DESCRIPTION

PRESSURE-SENSITIVE ADHESIVE COMPOSITION, SURFACE PROTECTIVE FILM, AND MOTHER GLASS SURFACE PROTECTIVE FILM FOR FLAT PANEL DISPLAY

TECHNICAL FIELD

[0001]

The invention relates to a pressure-sensitive adhesive composition. More specifically, the invention relates to a pressure-sensitive adhesive layer produced therewith and a mother glass surface protective film produced therewith for flat panel displays.

BACKGROUND ART

[0002]

Glass base materials are used for the production of flat panel displays such as liquid crystal displays, plasma display panels, and organic electroluminescent (EL) displays. Glass plates manufactured in factories are distributed (transported) as mother glasses, which are worked into such glass base materials. If the glass surface is scratched or damaged during the transportation, storage, shipping and transportation, or customers' storage of mother glass plates, it may cause a reduction in yield or an adverse effect on quality. In general, therefore, a

surface protective film is attached to the glass surface.

[0003]

The surface protective film-sticking mother glass plate for flat panel displays is delivered to panel manufacturers, in which the process of peeling off the surface protective film is performed. If the peeling off is laborious (it is hard to perform the peeling off), the workability will be degraded. If the film is not completely peeled off, the problem of defective peeling will occur.

[0004]

After the surface protective film is peeled off, residues derived from the surface protective film are cleaned and removed using a cleaning liquid or the like. This process also present a problem in which the residues resist being removed from the glass surface.

[0005]

Another problem also occurs, in which the residues derived from the surface protective film may degrade the quality during the process of manufacturing TFT substrates. Therefore, improvement of the process of cleaning and removing the residues has been demanded.

[0006]

Under the circumstances, Patent Document 1 proposes a surface protective film including a substrate layer made of

polyethylene and a pressure-sensitive adhesive layer that is placed on the substrate layer, which contains 50% by weight or more of low-density polyethylene with a density of 0.91 to 0.93 g/cm^3 and has a center line average roughness Ra of 0.05 μm or less.

[0007]

However, the surface protective film described in Patent Document 1 has a problem in which after attached to a glass plate, the surface protective film resists being peeled off to make the workability poor, or residues deposited on (transferred to) a glass plate resist being removed by cleaning.

[0008]

Patent Document 2 discloses a two-layer film including a substrate layer made of thermoplastic resin and a pressure-sensitive adhesive layer that is formed on one side of the substrate layer and made of an ethylene-vinyl acetate copolymer. Patent Document 3 discloses a surface protective pressure-sensitive adhesive tape including a substrate layer and a pressure-sensitive adhesive layer that is provided on one side of the substrate layer and made of an acryl-based pressure-sensitive adhesive made from a butyl acrylate-acrylic acid copolymer crosslinked with an aromatic isocyanate crosslinking agent.

[0009]

However, the two-layer film and the pressure-sensitive adhesive tape may also have the same problems.

[0010]

Patent Document 1: Japanese Patent No.3103190

Patent Document 2: Japanese Patent No.2980434

Patent Document 3: Japanese Patent Application Laid-Open (JP-A) No.7-143643

DISCLOSURE OF THE INVENSION

Problems to be solved by the invention

[0011]

It is therefore an object of the invention to solve the problems with the conventional surface protective films (sheets) and to provide a pressure-sensitive adhesive composition that makes it possible to produce a surface protective film that can be easily attached to a glass surface and then peeled off to such an extent that residues derived from the surface protective film (derived from the pressure-sensitive adhesive layer thereof) can be easily cleaned or removed, and to provide such a pressure-sensitive adhesive layer and a mother glass surface protective film produced therewith for flat panel displays.

Means for Solving the Problems

[0012]

As a result of investigations to achieve the above object, the inventors have found the pressure-sensitive adhesive composition and the pressure-sensitive adhesive layer described below and the mother glass surface protective film produced therewith as described below to complete the invention.

