. The T_g of the acrylic oligomer is a theoretical value calculated according to the Fox equation, as with the T_g of the acrylic polymer.

[0079]

The pressure-sensitive adhesive layer according to the present invention may further include a silane coupling agent. The pressure-sensitive adhesive layer according to the present invention, when including a silane coupling agent, can have higher water resistance at the interface with a hydrophilic adherend such as glass. The pressure-sensitive adhesive layer may include each of different silane coupling agents alone or in combination.

[0080]

Non-limiting examples of the silane coupling agents include epoxy-containing silane coupling agents such as 3-glycidoxypropyltrimethoxysilane, 3-glycidoxypropyltriethoxysilane, 3-glycidoxypropylmethyldiethoxysilane, and 2-(3,4-epoxycyclohexyl)ethyltrimethoxysilane; amino-containing silane coupling agents such as 3-aminopropyltrimethoxysilane, N-2-(aminoethyl)-3-aminopropylmethyldimethoxysilane, 3-

triethoxysilyl-N-(1,3-dimethylbutylidene)propylamine, and N-phenyl- γ -aminopropyltrimethoxysilane; (meth)acryl-containing silane coupling agents such as 3-acryloxypropyltrimethoxysilane and 3-methacryloxypropyltriethoxysilane; and isocyanate-containing silane coupling agents such as 3-isocyanatopropyltriethoxysilane. Among these silane coupling agents, γ -glycidoxypropyltrimethoxysilane is preferred.

[0081]

The pressure-sensitive adhesive layer according to the present invention may contain the silane coupling agent in a content of preferably 1 part by mass or less, more preferably 0.01 to 1 part by mass, and still more preferably 0.02 to 0.6 part by mass, per 100 parts by mass of the acrylic polymer, although the content is not limited. The pressure-sensitive adhesive layer, when containing the silane coupling agent in a content within the range, can have both good removability and good durability.

[0082]

The pressure-sensitive adhesive layer according to the present invention may further contain one or more additives as needed, within ranges not adversely affecting advantageous effects of the present invention. Non-limiting examples of the additives include cross-linking promoters,

tackifier resins (such as rosin derivatives, polyterpene resins, petroleum resins, and oil-soluble phenols), age inhibitors, fillers (such as metal powders, organic fillers, and inorganic fillers), colorants (such as pigments and dyes), antioxidants, plasticizers, softeners, surfactants, antistatic agents, surface lubricants, leveling agents, photostabilizers, ultraviolet absorbers, polymerization inhibitors, particulates, and foil substances. The pressure-sensitive adhesive layer may contain each of different additives alone or in combination.

[0083]

The pressure-sensitive adhesive layer according to the present invention is formed from the pressure-sensitive adhesive including the acrylic polymer. The pressure-sensitive adhesive layer according to the present invention has a thickness of typically about 1 to about 400 μm , although the pressure-sensitive adhesive layer can have any other thickness. A preferred range of the thickness of the pressure-sensitive adhesive layer according to the present invention can be set as appropriate according to the production technique of the acrylic polymer to constitute the pressure-sensitive adhesive. For example, when the acrylic polymer is produced typically by solution polymerization, the thickness of the pressure-sensitive adhesive layer is preferably 1 to 100 μm , more preferably 2

to 50 μm , still more preferably 2 to 40 μm , and particularly preferably 5 to 35 μm . When the acrylic polymer is produced typically by actinic radiation polymerization, the thickness of the pressure-sensitive adhesive layer is preferably 50 to 400 μm , more preferably 75 to 300 μm , and still more preferably 100 to 200 μm .

[0084]

The pressure-sensitive adhesive layer according to the present invention has a 300-percent tensile residual stress (residual stress after 300-percent tensile deformation) of 0.1 to 6 N/cm^2 , preferably 0.5 to 5.8 N/cm^2 , and more preferably 1.0 to 5.6 N/cm^2 . The pressure-sensitive adhesive layer, as having a 300-percent tensile residual stress of 0.1 N/cm^2 or more, advantageously resists sagging during processing and has other advantageous properties. The pressure-sensitive adhesive layer, as having a 300-percent tensile residual stress of 6 N/cm^2 or less, satisfactorily has level difference absorbency. The 300-percent tensile residual stress is a value (in N/cm^2) determined in the following manner. The pressure-sensitive adhesive layer (preferably about 400- μm thick) is pulled at an ambient temperature of 23°C in a lengthwise direction (machine direction) to an elongation (strain) of 300% and held at the elongation. The tensile load applied to the pressure-sensitive adhesive layer after elapse of 300 seconds from

the completion of pulling is determined. The tensile load is divided by the initial cross-sectional area (cross-sectional area before pulling) of the pressure-sensitive adhesive layer, and the resulting value is defined as the 300-percent tensile residual stress. The initial elongation of the pressure-sensitive adhesive layer is defined as 100%.
[0085]

