

Description

Title of Invention:

PRESSURE-SENSITIVE ADHESIVE, PRESSURE-SENSITIVE ADHESIVE FILM,
PRESSURE-SENSITIVE ADHESIVE TAPES, AND FILM SUBSTRATES

Technical Field

[0001]

The present invention relates to a pressure-sensitive adhesive. The present invention also relates to a pressure-sensitive adhesive tape including the pressure-sensitive adhesive of the present invention. The present invention also relates to a film substrate including the pressure-sensitive adhesive of the present invention.

[0002]

The present invention relates to a pressure-sensitive adhesive film. The present invention also relates to a pressure-sensitive adhesive tape including the pressure-sensitive adhesive film of the present invention. The present invention also relates to a film substrate including the pressure-sensitive adhesive film of the present invention.

Background Art

[0003]

When an integrated circuit (IC) or a flexible printed circuit board (FPC) is connected to the substrate (e.g., a TFT substrate)

of a semiconductor element, thermo-compression bonding is typically performed with an anisotropic conductive film (ACF). When such thermo-compression bonding is performed, a pressure-sensitive adhesive tape is bonded to the back side of the substrate of the semiconductor element in advance to reinforce the back side in some cases (Patent Literature 1).

[0004]

However, the thermo-compression bonding with the anisotropic conductive film (ACF) is performed at high temperature, and hence the fluidity of the pressure-sensitive adhesive of the pressure-sensitive adhesive tape is raised by heat. Accordingly, the following problem arises. The pressure-sensitive adhesive is largely strained at the time of, for example, the bump compression bonding of the integrated circuit (IC), and the strain of the substrate of the semiconductor element also occurs in association therewith to cause a connection failure.

Citation List

Patent Literature

[0005]

[PTL 1] JP 2012-015441 A

Summary of Invention

Technical Problem

[0006]

An object of the present invention is to provide a pressure-sensitive adhesive that has a sufficient adhesive strength and is reduced in high-temperature strain, to provide a pressure-sensitive adhesive tape including such pressure-sensitive adhesive, and to provide a film substrate including such pressure-sensitive adhesive. Another object of the present invention is to provide a pressure-sensitive adhesive film that has a sufficient adhesive strength and is reduced in high-temperature strain, to provide a pressure-sensitive adhesive tape including such pressure-sensitive adhesive film, and to provide a film substrate including such pressure-sensitive adhesive film.

Solution to Problem

[0007]

According to one embodiment of the present invention, there is provided a pressure-sensitive adhesive, which has an adhesive strength to a surface of a polyimide film of 1 N or more, and a storage modulus of elasticity G' at 160°C of 1×10^5 Pa or more.

[0008]

In one embodiment, the adhesive strength is 5 N or more.

[0009]

In one embodiment, the storage modulus of elasticity G' at

160°C is 5×10^5 Pa or more.

[0010]

In one embodiment, the pressure-sensitive adhesive of the present invention has a cross-linked structure.

[0011]

In one embodiment, the pressure-sensitive adhesive of the present invention is formed from a pressure-sensitive adhesive composition containing an acrylic polymer (A), and an isocyanate-based cross-linking agent and/or an epoxy-based cross-linking agent.

[0012]

In one embodiment, a total content of the isocyanate-based cross-linking agent and the epoxy-based cross-linking agent in the pressure-sensitive adhesive composition is from 0.1 part by weight to 30 parts by weight with respect to 100 parts by weight of the acrylic polymer (A).

[0013]

In one embodiment, a content of the isocyanate-based cross-linking agent in the pressure-sensitive adhesive composition is from 2 parts by weight to 20 parts by weight with respect to 100 parts by weight of the acrylic polymer (A).

[0014]

In one embodiment, a content of the epoxy-based cross-linking agent in the pressure-sensitive adhesive composition is from 0.3 part by weight to 10 parts by weight with respect to 100 parts by weight of the acrylic polymer (A).

[0015]

In one embodiment, the pressure-sensitive adhesive of the present invention is formed from a pressure-sensitive adhesive composition containing an acrylic polymer (B) and a UV-curable oligomer.

[0016]

In one embodiment, the UV-curable oligomer includes at least one kind selected from a UV-curable urethane-based oligomer, a UV-curable acrylic oligomer, and a UV-curable urethane-acrylic oligomer.

[0017]

In one embodiment, the pressure-sensitive adhesive of the present invention is formed from a pressure-sensitive adhesive composition containing a urethane-based polymer and an acrylic monomer.

[0018]

In one embodiment, the urethane-based polymer contains a (meth)acryloyl group-terminated urethane-based polymer.

[0019]

According to one embodiment of the present invention, there is provided a pressure-sensitive adhesive tape, including the pressure-sensitive adhesive of the present invention.

[0020]

According to one embodiment of the present invention, there is provided a film substrate, including the pressure-sensitive adhesive of the present invention.

[0021]

According to one embodiment of the present invention, there is provided a pressure-sensitive adhesive film, which has an adhesive strength to a surface of a polyimide film of 1 N or more, a storage modulus of elasticity G' at 160°C of 1×10^4 Pa or more, and a thickness of 20 μm or less.

[0022]

In one embodiment, the adhesive strength is 5 N or more.

[0023]

In one embodiment, the thickness is 15 μm or less.

[0024]

In one embodiment, the pressure-sensitive adhesive film of the present invention is formed from a pressure-sensitive adhesive composition containing an acrylic polymer.

[0025]

According to one embodiment of the present invention, there is provided a pressure-sensitive adhesive tape, including the pressure-sensitive adhesive film of the present invention.

[0026]

According to one embodiment of the present invention, there is provided a film substrate, including the pressure-sensitive adhesive film of the present invention.

Advantageous Effects of Invention

[0027]

According to the one embodiment of the present invention, the pressure-sensitive adhesive that has a sufficient adhesive strength and is reduced in high-temperature strain can be provided, the pressure-sensitive adhesive tape including such pressure-sensitive adhesive can be provided, and the film substrate including such pressure-sensitive adhesive can be provided. According to the one

embodiment of the present invention, the pressure-sensitive adhesive film that has a sufficient adhesive strength and is reduced in high-temperature strain can be provided, the pressure-sensitive adhesive tape including such pressure-sensitive adhesive film can be provided, and the film substrate including such pressure-sensitive adhesive film can be provided.

Description of Embodiments

[0028]

When the expression "mass" is used herein, the expression may be replaced with a "weight" that has heretofore been generally commonly used as a unit of a weight. In contrast, when the expression "weight" is used herein, the expression may be replaced with a "mass" that has been commonly used as an SI unit representing a weight.

[0029]

When the expression "(meth)acryl" is used herein, the expression means "acryl and/or methacryl." When the expression "(meth)acrylate" is used herein, the expression means "acrylate and/or methacrylate." When the expression "(meth)allyl" is used herein, the expression means "allyl and/or methallyl." When the expression "(meth)acrolein" is used herein, the expression means "acrolein and/or methacrolein."

[0030]

<<1. Pressure-sensitive Adhesive>>

The adhesive strength of a pressure-sensitive adhesive of the present invention to the surface of a polyimide film is 1 N or more, preferably 3 N or more, more preferably 5 N or more, still more preferably 7 N or more, particularly preferably 9 N or more. When the adhesive strength of the pressure-sensitive adhesive of the present invention to the surface of the polyimide film falls within the range, the pressure-sensitive adhesive of the present invention has a sufficient adhesive strength, and hence can be strongly and reliably bonded to, for example, the back side of the substrate of a semiconductor element for reinforcement. A method of measuring the adhesive strength to the surface of the polyimide film is described later.

[0031]

The storage modulus of elasticity G' of the pressure-sensitive adhesive of the present invention at 160°C is 1×10^5 Pa or more, preferably 2×10^5 Pa or more, more preferably 3×10^5 Pa or more, still more preferably 4×10^5 Pa or more, particularly preferably 5×10^5 Pa or more. When the storage modulus of elasticity G' of the pressure-sensitive adhesive of the present invention at 160°C falls within the range, the pressure-sensitive adhesive of the present invention is reduced in high-temperature strain. Accordingly, even in, for example, the case where the bump compression bonding of an integrated circuit (IC) onto the substrate of a semiconductor

element is performed with an anisotropic conductive film (ACF) at high temperature, the strain of the pressure-sensitive adhesive can be suppressed, and the strain of the substrate of the semiconductor element in association therewith can also be suppressed, and hence a connection failure can be reduced. A method of measuring the storage modulus of elasticity G' at 160°C is described later.

[0032]

The storage modulus of elasticity G' of the pressure-sensitive adhesive of the present invention at 25°C is preferably 5×10^4 Pa or more, more preferably 7×10^4 Pa or more, still more preferably 1×10^5 Pa or more, particularly preferably 5×10^5 Pa or more. An upper limit for the storage modulus of elasticity G' of the pressure-sensitive adhesive of the present invention at 25°C is preferably 1×10^8 Pa or less. When the storage modulus of elasticity G' of the pressure-sensitive adhesive of the present invention at 25°C falls within the range, the pressure-sensitive adhesive can be bonded to an adherend at normal temperature or with a heat roll, and is reduced in deformation even at the time of the application of a pressure, and hence can be easily used as a reinforcing tape. A method of measuring the storage modulus of elasticity G' at 25°C is described later.

[0033]

The pressure-sensitive adhesive of the present invention

preferably has a cross-linked structure. When the pressure-sensitive adhesive of the present invention has the cross-linked structure, the pressure-sensitive adhesive of the present invention has a more sufficient adhesive strength and is further reduced in high-temperature strain.

[0034]

<1-1. Embodiment A>

A pressure-sensitive adhesive according to one embodiment (sometimes referred to as "Embodiment A") of the present invention is formed from a pressure-sensitive adhesive composition containing an acrylic polymer (A), and an isocyanate-based cross-linking agent and/or an epoxy-based cross-linking agent.

[0035]

In Embodiment A, the content of the acrylic polymer (A) in the pressure-sensitive adhesive composition is preferably from 50 wt% to 99.9 wt%, more preferably from 70 wt% to 99 wt%, still more preferably from 75 wt% to 95 wt%, particularly preferably from 80 wt% to 93 wt%, most preferably from 85 wt% to 90 wt%. When the content of the acrylic polymer (A) in the pressure-sensitive adhesive composition falls within the range, a pressure-sensitive adhesive that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided. The number of kinds of the acrylic polymers (A) may be only one, or may be two or more.

[0036]

In Embodiment A, the acrylic polymer (A) is a polymer formed from monomer components essentially including an acrylic monomer. That is, the acrylic polymer (A) is a polymer having a constituent unit derived from the acrylic monomer as an essential monomer constituent unit.

[0037]

In Embodiment A, the weight-average molecular weight of the acrylic polymer (A) is preferably from 200,000 to 2,500,000, more preferably from 300,000 to 1,800,000, still more preferably from 400,000 to 1,500,000, particularly preferably from 500,000 to 1,200,000 from the viewpoint that the effects of the present invention can be further expressed.

[0038]

In Embodiment A, the acrylic polymer (A) is preferably a polymer formed from monomer components essentially including a (meth)acrylic acid alkyl ester having a linear or branched alkyl group and a polar group-containing monomer. The monomer components may include any other copolymerizable monomer.

[0039]

Examples of the (meth)acrylic acid alkyl ester having a linear

or branched alkyl group include (meth)acrylic acid alkyl esters each having a linear or branched alkyl group having 1 to 20 carbon atoms, such as methyl (meth)acrylate, ethyl (meth)acrylate, propyl (meth)acrylate, isopropyl (meth)acrylate, n-butyl (meth)acrylate, isobutyl (meth)acrylate, s-butyl (meth)acrylate, t-butyl (meth)acrylate, pentyl (meth)acrylate, isopentyl (meth)acrylate, hexyl (meth)acrylate, heptyl (meth)acrylate, octyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, isooctyl (meth)acrylate, nonyl (meth)acrylate, isononyl (meth)acrylate, decyl (meth)acrylate, isodecyl (meth)acrylate, undecyl (meth)acrylate, dodecyl (meth)acrylate, tridecyl (meth)acrylate, tetradecyl (meth)acrylate, pentadecyl (meth)acrylate, hexadecyl (meth)acrylate, heptadecyl (meth)acrylate, octadecyl (meth)acrylate, nonadecyl (meth)acrylate, and eicosyl (meth)acrylate. The (meth)acrylic acid alkyl ester having a linear or branched alkyl group is preferably, for example, methyl (meth)acrylate or 2-ethylhexyl (meth)acrylate from the viewpoint that the effects of the present invention can be further expressed.

[0040]

The (meth)acrylic acid alkyl esters each having a linear or branched alkyl group may be used alone or in combination thereof.

[0041]

Examples of the polar group-containing monomer include:

hydroxyl group-containing monomers, such as 2-hydroxyethyl (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, 6-hydroxyhexyl (meth)acrylate, vinyl alcohol, and allyl alcohol; nitrogen-containing monomers; epoxy group-containing monomers, such as glycidyl (meth)acrylate and methylglycidyl (meth)acrylate; sulfonic acid group-containing monomers, such as sodium vinylsulfonate; phosphoric acid group-containing monomers, such as 2-hydroxyethylacryloyl phosphate; and carboxyl group-containing monomers, such as (meth)acrylic acid, itaconic acid, maleic acid, fumaric acid, crotonic acid, and isocrotonic acid, and acid anhydrides thereof (e.g., acid anhydride-containing monomers, such as maleic anhydride and itaconic anhydride). The polar group-containing monomer is preferably, for example, a hydroxyl group-containing monomer or a nitrogen-containing monomer from the viewpoint that the effects of the present invention can be further expressed. The hydroxyl group-containing monomer is preferably, for example, 2-hydroxyethyl (meth)acrylate from the viewpoint that the effects of the present invention can be further expressed.

[0042]

The polar group-containing monomers may be used alone or in combination thereof.

[0043]

Examples of the nitrogen-containing monomer include: amide group-containing monomers, such as (meth)acrylamide, N,N-dimethyl (meth)acrylamide, N-methylol (meth)acrylamide, N-methoxymethyl (meth)acrylamide, N-butoxymethyl (meth)acrylamide, and N-hydroxyethyl (meth)acrylamide; nitrogen-containing heterocycle-containing monomers, such as a monomer having a nitrogen-containing heterocycle and an N-vinyl group (nitrogen-containing heterocycle-containing vinyl-based monomer) (e.g., N-vinyl-2-pyrrolidone, N-vinyl-2-piperidone, N-vinyl-2-caprolactam, N-vinylpiperazine, N-vinylpyrrole, or N-vinylimidazole) and a monomer having a nitrogen-containing heterocycle and a (meth)acryloyl group (nitrogen-containing heterocycle-containing (meth)acrylic monomer) (e.g., (meth)acryloylmorpholine); amino group-containing monomers, such as aminoethyl (meth)acrylate, dimethylaminoethyl (meth)acrylate, and t-butylaminoethyl (meth)acrylate; cyano group-containing monomers, such as acrylonitrile and methacrylonitrile; imide group-containing monomers, such as cyclohexylmaleimide and isopropylmaleimide; and isocyanate group-containing monomers, such as 2-methacryloyloxyethyl isocyanate. The nitrogen-containing monomer is preferably, for example, N-vinyl-2-pyrrolidone from the viewpoint that the effects of the present invention can be further expressed.

[0044]

The other copolymerizable monomer is, for example, a polyfunctional monomer. Examples of the polyfunctional monomer include hexanediol 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 acrylate, polyester acrylate, and urethane acrylate.

[0045]

Examples of the other copolymerizable monomer except the polyfunctional monomer include: (meth)acrylic acid esters each having an alicyclic hydrocarbon group, such as cyclopentyl (meth)acrylate, cyclohexyl (meth)acrylate, and isobornyl (meth)acrylate; (meth)acrylic acid esters each having an aromatic hydrocarbon group, such as phenyl (meth)acrylate, phenoxyethyl (meth)acrylate, and benzyl (meth)acrylate; vinyl esters, such as vinyl acetate and vinyl propionate; aromatic vinyl compounds, such as styrene and vinyltoluene; olefins or dienes, such as ethylene, butadiene, isoprene, and isobutylene; vinyl ethers, such as a vinyl alkyl ether; and vinyl chloride.

[0046]

The other copolymerizable monomers may be used alone or in combination thereof.

[0047]

In Embodiment A, the content of the (meth)acrylic acid alkyl ester having a linear or branched alkyl group in the total amount of the monomer components forming the acrylic polymer (A) is preferably from 50 wt% to 95 wt%, more preferably from 55 wt% to 90 wt%, still more preferably from 60 wt% to 85 wt%, particularly preferably from 65 wt% to 80 wt% from the viewpoint that the effects of the present invention can be further expressed.