[0013]

That is, the invention is directed to a pressure-sensitive adhesive composition including 100 parts by weight of a thermoplastic resin and 0.01 to 2 parts by weight of an alkylene oxide group-containing compound. Although the detail is not clear, the pressure-sensitive adhesive layer of the surface protective film produced with the composition containing the thermoplastic resin and the alkylene oxide group-containing compound can be easily attached to a glass surface, and residues derived from the surface protective film (derived from the pressure-sensitive adhesive layer thereof) such as low-molecular-weight compounds derived from the pressure-sensitive adhesive layer can be replaced by the alkylene oxide group-containing compound, so that the amount of such residues can be reduced. After the surface protective film is peeled off, the residues can be easily cleaned and removed by a cleaning process, which also makes the surface protective film useful.

[0014]

In the pressure-sensitive adhesive composition of the invention, the alkylene oxide group-containing compound is preferably a surfactant. Although the detail is not clear, the pressure-sensitive adhesive layer of the surface protective film produced with the composition containing the surfactant can be easily attached to a glass surface, and residues derived from the surface protective film (derived from the pressure-sensitive adhesive layer thereof) such as low-molecular-weight compounds derived from the pressure-sensitive adhesive layer can be replaced by the surfactant, so that the amount of such residues can be reduced. The addition of the surfactant makes it possible to easily clean and remove the residues in a cleaning process after the peeling off of the surface protective film, which also makes the surface protective film useful.

[0015]

The invention is also directed to a surface protective film that is preferably produced using the pressure-sensitive adhesive composition. The surface protective film produced with the pressure-sensitive adhesive composition can be easily formed into a film, a sheet, a tape, or any other shape and therefore is useful.

[0016]

The invention is also directed to a mother glass surface protective film for a flat panel display, which preferably includes a single layer produced with the pressure-sensitive adhesive composition. The single layer itself, which is produced with the pressure-sensitive adhesive composition, functions as a mother glass surface protective film for a flat panel display, which can reduce the number of manufacturing processes and provide high workability.

[0017]

The invention is also directed to a mother glass surface protective film for a flat panel display, which preferably includes a substrate and the pressure-sensitive adhesive composition formed on one or both sides of the substrate. The mother glass surface protective film for a flat panel display produced with the pressure-sensitive adhesive composition on a substrate is useful for protecting the surface of the adherend (glass) from contamination and preventing scratches and other damages

[0018]

As used herein, the term "mother glass for a flat panel display(s)" refers to a glass plate that may be distributed before it is worked or processed into various products and may be used for the production of flat panel displays. Examples of flat panel displays include display

devices such as liquid crystal displays, plasma display panels and organic EL displays.

BEST MODE FOR CARRYING OUT THE INVENTION

[0019]

Embodiments of the invention will be described in detail hereinafter.

[0020]

The invention is directed to a pressure-sensitive adhesive composition including 0.01 to 2 parts by weight of an alkylene oxide group-containing compound for 100 parts by weight of a thermoplastic resin.

[0021]

In an embodiment of the invention, a thermoplastic resin is used as a base polymer for the pressure-sensitive adhesive composition.

[0022]

The thermoplastic resin to be used may be any appropriate thermoplastic resin capable of exhibiting adherability, such as a polyethylene resin, a polypropylene resin, a propylene-ethylene block, random, or graft polymer, a polystyrene resin, an acryl-based resin, or any other known thermoplastic pressure-sensitive adhesive resins. These resins may be used alone or in combination of two or more.

[0023]

Examples of the polyethylene resin include polyolefin resins such as low-density polyethylene, linear low-density polyethylene, polypropylene, poly-1-butene, poly-4-methyl-1-pentene, ethylene/propylene copolymers, ethylene/1-butene copolymers, ethylene/1-hexene copolymers, ethylene/4-methyl-1-pentene copolymers, ethylene/1-octene copolymers, ethylene/methyl acrylate copolymers, ethylene/methyl methacrylate copolymers, ethylene/vinyl acetate copolymers, ethylene/ethyl acrylate copolymers, and ethylene/vinyl alcohol copolymers.