The pressure-sensitive adhesive layer according to the present invention has a storage modulus at 70°C of preferably 7.0×10^4 Pa or less, more preferably 6.5×10^4 Pa or less, and still more preferably 6.0×10^4 Pa or less. The pressure-sensitive adhesive layer, when having a storage modulus of 7.0×10^4 Pa or less at 70°C, tends to have a low 300-percent tensile residual stress and to have level difference absorbency more satisfactorily. The storage modulus at 70°C is typically 1.0×10^3 Pa or more, and preferably 1.0×10^4 Pa or more.
[0086]

The pressure-sensitive adhesive layer according to the present invention has a storage modulus at 25°C of preferably 1.0×10^4 Pa or more, more preferably 5.0×10^4 Pa or more, and still more preferably 1.0×10^5 Pa or more. The storage modulus at 25°C is typically 1.0×10^7 Pa or less, and preferably 1.0×10^6 Pa or less.
[0087]

The storage modulus at 70°C and the storage modulus at 25°C can be determined typically by dynamic viscoelastic measurement using a dynamic viscoelastometer ARES (trade name, TA Instruments). The measurement is performed in a searing mode at temperatures in the range of typically -70°C to 150°C, a rate of temperature rise of typically 5°C/min, and a frequency of typically 1 Hz.

[0088]

The pressure-sensitive adhesive layer according to the present invention has a gel fraction of preferably 30 to 85 mass percent, more preferably 35 to 80 mass percent, and still more preferably 40 to 70 mass percent. The pressure-sensitive adhesive layer, when having a gel fraction of 30 mass percent or more, has workability and handleability at better levels. The pressure-sensitive adhesive layer, when having a gel fraction of 85 mass percent or less, has less stress against level difference and more satisfactorily have level difference absorbency. The gel fraction is controllable by regulating the amounts of the crosslinker and the multifunctional monomer, as well as by considering (or adjusting) the temperature and time of the crosslinking treatment.

[0089]

The pressure-sensitive adhesive layer according to the present invention has a b^* value of preferably 2.0 or less,

more preferably 1.6 or less, and still more preferably 1.2 or less, after an ultraviolet irradiation test described below. The pressure-sensitive adhesive layer, when having a b^* value of 2.0 or less after the test, resists discoloration in an environment under exposure to ultraviolet radiation. The b^* value is a b^* value of the Lab color space and is measurable in conformity to JIS Z 8781-4:2013, typically using a handy spectrophotometric color difference meter DOT-3C (trade name, Murakami Color Research Laboratory).

Ultraviolet Irradiation Test

The pressure-sensitive adhesive layer is prepared to a thickness of 250 μm and placed between two plies of alkali glass to give a test specimen. The test specimen is irradiated with ultraviolet radiation from a xenon arc lamp at wavelengths in a range of 300 to 400 nm, an illuminance of 110 W/m^2 , and a black panel preset temperature of 83°C for 240 hours, and the b^* value of the resulting pressure-sensitive adhesive layer is measured.

[0090]

The pressure-sensitive adhesive layer according to the present invention, when having a thickness of 100 μm , has a haze of preferably 2% or less, more preferably 1.5% or less, and still more preferably 1% or less. The pressure-sensitive adhesive layer according to the present invention,

when having a haze of 2% or less, can have satisfactory transparency as required when used in or for optical members. The haze is measurable typically using a haze meter, according to JIS K 7136.

[0091]

The pressure-sensitive adhesive layer according to the present invention has an oozing (oozing amount) of preferably less than 2 mm, and more preferably less than 1 mm, where the oozing is measured by the following test for sebum-induced swelling. The oozing is preferably minimized, and is ideally 0 mm.

Test for Sebum-induced Swelling

A sample including a poly(ethylene terephthalate) film (100 μm thick), a pressure-sensitive adhesive layer (100 μm thick), and glass stacked in the specified order is prepared to a size of 5 cm by 10 cm. Separately, an artificial liquid sebum is prepared as a 1:1 (by mass) mixture of squalene and oleic acid. The sample is immersed in the artificial liquid sebum, left stand at 60°C for 5 days, retrieved from the artificial liquid sebum, and the amount of the pressure-sensitive adhesive layer oozed from the glass edge is measured.

[0092]

The pressure-sensitive adhesive layer according to the present invention may be prepared typically by applying a

pressure-sensitive adhesive (pressure-sensitive adhesive composition) including the acrylic polymer onto a substrate or release liner to give a pressure-sensitive adhesive composition layer, and drying and curing the pressure-sensitive adhesive composition layer; or by applying the pressure-sensitive adhesive composition onto a substrate or release liner to give a pressure-sensitive adhesive composition layer, and applying actinic radiation to the pressure-sensitive adhesive composition layer to cure the composition. As needed, the layer may further be heated and dried. Alternatively, the pressure-sensitive adhesive layer may be prepared by any other technique.