[0048]

In Embodiment A, the content of the polar group-containing monomer in the total amount of the monomer components forming the acrylic polymer (A) is preferably from 5 wt% to 50 wt%, more preferably from 10 wt% to 45 wt%, still more preferably from 15 wt% to 40 wt%, particularly preferably from 20 wt% to 35 wt% from the viewpoint that the effects of the present invention can be further expressed.

[0049]

In Embodiment A, from the viewpoint that the effects of the present invention can be further expressed, it is preferred that a hydroxyl group-containing monomer (e.g., 2-hydroxyethyl

(meth)acrylate, 3-hydroxypropyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, 6-hydroxyhexyl (meth)acrylate, vinyl alcohol, or allyl alcohol) be essentially incorporated as the polar group-containing monomer. When the hydroxyl group-containing monomer is essentially incorporated as the polar group-containing monomer, the content of the hydroxyl group-containing monomer in the total amount of the monomer components forming the acrylic polymer (A) is preferably from 10 wt% to 25 wt%, more preferably from 10 wt% to 24 wt%, still more preferably from 11 wt% to 23 wt%, particularly preferably from 12 wt% to 22 wt% from the viewpoint that the effects of the present invention can be further expressed.

[0050]

In Embodiment A, from the viewpoint that the effects of the present invention can be further expressed and the viewpoint that the corrosion of a metal or the like is suppressed, it is preferred that a carboxyl group-containing monomer (especially (meth)acrylic acid) be not used, or even when the monomer is used, its amount be small. Specifically, the content of the carboxyl group-containing monomer in the total amount of the monomer components forming the acrylic polymer (A) is preferably from 0 wt% to 5 wt%, more preferably from 0 wt% to 3 wt%, still more preferably from 0 wt% to 2 wt%, particularly preferably from 0 wt% to 0.5 wt%.

[0051]

In Embodiment A, the acrylic polymer (A) is obtained by polymerizing the monomer components through any appropriate polymerization method to the extent that the effects of the present invention are not impaired. Examples of the polymerization method for obtaining the acrylic polymer (A) include a solution polymerization method, an emulsion polymerization method, a bulk polymerization method, and a polymerization method based on irradiation with an active energy ray (active energy ray polymerization method). Of those, a solution polymerization method or an active energy ray polymerization method is preferred in terms of productivity.

[0052]

Examples of a solvent to be used when the solution polymerization method is adopted include organic solvents including: 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 number of kinds of the solvents may be only one, or may be two or more.

[0053]

In Embodiment A, a polymerization initiator, such as a photopolymerization initiator or a thermal polymerization initiator,

is preferably used at the time of the polymerization of the monomer components in accordance with the kind of the polymerization reaction. The number of kinds of the polymerization initiators may be only one, or may be two or more.

[0054]

Examples of the photopolymerization initiator include a benzoin ether-based photopolymerization initiator, an acetophenone-based photopolymerization initiator, an α -ketol-based photopolymerization initiator, an aromatic sulfonyl chloride-based photopolymerization initiator, a photoactive oxime-based photopolymerization initiator, a benzoin-based photopolymerization initiator, a benzil-based photopolymerization initiator, a benzophenone-based photopolymerization initiator, a ketal-based photopolymerization initiator, and a thioxanthone-based photopolymerization initiator.

[0055]

The usage amount of the photopolymerization initiator is, for example, preferably from 0.01 wt% to 0.2 wt%, more preferably from 0.05 wt% to 0.15 wt% with respect to the total amount of the monomer components forming the acrylic polymer (A).

[0056]

Examples of the thermal polymerization initiator include an

azo-based initiator, a peroxide-based polymerization initiator (e.g., dibenzoyl peroxide or tert-butyl permaleate), and a redox-based polymerization initiator. Of those, an azo-based initiator disclosed in JP 2002-69411 A is preferred.

[0057]

For example, when the thermal polymerization initiator is an azo-based initiator, its usage amount is preferably from 0.05 wt% to 0.5 wt%, more preferably from 0.1 wt% to 0.3 wt% with respect to the total amount of the monomer components forming the acrylic polymer (A).

[0058]

In Embodiment A, the pressure-sensitive adhesive composition contains the isocyanate-based cross-linking agent and/or the epoxy-based cross-linking agent. When the pressure-sensitive adhesive composition contains the isocyanate-based cross-linking agent and/or the epoxy-based cross-linking agent, a pressure-sensitive adhesive that has a sufficient adhesive strength and is reduced in high-temperature strain can be provided. The number of kinds of the isocyanate-based cross-linking agents may be only one, or may be two or more. The number of kinds of the epoxy-based cross-linking agents may be only one, or may be two or more.

[0059]

In Embodiment A, the total content of the isocyanate-based cross-linking agent and the epoxy-based cross-linking agent in the pressure-sensitive adhesive composition is preferably from 0.1 wt% to 30 wt%, more preferably from 0.2 wt% to 25 wt%, still more preferably from 0.5 wt% to 23 wt%, particularly preferably from 1 wt% to 20 wt%, most preferably from 5 wt% to 18 wt% with respect to 100 wt% of the acrylic polymer (A). When the total content of the isocyanate-based cross-linking agent and the epoxy-based cross-linking agent in the pressure-sensitive adhesive composition falls within the range with respect to 100 wt% of the acrylic polymer (A), a pressure-sensitive adhesive that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided.

[0060]

In Embodiment A, the content of the isocyanate-based cross-linking agent in the pressure-sensitive adhesive composition is preferably from 2 wt% to 20 wt%, more preferably from 3 wt% to 19 wt%, still more preferably from 5 wt% to 17 wt%, particularly preferably from 6 wt% to 15 wt%, most preferably from 7 wt% to 13 wt% with respect to 100 wt% of the acrylic polymer (A). When the content of the isocyanate-based cross-linking agent in the pressure-sensitive adhesive composition falls within the range with respect to 100 wt% of the acrylic polymer (A), a pressure-sensitive adhesive that has a more sufficient adhesive strength and is further

reduced in high-temperature strain can be provided.

[0061]

In Embodiment A, the content of the epoxy-based cross-linking agent in the pressure-sensitive adhesive composition is preferably from 0.3 wt% to 10 wt%, more preferably from 0.5 wt% to 9 wt%, still more preferably from 0.7 wt% to 8 wt%, particularly preferably from 1 wt% to 7 wt%, most preferably from 2 wt% to 6 wt% with respect to 100 wt% of the acrylic polymer (A). When the content of the epoxy-based cross-linking agent in the pressure-sensitive adhesive composition falls within the range with respect to 100 wt% of the acrylic polymer (A), a pressure-sensitive adhesive that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided.

[0062]

Examples of the isocyanate-based cross-linking agent (polyfunctional isocyanate compound) 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. The examples of the isocyanate-based cross-linking agent also include commercially available products such as a trimethylolpropane/tolylyene diisocyanate adduct (manufactured by Nippon Polyurethane Industry Co., Ltd., product name: "CORONATE L"), a trimethylolpropane/hexamethylene diisocyanate adduct (manufactured by Nippon Polyurethane Industry Co., Ltd., product name: "CORONATE HL" or "CORONATE HX"), and a trimethylolpropane/xylylene diisocyanate adduct (manufactured by Mitsui Chemicals, Incorporated, product name: "TAKENATE D110N").

[0063]

For example, an epoxy-based resin having two or more epoxy groups in a molecule thereof is used as the epoxy-based cross-linking agent. Specific examples thereof include diglycidylaniline, 1,3-bis(N,N-glycidylaminomethyl)cyclohexane, N,N,N',N'-tetraglycidyl-m-xylenediamine, 1,6-hexanediol diglycidylether, neopentyl glycol diglycidylether, ethylene glycol diglycidyl ether, and propylene glycol diglycidyl ether. The examples of the epoxy-based cross-linking agent also include commercially available products such as "TETRAD-C" manufactured by Mitsubishi Gas Chemical Company, Inc., "ADEKA RESIN EPU series" and "ADEKA RESIN EPR series" manufactured by Adeka Corporation, and "CELLOXIDE" manufactured by Daicel Corporation.

[0064]

In Embodiment A, the pressure-sensitive adhesive composition may contain any appropriate amount of an additive, such as any other cross-linking agent, a cross-linking accelerator, a silane coupling agent, a tackifying resin (e.g., a rosin derivative, a polyterpene resin, a petroleum resin, or an oil-soluble phenol), an age inhibitor, a filler, a colorant (e.g., a pigment or a dye), a UV absorber, an antioxidant, a chain transfer agent, a plasticizer, a softener, a surfactant, or an antistatic agent, as required to the extent that the effects of the present invention are not impaired. The number of kinds of such additives may be only one, or may be two or more.

[0065]

In Embodiment A, any appropriate method may be adopted as a method of forming the pressure-sensitive adhesive of the present invention from the pressure-sensitive adhesive composition to the extent that the effects of the present invention are not impaired. The pressure-sensitive adhesive of the present invention is formed by, for example, applying the pressure-sensitive adhesive composition onto any appropriate base material (e.g., a PET base material), performing heating or the like with an oven or the like to subject the composition to a cross-linking reaction, and further performing drying or the like as required. For example, any appropriate coating method may be used for applying the pressure-sensitive adhesive composition. Such coating method is,

for example, a coating method involving using a commonly-used coater, such as a gravure roll coater, a reverse roll coater, a kiss roll coater, a dip roll coater, a bar coater, a knife coater, a spray coater, a comma coater, or a direct coater.

[0066]

In Embodiment A, when the pressure-sensitive adhesive of the present invention is formed on the base material, the thickness of the layer of the pressure-sensitive adhesive (pressure-sensitive adhesive layer) to be obtained may be appropriately set in accordance with purposes. Such thickness is preferably from 1 μm to 500 μm , more preferably from 5 μm to 300 μm , still more preferably from 10 μm to 200 μm , particularly preferably from 15 μm to 100 μm , most preferably from 20 μm to 50 μm from the viewpoint that the effects of the present invention can be further expressed.

[0067]

<1-2. Embodiment B>

A pressure-sensitive adhesive according to another embodiment (sometimes referred to as "Embodiment B") of the present invention is formed from a pressure-sensitive adhesive composition containing an acrylic polymer (B) and a UV-curable oligomer.

[0068]

In Embodiment B, the content of the acrylic polymer (B) in

the pressure-sensitive adhesive composition is preferably from 20 wt% to 90 wt%, more preferably from 25 wt% to 85 wt%, still more preferably from 30 wt% to 80 wt%, particularly preferably from 35 wt% to 75 wt%, most preferably from 40 wt% to 70 wt%. When the content of the acrylic polymer (B) in the pressure-sensitive adhesive composition falls within the range, a pressure-sensitive adhesive that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided. The number of kinds of the acrylic polymers (B) may be only one, or may be two or more.

[0069]

In Embodiment B, the acrylic polymer (B) is a polymer formed from monomer components essentially including an acrylic monomer. That is, the acrylic polymer (B) is a polymer having a constituent unit derived from the acrylic monomer as an essential monomer constituent unit.

[0070]

In Embodiment B, the weight-average molecular weight of the acrylic polymer (B) is preferably from 200,000 to 2,500,000, more preferably from 300,000 to 1,800,000, still more preferably from 400,000 to 1,500,000, particularly preferably from 500,000 to 1,200,000 from the viewpoint that the effects of the present invention can be further expressed.

[0071]

In Embodiment B, the acrylic polymer (B) is preferably an acrylic polymer containing preferably 80 wt% or more of a (meth)acrylic acid alkyl ester having a glass transition temperature (T_g) when turned into a homopolymer of -20°C or less with respect to the total amount of the monomer components forming the acrylic polymer (B). The adoption of such polymer as the acrylic polymer (B) can provide a pressure-sensitive adhesive that has a more sufficient adhesive strength and is further reduced in high-temperature strain.

[0072]

The term "glass transition temperature (T_g) when turned into a homopolymer" means the "glass transition temperature (T_g) of a homopolymer of a monomer," and means the glass transition temperature (T_g) of a polymer formed by using only a certain monomer (sometimes referred to as "monomer X") as a monomer component. Specific examples of a value for the glass transition temperature include numerical values shown in Table 1, and for example, a numerical value described in "Polymer Handbook" (third edition, John Wiley & Sons, Inc., 1989) only needs to be used as the glass transition temperature (T_g) of a homopolymer that is not shown in Table 1. In addition, a value obtained by the following measurement method only needs to be adopted as the glass transition temperature (T_g) of a homopolymer that is not shown in the literature or the like. That is, 100 parts by weight

of the monomer X, 0.2 part by weight of 2,2'-azobisisobutyronitrile, and 200 parts by weight of ethyl acetate serving as a polymerization solvent are loaded into a reactor including a temperature gauge, a stirring machine, a nitrogen-introducing tube, and a reflux condenser, and the materials are stirred for 1 hour while a nitrogen gas is introduced into the reactor. After oxygen in a polymerization system has been removed as described above, a temperature in the reactor is increased to 63°C, and the mixture is subjected to a reaction for 10 hours. Next, the temperature is cooled to room temperature. Thus, a homopolymer solution having a solid content concentration of 33 wt% is obtained. Next, the homopolymer solution is cast and applied onto a release liner, and is dried to produce a test sample having a thickness of about 2 mm (sheet-like homopolymer). Then, about 1 mg to about 2 mg of the test sample is weighed in an open cell made of aluminum, and a temperature-modulated DSC (product name: "Q-2000," manufactured by TA Instruments) is used to obtain the reversing heat flow (specific heat component) behavior of the homopolymer under a nitrogen atmosphere at 50 ml/min and at a rate of temperature increase of 5°C/min. The temperature of the point of intersection of a straight line equidistant from straight lines obtained by extending a baseline at low temperatures of the resultant reversing heat flow curve and a baseline at high temperatures thereof in an ordinate direction, and the curve of the stepwise change portion of glass transition in the curve is defined as the glass transition temperature (T_g) when turned into

a homopolymer with reference to JIS-K-7121.

[0073]

Examples of the (meth)acrylic acid alkyl ester having a glass transition temperature when turned into a homopolymer of -20°C or less include (meth)acrylic acid alkyl esters shown in Table 1. The term "(meth)acrylic acid alkyl ester" as used herein refers to "an acrylic acid alkyl ester and/or a methacrylic acid alkyl ester." The number of kinds of the (meth)acrylic acid alkyl esters each having a glass transition temperature when turned into a homopolymer of -20°C or less may be only one, or may be two or more.

[0074]

Table 1

	Glass transition temperature when turned into homopolymer (Tg) (°C)
n-Butyl acrylate	-54
sec-Butyl acrylate	-22
2-Ethylbutyl acrylate	-50
2-Ethylhexyl acrylate	-50
n-Octyl acrylate	-65
n-Octyl methacrylate	-20
n-Nonyl acrylate	-58
Lauryl acrylate	-65

[0075]

The (meth)acrylic acid alkyl ester having a glass transition temperature when turned into a homopolymer of -20°C or less is preferably a (meth)acrylic acid alkyl ester having a glass transition temperature when turned into a homopolymer of -30°C or less, more preferably a (meth)acrylic acid alkyl ester having a glass transition temperature when turned into a homopolymer of -40°C or less from the viewpoint that the effects of the present invention can be further expressed.

[0076]

Preferred specific examples of the (meth)acrylic acid alkyl ester having a glass transition temperature when turned into a homopolymer of -20°C or less include n-butyl acrylate, 2-ethylhexyl acrylate, and lauryl acrylate from the viewpoint that the effects of the present invention can be further expressed.

[0077]

In the acrylic polymer (B), the content of the (meth)acrylic acid alkyl ester having a glass transition temperature (T_g) when turned into a homopolymer of -20°C or less with respect to the total amount of the monomer components forming the acrylic polymer (B) is preferably 80 wt% or more, more preferably 83 wt% or more, still more preferably 87 wt% or more, particularly preferably 90 wt% or more. An upper limit for the content is preferably 100 wt% or less, more preferably 98 wt% or less, still more preferably 96 wt% or less, particularly preferably 95 wt% or less. When the content falls within the range, a pressure-sensitive adhesive that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided.

[0078]

In Embodiment B, the acrylic polymer (B) may contain a copolymerizable monomer as a monomer component forming the polymer in addition to the (meth)acrylic acid alkyl ester from the viewpoint that the tuning of the characteristics of the pressure-sensitive adhesive, proper use of the characteristics in accordance with purposes, and the impartment of a function in accordance with needs are made possible. The number of kinds of the copolymerizable monomers may be only one, or may be two or more.