[0024]

Examples of the polystyrene resin include A-B diblock polymers such as styrene/butadiene (SB) copolymers, styrene-isoprene (SI) copolymers, styrene/ethylene-butylene (SEB) copolymers, and styrene/ethylene-propylene (SEP) copolymers; A-B-A triblock, A-B-A-B tetrablock, or multi-block polymers such as styrene/butadiene/styrene (SBS) copolymers, styrene-isoprene-styrene (SIS) copolymers, styrene/ethylene-butylene-styrene (SEBS) copolymers, and styrene/ethylene-propylene-styrene (SEPS) copolymers; styrene-based random copolymers such as styrene/butadiene rubber (SBR); and A-B-C styrene-olefin crystalline block polymers such as styrene/ethylene-butylene/olefin crystalline(SEBC) copolymers.

[0025]

When the polyethylene resin is used as the thermoplastic resin, the polyethylene resin is preferably a low-density polyethylene resin with a density of 0.880 to 0.950 g/cm^3, more preferably 0.880 to 0.923 g/cm^3, even more preferably 0.880 to 0.915 g/cm^3. Such a low-density polyethylene resin is highly flexible and practically useful. As used herein, the term "density (g/cm^3)" refers to a value measured according to ISO 1183.

[0026]

In an embodiment of the invention, the pressure-sensitive adhesive composition contains 0.01 to 2 parts by weight, preferably 0.05 to 1.5 parts by weight, more preferably 0.1 to 1 part by weight of an alkylene oxide group-containing compound, based on 100 parts by weight of the thermoplastic resin. If the content is less than 0.01 parts by weight, the ability to remove residues in a cleaning process may be low. If the content is more than 2 parts by weight, defective molding may occur in the process of forming a surface protective film (when the film is extrusion-molded). Such defective molding may be caused when the alkylene oxide group-containing compound, which has a relatively low viscosity, is mixed in a large amount so that its fluidity with the thermoplastic resin may be non-uniform. Also in that case, even if the film is formed,

a relatively large amount of a cleaning liquid must be used to remove residues in the cleaning process, which is not preferred in view of cost.

[0027]

Examples of the alkylene oxide group-containing compound that may be used include ethylene glycol, propylene glycol, butylene glycol, glycol salicylate, propylene glycol monofatty acid ester, polyoxyethylene/polyoxypropylene glycol, polyoxyalkylene decyl ether, polyoxyethylene styryl phenyl ether, polyoxyethylene alkyl ether, polyoxyethylene lauryl ether, polyoxyethylene lanolin alcohol ether, polyoxyethylene alkyl amine ether, polyoxyethylene (2) lauric acid monoethanolamide, polyoxyethylene (5) coconut oil fatty acid monoethanolamide, sodium polyoxyethylene lauryl sulfate, polyoxyethylene sorbitan fatty acid ester, sorbitan fatty acid ester, polyoxyethylene castor oil, polyoxyethylene hydrogenated castor oil, polyoxyethylene lanolin fatty acid ester, and other compounds. These compounds may be used as an emulsifying agent, a dispersing agent, a lubricant, a suspending agent, an anti-corrosion agent, a surfactant, an antistatic agent, or the like, and in particular, preferably used as a surfactant.

[0028]

The surfactant may be of any type as long as it

corresponds to the alkylene oxide group-containing compound. Preferred examples of the surfactant include the above ether compounds such as polyoxyethylene/polyoxypropylene glycol, polyoxyalkylene decyl ether, polyoxyethylene styryl phenyl ether, polyoxyethylene alkyl ether, polyoxyethylene lauryl ether, polyoxyethylene lanolin alcohol ether, and polyoxyethylene alkyl amine ether. Preferred examples also include the amide compounds such as polyoxyethylene (2) lauric acid monoethanolamide, polyoxyethylene (5) coconut oil fatty acid monoethanolamide, and sodium polyoxyethylene lauryl sulfate. Preferred examples further include the ester compounds such as polyoxyethylene sorbitan fatty acid ester, sorbitan fatty acid ester, polyoxyethylene castor oil, polyoxyethylene hydrogenated castor oil, and polyoxyethylene lanolin fatty acid ester.