[0093]

Non-limiting examples of the actinic radiation include ionizing radiation such as alpha rays, beta rays, gamma rays, neutron beams, and electron beams; and ultraviolet radiation, of which ultraviolet radiation is preferred. Irradiation energy, irradiation time, irradiation technique, and other conditions for the actinic radiation are not limited.

[0094]

The pressure-sensitive adhesive composition can be prepared by any known or common technique. For example, the pressure-sensitive adhesive composition, when being a solvent-borne pressure-sensitive adhesive composition, can be prepared by mixing a solution containing the acrylic

polymer with additives as needed. For example, the pressure-sensitive adhesive composition, when being an actinic-radiation-curable pressure-sensitive adhesive composition, can be prepared by mixing, with additives as needed, a mixture of monomer components to form the acrylic polymer or a partial polymer derived from the mixture.

[0095]

The pressure-sensitive adhesive composition may be applied by any known coating technique. For example, the composition may be applied using a coater. Non-limiting examples of the coater include rotogravure roll coaters, reverse roll coaters, kiss-contact roll coaters, dip roll coaters, bar coaters, knife coaters, spray coaters, comma coaters, and direct coaters.

[0096]

The solvent-borne pressure-sensitive adhesive composition is heated and dried at a temperature of preferably 40°C to 200°C, more preferably 50°C to 180°C, and still more preferably 70°C to 170°C. The composition may be dried for typically 5 seconds to 20 minute, preferably 5 seconds to 10 minutes, and more preferably 10 seconds to 5 minutes. Alternatively, the drying may be performed for any other appropriate or adequate time.

[0097]

The pressure-sensitive adhesive layer, when to be

formed by actinic radiation irradiation, can be formed while the acrylic polymer is formed from the monomer components. The monomer components can be used in actinic radiation irradiation as a syrup resulting from partial polymerization of the monomer components. The ultraviolet irradiation may be performed using a light source such as high-pressure mercury lamps, low-pressure mercury lamps, and metal halide lamps.

[0098]

The pressure-sensitive adhesive layer according to the present invention can give a pressure-sensitive adhesive sheet. Such a pressure-sensitive adhesive sheet having or including the pressure-sensitive adhesive layer according to the present invention is also referred to as a "pressure-sensitive adhesive sheet according to the present invention".

[0099]

The pressure-sensitive adhesive sheet according to the present invention may be a so-called "transfer" or "substrate-less" pressure-sensitive adhesive sheet devoid of substrates (base layers) or a pressure-sensitive adhesive sheet including a substrate. As used herein, the "substrate-less" pressure-sensitive adhesive sheet is also referred to as a "transfer pressure-sensitive adhesive sheet"; and the pressure-sensitive adhesive sheet including a substrate is also referred to as a "substrate-borne

pressure-sensitive adhesive sheet". Non-limiting examples of the transfer pressure-sensitive adhesive sheet include a double-sided pressure-sensitive adhesive sheet including the pressure-sensitive adhesive layer according to the present invention alone; and a double-sided pressure-sensitive adhesive sheet including the pressure-sensitive adhesive layer according to the present invention and another pressure-sensitive adhesive layer (a pressure-sensitive adhesive layer other than the pressure-sensitive adhesive layer according to the present invention). The substrate-borne pressure-sensitive adhesive sheet is a pressure-sensitive adhesive sheet including a substrate, and the pressure-sensitive adhesive layer according to the present invention on at least one side of the substrate. Non-limiting examples of the substrate-borne pressure-sensitive adhesive sheet include a single-sided pressure-sensitive adhesive sheet including a substrate and the pressure-sensitive adhesive layer according to the present invention on one side of the substrate; a double-sided pressure-sensitive adhesive sheet including a substrate and the pressure-sensitive adhesive layer according to the present invention on both sides of the substrate; and a double-sided pressure-sensitive adhesive sheet including a substrate, the pressure-sensitive adhesive layer according to the present invention on one side of the substrate, and another

pressure-sensitive adhesive layer on the other side. The "substrate (substrate layer)" refers to a carrier and is a portion that is applied, together with the pressure-sensitive adhesive layer, to an adherend when the pressure-sensitive adhesive sheet according to the present invention is applied to the adherend. The concept "substrate" herein excludes a separator (release liner), which is removed upon the use (application) of the pressure-sensitive adhesive sheet.