[0079]

The copolymerizable monomer is, for example, a polar group-containing monomer. When the monomer components forming the acrylic polymer (B) include the polar group-containing monomer, a pressure-sensitive adhesive that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided.

[0080]

Examples of the polar group-containing monomer include: carboxyl group-containing monomers, such as (meth)acrylic acid, itaconic acid, maleic acid, fumaric acid, crotonic acid, and isocrotonic acid, and acid anhydrides thereof (e.g., acid anhydride group-containing monomers, such as maleic anhydride and itaconic anhydride); hydroxyl group-containing monomers, such as 2-hydroxyethyl (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, 6-hydroxyhexyl (meth)acrylate, vinyl alcohol, and allyl alcohol; amide group-containing monomers, such as (meth)acrylamide, N,N-dimethyl (meth)acrylamide, N-methylol (meth)acrylamide, N-methoxymethyl (meth)acrylamide, N-butoxymethyl (meth)acrylamide, and N-hydroxyethyl (meth)acrylamide; amino group-containing monomers, such as aminoethyl (meth)acrylate, dimethylaminoethyl (meth)acrylate, and t-butylaminoethyl (meth)acrylate; epoxy group-containing monomers, such as glycidyl (meth)acrylate and methylglycidyl (meth)acrylate;

cyano group-containing monomers, such as acrylonitrile and methacrylonitrile; heterocycle-containing vinyl-based monomers, such as N-vinyl-2-pyrrolidone, (meth)acryloylmorpholine, N-vinylpiperidone, N-vinylpiperazine, N-vinylpyrrole, N-vinylimidazole, vinylpyridine, vinylpyrimidine, and vinyloxazole; sulfonic acid group-containing monomers, such as sodium vinylsulfonate; phosphoric acid group-containing monomers, such as 2-hydroxyethylacryloyl phosphate; imide group-containing monomers, such as cyclohexylmaleimide and isopropylmaleimide; and isocyanate group-containing monomers, such as 2-methacryloyloxyethyl isocyanate. The polar group-containing monomers may be used alone or in combination thereof.

[0081]

The polar group-containing monomer is preferably a carboxyl group-containing monomer or a hydroxyl group-containing monomer, more preferably acrylic acid, 4-hydroxybutyl acrylate, or 2-hydroxyethyl acrylate from the viewpoint that the effects of the present invention can be further expressed.

[0082]

The content of the polar group-containing monomer in the total amount of the monomer components forming the acrylic polymer (B) is preferably from 1 wt% to 20 wt%, more preferably from 1 wt% to 15 wt% from the viewpoint that the effects of the present invention

can be further expressed.

[0083]

In Embodiment B, the copolymerizable monomer is, for example, a polyfunctional monomer. The polyfunctional monomer refers to a monomer having two or more ethylenically unsaturated groups in a molecule thereof. Examples of the ethylenically unsaturated group include radically polymerizable functional groups, such as a vinyl group, a propenyl group, an isopropenyl group, a vinyl ether group (vinyl group), and an allyl ether group (allyl group).

[0084]

Examples of the polyfunctional monomer include hexanediol 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 acrylate, polyester acrylate, and urethane acrylate. The number of kinds of the polyfunctional monomers may be only one, or may be two or more.

[0085]

In Embodiment B, another example of the copolymerizable monomer is a (meth)acrylic acid alkoxyalkyl ester. Examples of the (meth)acrylic acid alkoxyalkyl ester 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. The number of kinds of the (meth)acrylic acid alkoxyalkyl esters may be only one, or may be two or more.

[0086]

In Embodiment B, examples of the copolymerizable monomer include: (meth)acrylic acid esters each having an alicyclic hydrocarbon group, such as cyclopentyl (meth)acrylate, cyclohexyl (meth)acrylate, and isobornyl (meth)acrylate; (meth)acrylic acid esters each having an aromatic hydrocarbon group, such as phenyl (meth)acrylate, phenoxyethyl (meth)acrylate, and benzyl (meth)acrylate; (meth)acrylic acid esters except the (meth)acrylic acid alkyl ester, the (meth)acrylic acid alkoxyalkyl ester, the polar group-containing monomer, and the polyfunctional monomer; vinyl esters, such as vinyl acetate and vinyl propionate; aromatic vinyl compounds, such as styrene and vinyltoluene; olefins or dienes, such as ethylene, butadiene, isoprene, and isobutylene; vinyl ethers, such as a vinyl alkyl ether; vinyl chloride; and (meth)acrylic acid alkyl esters each having a glass transition temperature when turned

into a homopolymer of more than -20°C . The number of kinds of those monomers may be only one, or may be two or more.

[0087]

In Embodiment B, the acrylic polymer (B) is obtained by polymerizing the monomer components through any appropriate polymerization method to the extent that the effects of the present invention are not impaired. Examples of the polymerization method for obtaining the acrylic polymer (B) include a solution polymerization method, an emulsion polymerization method, a bulk polymerization method, and a polymerization method based on irradiation with an active energy ray (active energy ray polymerization method). Of those, a solution polymerization method or an active energy ray polymerization method is preferred, and a solution polymerization method is more preferred in terms of productivity.

[0088]

Examples of a solvent to be used when the solution polymerization method is adopted include organic solvents including: 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 number of kinds of the

solvents may be only one, or may be two or more.

[0089]

In Embodiment B, a polymerization initiator, such as a photopolymerization initiator or a thermal polymerization initiator, may be used at the time of the polymerization of the monomer components in accordance with the kind of the polymerization reaction. The number of kinds of the polymerization initiators may be only one, or may be two or more.

[0090]

Examples of the photopolymerization initiator include a benzoin ether-based photopolymerization initiator, an acetophenone-based photopolymerization initiator, an α -ketol-based photopolymerization initiator, an aromatic sulfonyl chloride-based photopolymerization initiator, a photoactive oxime-based photopolymerization initiator, a benzoin-based photopolymerization initiator, a benzil-based photopolymerization initiator, a benzophenone-based photopolymerization initiator, a ketal-based photopolymerization initiator, and a thioxanthone-based photopolymerization initiator.

[0091]

The usage amount of the photopolymerization initiator is, for example, preferably from 0.01 wt% to 0.2 wt%, more preferably from

0.05 wt% to 0.15 wt% with respect to the total amount of the monomer components forming the acrylic polymer (B).

[0092]

Examples of the thermal polymerization initiator include an azo-based initiator, a peroxide-based polymerization initiator (e.g., dibenzoyl peroxide or tert-butyl permaleate), and a redox-based polymerization initiator. Of those, an azo-based initiator disclosed in JP 2002-69411 A is preferred.

[0093]

For example, when the thermal polymerization initiator is an azo-based initiator, its usage amount is preferably from 0.05 wt% to 0.5 wt%, more preferably from 0.1 wt% to 0.3 wt% with respect to the total amount of the monomer components forming the acrylic polymer (B).

[0094]

In Embodiment B, the pressure-sensitive adhesive composition contains the UV-curable oligomer. When the pressure-sensitive adhesive composition contains the UV-curable oligomer, a pressure-sensitive adhesive that has a sufficient adhesive strength and is reduced in high-temperature strain can be provided. The number of kinds of the UV-curable oligomers may be only one, or may be two or more.

[0095]

In Embodiment B, the content of the UV-curable oligomer in the pressure-sensitive adhesive composition is preferably from 10 wt% to 300 wt%, more preferably from 20 wt% to 150 wt%, still more preferably from 30 wt% to 120 wt%, particularly preferably from 35 wt% to 110 wt%, most preferably from 40 wt% to 105 wt% with respect to 100 wt% of the acrylic polymer (B). When the content of the UV-curable oligomer in the pressure-sensitive adhesive composition falls within the range with respect to 100 wt% of the acrylic polymer (B), a pressure-sensitive adhesive that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided.

[0096]

The UV-curable oligomer is, for example, a UV-curable oligomer having a polymerizable ethylenically unsaturated double bond, and examples thereof include an aromatic urethane oligomer, an aliphatic urethane oligomer, an epoxy acrylate oligomer, a polyester acrylate oligomer, and other special oligomers.

[0097]

Specific examples of the UV-curable oligomer include commercially available products such as: UV-2000B, UV-2750B, UV-3000B, UV-3010B, UV-3200B, UV-3300B, UV-3700B, UV-6640B,

UV-8630B, UV-7000B, UV-7610B, UV-1700B, UV-7630B, UV-6300B, UV-6640B, UV-7550B, UV-7600B, UV-7605B, UV-7610B, UV-7630B, UV-7640B, UV-7650B, UT-5449, and UT-5454 manufactured by The Nippon Synthetic Chemical Industry Co., Ltd.; CN902, CN902J75, CN929, CN940, CN944, CN944B85, CN959, CN961E75, CN961H81, CN962, CN963, CN963A80, CN963B80, CN963E75, CN963E80, CN963J85, CN964, CN965, CN965A80, CN966, CN966A80, CN966B85, CN966H90, CN966J75, CN968, CN969, CN970, CN970A60, CN970E60, CN971, CN971A80, CN971J75, CN972, CN973, CN973A80, CN973H85, CN973J75, CN975, CN977, CN977C70, CN978, CN980, CN981, CN981A75, CN981B88, CN982, CN982A75, CN982B88, CN982E75, CN983, CN984, CN985, CN985B88, CN986, CN989, CN991, CN992, CN994, CN996, CN997, CN999, CN9001, CN9002, CN9004, CN9005, CN9006, CN9007, CN9008, CN9009, CN9010, CN9011, CN9013, CN9018, CN9019, CN9024, CN9025, CN9026, CN9028, CN9029, CN9030, CN9060, CN9165, CN9167, CN9178, CN9290, CN9782, CN9783, CN9788, and CN9893 manufactured by Sartomer; and EBECRYL210, EBECRYL220, EBECRYL230, EBECRYL270, KRM8200, EBECRYL5129, EBECRYL8210, EBECRYL8301, EBECRYL8804, EBECRYL8807, EBECRYL9260, KRM7735, KRM8296, KRM8452, EBECRYL4858, EBECRYL8402, EBECRYL9270, EBECRYL8311, and EBECRYL8701 manufactured by Daicel-Cytec Company, Ltd.

[0098]

In Embodiment B, the pressure-sensitive adhesive composition may contain any appropriate amount of an additive, such as a cross-linking agent, a cross-linking accelerator, a silane coupling

agent, a tackifying resin (e.g., a rosin derivative, a polyterpene resin, a petroleum resin, or an oil-soluble phenol), an age inhibitor, a filler, a colorant (e.g., a pigment or a dye), a UV absorber, an antioxidant, a chain transfer agent, a plasticizer, a softener, a surfactant, or an antistatic agent, as required to the extent that the effects of the present invention are not impaired. The number of kinds of such additives may be only one, or may be two or more.

[0099]

In Embodiment B, any appropriate method may be adopted as a method of forming the pressure-sensitive adhesive of the present invention from the pressure-sensitive adhesive composition to the extent that the effects of the present invention are not impaired. The pressure-sensitive adhesive of the present invention is formed by, for example, applying the pressure-sensitive adhesive composition onto any appropriate base material (e.g., a PET base material), performing heating or the like with an oven or the like to subject the composition to a cross-linking reaction, further performing drying or the like as required, and further curing the resultant through UV irradiation or the like. For example, any appropriate coating method may be used for applying the pressure-sensitive adhesive composition. Such coating method is, for example, a coating method involving using a commonly-used coater, such as a gravure roll coater, a reverse roll coater, a kiss roll

coater, a dip roll coater, a bar coater, a knife coater, a spray coater, a comma coater, or a direct coater.

[0100]

In Embodiment B, when the pressure-sensitive adhesive of the present invention is formed on the base material, the thickness of the layer of the pressure-sensitive adhesive (pressure-sensitive adhesive layer) to be obtained may be appropriately set in accordance with purposes. Such thickness is preferably from 1 μm to 500 μm , more preferably from 5 μm to 300 μm , still more preferably from 10 μm to 200 μm , particularly preferably from 15 μm to 100 μm , most preferably from 20 μm to 50 μm from the viewpoint that the effects of the present invention can be further expressed.

[0101]

<1-3. Embodiment C>

A pressure-sensitive adhesive according to still another embodiment (sometimes referred to as "Embodiment C") of the present invention is formed from a pressure-sensitive adhesive composition containing a urethane-based polymer and an acrylic monomer.

[0102]

In Embodiment C, the content of the urethane-based polymer in the pressure-sensitive adhesive composition is preferably from 10 wt% to 90 wt%, more preferably from 20 wt% to 80 wt%, still more

preferably from 30 wt% to 75 wt%, particularly preferably from 35 wt% to 70 wt%, most preferably from 40 wt% to 65 wt%. When the content of the urethane-based polymer in the pressure-sensitive adhesive composition falls within the range, a pressure-sensitive adhesive that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided. The number of kinds of the urethane-based polymers in the pressure-sensitive adhesive composition may be only one, or may be two or more.

[0103]

In Embodiment C, the content of the acrylic monomer in the pressure-sensitive adhesive composition is preferably from 20 wt% to 80 wt%, more preferably from 30 wt% to 75 wt%, particularly preferably from 35 wt% to 70 wt%, most preferably from 40 wt% to 65 wt%. When the content of the acrylic monomer in the pressure-sensitive adhesive composition falls within the range, a pressure-sensitive adhesive that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided. The number of kinds of the acrylic monomers may be only one, or may be two or more.

[0104]

In Embodiment C, the urethane-based polymer is preferably obtained by using a reaction between a polyol compound and a

polyisocyanate compound. That is, the urethane-based polymer may be obtained by using raw materials including the polyol compound and the polyisocyanate compound through the use of the reaction between the polyol compound and the polyisocyanate compound. The number of kinds of the polyol compounds may be only one, or may be two or more. The number of kinds of the polyisocyanate compounds may be only one, or may be two or more.

[0105]

In Embodiment C, the reaction between the polyol compound and the polyisocyanate compound may be performed by any appropriate method that may be adopted in the production of the urethane-based polymer. The urethane-based polymer is obtained by, for example, mixing and stirring the polyol compound and the polyisocyanate compound, and the polyisocyanate compound is preferably added so that an isocyanate group may be excessive with respect to a hydroxyl group in the polyol compound. In addition, the reaction may be performed by adding an organic solvent free of active hydrogen with which an isocyanate group may react (e.g., ethyl acetate, methyl ethyl ketone, or chloroform) and a catalyst (e.g., an organometallic catalyst, such as a tin chloride or an organotin compound, an organic base, such as a tertiary amine compound, or an organic acid, such as acetic acid or acrylic acid) as required in the reaction.

[0106]

In Embodiment C, a ratio "NCO/OH" between the polyisocyanate compound and the polyol compound is preferably from 0.1 to 2.0, more preferably from 0.3 to 1.8, still more preferably from 0.5 to 1.5, particularly preferably from 0.8 to 1.3 in terms of an equivalent ratio. When the ratio "NCO/OH" falls within the range, a pressure-sensitive adhesive that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided.

[0107]

In Embodiment C, the molecular weight of the urethane-based polymer may be appropriately set in accordance with purposes. With regard to the molecular weight of the urethane-based polymer, its number-average molecular weight (M_n) is preferably 5,000 or more, more preferably 10,000 or more from the viewpoint that the effects of the present invention can be further expressed.

[0108]

In Embodiment C, a polyol compound having a melting point and/or a freezing point of from 15°C to 75°C is preferably selected as the polyol compound. Such polyol compound is, for example, a polyol compound having a crystalline component, and shows crystallization and melting behavior through a temperature change. In the present invention, the melting point and/or freezing point of the polyol compound may be identified with, for example, a manufacturer's

catalog or a material safety data sheet (MSDS). In addition, in the present invention, the "melting point" and the "freezing point" can be similarly treated as physical property values specifying a specific polyol compound. When only one of the physical property values is described in the catalog or the like, the value only needs to be adopted, and it is not necessarily required to identify both the physical property values, that is, the "melting point" and the "freezing point" at the time of the selection of the specific polyol compound.

[0109]

In Embodiment C, examples of the polyol compound include polyester polyol (e.g., a polycondensate of a dihydric alcohol and a divalent basic acid, such as adipic acid, azelaic acid, or sebacic acid), polyether polyol (e.g., polyether polyol obtained by addition polymerization of, for example, ethylene oxide or tetrahydrofuran), polyacrylate polyol, polycarbonate polyol, polyolefin polyol, polybutadiene polyol and hydrogenated products thereof, polyisoprene polyol and hydrogenated products thereof, phenolic polyol, epoxy polyol, caprolactone polyol, and polysulfone polyol. In addition, the examples of the polyol compound also include copolymer polyols, such as polyester-polyether polyol.