[0029]

In an embodiment of the invention, the pressure-sensitive adhesive layer used for the surface protective film may contain any of various known conventional additives such as additives for controlling adherability or the like, such as various known conventional softening agents and tackifiers, olefin reins that may be used in the substrate layer, silicone polymers, and liquid acryl-based copolymers, phosphoric acid ester compounds, anti-aging agents, hindered amine light stabilizers, ultraviolet-

absorbing agents, surface lubricants, leveling agents, plasticizers, low-molecular-weight polymers, antioxidants, corrosion inhibitors, polymerization inhibitors, silane coupling agents, inorganic and organic fillers (such as calcium oxide, magnesium oxide, silica, zinc oxide, and titanium oxide), powders, particles or foils of metals, colorants or pigments, and heat-resistant stabilizers, depending on the intended use.

[0030]

The pressure-sensitive adhesive composition may be melted by heating and formed into a pressure-sensitive adhesive layer. The pressure-sensitive adhesive layer obtained by heating and melting the pressure-sensitive adhesive composition is useful, because it can be easily formed into a film, a sheet, a tape, or any other shape.

[0031]

The pressure-sensitive adhesive layer may be formed using any known method such as melt extrusion or calendering.

[0032]

If necessary, the surface of the pressure-sensitive adhesive layer may be subjected to a surface treatment for the control of the adherability, the bonding or sticking workability, or other purposes, such as a corona discharge treatment, an ultraviolet irradiation treatment, a flame

treatment, a plasma treatment, or a sputter etching treatment.

[0033]

If necessary, a separator or any other material may be temporarily attached to the pressure-sensitive adhesive layer so that the pressure-sensitive adhesive layer can be protected until actual use.

[0034]

In the surface protective film of the invention, the pressure-sensitive adhesive layer generally has a thickness of about 1 to about 50 μm, preferably 2 to 40 μm, more preferably 3 to 20 μm. If the thickness is less than 1 μm, it may be difficult to perform the adherability. If the thickness is more than 50 μm, peeling may be difficult, or a large amount of the alkylene oxide group-containing compound should be added to the pressure-sensitive adhesive layer, which is disadvantageous in cost and is not preferred.

[0035]

The pressure-sensitive adhesive layer may be used in the form of a single layer to form a surface protective film, particularly, a mother glass surface protective film for flat panel displays. The pressure-sensitive adhesive layer itself can function as the surface protective film, which is useful for reducing the number of manufacturing

processes.

[0036]

The pressure-sensitive adhesive layer may be formed on one or both sides of a substrate so that a mother glass surface protective film for flat panel displays can be formed. The surface protective film including the pressure-sensitive adhesive layer formed on the substrate is useful for protecting the surface of the adherend (glass) from contamination and preventing scratches or other damages.

[0037]

In an embodiment of the invention, any material capable of being formed into a sheet, a film, a tape, or any other shape may be used for the substrate (layer). For example, a polyolefin resin having heat resistance, solvent resistance and flexibility is preferably used. The substrate layer having flexibility may be taken up into a roll or subjected to various working processes as needed.

[0038]

Examples of the polyolefin resin include polyethylene resins, propylene resins composed of propylene or propylene and ethylene components, and ethylene-vinyl acetate copolymers, and so on.