[0100]

When the pressure-sensitive adhesive sheet according to the present invention is a substrate-borne pressure-sensitive adhesive sheet, non-limiting examples of the substrate include various optical films such as plastic films, antireflection (AR) films, polarizing plates, and retardation films. Non-limiting examples of the substrate also include porous material substrates such as paper, woven fabrics, and nonwoven fabrics; as well as nets, foamed sheets, and metallic foils. Alternatively, the substrate may be any other substrate. Non-limiting examples of materials typically for the plastic films include plastic materials exemplified by polyester resins such as poly(ethylene terephthalate)s (PETs); acrylic resins such as poly(methyl methacrylate)s (PMMA)s; polycarbonates; triacetyl cellulose (TAC); polysulfones; polyarylates;

polyimides; poly(vinyl chloride)s; poly(vinyl acetate)s; polyethylenes; polypropylenes; ethylene-propylene copolymers; and cycloolefin polymers such as ARTON (trade name, a cycloolefin polymer, JSR Corporation) and ZEONOR (trade name, a cycloolefin polymer, ZEON CORPORATION). Each of different plastic materials may be used alone or in combination.

[0101]

The substrate has a thickness of typically preferably 12 to 75 μm , but may have any other thickness. The substrate may have a single-layer structure or multi-layer structure. The substrate may have appropriately undergone a known or common surface treatment. Non-limiting examples of the surface treatment include physical treatments such as corona discharge treatment and plasma treatment; and chemical treatments such as primer coating.

[0102]

The pressure-sensitive adhesive sheet according to the present invention may carry a release liner on the surface (adhesive face) of the pressure-sensitive adhesive layer(s), before use. The pressure-sensitive adhesive sheet according to the present invention, when being a double-sided pressure-sensitive adhesive sheet, may be protected on its two adhesive faces respectively by two release liners, or may be rolled with one release liner having release surfaces

on both sides to form a roll to thereby be protected on its adhesive faces. The release liner(s) is used as a protectant for the pressure-sensitive adhesive layer(s) and will be removed when the sheet is applied to an adherend or adherends. The release liner(s) also functions as a carrier for the pressure-sensitive adhesive layer(s) when the pressure-sensitive adhesive sheet according to the present invention is a transfer pressure-sensitive adhesive sheet. The pressure-sensitive adhesive sheet does not always have to carry such a release liner.

[0103]

The release liner can be selected typically from common release papers and is exemplified by bases having a release coat layer; low-adhesive bases including fluorocarbon polymers; and low-adhesive bases including nonpolar polymers. Alternatively, the release liner is selectable from any other release liners. Non-limiting examples of the bases having a release coat layer include plastic films and papers which have been surface-treated with a release agent such as a silicone-, long-chain alkyl-, fluorine-, or molybdenum sulfide-release agent. Non-limiting examples of fluorocarbon polymers to constitute the low-adhesive bases include polytetrafluoroethylenes, polychlorotrifluoroethylenes, poly(vinyl fluoride)s, poly(vinylidene fluoride)s, tetrafluoroethylene-

hexafluoropropylene copolymers, and chlorofluoroethylene-vinylidene fluoride copolymers. Non-limiting examples of the nonpolar polymers to constitute the low-adhesive bases include olefinic resins such as polyethylenes and polypropylenes. The release liner can be formed by a known or common technique. The release liner may have any thickness.

[0104]

The pressure-sensitive adhesive sheet according to the present invention may be produced according to a known or common production method, although the production method is not limited. For example, the pressure-sensitive adhesive sheet according to the present invention, when being a transfer pressure-sensitive adhesive sheet, can be produced by forming the pressure-sensitive adhesive layer according to the present invention on a release liner by the technique. The pressure-sensitive adhesive sheet according to the present invention, when being a substrate-borne pressure-sensitive adhesive sheet, may be obtained by a direct process or by a transfer process. In the direct process, the pressure-sensitive adhesive layer according to the present invention is formed directly on a substrate. In the transfer process, the pressure-sensitive adhesive layer according to the present invention is once formed on a release liner and then transferred (applied) to and provided

on a substrate.

[0105]

The pressure-sensitive adhesive layer according to the present invention and the pressure-sensitive adhesive sheet according to the present invention are preferably used in or for an optical-use optical member or members. The "optical member" refers to a member having one or more optical properties (such as polarizability, photorefractivity, light scattering, light reflectivity, optical transparency, optical absorptivity, optical diffractive ability, optical rotatory power, and visibility). The optical member includes a substrate. Examples of the substrate include substrates to constitute or to be used in devices (optical devices) such as display devices (image display devices) and input devices. Non-limiting examples of such substrates include polarizing plates, wave plates, retardation films, compensation films, brightness enhancing films, light guide plates, reflective films, antireflection films, hard coat films (films including a PET film or another plastic film whose at least one side has undergone hard coat treatment), transparent conductive films, films with graphical design functions, decorative films, surface-protecting plates, prisms, lenses, color filters, transparent substrates (glass sensors, glass display panels (such as liquid crystal displays (LCDs)), glass plates with transparent electrodes,

and other glass substrates), as well as substrates as a stack of these substrates. These are generically also referred to as "functional films". These films may have a layer such as a print layer or a conductive polymer layer. The terms "plate" and "film" each include a plate, a film, a sheet, or one with a similar form. For example, the "polarizing film" includes a "polarizing plate", a "polarizing sheet", and other polarizers.