[0110]

In Embodiment C, the polyol compound is preferably, for example,

polyester polyol, polyether polyol, or polycarbonate diol.

[0111]

Specific examples of the polyester polyol include commercially available products such as polyethylene adipate glycol available under the product name "NIPPOLAN 4002," polybutylene adipate glycol available under the product name "NIPPOLAN 4009," and polyhexamethylene adipate glycol available under the product name "NIPPOLAN 164" (all of which are manufactured by Nippon Polyurethane Industry Co., Ltd.).

[0112]

Specific examples of the polyether polyol include commercially available products such as polytetramethylene ether glycols (PTMG) available under the product names "PTMG1000" (melting point (T_m): 17°C), "PTMG1300" (melting point (T_m): 18°C), "PTMG1500" (melting point (T_m): 18°C), "PTMG1800" (melting point (T_m): 20°C), "PTMG2000" (melting point (T_m): 20°C), and "PTMG3000" (melting point (T_m): 21°C) (all of which are manufactured by Dia Chemical Co., Ltd.).

[0113]

A specific example of the polycarbonate diol is a commercially available product such as 1,6-hexamethylene carbonate glycol available under the product name "NIPPOLAN 981" (melting point (T_m): 42°C) (manufactured by Nippon Polyurethane Industry Co., Ltd.).

[0114]

In Embodiment C, examples of the polyisocyanate compound include hexamethylene diisocyanate, diphenylmethane diisocyanate, tolylene diisocyanate, isophorone diisocyanate, dicyclohexylmethane diisocyanate, tetramethylxylene diisocyanate, xylylene diisocyanate, naphthalene diisocyanate, trimethylhexamethylene diisocyanate, tolidine diisocyanate, p-phenylene diisocyanate, cyclohexylene diisocyanate, methylenebis(4-phenylmethane) diisocyanate, hexamethylene diisocyanate, dimer acid diisocyanate, hydrogenated tolylene diisocyanate, hydrogenated xylylene diisocyanate, lysine diisocyanate, triphenylmethane triisocyanate, and tri(isocyanatophenyl) triphosphate.

[0115]

In Embodiment C, the polyisocyanate compound is preferably, for example, hydrogenated xylylene diisocyanate.

[0116]

In Embodiment C, the urethane-based polymer preferably contains a (meth)acryloyl group-terminated urethane-based polymer. The (meth)acryloyl group-terminated urethane-based polymer is a compound that has two or more acryloyl groups or methacryloyl groups in a molecule thereof, and has a urethane bond in a repeating

structural unit thereof.

[0117]

In Embodiment C, when the urethane-based polymer contains the (meth)acryloyl group-terminated urethane-based polymer, the content of the (meth)acryloyl group-terminated urethane-based polymer in the urethane-based polymer is preferably from 50 wt% to 100 wt%, more preferably from 70 wt% to 100 wt%, still more preferably from 90 wt% to 100 wt%, particularly preferably from 95 wt% to 100 wt%, most preferably substantially 100 wt%.

[0118]

The (meth)acryloyl group-terminated urethane-based polymer is preferably obtained by causing a hydroxyl group-containing acrylic monomer to react with a polyurethane prepolymer obtained by the reaction between the polyol compound and the polyisocyanate compound. The reaction may be performed by adding an organic solvent free of active hydrogen with which an isocyanate group may react (e.g., ethyl acetate, methyl ethyl ketone, or chloroform) and a catalyst (e.g., an organometallic catalyst, such as a tin chloride or an organotin compound, an organic base, such as a tertiary amine compound, or an organic acid, such as acetic acid or acrylic acid) as required in the reaction.

[0119]

Examples of the hydroxyl group-containing acrylic monomer include 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, (4-hydroxymethylcyclohexyl)methyl (meth)acrylate, 2-hydroxy-3-phenyloxypropyl (meth)acrylate, neopentylglycol mono(meth)acrylate, trimethylolpropane di(meth)acrylate, and pentaerythritol tri(meth)acrylate. The number of kinds of the hydroxyl group-containing acrylic monomers may be only one, or may be two or more.

[0120]

The usage amount of the hydroxyl group-containing acrylic monomer is preferably from 0.1 wt% to 10 wt%, more preferably from 0.1 wt% to 5 wt% with respect to the polyurethane prepolymer.

[0121]

The polyurethane prepolymer and the hydroxyl group-containing acrylic monomer are preferably added at such a ratio that the amount of a hydroxyl group in the hydroxyl group-containing acrylic monomer is equal to that of the isocyanate residue of the polyurethane prepolymer. Specifically, the hydroxyl group-containing acrylic monomer is added at the following ratio with respect to the polyol compound compounded in the production of the polyurethane prepolymer: a molar ratio "polyol compound:hydroxyl group-containing acrylic monomer" is preferably from 1:0.08 to 1:0.5,

and the molar ratio "polyol compound:hydroxyl group-containing acrylic monomer" is more preferably from 1:0.1 to 1:0.4. When the ratio between the polyol compound and the hydroxyl group-containing acrylic monomer falls within the range, a pressure-sensitive adhesive that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided.

[0122]

In Embodiment C, the pressure-sensitive adhesive composition contains the acrylic monomer.

[0123]

In Embodiment C, the acrylic monomer preferably contains a (meth)acrylic monomer having an amide group.

[0124]

In Embodiment C, when the acrylic monomer contains the (meth)acrylic monomer having an amide group, the content of the (meth)acrylic monomer having an amide group in the total amount of the acrylic monomer is preferably from 5 wt% to 99 wt%, more preferably from 15 wt% to 97 wt%, still more preferably from 25 wt% to 95 wt%. When the content of the (meth)acrylic monomer having an amide group falls within the range, a pressure-sensitive adhesive that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided.

[0125]

Examples of the (meth)acrylic monomer having an amide group include: monosubstituted (meth)acrylamides, such as N-methylol (meth)acrylamide, N-isopropyl (meth)acrylamide, N-n-butoxymethyl (meth)acrylamide, N-(1,1-dimethyl-3-oxobutyl) (meth)acrylamide, and N,N-dimethylaminopropyl (meth)acrylamide; N,N-disubstituted acrylamides, such as N,N-dimethyl (meth)acrylamide, N,N-diethyl (meth)acrylamide, N,N-di-n-propyl (meth)acrylamide, N,N-diallyl (meth)acrylamide, N,N-di-isopropyl (meth)acrylamide, N,N-di-n-butyl (meth)acrylamide, and N,N-ethylmethyl (meth)acrylamide; N-(meth)acryloyl morpholine; N-(meth)acryloyl pyrrolidone; N-(meth)acryloyl piperidine; N-(meth)acryloyl pyrrolidine; N-(meth)acryloyl aziridine; and dimethylaminoethyl acrylate. The number of kinds of the (meth)acrylic monomers each having an amide group may be only one, or may be two or more.

[0126]

In Embodiment C, the acrylic monomer may contain any appropriate other acrylic monomer to the extent that the effects of the present invention are not impaired. The number of kinds of such other acrylic monomers may be only one, or may be two or more. Examples of such other acrylic monomer include: (meth)acrylic monomers; and polyfunctional monomers, such as hexanediol diacrylate, trimethylolpropane triacrylate, and dipentaerythritol

hexaacrylate. Such other acrylic monomer is preferably a (meth)acrylic monomer.

[0127]

Examples of the (meth)acrylic monomer include: (meth)acrylic acid esters, such as methyl (meth)acrylate, ethyl (meth)acrylate, propyl (meth)acrylate, butyl (meth)acrylate, amyl (meth)acrylate, hexyl (meth)acrylate, heptyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, octyl (meth)acrylate, decyl (meth)acrylate, lauryl (meth)acrylate, cyclohexyl (meth)acrylate, isobornyl (meth)acrylate, tetrahydrofurfuryl (meth)acrylate, polyethylene glycol (meth)acrylate, and polypropylene glycol (meth)acrylate; carboxyl group-containing monomers, such as (meth)acrylic acid, crotonic acid, maleic acid, fumaric acid, and itaconic acid; acid anhydride monomers, such as maleic anhydride and itaconic anhydride; hydroxyl group-containing monomers, such as 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, and allyl alcohol; tertiary amino group-containing monomers, such as dimethylaminoethyl (meth)acrylate, diethylaminoethyl (meth)acrylate, and dimethylaminopropyl (meth)acrylate; epoxy group-containing monomers, such as glycidyl methacrylate; sulfonic acid group-containing monomers, such as 2-(meth)acrylamido-2-methylpropanesulfonic acid and sulfopropyl (meth)acrylate; phosphoric acid-containing monomers, such as 2-hydroxyethyl (meth)acryloyl phosphate; succinimide-based

monomers, such as N-(meth)acryloyloxymethylene succinimide, N-(meth)acryloyl-6-oxyhexamethylene succinimide, and N-(meth)acryloyl-8-oxyoctamethylene succinimide; and cyanoacrylate-based monomers, such as (meth)acrylonitrile.

[0128]

In Embodiment C, the (meth)acrylic monomer is preferably, for example, butyl (meth)acrylate, isobornyl (meth)acrylate, or (meth)acrylic acid.

[0129]

In Embodiment C, the content of butyl (meth)acrylate in the total amount of the acrylic monomer is preferably from 1 wt% to 90 wt%, more preferably from 5 wt% to 60 wt%, still more preferably from 10 wt% to 40 wt%, particularly preferably from 15 wt% to 30 wt%. When the content of butyl (meth)acrylate in the total amount of the acrylic monomer falls within the range, a pressure-sensitive adhesive that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided.

[0130]

In Embodiment C, the content of isobornyl (meth)acrylate in the total amount of the acrylic monomer is preferably from 1 wt% to 90 wt%, more preferably from 5 wt% to 60 wt%, still more preferably from 10 wt% to 40 wt%, particularly preferably from 15 wt% to 30

wt%. When the content of isobornyl (meth)acrylate in the total amount of the acrylic monomer falls within the range, a pressure-sensitive adhesive that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided.

[0131]

In Embodiment C, the content of (meth)acrylic acid in the total amount of the acrylic monomer is preferably from 1 wt% to 90 wt%, more preferably from 2 wt% to 65 wt%, still more preferably from 3 wt% to 40 wt%, particularly preferably from 4 wt% to 25 wt%. When the content of (meth)acrylic acid in the total amount of the acrylic monomer falls within the range, a pressure-sensitive adhesive that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided.

[0132]

In Embodiment C, the pressure-sensitive adhesive composition may contain any appropriate amount of an additive, such as a cross-linking agent, a cross-linking accelerator, a silane coupling agent, a tackifying resin (e.g., a rosin derivative, a polyterpene resin, a petroleum resin, or an oil-soluble phenol), an age inhibitor, a filler, a colorant (e.g., a pigment or a dye), a UV absorber, an antioxidant, a chain transfer agent, a plasticizer, a softener, a surfactant, or an antistatic agent, as required to the extent that the effects of the present invention are not impaired. The

number of kinds of such additives may be only one, or may be two or more.

[0133]

In Embodiment C, any appropriate method may be adopted as a method of forming the pressure-sensitive adhesive of the present invention from the pressure-sensitive adhesive composition to the extent that the effects of the present invention are not impaired. Such method is preferably as described below. The urethane-based polymer is formed in the presence of the acrylic monomer, and a photopolymerization initiator is further added to a mixture containing the urethane-based polymer and the acrylic monomer. The resultant mixture is applied onto any appropriate base material (e.g., a PET base material), and is irradiated with any appropriate active energy ray (e.g., an α -ray, a β -ray, a γ -ray, a neutron beam, an electron beam, UV light, or visible light) in accordance with, for example, the kind of the photopolymerization initiator to be cured. Thus, the pressure-sensitive adhesive can be formed. Any appropriate condition that may be generally adopted in polymerization by irradiation with an active energy ray may be adopted as a reaction condition at the time of the irradiation with the active energy ray.

[0134]

In Embodiment C, when the hydroxyl group-containing acrylic

monomer is used at the time of the formation of the urethane-based polymer, the pressure-sensitive adhesive of the present invention can be formed by: causing the polyol compound and the polyisocyanate compound to react with each other in the presence of an acrylic monomer component to form the polyurethane prepolymer; then adding the hydroxyl group-containing acrylic monomer to the polyurethane prepolymer to cause the monomer to react with the prepolymer; further adding the photopolymerization initiator to the resultant mixture; applying the resultant mixture onto any appropriate base material (e.g., a PET base material); and irradiating the applied mixture with any appropriate active energy ray (e.g., an α -ray, a β -ray, a γ -ray, a neutron beam, an electron beam, UV light, or visible light) in accordance with, for example, the kind of the photopolymerization initiator to cure the mixture. Any appropriate condition that may be generally adopted in polymerization by irradiation with an active energy ray may be adopted as a reaction condition at the time of the irradiation with the active energy ray.

[0135]

In Embodiment C, the pressure-sensitive adhesive of the present invention can be specifically formed by, for example, dissolving the polyol compound in the acrylic monomer component, then adding the polyisocyanate compound to the solution to cause the compound to react with the polyol compound, performing, for example, the

adjustment of the viscosity of the solution, applying the resultant mixture to any appropriate base material (e.g., a PET base material), and then curing the mixture through UV irradiation or the like. In addition, after the curing, the cured product may be peeled from the base material to be used as the pressure-sensitive adhesive of the present invention.

[0136]

For example, any appropriate coating method may be used for applying the pressure-sensitive adhesive composition. Such coating method is, for example, a coating method involving using a commonly-used coater, such as a gravure roll coater, a reverse roll coater, a kiss roll coater, a dip roll coater, a bar coater, a knife coater, a spray coater, a comma coater, or a direct coater.

[0137]

In Embodiment C, in order to avoid polymerization inhibition by oxygen at the time of the formation of the pressure-sensitive adhesive of the present invention, any appropriate base material subjected to release treatment may be further mounted on the pressure-sensitive adhesive composition applied onto any appropriate base material (e.g., a PET base material).

[0138]

In Embodiment C, any appropriate solvent may be added at the

time of the formation of the pressure-sensitive adhesive of the present invention for the viscosity adjustment. Examples of such solvent include ethyl acetate, toluene, chloroform, and dimethyl formamide.

[0139]

The number of kinds of the photopolymerization initiators may be only one, or may be two or more.

[0140]

Any appropriate amount typically used in photopolymerization may be adopted as the usage amount of the photopolymerization initiator.

[0141]

In Embodiment C, when the pressure-sensitive adhesive of the present invention is formed on the base material, the thickness of the layer of the pressure-sensitive adhesive (pressure-sensitive adhesive layer) to be obtained may be appropriately set in accordance with purposes. Such thickness is preferably from 1 μm to 500 μm , more preferably from 5 μm to 300 μm , still more preferably from 10 μm to 200 μm , particularly preferably from 15 μm to 100 μm , most preferably from 20 μm to 50 μm from the viewpoint that the effects of the present invention can be further expressed.

[0142]

In Embodiment C, in the case where the urethane-based polymer contains the (meth)acryloyl group-terminated urethane-based polymer, when a vinyl-based monomer is polymerized in the presence of the urethane-based polymer, the (meth)acryloyl groups may be polymerized with a vinyl group to provide a vinyl-based polymer bonded to the (meth)acryloyl group-terminated urethane-based polymer.

[0143]

<<2. Pressure-sensitive Adhesive Film>>

The adhesive strength of a pressure-sensitive adhesive film of the present invention to the surface of a polyimide film is 1 N or more, preferably 3 N or more, more preferably 5 N or more, still more preferably 7 N or more, particularly preferably 9 N or more. When the adhesive strength of the pressure-sensitive adhesive film of the present invention to the surface of the polyimide film falls within the range, the pressure-sensitive adhesive film of the present invention has a sufficient adhesive strength, and hence can be strongly and reliably bonded to, for example, the back side of the substrate of a semiconductor element for reinforcement. A method of measuring the adhesive strength to the surface of the polyimide film is described later.

[0144]

The storage modulus of elasticity G' of the pressure-sensitive adhesive film of the present invention at 160°C is 1×10^4 Pa or more, preferably 1.5×10^4 Pa or more, more preferably 2×10^4 Pa or more, still more preferably 2.3×10^4 Pa or more, particularly preferably 2.4×10^4 Pa or more. When the storage modulus of elasticity G' of the pressure-sensitive adhesive film of the present invention at 160°C falls within the range, the pressure-sensitive adhesive film of the present invention is reduced in high-temperature strain. Accordingly, even in, for example, the case where the bump compression bonding of an integrated circuit (IC) onto the substrate of a semiconductor element is performed with an anisotropic conductive film (ACF) at high temperature, the strain of the pressure-sensitive adhesive film can be suppressed, and the strain of the substrate of the semiconductor element in association therewith can also be suppressed, and hence a connection failure can be reduced. A method of measuring the storage modulus of elasticity G' at 160°C is described later.