[0039]

Specific examples thereof include low-density

polyethylene, linear low-density polyethylene, polypropylene, poly-1-butene, poly-4-methyl-1-pentene, ethylene/propylene copolymers, ethylene/1-butene copolymers, ethylene/1-hexene copolymers, ethylene/4-methyl-1-pentene copolymers, ethylene/1-octene copolymers, ethylene/-methyl acrylate copolymers, ethylene/methyl methacrylate copolymers, ethylene/vinyl acetate copolymers, ethylene/ethyl acrylate copolymers, ethylene/vinyl alcohol copolymers, and other polyolefin reins.

[0040]

In an embodiment of the invention, if desired, the substrate layer may contain any of various known conventional additives generally used in substrates for this type of films, sheets, tapes, or other materials. Examples of such additives include a variety of fillers, pigments, ultraviolet-absorbing agents, antioxidants, heat-resistant stabilizers, lubricants, and so on.

[0041]

In general, the substrate layer preferably has a thickness of about 20 to about 300 μm, more preferably about 20 to about 250 μm, even more preferably about 25 to about 200 μm. If the substrate layer has a thickness of less than 20 μm, it may be broken or torn during peeling. If the thickness is more than 300 μm, the substrate may be so stiff that it may separate or peel after bonding.

[0042]

The substrate layer side of the surface protective film may be subjected to a hand-tearability- or slip-resistance-imparting process such as an embossing or irregularities-forming process.

[0043]

In an embodiment of the invention, a method for producing the surface protective film may include heating and melting materials for forming a polyolefin resin substrate layer and a thermoplastic resin pressure-sensitive adhesive layer, respectively, and co-extruding the melted materials to integrally form a substrate layer and a pressure-sensitive adhesive layer or layers on one or both sides thereof, so that a film having a predetermined thickness and a two-layer structure (or a multilayer structure having three or more layers) is formed. This method is preferred, because it can produce the surface protective film of the invention with high efficiency at low cost.

[0044]

The co-extrusion may be performed by any method generally used for the production of films, sheets and other materials. For example, an inflation method, a co-extrusion T-die method or the like may be used. These co-extrusion methods are preferably used in view of cost and

productivity.

[0045]

Any number of layers may be formed in each of the above layers. The substrate layer and the pressure-sensitive adhesive layer may each be a single layer or, if necessary, have a multilayered structure.

[0046]

In an embodiment of the invention, the entire thickness of the surface protective film is preferably from 20 to 150 μm, more preferably from about 30 to about 100 μm. If the entire thickness is less than 20 μm, the peeling workability may be poor, so that breakage or other problems may occur. If it is more than 150 μm, the problem of separation after bonding may occur, or the film may be disadvantageous in cost, which is not preferred.

EXAMPLES

[0047]

The features and effects of the invention are more specifically described by the examples and others below which are not intended to limit the scope of the invention. The evaluation items in the examples and others were measured as described below.

[0048]

(1) Peel Force

The surface protective film was attached to a mother glass plate (NA35 manufactured by NH TECHNO GLASS CORPORATION) for a liquid crystal substrate, then press-bonded (0.2 MPa, 1.0 m/minute) thereto and stored at 23°C for 1 day. The surface protective film was peeled off using a tensile tester (TCM-5KNB-3 manufactured by Minebea Co., Ltd., at a tension rate of 0.3 m/minute and an angle of 180°), when the peel force (N/20 mm) was measured. The peel force is preferably 0.02 N/20 mm or less, more preferably 0.015 N/20 mm or less. In view of adhesion and the measuring limit of the tester, the peel force is preferably 0.001 N/20 mm or more. If the peel force is high, peeling workability may be poor, and the residues derived from the surface protective film may tend to increase.

[0049]

(2) Contact Angle

The surface protective film was attached to a glass plate (NA35 manufactured by NH TECHNO GLASS CORPORATION), then press-bonded (0.2 MPa, 1.0 m/minute) thereto, and stored at 40°C for 4 days. Thereafter, the contact angle was measured before cleaning. The glass surface was then subjected to ultrasonic cleaning with an aqueous solution of 2.0% of an inorganic alkaline cleaner (KG manufactured by YOKOHAMA OILS & FATS INDUSTRY CO., LTD.) for 2 minutes

and further to rinsing with distilled water for 3 minutes. After the cleaning process, the contact angle was also measured.