[0106]

The pressure-sensitive adhesive layer according to the present invention and the pressure-sensitive adhesive sheet according to the present invention are particularly preferably used to be applied to a thin metal film or a metal electrode in optical uses. The thin metal film is exemplified by, but not limited to, thin films including any of metals, metal oxides, and mixtures of them, such as thin films of indium tin oxide (ITO), ZnO, SnO, or cadmium tin oxide (CTO). The thin metal film has a thickness of about 10 to about 200 nm, although the thin metal film may have any other thickness. The thin metal film such as thin ITO film is generally provided on a transparent plastic base film such as a poly(ethylene terephthalate) film (PET film) and used as a transparent conductive film. The pressure-sensitive adhesive sheet according to the present invention, when to be applied to such a thin metal film, is preferably

used so that the surface of the pressure-sensitive adhesive layer serves as an adhesive face to be applied to the thin metal film.

[0107]

Non-limiting examples of the metal electrode include electrodes including any of metals, metal oxides, and mixtures of them, such as electrodes of ITO, silver, copper, or carbon nanotubes (CNTs).

[0108]

Specifically, an exemplary use of the pressure-sensitive adhesive sheet according to the present invention is a touch screen-use pressure-sensitive adhesive sheet for the production of a touch screen. The touch screen-use pressure-sensitive adhesive sheet is used typically in production of a capacitive touch screen for the lamination of a transparent conductive film carrying an ITO film or another thin metal film with another member such as a poly(methyl methacrylate) resin (PMMA) plate, hard coat film, or glass lens. The touch screen is used typically for cellular phones, tablet computers, and personal digital assistants, although the touch screen can be used for any other use.

[0109]

More specifically, FIG. 1 is a view of an exemplary capacitive touch screen using the pressure-sensitive

adhesive layer according to the present invention or the pressure-sensitive adhesive sheet according to the present invention. As illustrated in FIG. 1, the capacitive touch screen 1 includes an ornamental panel 11, the pressure-sensitive adhesive layer or pressure-sensitive adhesive sheet 12, an ITO film 13, and a hard coat film 14. The ornamental panel 11 is preferably a glass plate or transparent acrylic plate (such as a PMMA plate). The ITO film 13 is preferably one including a glass plate or a transparent plastic film (in particular, a PET film) and an ITO film on the plate or film. The hard coat film 14 is preferably one including a PET film or another transparent plastic film which has undergone hard coat treatment. The capacitive touch screen 1 uses the pressure-sensitive adhesive layer according to the present invention or the pressure-sensitive adhesive sheet according to the present invention, thereby resists sebum-induced swelling, can have a small thickness, satisfactorily has level difference absorbency such as print level difference, and is highly stable in operation. In addition, the capacitive touch screen has good appearance and visibility.

Examples

[0110]

The present invention will be illustrated in further detail with reference to several examples below. It should

be noted, however, that these examples are never construed to limit the scope of the invention. All the percentages indicating contents are by mass, unless otherwise specified. All the compounding proportions (part by mass) are in terms of solids contents (non-volatile contents).

[0111]

Example 1

A monomer mixture was prepared by mixing, in a four-necked flask, 67 parts by mass of butyl acrylate (BA), 19 parts by mass of 4-hydroxybutyl acrylate (4BHA), 14 parts by mass of cyclohexyl acrylate (CHA), 0.09 part by mass of photoinitiator Omnirad 184 (trade name, BASF SE), and 0.09 part by mass of photoinitiator Omnirad 651 (trade name, BASF SE). Next, the monomer mixture was exposed to ultraviolet radiation in a nitrogen atmosphere to be partially photopolymerized, and yielded a partial polymer (acrylic polymer syrup) having a degree of polymerization of about 10 mass percent.

[0112]

The totality of the prepared acrylic polymer syrup was combined with 8 parts by mass of 4-hydroxybutyl acrylate, 9 parts by mass of 2-hydroxyethyl acrylate (HEA), 0.02 part by mass of dipentaerythritol pentaacrylate KAYARAD DPHA (trade name, Nippon Kayaku Co., Ltd.), 0.3 part by mass of photoinitiator Omnirad 651 (trade name, BASF SE), and 0.35

part by mass of silane coupling agent KBM-403 (trade name, γ -glycidoxypyrpyltrimethoxysilane, Shin-Etsu Chemical Co., Ltd.), then mixed uniformly, and yielded a pressure-sensitive adhesive composition.