[0145]

The storage modulus of elasticity G' of the pressure-sensitive adhesive film of the present invention at 25°C is preferably 5×10^4 Pa or more, more preferably 7×10^4 Pa or more, still more preferably 1×10^5 Pa or more, particularly preferably 5×10^5 Pa or more. An upper limit for the storage modulus of elasticity G' of the pressure-sensitive adhesive of the present invention at 25°C is

preferably 1×10^8 Pa or less. When the storage modulus of elasticity G' of the pressure-sensitive adhesive of the present invention at 25°C falls within the range, the pressure-sensitive adhesive can be bonded to an adherend at normal temperature or with a heat roll, and is reduced in deformation even at the time of the application of a pressure, and hence can be easily used as a reinforcing tape. A method of measuring the storage modulus of elasticity G' at 25°C is described later.

[0146]

The thickness of the pressure-sensitive adhesive film of the present invention is $20\text{ }\mu\text{m}$ or less, preferably $18\text{ }\mu\text{m}$ or less, more preferably $15\text{ }\mu\text{m}$ or less, still more preferably $13\text{ }\mu\text{m}$ or less, particularly preferably $12\text{ }\mu\text{m}$ or less, most preferably $10\text{ }\mu\text{m}$ or less. A lower limit for the thickness of the pressure-sensitive adhesive film of the present invention is preferably $3\text{ }\mu\text{m}$ or more. When the thickness of the pressure-sensitive adhesive film of the present invention falls within the range, the pressure-sensitive adhesive film of the present invention is reduced in high-temperature strain. Accordingly, even in, for example, the case where the bump compression bonding of an integrated circuit (IC) onto the substrate of a semiconductor element is performed with an anisotropic conductive film (ACF) at high temperature, the strain of the pressure-sensitive adhesive film can be suppressed, and the strain of the substrate of the semiconductor element in association

therewith can also be suppressed, and hence a connection failure can be reduced. A method of measuring the thickness of the pressure-sensitive adhesive film is described later.

[0147]

The pressure-sensitive adhesive film of the present invention preferably has a cross-linked structure. When the pressure-sensitive adhesive film of the present invention has the cross-linked structure, the pressure-sensitive adhesive film of the present invention has a more sufficient adhesive strength and is further reduced in high-temperature strain.

[0148]

The pressure-sensitive adhesive film of the present invention may be formed from any appropriate pressure-sensitive adhesive composition to the extent that the effects of the present invention are not impaired as long as the three requirements, that is, the adhesive strength to the surface of the polyimide film, the storage modulus of elasticity G' at 160°C, and the thickness fall within the above-mentioned ranges.

[0149]

Examples of such pressure-sensitive adhesive composition include a pressure-sensitive adhesive composition containing an acrylic polymer and a pressure-sensitive adhesive composition

containing a urethane-based polymer.

[0150]

The acrylic polymer is a polymer formed from monomer components essentially including an acrylic monomer. That is, the acrylic polymer is a polymer having a constituent unit derived from the acrylic monomer as an essential monomer constituent unit.

[0151]

Any appropriate acrylic polymer may be adopted as the acrylic polymer to the extent that the effects of the present invention are not impaired as long as the three requirements, that is, the adhesive strength to the surface of the polyimide film, the storage modulus of elasticity G' at 160°C, and the thickness fall within the above-mentioned ranges.

[0152]

Examples of the pressure-sensitive adhesive composition forming the pressure-sensitive adhesive film of the present invention include such a pressure-sensitive adhesive composition containing an acrylic polymer (A), a pressure-sensitive adhesive composition containing an acrylic polymer (B), and a pressure-sensitive adhesive composition containing a urethane-based polymer as described below.

[0153]

<2-1. Pressure-sensitive Adhesive Composition containing Acrylic Polymer (A)>

In the pressure-sensitive adhesive composition containing the acrylic polymer (A), the content of the acrylic polymer (A) in the pressure-sensitive adhesive composition is preferably from 50 wt% to 99.9 wt%, more preferably from 70 wt% to 99 wt%, still more preferably from 75 wt% to 95 wt%, particularly preferably from 80 wt% to 93 wt%, most preferably from 85 wt% to 90 wt%. When the content of the acrylic polymer (A) in the pressure-sensitive adhesive composition falls within the range, a pressure-sensitive adhesive film that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided. The number of kinds of the acrylic polymers (A) may be only one, or may be two or more.

[0154]

The acrylic polymer (A) is a polymer formed from monomer components essentially including an acrylic monomer. That is, the acrylic polymer (A) is a polymer having a constituent unit derived from the acrylic monomer as an essential monomer constituent unit.

[0155]

The weight-average molecular weight of the acrylic polymer (A) is preferably from 200,000 to 2,500,000, more preferably from

300,000 to 1,800,000, still more preferably from 400,000 to 1,500,000, particularly preferably from 500,000 to 1,200,000 from the viewpoint that the effects of the present invention can be further expressed.

[0156]

The acrylic polymer (A) is preferably a polymer formed from monomer components essentially including a (meth)acrylic acid alkyl ester having a linear or branched alkyl group and a polar group-containing monomer. The monomer components may include any other copolymerizable monomer.

[0157]

The description in the section <1-1. Embodiment A> may be incorporated for the (meth)acrylic acid alkyl ester having a linear or branched alkyl group.

[0158]

The description in the section <1-1. Embodiment A> may be incorporated for the polar group-containing monomer.

[0159]

The description in the section <1-1. Embodiment A> may be incorporated for the other copolymerizable monomer.

[0160]

The content of the (meth)acrylic acid alkyl ester having a linear or branched alkyl group in the total amount of the monomer components forming the acrylic polymer (A) is preferably from 50 wt% to 95 wt%, more preferably from 55 wt% to 90 wt%, still more preferably from 60 wt% to 85 wt%, particularly preferably from 65 wt% to 80 wt% from the viewpoint that the effects of the present invention can be further expressed.

[0161]

The content of the polar group-containing monomer in the total amount of the monomer components forming the acrylic polymer (A) is preferably from 5 wt% to 50 wt%, more preferably from 10 wt% to 45 wt%, still more preferably from 15 wt% to 40 wt%, particularly preferably from 20 wt% to 35 wt% from the viewpoint that the effects of the present invention can be further expressed.

[0162]

From the viewpoint that the effects of the present invention can be further expressed, it is preferred that a hydroxyl group-containing monomer (e.g., 2-hydroxyethyl (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, 6-hydroxyhexyl (meth)acrylate, vinyl alcohol, or allyl alcohol) be essentially incorporated as the polar group-containing monomer. When the hydroxyl group-containing monomer is essentially incorporated as the polar group-containing monomer, the content

of the hydroxyl group-containing monomer in the total amount of the monomer components forming the acrylic polymer (A) is preferably from 10 wt% to 25 wt%, more preferably from 10 wt% to 24 wt%, still more preferably from 11 wt% to 23 wt%, particularly preferably from 12 wt% to 22 wt% from the viewpoint that the effects of the present invention can be further expressed.

[0163]

From the viewpoint that the effects of the present invention can be further expressed and the viewpoint that the corrosion of a metal or the like is suppressed, it is preferred that a carboxyl group-containing monomer (especially (meth)acrylic acid) be not used, or even when the monomer is used, its amount be small. Specifically, the content of the carboxyl group-containing monomer in the total amount of the monomer components forming the acrylic polymer (A) is preferably from 0 wt% to 5 wt%, more preferably from 0 wt% to 3 wt%, still more preferably from 0 wt% to 2 wt%, particularly preferably from 0 wt% to 0.5 wt%.

[0164]

The description in the section <1-1. Embodiment A> may be incorporated for a method of polymerizing the acrylic polymer (A).

[0165]

The pressure-sensitive adhesive composition containing the

acrylic polymer (A) may contain a cross-linking agent. Any appropriate cross-linking agent may be adopted as such cross-linking agent to the extent that the effects of the present invention are not impaired. Such cross-linking agent is preferably an isocyanate-based cross-linking agent. When the pressure-sensitive adhesive composition containing the acrylic polymer (A) contains the isocyanate-based cross-linking agent, a pressure-sensitive adhesive film that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided. The number of kinds of the isocyanate-based cross-linking agents may be only one, or may be two or more.

[0166]

When the pressure-sensitive adhesive composition containing the acrylic polymer (A) contains the isocyanate-based cross-linking agent, the content of the isocyanate-based cross-linking agent in the pressure-sensitive adhesive composition is preferably from 0.1 wt% to 50 wt%, more preferably from 2 wt% to 40 wt%, still more preferably from 5 wt% to 30 wt%, particularly preferably from 7 wt% to 20 wt%, most preferably from 9 wt% to 18 wt% with respect to 100 wt% of the acrylic polymer (A). When the content of the isocyanate-based cross-linking agent in the pressure-sensitive adhesive composition falls within the range with respect to 100 wt% of the acrylic polymer (A), a pressure-sensitive adhesive film that has a more sufficient adhesive strength and is further reduced

in high-temperature strain can be provided.

[0167]

The description in the section <1-1. Embodiment A> may be incorporated for the isocyanate-based cross-linking agent (polyfunctional isocyanate compound).

[0168]

The pressure-sensitive adhesive composition containing the acrylic polymer (A) may contain any appropriate amount of an additive, such as any other cross-linking agent, a cross-linking accelerator, a silane coupling agent, a tackifying resin (e.g., a rosin derivative, a polyterpene resin, a petroleum resin, or an oil-soluble phenol), an age inhibitor, a filler, a colorant (e.g., a pigment or a dye), a UV absorber, an antioxidant, a chain transfer agent, a plasticizer, a softener, a surfactant, or an antistatic agent, as required to the extent that the effects of the present invention are not impaired. The number of kinds of such additives may be only one, or may be two or more.

[0169]

Any appropriate method may be adopted as a method of forming the pressure-sensitive adhesive film of the present invention from the pressure-sensitive adhesive composition containing the acrylic polymer (A) to the extent that the effects of the present invention

are not impaired. The pressure-sensitive adhesive film of the present invention is formed by, for example, applying the pressure-sensitive adhesive composition containing the acrylic polymer (A) onto any appropriate base material (e.g., a PET base material), performing heating or the like with an oven or the like to subject the composition to a cross-linking reaction, and further performing drying or the like as required. For example, any appropriate coating method may be used for applying the pressure-sensitive adhesive composition. Such coating method is, for example, a coating method involving using a commonly-used coater, such as a gravure roll coater, a reverse roll coater, a kiss roll coater, a dip roll coater, a bar coater, a knife coater, a spray coater, a comma coater, or a direct coater.

[0170]

<2-2. Pressure-sensitive Adhesive Composition containing Acrylic Polymer (B)>

In the pressure-sensitive adhesive composition containing the acrylic polymer (B), the content of the acrylic polymer (B) in the pressure-sensitive adhesive composition is preferably from 20 wt% to 90 wt%, more preferably from 25 wt% to 85 wt%, still more preferably from 30 wt% to 80 wt%, particularly preferably from 35 wt% to 75 wt%, most preferably from 40 wt% to 70 wt%. When the content of the acrylic polymer (B) in the pressure-sensitive adhesive composition falls within the range, a pressure-sensitive adhesive

film that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided. The number of kinds of the acrylic polymers (B) may be only one, or may be two or more.

[0171]

The acrylic polymer (B) is a polymer formed from monomer components essentially including an acrylic monomer. That is, the acrylic polymer (B) is a polymer having a constituent unit derived from the acrylic monomer as an essential monomer constituent unit.

[0172]

The weight-average molecular weight of the acrylic polymer (B) is preferably from 200,000 to 2,500,000, more preferably from 300,000 to 1,800,000, still more preferably from 400,000 to 1,500,000, particularly preferably from 500,000 to 1,200,000 from the viewpoint that the effects of the present invention can be further expressed.

[0173]

The acrylic polymer (B) is preferably an acrylic polymer containing preferably 80 wt% or more of a (meth)acrylic acid alkyl ester having a glass transition temperature (T_g) when turned into a homopolymer of -20°C or less with respect to the total amount of the monomer components forming the acrylic polymer (B). The description in the section <1-2. Embodiment B> may be incorporated

for such acrylic polymer.

[0174]

In the acrylic polymer (B), the content of the (meth)acrylic acid alkyl ester having a glass transition temperature (T_g) when turned into a homopolymer of -20°C or less with respect to the total amount of the monomer components forming the acrylic polymer (B) is preferably 80 wt% or more, more preferably 83 wt% or more, still more preferably 87 wt% or more, particularly preferably 90 wt% or more. An upper limit for the content is preferably 100 wt% or less, more preferably 98 wt% or less, still more preferably 96 wt% or less, particularly preferably 95 wt% or less. When the content falls within the range, a pressure-sensitive adhesive film that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided.

[0175]

The acrylic polymer (B) may contain a copolymerizable monomer as a monomer component forming the polymer in addition to the (meth)acrylic acid alkyl ester from the viewpoint that the tuning of the characteristics of the pressure-sensitive adhesive film, proper use of the characteristics in accordance with purposes, and the impartment of a function in accordance with needs are made possible. The number of kinds of the copolymerizable monomers may be only one, or may be two or more.

[0176]

The description in the section <1-2. Embodiment B> may be incorporated for the copolymerizable monomer.

[0177]

The acrylic polymer (B) is obtained by polymerizing the monomer components through any appropriate polymerization method to the extent that the effects of the present invention are not impaired. The description in the section <1-2. Embodiment B> may be incorporated for a method of polymerizing the acrylic polymer (B).

[0178]

The pressure-sensitive adhesive composition containing the acrylic polymer (B) may contain a UV-curable oligomer. When the pressure-sensitive adhesive composition containing the acrylic polymer (B) contains the UV-curable oligomer, a pressure-sensitive adhesive film that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided. The number of kinds of the UV-curable oligomers may be only one, or may be two or more.

[0179]

The content of the UV-curable oligomer in the pressure-sensitive adhesive composition containing the acrylic

polymer (B) is preferably from 10 wt% to 300 wt%, more preferably from 20 wt% to 150 wt%, still more preferably from 30 wt% to 120 wt%, particularly preferably from 35 wt% to 110 wt%, most preferably from 40 wt% to 105 wt% with respect to 100 wt% of the acrylic polymer (B). When the content of the UV-curable oligomer in the pressure-sensitive adhesive composition containing the acrylic polymer (B) falls within the range with respect to 100 wt% of the acrylic polymer (B), a pressure-sensitive adhesive film that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided.

[0180]

The description in the section <1-2. Embodiment B> may be incorporated for the UV-curable oligomer.

[0181]

The pressure-sensitive adhesive composition containing the acrylic polymer (B) may contain any appropriate amount of an additive, such as a cross-linking agent, a cross-linking accelerator, a silane coupling agent, a tackifying resin (e.g., a rosin derivative, a polyterpene resin, a petroleum resin, or an oil-soluble phenol), an age inhibitor, a filler, a colorant (e.g., a pigment or a dye), a UV absorber, an antioxidant, a chain transfer agent, a plasticizer, a softener, a surfactant, or an antistatic agent, as required to the extent that the effects of the present invention are not impaired.

The number of kinds of such additives may be only one, or may be two or more.

[0182]

Any appropriate method may be adopted as a method of forming the pressure-sensitive adhesive film of the present invention from the pressure-sensitive adhesive composition containing the acrylic polymer (B) to the extent that the effects of the present invention are not impaired. The pressure-sensitive adhesive film of the present invention is formed by, for example, applying the pressure-sensitive adhesive composition containing the acrylic polymer (B) onto any appropriate base material (e.g., a PET base material), performing heating or the like with an oven or the like to subject the composition to a cross-linking reaction, further performing drying or the like as required, and further curing the resultant through UV irradiation or the like. For example, any appropriate coating method may be used for applying the pressure-sensitive adhesive composition. Such coating method is, for example, a coating method involving using a commonly-used coater, such as a gravure roll coater, a reverse roll coater, a kiss roll coater, a dip roll coater, a bar coater, a knife coater, a spray coater, a comma coater, or a direct coater.