[0050]

(3) Cleaning Effect (Cleaning Rate)

The cleaning effect (cleaning rate) was calculated from the formula below. The cleaning effect is preferably 65% or more, more preferably 70% or more. If the cleaning effect is less than 65%, residues may undesirably cause defective peeling.

Cleaning effect (cleaning rate) (%) = 100 × [(contact angle before cleaning - contact angle after cleaning)/(contact angle before cleaning)]

[0051]

(4) Molding Conditions

In each of the examples (exclusive of Example 10) and the comparative examples, molding was performed by an inflation method, in which concerning the melting temperature for the substrate layer and the pressure-sensitive adhesive layer, the die temperature and the co-extrusion temperature were all set at 180°C. In Example 10, molding was performed by a T-die method, in which concerning the melding temperature, the extruder temperature and the die temperature were all set at 190°C.

[0052]

Example 1

A surface protective film (30 μm in thickness) having a two-layer structure was obtained by the inflation method under the above molding conditions using a substrate layer (26 μm in thickness) made of low-density polyethylene (LDPE) (PETROCENE 183 manufactured by TOSOH CORPORATION) and a pressure-sensitive adhesive layer (4 μm in thickness) containing 100 parts by weight of linear low-density polyethylene (LLDPE) (Sumikacene EFV402 manufactured by Sumitomo Chemical Co., Ltd.) and 0.06 parts by weight of polyoxyethylene/polyoxypropylene glycol (EPAN 485 manufactured by DAI-ICHI KOGYO SEIYAKU CO., LTD.).

[0053]

Example 2

A surface protective film (30 μm in thickness) was obtained using the process of Example 1, except that the amount of the addition of polyoxyethylene/polyoxypropylene glycol was changed to 0.36 parts by weight.

[0054]

Example 3

A surface protective film (30 μm in thickness) was obtained using the process of Example 1, except that the amount of the addition of polyoxyethylene/polyoxypropylene glycol was changed to 0.6 parts by weight.

[0055]

Example 4

A surface protective film (30 μm in thickness) was obtained using the process of Example 1, except that the amount of the addition of polyoxyethylene/polyoxypropylene glycol was changed to 0.9 parts by weight.

[0056]

Example 5

A surface protective film (30 μm in thickness) having a two-layer structure was obtained by the inflation method under the above molding conditions using a substrate layer (26 μm in thickness) made of low-density polyethylene (LDPE) (PETROCENE 183 manufactured by TOSOH CORPORATION) and a pressure-sensitive adhesive layer (4 μm in thickness) containing 100 parts by weight of linear low-density polyethylene (Evolue SP1540 manufactured by Prime Polymer Co., Ltd.) and 0.06 parts by weight of polyoxyethylene (2) lauric acid monoethanolamide (Amizett 2L-Y manufactured by Kawaken Fine Chemicals Co., Ltd.).

[0057]

Example 6

A surface protective film (30 μm in thickness) was obtained using the process of Example 5, except that 0.18 parts by weight of polyoxyalkylene decyl ether (NOIGEN XL-400 manufactured by DAI-ICHI KOGYO SEIYAKU CO., LTD.) was added in place of polyoxyethylene (2) lauric acid

monoethanolamide.

[0058]

Example 7

A surface protective film (30 μm in thickness) having a two-layer structure was obtained by the inflation method under the above molding conditions using a substrate layer (26 μm in thickness) made of low-density polyethylene (LDPE) (PETROCENE 183 manufactured by TOSOH CORPORATION) and a pressure-sensitive adhesive layer (4 μm in thickness) containing 50 parts by weight of linear low-density polyethylene (Evolue SP1540 manufactured by Prime Polymer Co., Ltd.) and 50 parts by weight of linear low-density polyethylene (LLDPE) (Sumikacene EFV402 manufactured by Sumitomo Chemical Co., Ltd.) (100 parts by weight in total) and 0.06 parts by weight of polyoxyethylene styryl phenyl ether (NOIGEN EA-177 manufactured by DAI-ICHI KOGYO SEIYAKU CO., LTD.).