[0113]

Next, a 38- μ m thick polyester film DIAFOIL MRF (trade name, Mitsubishi Chemical Corporation), whose one side had undergone release treatment with a silicone, was prepared, and the above-prepared pressure-sensitive adhesive composition was applied to the release-treated surface of the polyester film to a final thickness of 100 μ m, to form a coat layer. Next, a 38- μ m thick polyester film DIAFOIL MRE (trade name, Mitsubishi Chemical Corporation), whose one side had undergone release treatment with a silicone, was prepared, and covered the surface of the coat layer so that the release-treated surface of the film faced the coat layer. This blocked the pressure-sensitive adhesive composition coat layer from oxygen. The sheet having the prepared coat layer was irradiated with ultraviolet radiation using a chemical lamp (chemical light lamp, TOSHIBA CORPORATION) for 360 seconds at an illuminance of 5 mW/cm² to cure the coat layer to thereby form a pressure-sensitive adhesive layer, where the illuminance was measured with TOPCON UVR-T1, which has a maximum sensitivity at about 350 nm. This gave a pressure-sensitive adhesive sheet. The polyester films

carried on both sides of the pressure-sensitive adhesive layer function as release liners.

[0114]

Examples 2 and 3, Comparative Examples 1 and 2

A series of pressure-sensitive adhesive layers and pressure-sensitive adhesive sheets were prepared by a procedure similar to that in Example 1, except for using monomer components and photoinitiators and other additives in kinds and proportions as indicated in Table 1. The chain-transfer agent used in Example 3 was NOFMER MSD (trade name, NOF CORPORATION). The acrylic oligomer used in Comparative Example 2 had been prepared in the following manner.

[0115]

Acrylic Oligomer Preparation

Materials were placed into a separable flask, where the materials were monomer components composed of 60 parts by mass of methyl methacrylate (MMA, MITSUBISHI GAS CHEMICAL COMPANY, INC.) and 40 parts by mass of dicyclopentanyl methacrylate (DCPMA, Hitachi Chemical Company, Ltd.), as well as 30 parts by mass of α -thioglycerol chain-transfer agent (Tokyo Chemical Industry Co., Ltd.), 0.2 part by mass of 2,2'-azobisisobutyronitrile (AIBN) polymerization initiator (KISHIDA CHEMICAL Co., Ltd.), and 60 parts by mass of ethyl acetate polymerization solvent. The materials were

stirred for one hour while introducing nitrogen gas into the system. After oxygen was removed from the polymerization system in the above manner, the materials were raised in temperature to 70°C, reacted for 2 hours, further reacted at 80°C for 8 hours, and yielded an oligomer solution having a solids concentration of 60 mass percent. The oligomer solution was heated and dried at 85°C and a degree of vacuum of 7.5 kPa for one hour and yielded an oligomer powder having a solids concentration of 100 mass percent.

[0116]

Evaluations

The pressure-sensitive adhesive layers and pressure-sensitive adhesive sheets obtained in the examples and comparative examples were evaluated as follows. The results are given in Table 1.

[0117]

(1) Resistance to Sebum-induced Swelling

A sample including a poly(ethylene terephthalate) film (100- μ m thick), the pressure-sensitive adhesive layer (100- μ m thick), and glass stacked in the specified order was prepared to a size of 5 cm by 10 cm. Separately, an artificial liquid sebum was prepared as a 1:1 (by mass) mixture of squalene and oleic acid. The sample was immersed in the artificial liquid sebum, left stand at 60°C for 5 days, retrieved from the artificial liquid sebum, and the

amount (length) of the pressure-sensitive adhesive layer oozed from the glass edge was measured. A sample having an oozing of less than 2 mm was evaluated as having good resistance to sebum-induced swelling, and a sample having an oozing of 2 mm or more was evaluated as having poor resistance.

[0118]

(2) 300-Percent Tensile Residual Stress

Each of the pressure-sensitive adhesive sheets obtained in the examples and comparative examples was cut into a piece of 40 mm by 40 mm, from which the separator on one side was removed. The resulting piece was folded in two to allow the exposed pressure-sensitive adhesive faces to lie on each other, the separator on the other side was removed, and the folded piece was further folded in two to allow the exposed pressure-sensitive adhesive faces to lie on each other. This gave a pressure-sensitive adhesive layer sample having a size of about 10 mm by 40 mm and a thickness of about 400 μm . The pressure-sensitive adhesive layer sample was loaded into a tensile tester at a set gripping distance of 20 mm, and pulled at a tensile speed of 200 mm/min by 60 mm (300-percent), to a gripping distance of 80 mm after pulling. The sample was secured and held at the position of 60-mm pulling for 300 seconds, the stress thereafter was measured, and a "300-percent tensile residual stress" was

calculated according to the equation as follows:

$$300\text{-Percent tensile residual stress (N/cm}^2\text{)} = (\text{Stress (N) after holding for 300 seconds}) / [(4 \times (\text{Pressure-sensitive adhesive sheet thickness (mm)}) / 10)]$$