[0183]

<2-3. Pressure-sensitive Adhesive Composition containing

Urethane-based Polymer>

In the pressure-sensitive adhesive composition containing the urethane-based polymer, the content of the urethane-based polymer in the pressure-sensitive adhesive composition is preferably from 10 wt% to 90 wt%, more preferably from 20 wt% to 80 wt%, still more preferably from 30 wt% to 75 wt%, particularly preferably from 35 wt% to 70 wt%, most preferably from 40 wt% to 65 wt%. When the content of the urethane-based polymer in the pressure-sensitive adhesive composition containing the urethane-based polymer falls within the range, a pressure-sensitive adhesive film that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided. The number of kinds of the urethane-based polymers in the pressure-sensitive adhesive composition containing the urethane-based polymer may be only one, or may be two or more.

[0184]

The urethane-based polymer is preferably obtained by using a reaction between a polyol compound and a polyisocyanate compound. That is, the urethane-based polymer may be obtained by using raw materials including the polyol compound and the polyisocyanate compound through the use of the reaction between the polyol compound and the polyisocyanate compound. The number of kinds of the polyol compounds may be only one, or may be two or more. The number of kinds of the polyisocyanate compounds may be only one, or may be two or more.

[0185]

The reaction between the polyol compound and the polyisocyanate compound may be performed by any appropriate method that may be adopted in the production of the urethane-based polymer. The urethane-based polymer is obtained by, for example, mixing and stirring the polyol compound and the polyisocyanate compound, and the polyisocyanate compound is preferably added so that an isocyanate group may be excessive with respect to a hydroxyl group in the polyol compound. In addition, the reaction may be performed by adding an organic solvent free of active hydrogen with which an isocyanate group may react (e.g., ethyl acetate, methyl ethyl ketone, or chloroform) and a catalyst (e.g., an organometallic catalyst, such as a tin chloride or an organotin compound, an organic base, such as a tertiary amine compound, or an organic acid, such as acetic acid or acrylic acid) as required in the reaction.

[0186]

A ratio "NCO/OH" between the polyisocyanate compound and the polyol compound is preferably from 0.1 to 2.0, more preferably from 0.3 to 1.8, still more preferably from 0.5 to 1.5, particularly preferably from 0.8 to 1.3 in terms of an equivalent ratio. When the ratio "NCO/OH" falls within the range, a pressure-sensitive adhesive film that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided.

[0187]

The molecular weight of the urethane-based polymer may be appropriately set in accordance with purposes. With regard to the molecular weight of the urethane-based polymer, its number-average molecular weight (M_n) is preferably 5,000 or more, more preferably 10,000 or more from the viewpoint that the effects of the present invention can be further expressed.

[0188]

The description in the section <1-3. Embodiment C> may be incorporated for the polyol compound.

[0189]

The description in the section <1-3. Embodiment C> may be incorporated for the polyisocyanate compound.

[0190]

The urethane-based polymer preferably contains a (meth)acryloyl group-terminated urethane-based polymer. The (meth)acryloyl group-terminated urethane-based polymer is a compound that has two or more acryloyl groups or methacryloyl groups in a molecule thereof, and has a urethane bond in a repeating structural unit thereof.

[0191]

When the urethane-based polymer contains the (meth)acryloyl group-terminated urethane-based polymer, the content of the (meth)acryloyl group-terminated urethane-based polymer in the urethane-based polymer is preferably from 50 wt% to 100 wt%, more preferably from 70 wt% to 100 wt%, still more preferably from 90 wt% to 100 wt%, particularly preferably from 95 wt% to 100 wt%, most preferably substantially 100 wt%.

[0192]

The (meth)acryloyl group-terminated urethane-based polymer is preferably obtained by causing a hydroxyl group-containing acrylic monomer to react with a polyurethane prepolymer obtained by the reaction between the polyol compound and the polyisocyanate compound. The reaction may be performed by adding an organic solvent free of active hydrogen with which an isocyanate group may react (e.g., ethyl acetate, methyl ethyl ketone, or chloroform) and a catalyst (e.g., an organometallic catalyst, such as a tin chloride or an organotin compound, an organic base, such as a tertiary amine compound, or an organic acid, such as acetic acid or acrylic acid) as required in the reaction.

[0193]

The description in the section <1-3. Embodiment C> may be incorporated for the hydroxyl group-containing acrylic monomer.

[0194]

The polyurethane prepolymer and the hydroxyl group-containing acrylic monomer are preferably added at such a ratio that the amount of a hydroxyl group in the hydroxyl group-containing acrylic monomer is equal to that of the isocyanate residue of the polyurethane prepolymer. Specifically, the hydroxyl group-containing acrylic monomer is added at the following ratio with respect to the polyol compound compounded in the production of the polyurethane prepolymer: a molar ratio "polyol compound:hydroxyl group-containing acrylic monomer" is preferably from 1:0.08 to 1:0.5, and the molar ratio "polyol compound:hydroxyl group-containing acrylic monomer" is more preferably from 1:0.1 to 1:0.4. When the ratio between the polyol compound and the hydroxyl group-containing acrylic monomer falls within the range, a pressure-sensitive adhesive film that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided.

[0195]

The pressure-sensitive adhesive composition containing the urethane-based polymer may contain an acrylic monomer.

[0196]

When the pressure-sensitive adhesive composition containing the urethane-based polymer contains the acrylic monomer, the content

of the acrylic monomer in the pressure-sensitive adhesive composition containing the urethane-based polymer is preferably from 20 wt% to 80 wt%, more preferably from 30 wt% to 75 wt%, particularly preferably from 35 wt% to 70 wt%, most preferably from 40 wt% to 65 wt%. When the content of the acrylic monomer in the pressure-sensitive adhesive composition containing the urethane-based polymer falls within the range, a pressure-sensitive adhesive film that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided. The number of kinds of the acrylic monomers in the pressure-sensitive adhesive composition containing the urethane-based polymer may be only one, or may be two or more.

[0197]

The acrylic monomer preferably contains a (meth)acrylic monomer having an amide group.

[0198]

When the acrylic monomer contains the (meth)acrylic monomer having an amide group, the content of the (meth)acrylic monomer having an amide group in the total amount of the acrylic monomer is preferably from 5 wt% to 99 wt%, more preferably from 15 wt% to 97 wt%, still more preferably from 25 wt% to 95 wt%. When the content of the (meth)acrylic monomer having an amide group falls within the range, a pressure-sensitive adhesive film that has a

more sufficient adhesive strength and is further reduced in high-temperature strain can be provided.

[0199]

The description in the section <1-3. Embodiment C> may be incorporated for the (meth)acrylic monomer having an amide group.

[0200]

The acrylic monomer may contain any appropriate other acrylic monomer to the extent that the effects of the present invention are not impaired. The number of kinds of such other acrylic monomers may be only one, or may be two or more. The description in the section <1-3. Embodiment C> may be incorporated for such other acrylic monomer.

[0201]

The content of butyl (meth)acrylate in the total amount of the acrylic monomer is preferably from 1 wt% to 90 wt%, more preferably from 5 wt% to 60 wt%, still more preferably from 10 wt% to 40 wt%, particularly preferably from 15 wt% to 30 wt%. When the content of butyl (meth)acrylate in the total amount of the acrylic monomer falls within the range, a pressure-sensitive adhesive film that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided.

[0202]

The content of isobornyl (meth)acrylate in the total amount of the acrylic monomer is preferably from 1 wt% to 90 wt%, more preferably from 5 wt% to 60 wt%, still more preferably from 10 wt% to 40 wt%, particularly preferably from 15 wt% to 30 wt%. When the content of isobornyl (meth)acrylate in the total amount of the acrylic monomer falls within the range, a pressure-sensitive adhesive film that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided.

[0203]

The content of (meth)acrylic acid in the total amount of the acrylic monomer is preferably from 1 wt% to 90 wt%, more preferably from 2 wt% to 65 wt%, still more preferably from 3 wt% to 40 wt%, particularly preferably from 4 wt% to 25 wt%. When the content of (meth)acrylic acid in the total amount of the acrylic monomer falls within the range, a pressure-sensitive adhesive film that has a more sufficient adhesive strength and is further reduced in high-temperature strain can be provided.

[0204]

The pressure-sensitive adhesive composition containing the urethane-based polymer may contain any appropriate amount of an additive, such as a cross-linking agent, a cross-linking accelerator, a silane coupling agent, a tackifying resin (e.g., a rosin derivative,

a polyterpene resin, a petroleum resin, or an oil-soluble phenol), an age inhibitor, a filler, a colorant (e.g., a pigment or a dye), a UV absorber, an antioxidant, a chain transfer agent, a plasticizer, a softener, a surfactant, or an antistatic agent, as required to the extent that the effects of the present invention are not impaired. The number of kinds of such additives may be only one, or may be two or more.

[0205]

Any appropriate method may be adopted as a method of forming the pressure-sensitive adhesive film of the present invention from the pressure-sensitive adhesive composition containing the urethane-based polymer to the extent that the effects of the present invention are not impaired. Such method is preferably as described below. The urethane-based polymer is formed in the presence of the acrylic monomer, and a photopolymerization initiator is further added to a mixture containing the urethane-based polymer and the acrylic monomer. The resultant mixture is applied onto any appropriate base material (e.g., a PET base material), and is irradiated with any appropriate active energy ray (e.g., an α -ray, a β -ray, a γ -ray, a neutron beam, an electron beam, UV light, or visible light) in accordance with, for example, the kind of the photopolymerization initiator to be cured. Thus, the pressure-sensitive adhesive film can be formed. Any appropriate condition that may be generally adopted in polymerization by

irradiation with an active energy ray may be adopted as a reaction condition at the time of the irradiation with the active energy ray.

[0206]

When the hydroxyl group-containing acrylic monomer is used at the time of the formation of the urethane-based polymer, the pressure-sensitive adhesive film of the present invention can be formed by: causing the polyol compound and the polyisocyanate compound to react with each other in the presence of an acrylic monomer component to form the polyurethane prepolymer; then adding the hydroxyl group-containing acrylic monomer to the polyurethane prepolymer to cause the monomer to react with the prepolymer; further adding the photopolymerization initiator to the resultant mixture; applying the resultant mixture onto any appropriate base material (e.g., a PET base material); and irradiating the applied mixture with any appropriate active energy ray (e.g., an α -ray, a β -ray, a γ -ray, a neutron beam, an electron beam, UV light, or visible light) in accordance with, for example, the kind of the photopolymerization initiator to cure the mixture. Any appropriate condition that may be generally adopted in polymerization by irradiation with an active energy ray may be adopted as a reaction condition at the time of the irradiation with the active energy ray.

[0207]

The pressure-sensitive adhesive film of the present invention can be specifically formed by, for example, dissolving the polyol compound in the acrylic monomer component, then adding the polyisocyanate compound to the solution to cause the compound to react with the polyol compound, performing, for example, the adjustment of the viscosity of the solution, applying the resultant mixture to any appropriate base material (e.g., a PET base material), and then curing the mixture through UV irradiation or the like. In addition, after the curing, the cured product may be peeled from the base material to be used as the pressure-sensitive adhesive film of the present invention.

[0208]

For example, any appropriate coating method may be used for applying the pressure-sensitive adhesive composition containing the urethane-based polymer. Such coating method is, for example, a coating method involving using a commonly-used coater, such as a gravure roll coater, a reverse roll coater, a kiss roll coater, a dip roll coater, a bar coater, a knife coater, a spray coater, a comma coater, or a direct coater.

[0209]

In order to avoid polymerization inhibition by oxygen at the time of the formation of the pressure-sensitive adhesive film of

the present invention, any appropriate base material subjected to release treatment may be further mounted on the pressure-sensitive adhesive composition containing the urethane-based polymer applied onto any appropriate base material (e.g., a PET base material).

[0210]

Any appropriate solvent may be added at the time of the formation of the pressure-sensitive adhesive film of the present invention for the viscosity adjustment. Examples of such solvent include ethyl acetate, toluene, chloroform, and dimethyl formamide.

[0211]

The number of kinds of the photopolymerization initiators may be only one, or may be two or more.

[0212]

Any appropriate amount typically used in photopolymerization may be adopted as the usage amount of the photopolymerization initiator.

[0213]

In the case where the urethane-based polymer contains the (meth)acryloyl group-terminated urethane-based polymer, when a vinyl-based monomer is polymerized in the presence of the urethane-based polymer, the (meth)acryloyl groups may be polymerized

with a vinyl group to provide a vinyl-based polymer bonded to the (meth)acryloyl group-terminated urethane-based polymer.

[0214]

<<Pressure-sensitive Adhesive Tape>>

A pressure-sensitive adhesive tape of the present invention includes the pressure-sensitive adhesive or pressure-sensitive adhesive film of the present invention.

[0215]

The pressure-sensitive adhesive tape of the present invention includes the pressure-sensitive adhesive or pressure-sensitive adhesive film of the present invention as a pressure-sensitive adhesive layer. The pressure-sensitive adhesive tape of the present invention may include only one pressure-sensitive adhesive layer, or may include two or more pressure-sensitive adhesive layers.

[0216]

The pressure-sensitive adhesive tape of the present invention may include a base material. Examples of such base material include base materials formed from plastic materials, such as a polyester-based resin, such as polyethylene terephthalate (PET), an acrylic resin, such as polymethyl methacrylate (PMMA), polycarbonate, triacetyl cellulose (TAC), polysulfone, polyarylate, polyimide, polyvinyl chloride, polyvinyl acetate, polyethylene,

polypropylene, an ethylene-propylene copolymer, and a cyclic olefin-based polymer. The pressure-sensitive adhesive tape of the present invention may include only one base material, or may include two or more base materials.

[0217]

The pressure-sensitive adhesive tape according to one embodiment of the present invention is configured so as to include one pressure-sensitive adhesive layer on one base material.

[0218]

The thickness of the base material may be appropriately set in accordance with purposes. Such thickness is preferably from 1 μm to 500 μm , more preferably from 5 μm to 300 μm , still more preferably from 10 μm to 200 μm , particularly preferably from 15 μm to 100 μm , most preferably from 20 μm to 50 μm from the viewpoint that the effects of the present invention can be further expressed.

[0219]

The surface of the base material may be subjected to known and commonly-used surface treatment, such as: physical treatment, such as corona discharge treatment or plasma treatment; or chemical treatment, such as undercoating treatment.

[0220]

<<Film Substrate>>

A film substrate of the present invention includes the pressure-sensitive adhesive or pressure-sensitive adhesive film of the present invention.

[0221]

The film substrate of the present invention is a film obtained by laminating a conductive metal layer made of copper or the like on one surface, or each of both surfaces, of a heat-resistant insulating film or by subjecting the surface to wiring processing, a film obtained by forming the wiring pattern of a metal layer on the surface through, for example, etching involving using a photolithography technology or the like, or a film obtained by forming a field-effect transistor on the surface, and is sometimes referred to as "FPC" or the like. The substrate is a substrate having pliability, has flexibility, can be repeatedly deformed by a weak force, and has such a characteristic as to maintain its electrical characteristics even when deformed. In general, the substrate is such a plate- or film-like part that many electronic parts, such as an integrated circuit, a resistor, and a capacitor, are fixed on its surface, and the parts are connected to each other with wiring to form an electronic circuit.

Examples

[0222]

Now, the present invention is described specifically by way of Examples. However, the present invention is by no means limited to Examples. Test and evaluation methods in Examples and the like are as described below. The term "part(s)" in the following description means "part(s) by weight" unless otherwise specified, and the term "%" in the following description means "wt%" unless otherwise specified.

[0223]

<Measurement of Weight-average Molecular Weight>

A weight-average molecular weight was measured by gel permeation chromatography (GPC). Specifically, the measurement was performed by using an apparatus available under the product name "HLC-8120GPC" (manufactured by Tosoh Corporation) as a GPC measurement apparatus under the following conditions, and the weight-average molecular weight was calculated by converting the measured value into a value in terms of standard polystyrene.

(Conditions for Measurement of Molecular Weight)

•Sample concentration: About 2.0 g/L (tetrahydrofuran solution)

•Sample injection amount: 20 μ L

•Column: Product name: "TSKgel, Super AWM-H+Super AW4000+Super AW2500" (manufactured by Tosoh Corporation)

- Column size: Each column measured 6.0 mm in inner diameter by 150 mm
- Eluent: Tetrahydrofuran (THF)
- Flow rate: 0.4 mL/min
- Detector: Differential refractometer (RI)
- Column temperature (measurement temperature): 40°C

[0224]

<Measurement of Storage Modulus of Elasticity>

A storage modulus of elasticity G' at each of 25°C and 160°C was measured as described below. In each of Examples and Comparative Examples, a pressure-sensitive adhesive composition was applied to a separator film instead of a PET film base material, and the separator was peeled from a pressure-sensitive adhesive layer produced by a predetermined method of each of Examples and Comparative Examples. Only the pressure-sensitive adhesive layer was laminated to produce a laminate of the pressure-sensitive adhesive layer having a thickness of about 1.5 mm. The laminate was used as a measurement sample.