[0059]

Example 8

A surface protective film (30 μm in thickness) was obtained using the process of Example 7, except that the amount of the addition of polyoxyethylene styryl phenyl ether was changed to 0.18 parts by weight.

[0060]

Example 9

A surface protective film (30 μm in thickness) was obtained using the process of Example 7, except that the amount of the addition of polyoxyethylene styryl phenyl ether was changed to 0.36 parts by weight.

[0061]

Example 10

A surface protective film (35 μm in thickness) having a single layer structure was obtained by the T-die method using a single pressure-sensitive adhesive layer containing 100 parts by weight of an ethylene-vinyl alcohol copolymer (EVA) (Novatec LV440 manufactured by Japan Polyethylene Corporation) and 1.2 parts by weight of polyoxyethylene polyoxypropylene glycol (EPAN 485 manufactured by DAI-ICHI KOGYO SEIYAKU CO., LTD.).

[0062]

Example 11

A surface protective film (30 μm in thickness) having a two-layer structure was obtained by the inflation method under the above molding conditions using a substrate layer (26 μm in thickness) made of an ethylene/vinyl alcohol copolymer (EVA) (Novatec LV440 manufactured by Japan Polyethylene Corporation) and a pressure-sensitive adhesive layer (4 μm in thickness) containing 100 parts by weight of a styrene-ethylene/butylene-ethylene block copolymer (SEBC) (DYNARON 4600P manufactured by JSR Corporation) and 1.8

parts by weight of polyoxyethylene/polyoxypropylene glycol (EPAN 485 manufactured by DAI-ICHI KOGYO SEIYAKU CO., LTD.).

[0063]

Comparative Example 1

A surface protective film (30 μm in thickness) having a two-layer structure was obtained by the inflation method under the above molding conditions using a substrate layer (26 μm in thickness) made of low-density polyethylene (LDPE) (PETROCENE 183 manufactured by TOSOH CORPORATION) and a pressure-sensitive adhesive layer (4 μm in thickness) made of linear low-density polyethylene (LLDPE) (Sumikacene EFV402 manufactured by Sumitomo Chemical Co., Ltd.).

[0064]

Comparative Example 2

A surface protective film (30 μm in thickness) having a two-layer structure was obtained by the inflation method under the above molding conditions using a substrate layer (26 μm in thickness) made of low-density polyethylene (LDPE) (PETROCENE 183 manufactured by TOSOH CORPORATION) and a pressure-sensitive adhesive layer (4 μm in thickness) made of an ethylene-vinyl alcohol copolymer (EVA) (Novatec LV440 manufactured by Japan Polyethylene Corporation).

[0065]

Comparative Example 3

A pressure-sensitive adhesive solution prepared by

the polymerization of 94 parts by weight of butylene acrylate, 6 parts by weight of acrylic acid and 30 parts by weight of an isocyanate crosslinking agent (CORONATE L manufactured by NIPPON POLYURETHANE INDUSTRY CO., LTD.) was applied to one side of a substrate layer (26 μm in thickness) made of low-density polyethylene (LDPE) (PETROCENE 183 manufactured by TOSOH CORPORATION) to form a pressure-sensitive adhesive layer (4 μm in thickness), so that a surface protective film (30 μm in thickness) having a two-layer structure was obtained.