[0119]

(3) Print Level Difference Absorptivity

The separator on one side was removed from each of the pressure-sensitive adhesive sheets obtained in the examples and comparative examples to expose one surface, the exposed surface lay on a 100- μm thick PET film, the separator on the other side was removed to expose the other surface, and the exposed surface lay on a printed glass having a print level difference of about 30 μm . This gave a series of evaluation samples. Each evaluation sample was treated in an autoclave (at 50°C, 5 atmospheres, for 15 minutes). After the treatment, a sample devoid of bubbles in the vicinity of the print level difference was evaluated as having good print level difference absorbency, and a sample carrying bubbles was evaluated as having poor print level difference absorbency.

[0120]

(4) b* Value after Ultraviolet Irradiation Test

Each of the pressure-sensitive adhesive sheets obtained in the examples and comparative examples, from which one separator had been removed, lay on a pressure-sensitive

adhesive layer prepared in the same manner, to have a total thickness of 250 μm , and the laminated pressure-sensitive adhesive layers were placed between two plies of alkali glass. This yielded a series of test specimens. Each test specimen was irradiated with ultraviolet radiation using a xenon arc lamp at wavelengths in the range of 300 to 400 nm, an illuminance of 110 W/m^2 , and a black panel preset temperature of 83°C for 240 hours. The b^* value of the resulting pressure-sensitive adhesive layer was measured. The b^* value was measured with a handy spectrophotometric color difference meter DOT-3C (trade name, Murakami Color Research Laboratory).

[0121]

[Table 1]

TABLE 1

		Example 1	Example 2	Example 3	Comparative Example 1	Comparative Example 2
Acrylic polymer syrup	(Meth)acrylic alkyl ester	BA	67	67	67	-
		2EHA	-	-	-	78
	Hydroxy-containing monomer	4HBA	19	19	19	--
		HEA	-	-	-	4
	Alicyclic structure-containing monomer	CHA	14	14	14	-
Additional monomer	Cyclic nitrogen-containing monomer	NVP	-	-	-	18
		Omnirad 184	0.09	0.09	0.09	0.035
	Photoinitiator	Omnirad 651	0.09	0.09	0.09	0.035
		HDDA	-	-	-	0.088
	Multifunctional monomer	DPHA	0.01	0.02	0.12	-
Additional initiator	Hydroxy-containing monomer	4HBA	8	8	8	-
		HEA	9	9	9	17.6
	Photoinitiator	Omnirad 651	0.3	0.1	-	-
	Chain-transfer agent		-	-	-	-
	Silane coupling agent		0.35	0.35	0.35	0.35
	Acrylic oligomer		-	-	-	11.8
	Resistance to sebum-induced swelling		Good	Good	Good	Poor
	300-Percent tensile residual stress (N/cm ²)		3.2	5.2	12	13
	Print level difference absorbency		Good	Good	Poor	Poor
	b* Value after ultraviolet irradiation test		0.75	0.8	0.7	13.5
	Gel fraction (mass percent)		52	60	86	88
	Storage modulus (Pa)	25°C	1.2x 10 ⁵	1.3x 10 ⁵	1.4x 10 ⁵	1.3x 10 ⁵
		70°C	4.5x 10 ⁴	5.0x 10 ⁴	1.0x 10 ⁵	7.6x 10 ⁴

[0122]

The abbreviations in the table indicate as follows:

BA: Butyl acrylate (Toagosei Co. Ltd.)

2EHA: 2-Ethylhexyl acrylate (Toagosei Co. Ltd.)

4HBA: 4-Hydroxybutyl acrylate (Osaka Organic Chemical Industry, Ltd.)

HEA: 2-Hydroxyethyl acrylate (Toagosei Co. Ltd.)

CHA: Cyclohexyl acrylate (Osaka Organic Chemical Industry, Ltd.)

NVP: N-Vinyl-2-pyrrolidone (Nippon Shokubai Co., Ltd.)