The storage moduli of elasticity of the measurement sample were measured with "Advanced Rheometric Expansion System (ARES)" manufactured by Rheometric Scientific in a shear mode under the condition of a frequency of 1 Hz in the range of from -70°C to 200°C

at a rate of temperature increase of 5°C/min.

[0225]

<Measurement of Adhesive Strength to Surface of Polyimide Film>

A polyimide film having a thickness of 12.5 μm (KAPTON 50EN, manufactured by Du Pont-Toray Co., Ltd.) was bonded to a SUS304 plate via a double-sided adhesive tape (manufactured by Nitto Denko Corporation, product name: "No. 531") with a 2-kilogram hand roller. Thus, a polyimide film substrate for measurement was obtained.

Next, a tape piece having a length of 100 mm and a width of 25 mm was obtained from a pressure-sensitive adhesive tape. Under an atmosphere at 23°C and 50%RH, the release liner of the tape piece was peeled, and the remainder was compression-bonded onto the polyimide film substrate for measurement by reciprocating a 2-kilogram roller once.

After the resultant had been left to stand under the atmosphere at 23°C and 50%RH for 30 minutes, a peel test was performed with a tensile tester (product name: "TCM-1kNB," manufactured by Minebea Co., Ltd.) to measure the adhesive strength of the pressure-sensitive adhesive tape to the polyimide film. An average load at that time was defined as the adhesive strength to the polyimide film. The measurement was performed under the atmosphere at 23°C and 50%RH, and under the conditions of a peel angle of 180° and a tensile rate

of 300 mm/min.

[0226]

<Evaluation of Deformation of Pressure-sensitive Adhesive by 30 MPa Pressing at 160°C>

A pressure-sensitive adhesive tape was bonded to the lower surface of a polyimide film having a thickness of 12.5 μm (KAPTON 50EN, manufactured by Du Pont-Toray Co., Ltd.), and an iron plate measuring 2 mm wide by 20 mm long by 1 mm thick was mounted on the upper surface of the polyimide film. A pressure was applied to the iron plate mounted on the polyimide film with a hot-pressing machine (Sintokogio, Ltd., CYPT-10) at 160°C for 5 seconds so that a pressure of 30 MPa was applied to the polyimide film.

A section of the polyimide film having bonded thereto the pressure-sensitive adhesive tape in a portion to which the pressure had been applied by the iron plate was cut, and whether or not the pressure-sensitive adhesive of the pressure-sensitive adhesive tape was deformed by the applied heat and pressure was observed. A case in which substantially no deformation of the pressure-sensitive adhesive was observed was indicated by Symbol "o", a case in which the pressure-sensitive adhesive was deformed, but to a slight extent was indicated by Symbol " Δ ", and a case in which the deformation of the pressure-sensitive adhesive was large was indicated by Symbol "x".

[0227]

[Example 1]

63 Parts by weight of 2-ethylhexyl acrylate (2EHA), 15 parts by weight of N-vinyl-2-pyrrolidone (NVP), 9 parts by weight of methyl methacrylate (MMA), and 13 parts by weight of 2-hydroxyethyl acrylate (HEA) serving as monomer components, 0.2 part by weight of 2,2'-azobisisobutyronitrile serving as a polymerization initiator, and 133 parts by weight of ethyl acetate serving as a polymerization solvent were loaded into a separable flask, and the materials were stirred for 1 hour while a nitrogen gas was introduced into the flask. After oxygen in a polymerization system had been removed as described above, a temperature in the flask was increased to 65°C, and the mixture was subjected to a reaction for 10 hours, followed by the addition of ethyl acetate. Thus, a solution of an acrylic polymer (1) having a solid content concentration of 30 wt% was obtained. The weight-average molecular weight of the acrylic polymer (1) was 800,000.

Next, an isocyanate-based cross-linking agent (product name: "TAKENATE D110N," manufactured by Mitsui Chemicals, Incorporated) was added to the solution of the acrylic polymer (1) so that its amount became 5 parts by weight in terms of a solid content with respect to 100 parts by weight of the acrylic polymer (1) (solid content). A silane coupling agent

(γ -glycidoxypropyltrimethoxysilane, product name: "KBM403," manufactured by Shin-Etsu Chemical Co., Ltd.) was added to the mixture so that its amount became 0.5 part by weight in terms of a solid content with respect to 100 parts by weight of the acrylic polymer (solid content), followed by the mixing of the materials. Thus, a pressure-sensitive adhesive composition (1) was prepared.

The pressure-sensitive adhesive composition (1) was applied to one surface of a PET base material ("LUMIRROR S10" (thickness: 75 μm , manufactured by Toray Industries, Inc.)) to form an applied layer on the PET base material. Next, the PET base material having formed thereon the applied layer was loaded into an oven, and the applied layer was dried at 130°C for 3 minutes. Thus, a pressure-sensitive adhesive tape (1) including a pressure-sensitive adhesive layer having a thickness of 25 μm on one surface of the PET base material was obtained.

The results are shown in Table 2.

[0228]

[Example 2]

63 Parts by weight of 2-ethylhexyl acrylate (2EHA), 15 parts by weight of N-vinyl-2-pyrrolidone (NVP), 9 parts by weight of methyl methacrylate (MMA), and 13 parts by weight of 2-hydroxyethyl acrylate (HEA) serving as monomer components, 0.2 part by weight of

2,2'-azobisisobutyronitrile serving as a polymerization initiator, and 133 parts by weight of ethyl acetate serving as a polymerization solvent were loaded into a separable flask, and the materials were stirred for 1 hour while a nitrogen gas was introduced into the flask. After oxygen in a polymerization system had been removed as described above, a temperature in the flask was increased to 65°C, and the mixture was subjected to a reaction for 10 hours, followed by the addition of ethyl acetate. Thus, a solution of an acrylic polymer (2) having a solid content concentration of 30 wt% was obtained. The weight-average molecular weight of the acrylic polymer (2) was 800,000.

Next, an isocyanate-based cross-linking agent (product name: "TAKENATE D110N," manufactured by Mitsui Chemicals, Incorporated) was added to the solution of the acrylic polymer (2) so that its amount became 10 parts by weight in terms of a solid content with respect to 100 parts by weight of the acrylic polymer (2) (solid content). A silane coupling agent (γ -glycidoxypyrpyltrimethoxysilane, product name: "KBM403," manufactured by Shin-Etsu Chemical Co., Ltd.) was added to the mixture so that its amount became 0.5 part by weight in terms of a solid content with respect to 100 parts by weight of the acrylic polymer (solid content), followed by the mixing of the materials. Thus, a pressure-sensitive adhesive composition (2) was prepared.

The pressure-sensitive adhesive composition (2) was applied to one surface of a PET base material (thickness: 75 μm) to form an applied layer on the PET base material. Next, the PET base material having formed thereon the applied layer was loaded into an oven, and the applied layer was dried at 130°C for 3 minutes. Thus, a pressure-sensitive adhesive tape (2) including a pressure-sensitive adhesive layer having a thickness of 25 μm on one surface of the PET base material was obtained.

The results are shown in Table 2.

[0229]

[Example 3]

95 Parts by weight of n-butyl acrylate (BA) and 5 parts by weight of acrylic acid (AA) serving as monomer components, and 185.7 parts by weight of ethyl acetate serving as a polymerization solvent were loaded into a separable flask, and the materials were stirred for 1 hour while a nitrogen gas was introduced into the flask. After oxygen in a polymerization system had been removed as described above, a temperature in the flask was increased to 63°C, and the mixture was subjected to a reaction for 10 hours, followed by the addition of toluene. Thus, a solution of an acrylic polymer (3) having a solid content concentration of 25 wt% was obtained. The weight-average molecular weight of the acrylic polymer (3) was 600,000.

Next, SHIKOH UV-3700B (manufactured by The Nippon Synthetic Chemical Industry Co., Ltd.) was added to the solution of the acrylic polymer (3) so that its amount became 100 parts by weight in terms of a solid content with respect to 100 parts by weight of the acrylic polymer (3) (solid content). A photopolymerization initiator IRGACURE 651 (manufactured by BASF) was added to the mixture so that its amount became 3 parts by weight, followed by the mixing of the materials. Thus, a pressure-sensitive adhesive composition (3) was prepared.

The pressure-sensitive adhesive composition (3) was applied to one surface of a PET base material (thickness: 75 μm) so that its thickness after drying became 25 μm . The PET base material having formed thereon the applied layer was loaded into an oven, and the applied layer was dried at 130°C for 3 minutes. A release-treated PET separator was superimposed on the dried layer to cover the layer, and then the layer was cured by irradiating the surface covered with the PET separator with UV light (irradiance: 5 mW/cm^2 , light quantity: 1,200 mJ/cm^2) through the use of a black light. Thus, a pressure-sensitive adhesive tape (3) including the release-treated PET separator on one surface thereof was obtained.

The results are shown in Table 2.

[0230]

[Example 4]

36.18 Parts by weight of N,N-dimethylacrylamide (DMAA), 18.08 parts by weight of acrylic acid (AA), 126.56 parts by weight of butyl acrylate (BA), 180.81 parts by weight of isobornyl acrylate (IBXA), and 278.00 parts by weight of poly(hexamethylene carbonate) glycol having a number-average molecular weight of 1,000 (manufactured by Nippon Polyurethane Industry Co., Ltd., product name: "NIPPOLAN 981" (melting point (described in a MSDS): 42°C)) serving as a polyol compound were loaded into a reaction vessel including a cooling tube, a temperature gauge, and a stirring apparatus. While the materials were stirred, 67.48 parts by weight of hydrogenated xylylene diisocyanate (HXDI, manufactured by Mitsui Chemical Polyurethane) was dropped as a polyisocyanate compound into the materials. The mixture was subjected to a reaction at 65°C for 5 hours to provide a urethane polymer-acrylic monomer mixture. After that, 16.14 parts by weight of hydroxyethyl acrylate (HEA) was loaded into the mixture, and the whole was subjected to a reaction at 65°C for 1 hour to provide an acryloyl group-terminated urethane polymer-acrylic monomer mixture. Further, 0.15 part by weight of 2,2-dimethoxy-1,2-diphenylethan-1-one (manufactured by BASF, product name: "IRGACURE 651") was added as a photopolymerization initiator to the mixture. Thus, a pressure-sensitive adhesive composition (4) was prepared. A ratio "NCO/OH" (equivalent ratio) between the usage amounts of the polyisocyanate compound and the

polyol compound was 1.25.

The resultant pressure-sensitive adhesive composition (4) was applied onto a PET film having a thickness of 75 μm so that its thickness after curing became 25 μm . A release-treated PET separator was superimposed on the applied composition to cover the composition, and then the composition was cured by irradiating the surface covered with the PET separator with UV light (irradiance: 5 mW/cm^2 , light quantity: 1,200 mJ/cm^2) through the use of a black light. Thus, a pressure-sensitive adhesive tape (4) including the release-treated PET separator on one surface thereof was obtained.

The results are shown in Table 2.

[0231]

[Comparative Example 1]

63 Parts by weight of 2-ethylhexyl acrylate (2EHA), 15 parts by weight of N-vinyl-2-pyrrolidone (NVP), 9 parts by weight of methyl methacrylate (MMA), and 13 parts by weight of 2-hydroxyethyl acrylate (HEA) serving as monomer components, 0.2 part by weight of 2,2'-azobisisobutyronitrile serving as a polymerization initiator, and 133 parts by weight of ethyl acetate serving as a polymerization solvent were loaded into a separable flask, and the materials were stirred for 1 hour while a nitrogen gas was introduced into the flask. After oxygen in a polymerization system had been removed

as described above, a temperature in the flask was increased to 65°C, and the mixture was subjected to a reaction for 10 hours, followed by the addition of ethyl acetate. Thus, a solution of an acrylic polymer having a solid content concentration of 30 wt% was obtained.

The resultant solution of the acrylic polymer was cooled to room temperature. After that, 5.17 parts by weight of 2-isocyanatoethyl methacrylate (manufactured by Showa Denko K.K., product name: "KarencMOI") serving as a compound having a polymerizable carbon-carbon double bond with respect to 100 parts by weight of the acrylic polymer was added to the resin solution. Further, 0.0272 part by weight of dibutyltin(IV) dilaurate (manufactured by Wako Pure Chemical Industries, Ltd.) was added to the mixture, and the whole was stirred under an air atmosphere at 40°C for 20 hours to provide a solution of an acrylic polymer (C1).

Next, an isocyanate-based cross-linking agent (product name: "TAKENATE D110N," manufactured by Mitsui Chemicals, Incorporated) was added to the solution of the acrylic polymer (C1) so that its amount became 1 part by weight in terms of a solid content with respect to 100 parts by weight of the acrylic polymer (C1) (solid content).

Further,
2-benzyl-2-(dimethylamino)-4'-morpholinobutyrophenone

(manufactured by BASF, product name: "IRGACURE 369") was added as a photopolymerization initiator in an amount of 3 parts by weight in terms of a solid content with respect to 100 parts by weight of the acrylic polymer (C1) (solid content). Thus, a pressure-sensitive adhesive composition (C1) was prepared.

The resultant pressure-sensitive adhesive composition (C1) was applied onto a PET film having a thickness of 75 μm so that its thickness after drying became 25 μm . The PET film having formed thereon the applied layer was loaded into an oven, and the applied layer was dried at 130°C for 3 minutes. A release-treated PET separator was superimposed on the dried layer to cover the layer, and then the layer was cured by irradiating the surface covered with the PET separator with UV light (irradiance: 5 mW/cm^2 , light quantity: 1,200 mJ/cm^2) through the use of a black light. Thus, a pressure-sensitive adhesive tape (C1) including the release-treated PET separator on one surface thereof was obtained.

The results are shown in Table 2.

[0232]

[Comparative Example 2]

95 Parts by weight of n-butyl acrylate (BA) and 5 parts by weight of acrylic acid (AA) serving as monomer components, and 185.7 parts by weight of ethyl acetate serving as a polymerization solvent

were loaded into a separable flask, and the materials were stirred for 1 hour while a nitrogen gas was introduced into the flask. After oxygen in a polymerization system had been removed as described above, a temperature in the flask was increased to 63°C, and the mixture was subjected to a reaction for 10 hours, followed by the addition of toluene. Thus, a solution of an acrylic polymer having a solid content concentration of 25 wt% was obtained.

The weight-average molecular weight of an acrylic polymer in the acrylic polymer solution was 600,000.

Next, 95 parts by weight of cyclohexyl methacrylate [glass transition temperature of a homopolymer (polycyclohexyl methacrylate): 66°C] and 5 parts by weight of acrylic acid serving as monomer components, 10 parts by weight of α -methylstyrene dimer serving as a chain transfer agent, 10 parts by weight of 2,2'-azobisisobutyronitrile serving as a polymerization initiator, and 120 parts by weight of toluene serving as a polymerization solvent were loaded into a separable flask, and the materials were stirred for 1 hour while a nitrogen gas was introduced into the flask. After oxygen in a polymerization system had been removed as described above, a temperature in the flask was increased to 85°C, and the mixture was subjected to a reaction for 5 hours. Thus, an acrylic oligomer solution having a solid content concentration of 50 wt% was obtained.

The weight-average molecular weight of an acrylic oligomer in the acrylic oligomer solution was 4,000.

Next, a silane coupling agent (γ -glycidoxypropyltrimethoxysilane, product name: "KBM403," manufactured by Shin-Etsu Chemical Co., Ltd.) was added to the acrylic polymer solution so that its amount became 0.15 part by weight in terms of a solid content with respect to 100 parts by weight of the acrylic polymer (solid content). A cross-linking agent (epoxy-based cross-linking agent, product name: "TETRAD-C," manufactured by Mitsubishi Gas Chemical Company, Inc.) was added to the mixture so that its amount became 0.075 part by weight in terms of a solid content with respect to 100 parts by weight of the acrylic polymer (solid content). Further, the acrylic oligomer solution was added to the resultant so that the amount of the acrylic oligomer became 25 parts by weight in terms of a solid content with respect to 100 parts by weight of the acrylic polymer (solid content), followed by the mixing of the materials. Thus, a pressure-sensitive adhesive composition (C2) was prepared.

The pressure-sensitive adhesive composition (C2) was applied to one surface of a PET base material (thickness: 75 μ m) to form an applied layer on the PET base material. Next, the PET base material having formed thereon the applied layer was loaded into an oven,

and the applied layer was dried at 130°C for 3 minutes. Thus, a pressure-sensitive adhesive tape (C2) including a pressure-sensitive adhesive layer having a thickness of 25 μm on one surface of the PET base material was obtained.