[0066]

Comparative Example 4

A surface protective film (30 μm in thickness) having a two-layer structure was obtained by the inflation method under the above conditions using a substrate layer (26 μm in thickness) made of low-density polyethylene (LDPE) (PETROCENE 183 manufactured by TOSOH CORPORATION) and a pressure-sensitive adhesive layer (4 μm in thickness) provided on one side of the substrate layer and containing 50 parts by weight of linear low-density polyethylene (LLDPE) (Evolue SP1540 manufactured by Prime Polymer Co., Ltd.) and 50 parts by weight of linear low-density polyethylene (LLDPE) (Sumikacene EFV402 manufactured by Sumitomo Chemical Co., Ltd.) and 2.5 parts by weight of polyoxyethylene styryl phenyl ether (NOIGEN EA-177

manufactured by DAI-ICHI KOGYO SEIYAKU CO., LTD.). However, the surface protective film suffered from defective film formation and significantly varied in thickness, and as a result, its properties were not able to be evaluated. It is considered that defective film formation occurred because the polyoxyethylene styryl phenyl ether was added in an excess amount so that the fluidity with the thermoplastic resin became non-uniform.

[0067]

The surface protective films prepared were measured and evaluated according the methods described above. The results are shown in Table 1.

[0068]

Table 1

(Note) For surface protecting film, the values are in units of parts by weight.				Examples											Comparative Examples			
				1	2	3	4	5	6	7	8	9	10	11	1	2	3	4
Surface protective film	Pressure-sensitive adhesive layer	Thermoplastic resin	LLDPE	100	100	100	100	100	100	100	100	100			100			100
			EVA										100			100		
			SEBC											100				
			Acrylic														100	
		Surfactant	A	0.06	0.36	0.6	0.9						1.2	1.8				
			B					0.06										
			C						0.18									
			D							0.06	0.18	0.36						2.5
	Substrate		LPDE	100	100	100	100	100	100	100	100	100			100	100	100	100
			EVA											100				
Resulting properties	Peel force (N/20 mn)			0.012	0.009	0.007	0.006	0.014	0.010	0.014	0.015	0.014	0.013	0.012	0.023	0.051	0.254	Not evaluable
	Contact angle (°)	Before cleaning		49.3	53.2	52.7	50.5	49.6	52.7	37.9	30.1	28.7	52.9	53.6	51.5	41.6	46.2	
		After cleaning		10.7	13.2	14.1	10.3	12.9	13.3	11.3	7.9	7.2	15.8	14.9	20.8	20.5	21.9	
	Cleaning effect (%)			78.3	75.2	73.2	79.6	74.0	74.8	70.2	73.8	74.9	70.1	72.2	59.6	50.7	52.6	

(Note) In Table 1, A represents polyoxyethylene/polyoxypropylene glycol, B polyoxyethylene (2) lauric acid monoethanolamide, C polyoxyalkylene decyl ether, and D polyoxyethylene styryl phenyl ether.

[0069]

From the results in Table 1, it was demonstrated that in each of the examples where the surface protective film was prepared according to the invention and used, the peel force was kept low, and the peeling workability and the cleaning effect (cleaning rate) were good and very high, respectively.

[0070]

It was also demonstrated that in the comparative examples where the alkylene oxide group-containing compound was not used, the peel force was high, and the peeling workability and the cleaning effect were both low.

[0071]

Thus, it is demonstrated that the surface protective film of the invention can be easily peeled off after it is attached to a glass surface, and after the peeling off, the residues derived from the surface protective film can be easily cleaned and removed.

CLAIMS

1. A pressure-sensitive adhesive composition, comprising:

100 parts by weight of a thermoplastic resin; and

0.01 to 2 parts by weight of an alkylene oxide group-containing compound.

2. The pressure-sensitive adhesive composition according to claim 1, wherein the alkylene oxide group-containing compound is a surfactant.

3. A surface protective film, comprising a product produced with the pressure-sensitive adhesive composition according to claim 1 or 2.

4. A mother glass surface protective film for a flat panel display, comprising a single layer produced with the pressure-sensitive adhesive composition according to claim 1 or 2.

5. A mother glass surface protective film for a flat panel display, comprising:

a substrate; and

the pressure-sensitive adhesive composition according to claim 1 or 2 formed on one or both sides of the substrate.