HDDA: 1,6-Hexanediol diacrylate

DPHA: Dipentaerythritol hexaacrylate

Reference Signs List

[0123]

1 capacitive touch screen

11 ornamental panel

12 pressure-sensitive adhesive layer or pressure-sensitive adhesive sheet

13 ITO film

14 hard coat film

CLAIMS

Claim 1

A pressure-sensitive adhesive layer being formed from a pressure-sensitive adhesive and having a residual stress of 0.1 to 6 N/cm² after 300-percent tensile deformation, the pressure-sensitive adhesive comprising an acrylic polymer, the acrylic polymer derived from monomer components including:

a (meth)acrylic alkyl ester having a C₁-C₅ alkyl moiety at an ester end;

a hydroxy-containing monomer; and

an alicyclic structure-containing monomer,

the alicyclic structure-containing monomer being at least one selected from the group consisting of:

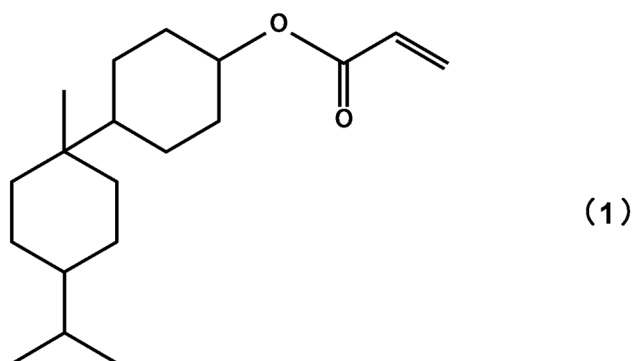
cyclohexyl (meth)acrylate;

a compound represented by Formula (1);

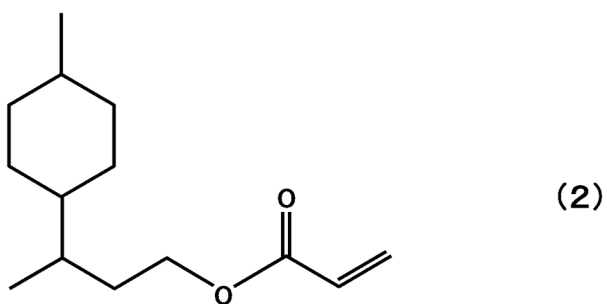
a compound represented by Formula (2); and

a compound represented by Formula (3), Formulae (1), (2), and (3) expressed as follows:

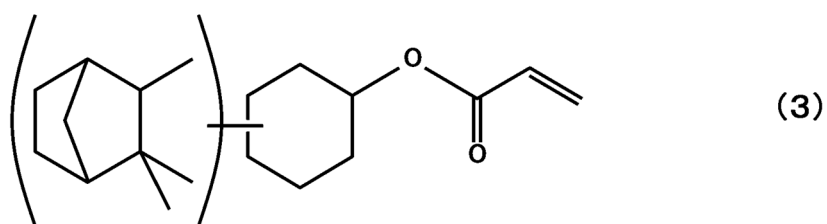
[Chem. 1]



[Chem. 2]



[Chem. 3]



the monomer components to form the acrylic polymer including, relative to the totality of the monomer components:

40 to 82 mass percent of the (meth)acrylic alkyl ester having a C₁-C₅ alkyl moiety at the ester end;

17 to 35 mass percent of the hydroxy-containing

monomer; and

42 mass percent or less of the alicyclic structure-containing monomer.

Claim 2

The pressure-sensitive adhesive layer according to claim 1,

which has a storage modulus of 7.0×10^4 Pa or less at 70°C.

Claim 3

The pressure-sensitive adhesive layer according to one of claims 1 and 2,

which has a gel fraction of 30 to 85 mass percent.

Claim 4

The pressure-sensitive adhesive layer according to any one of claims 1 to 3,

which has a b^* value of 2.0 or less after an ultraviolet irradiation test,

where, in the ultraviolet irradiation test,

the pressure-sensitive adhesive layer is prepared to a thickness of 250 μm ; is placed between two plies of alkali glass to give a test specimen; the test specimen is irradiated with ultraviolet radiation from a xenon arc lamp

at wavelengths in a range of 300 to 400 nm, an illuminance of 110 W/m², and a black panel preset temperature of 83°C for 240 hours; and the b* value of the resulting pressure-sensitive adhesive layer is measured.

Claim 5

The pressure-sensitive adhesive layer according to any one of claims 1 to 4,

wherein the monomer components to form the acrylic polymer further include a multifunctional monomer.

Claim 6

The pressure-sensitive adhesive layer according to claim 5,

wherein the monomer components to form the acrylic polymer include the multifunctional monomer in a content of 3 mass percent or less of the totality of the monomer components.

Claim 7

The pressure-sensitive adhesive layer according to any one of claims 1 to 6,

which is used in or for an optical member or members.

Claim 8

A pressure-sensitive adhesive sheet comprising:
a substrate; and
the pressure-sensitive adhesive layer according to any
one of claims 1 to 7 on at least one side of the substrate.