The results are shown in Table 2.

[0233]

[Comparative Example 3]

63 Parts by weight of 2-ethylhexyl acrylate (2EHA), 15 parts by weight of N-vinyl-2-pyrrolidone (NVP), 9 parts by weight of methyl methacrylate (MMA), and 13 parts by weight of 2-hydroxyethyl acrylate (HEA) serving as monomer components, 0.2 part by weight of 2,2'-azobisisobutyronitrile serving as a polymerization initiator, and 133 parts by weight of ethyl acetate serving as a polymerization solvent were loaded into a separable flask, and the materials were stirred for 1 hour while a nitrogen gas was introduced into the flask. After oxygen in a polymerization system had been removed as described above, a temperature in the flask was increased to 65°C, and the mixture was subjected to a reaction for 10 hours, followed by the addition of ethyl acetate. Thus, a solution of an acrylic polymer having a solid content concentration of 30 wt% was obtained.

The weight-average molecular weight of an acrylic polymer in

the acrylic polymer solution was 800,000.

Next, an isocyanate-based cross-linking agent (product name: "TAKENATE D110N," manufactured by Mitsui Chemicals, Incorporated) was added to the acrylic polymer solution so that its amount became 1.1 parts by weight in terms of a solid content with respect to 100 parts by weight of the acrylic polymer (solid content). A silane coupling agent (γ -glycidoxypropyltrimethoxysilane, product name: "KBM403," manufactured by Shin-Etsu Chemical Co., Ltd.) was added to the mixture so that its amount became 0.15 part by weight in terms of a solid content with respect to 100 parts by weight of the acrylic polymer (solid content), followed by the mixing of the materials. Thus, a pressure-sensitive adhesive composition (C3) was prepared.

The pressure-sensitive adhesive composition (C3) was applied to one surface of a PET base material (thickness: 75 μm) to form an applied layer on the PET base material. Next, the PET base material having formed thereon the applied layer was loaded into an oven, and the applied layer was dried at 130°C for 3 minutes. Thus, a pressure-sensitive adhesive tape (C3) including a pressure-sensitive adhesive layer having a thickness of 25 μm on one surface of the PET base material was obtained.

The results are shown in Table 2.

[0234]

Table 2

	Adhesive strength to surface of polyimide film (N)	Storage modulus of elasticity G' at 25°C (Pa)	Storage modulus of elasticity G' at 160°C (Pa)	Evaluation of deformation of pressure-sensitive adhesive by 30 MPa pressing at 160°C
Example 1	13.7	4.3×10^5	2.5×10^5	Δ
Example 2	10.0	5.7×10^5	5.7×10^5	○
Example 3	7.9	1.9×10^5	1.6×10^5	Δ
Example 4	15.0	9.9×10^7	3.2×10^6	○
Comparative Example 1	0.6	4.2×10^6	4.4×10^6	○
Comparative Example 2	15	1.2×10^5	4.8×10^4	×
Comparative Example 3	16.5	2.8×10^5	8.6×10^4	×

[0235]

[Example 5]

63 Parts by weight of 2-ethylhexyl acrylate (2EHA), 15 parts by weight of N-vinyl-2-pyrrolidone (NVP), 9 parts by weight of methyl methacrylate (MMA), and 13 parts by weight of 2-hydroxyethyl acrylate (HEA) serving as monomer components, 0.2 part by weight of 2,2'-azobisisobutyronitrile serving as a polymerization initiator, and 133 parts by weight of ethyl acetate serving as a polymerization solvent were loaded into a separable flask, and the materials were stirred for 1 hour while a nitrogen gas was introduced into the flask. After oxygen in a polymerization system had been removed as described above, a temperature in the flask was increased to 65°C, and the mixture was subjected to a reaction for 10 hours, followed by the addition of ethyl acetate. Thus, a solution of an

acrylic polymer (5) having a solid content concentration of 30 wt% was obtained. The weight-average molecular weight of the acrylic polymer (5) was 800,000.

Next, an isocyanate-based cross-linking agent (product name: "TAKENATE D110N," manufactured by Mitsui Chemicals, Incorporated) was added to the solution of the acrylic polymer (5) so that its amount became 5 parts by weight in terms of a solid content with respect to 100 parts by weight of the acrylic polymer (5) (solid content). A silane coupling agent (γ -glycidoxypyrpyltrimethoxysilane, product name: "KBM403," manufactured by Shin-Etsu Chemical Co., Ltd.) was added to the mixture so that its amount became 0.5 part by weight in terms of a solid content with respect to 100 parts by weight of the acrylic polymer (solid content), followed by the mixing of the materials. Thus, a pressure-sensitive adhesive composition (5) was prepared.

The pressure-sensitive adhesive composition (5) was applied to one surface of a PET base material ("LUMIRROR S10" (thickness: 75 μ m, manufactured by Toray Industries, Inc.)) to form an applied layer on the PET base material. Next, the PET base material having formed thereon the applied layer was loaded into an oven, and the applied layer was dried at 130°C for 3 minutes. Thus, a pressure-sensitive adhesive tape (5) including a pressure-sensitive adhesive layer having a thickness of 10 μ m on one surface of the

PET base material was obtained.

The results are shown in Table 3.

[0236]

[Example 6]

The same procedure as that of Example 5 was followed except that the pressure-sensitive adhesive composition (5) was applied so as to provide a pressure-sensitive adhesive tape (6) including a pressure-sensitive adhesive film (pressure-sensitive adhesive layer) having a thickness of 15 μm .

The results are shown in Table 3.

[0237]

[Example 7]

95 Parts by weight of n-butyl acrylate (BA) and 5 parts by weight of acrylic acid (AA) serving as monomer components, and 185.7 parts by weight of ethyl acetate serving as a polymerization solvent were loaded into a separable flask, and the materials were stirred for 1 hour while a nitrogen gas was introduced into the flask. After oxygen in a polymerization system had been removed as described above, a temperature in the flask was increased to 63°C, and the mixture was subjected to a reaction for 10 hours, followed by the addition of toluene. Thus, a solution of an acrylic polymer having

a solid content concentration of 25 wt% was obtained.

The weight-average molecular weight of an acrylic polymer in the acrylic polymer solution was 600,000.

Next, 95 parts by weight of cyclohexyl methacrylate [glass transition temperature of a homopolymer (polycyclohexyl methacrylate): 66°C] and 5 parts by weight of acrylic acid serving as monomer components, 10 parts by weight of α -methylstyrene dimer serving as a chain transfer agent, 10 parts by weight of 2,2'-azobisisobutyronitrile serving as a polymerization initiator, and 120 parts by weight of toluene serving as a polymerization solvent were loaded into a separable flask, and the materials were stirred for 1 hour while a nitrogen gas was introduced into the flask. After oxygen in a polymerization system had been removed as described above, a temperature in the flask was increased to 85°C, and the mixture was subjected to a reaction for 5 hours. Thus, an acrylic oligomer solution having a solid content concentration of 50 wt% was obtained.

The weight-average molecular weight of an acrylic oligomer in the acrylic oligomer solution was 4,000.

Next, a silane coupling agent (γ -glycidoxypropyltrimethoxysilane, product name: "KBM403,"

manufactured by Shin-Etsu Chemical Co., Ltd.) was added to the acrylic polymer solution so that its amount became 0.15 part by weight in terms of a solid content with respect to 100 parts by weight of the acrylic polymer (solid content). A cross-linking agent (epoxy-based cross-linking agent, product name: "TETRAD-C," manufactured by Mitsubishi Gas Chemical Company, Inc.) was added to the mixture so that its amount became 0.075 part by weight in terms of a solid content with respect to 100 parts by weight of the acrylic polymer (solid content). Further, the acrylic oligomer solution was added to the resultant so that the amount of the acrylic oligomer became 25 parts by weight in terms of a solid content with respect to 100 parts by weight of the acrylic polymer (solid content), followed by the mixing of the materials. Thus, a pressure-sensitive adhesive composition (7) was prepared.

The pressure-sensitive adhesive composition (7) was applied to one surface of a PET base material (thickness: 75 μm) to form an applied layer on the PET base material. Next, the PET base material having formed thereon the applied layer was loaded into an oven, and the applied layer was dried at 130°C for 3 minutes. Thus, a pressure-sensitive adhesive tape (7) including a pressure-sensitive adhesive film (pressure-sensitive adhesive layer) having a thickness of 10 μm on one surface of the PET base material was obtained.

The results are shown in Table 3.

[0238]

[Example 8]

63 Parts by weight of 2-ethylhexyl acrylate (2EHA), 15 parts by weight of N-vinyl-2-pyrrolidone (NVP), 9 parts by weight of methyl methacrylate (MMA), and 13 parts by weight of 2-hydroxyethyl acrylate (HEA) serving as monomer components, 0.2 part by weight of 2,2'-azobisisobutyronitrile serving as a polymerization initiator, and 133 parts by weight of ethyl acetate serving as a polymerization solvent were loaded into a separable flask, and the materials were stirred for 1 hour while a nitrogen gas was introduced into the flask. After oxygen in a polymerization system had been removed as described above, a temperature in the flask was increased to 65°C, and the mixture was subjected to a reaction for 10 hours, followed by the addition of ethyl acetate. Thus, a solution of an acrylic polymer having a solid content concentration of 30 wt% was obtained.

The weight-average molecular weight of an acrylic polymer in the acrylic polymer solution was 800,000.

Next, an isocyanate-based cross-linking agent (product name: "TAKENATE D110N," manufactured by Mitsui Chemicals, Incorporated) was added to the acrylic polymer solution so that its amount became 1.1 parts by weight in terms of a solid content with respect to

100 parts by weight of the acrylic polymer (solid content). A silane coupling agent (γ -glycidoxypyrpyltrimethoxysilane, product name: "KBM403," manufactured by Shin-Etsu Chemical Co., Ltd.) was added to the mixture so that its amount became 0.15 part by weight in terms of a solid content with respect to 100 parts by weight of the acrylic polymer (solid content), followed by the mixing of the materials. Thus, a pressure-sensitive adhesive composition (8) was prepared.

The pressure-sensitive adhesive composition (8) was applied to one surface of a PET base material (thickness: 75 μ m) to form an applied layer on the PET base material. Next, the PET base material having formed thereon the applied layer was loaded into an oven, and the applied layer was dried at 130°C for 3 minutes. Thus, a pressure-sensitive adhesive tape (8) including a pressure-sensitive adhesive film (pressure-sensitive adhesive layer) having a thickness of 10 μ m on one surface of the PET base material was obtained.

The results are shown in Table 3.

[0239] [Comparative Example 4]

The same procedure as that of Example 5 was followed except that the pressure-sensitive adhesive composition (5) was applied so as to provide a pressure-sensitive adhesive tape (C4) including a pressure-sensitive adhesive film (pressure-sensitive adhesive

layer) having a thickness of 25 μm .

The results are shown in Table 3.

[0240]

[Comparative Example 5]

The same procedure as that of Example 7 was followed except that the pressure-sensitive adhesive composition (7) was applied so as to provide a pressure-sensitive adhesive tape (C5) including a pressure-sensitive adhesive film (pressure-sensitive adhesive layer) having a thickness of 25 μm .

The results are shown in Table 3.

[0241]

[Comparative Example 6]

The same procedure as that of Example 8 was followed except that the pressure-sensitive adhesive composition (8) was applied so as to provide a pressure-sensitive adhesive tape (C6) including a pressure-sensitive adhesive film (pressure-sensitive adhesive layer) having a thickness of 25 μm .

The results are shown in Table 3.

[0242]

Table 3

	Pressure-sensitive adhesive composition	Pressure-sensitive adhesive film thickness (μm)	Adhesive strength to surface of polyimide film (N)	Storage modulus of elasticity G' at 25°C (Pa)	Storage modulus of elasticity G' at 160°C (Pa)	Evaluation of deformation of pressure-sensitive adhesive by 30 MPa pressing at 160°C
Example 5	(5)	10	11	1.2×10^5	2.4×10^4	o
Example 6	(5)	15	11	1.2×10^5	2.4×10^4	Δ
Example 7	(7)	10	10	1.2×10^5	4.8×10^4	o
Example 8	(8)	10	12	2.8×10^5	8.6×10^4	o
Comparative Example 4	(5)	25	15	1.2×10^5	2.4×10^4	x
Comparative Example 5	(7)	25	15	1.2×10^5	4.8×10^4	x
Comparative Example 6	(8)	25	16.5	2.8×10^5	8.6×10^4	x

Industrial Applicability

[0243]

The pressure-sensitive adhesive or pressure-sensitive adhesive tape of the present invention has a sufficient adhesive strength and is reduced in high-temperature strain. Accordingly, the pressure-sensitive adhesive or the pressure-sensitive adhesive tape can be utilized in, for example, a pressure-sensitive adhesive tape to be bonded to, for example, the substrate of a semiconductor element.

Claims

[Claim 1]

A pressure-sensitive adhesive, which has an adhesive strength to a surface of a polyimide film of 1 N or more, and a storage modulus of elasticity G' at 160°C of 1×10^5 Pa or more.

[Claim 2]

The pressure-sensitive adhesive according to claim 1, wherein the adhesive strength is 5 N or more.

[Claim 3]

The pressure-sensitive adhesive according to claim 1 or 2, wherein the storage modulus of elasticity G' at 160°C is 5×10^5 Pa or more.

[Claim 4]

The pressure-sensitive adhesive according to any one of claims 1 to 3, wherein the pressure-sensitive adhesive has a cross-linked structure.

[Claim 5]

The pressure-sensitive adhesive according to any one of claims 1 to 4, wherein the pressure-sensitive adhesive is formed from a pressure-sensitive adhesive composition containing an acrylic polymer (A), and an isocyanate-based cross-linking agent and/or

an epoxy-based cross-linking agent.

[Claim 6]

The pressure-sensitive adhesive according to claim 5, wherein a total content of the isocyanate-based cross-linking agent and the epoxy-based cross-linking agent in the pressure-sensitive adhesive composition is from 0.1 part by weight to 30 parts by weight with respect to 100 parts by weight of the acrylic polymer (A).

[Claim 7]

The pressure-sensitive adhesive according to claim 6, wherein a content of the isocyanate-based cross-linking agent in the pressure-sensitive adhesive composition is from 2 parts by weight to 20 parts by weight with respect to 100 parts by weight of the acrylic polymer (A).

[Claim 8]

The pressure-sensitive adhesive according to claim 6, wherein a content of the epoxy-based cross-linking agent in the pressure-sensitive adhesive composition is from 0.3 part by weight to 10 parts by weight with respect to 100 parts by weight of the acrylic polymer (A).

[Claim 9]

The pressure-sensitive adhesive according to any one of claims

1 to 4, wherein the pressure-sensitive adhesive is formed from a pressure-sensitive adhesive composition containing an acrylic polymer (B) and a UV-curable oligomer.

[Claim 10]

The pressure-sensitive adhesive according to claim 9, wherein the UV-curable oligomer comprises at least one kind selected from a UV-curable urethane-based oligomer, a UV-curable acrylic oligomer, and a UV-curable urethane-acrylic oligomer.

[Claim 11]

The pressure-sensitive adhesive according to any one of claims 1 to 4, wherein the pressure-sensitive adhesive is formed from a pressure-sensitive adhesive composition containing a urethane-based polymer and an acrylic monomer.

[Claim 12]

The pressure-sensitive adhesive according to claim 11, wherein the urethane-based polymer contains a (meth)acryloyl group-terminated urethane-based polymer.

[Claim 13]

A pressure-sensitive adhesive tape, comprising the pressure-sensitive adhesive of any one of claims 1 to 12.

[Claim 14]

A film substrate, comprising the pressure-sensitive adhesive of any one of claims 1 to 12.

[Claim 15]

A pressure-sensitive adhesive film, which has an adhesive strength to a surface of a polyimide film of 1 N or more, a storage modulus of elasticity G' at 160°C of 1×10^4 Pa or more, and a thickness of 20 μm or less.

[Claim 16]

The pressure-sensitive adhesive film according to claim 15, wherein the adhesive strength is 5 N or more.

[Claim 17]

The pressure-sensitive adhesive film according to claim 15 or 16, wherein the thickness is 15 μm or less.

[Claim 18]

The pressure-sensitive adhesive film according to any one of claims 15 to 17, wherein the pressure-sensitive adhesive film is formed from a pressure-sensitive adhesive composition containing an acrylic polymer.

[Claim 19]

A pressure-sensitive adhesive tape, comprising the pressure-sensitive adhesive film of any one of claims 15 to 18.

[Claim 20]

A film substrate, comprising the pressure-sensitive adhesive film of any one of claims 15 to 18.