

SPECIFICATION

TITLE OF INVENTION: Multilayer film

TECHNICAL FIELD

[0001] The present invention relates to a multilayer film

BACKGROUND ART

[0002] Japanese Unexamined Patent Publication No. 2001-315273 proposes "a multilayer film provided with a release layer comprising a resin having a syndiotactic polystyrene resin as the main component, and an intermediate layer constituted from a resin mixture containing 30-60 wt% of elastomer resin units and olefin resin units in a syndiotactic polystyrene resin, or mixtures thereof." Such multilayer films can be used as mold release films for the manufacture of flexible printed circuit boards (hereafter referred to as "FPCs") with a cover lay film (hereafter referred to as "CL film") bonded using a hot press via an adhesive agent in a flexible film with exposed circuits (hereafter referred to as "circuit exposure film").

PRIOR ART LITERATURE

PATENT LITERATURE

[0003] Patent Document 1: Japanese Unexamined Patent Publication No. 2001-315273

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0004] However, the results of an investigation by the present inventors showed that the "multilayer film including a comparatively large amount of syndiotactic polystyrene resin in the intermediate layer" disclosed in Japanese Unexamined Patent Publication No. 2001-315273 had an elasticity modulus that was too high, and it was found to be susceptible to fracture in the press. Thus, the multilayer film ultimately underwent fracture in the press, and there is a risk of damage to the FPC by the fractured multilayer film, eventually it would become result in a higher rate of defective FPCs.

[0005] Moreover, for the same reasons as before, such multilayer films can be problematic in the uniform pressing of a CL film onto a circuit exposure film

during the manufacture of an FPC in that voids (microcavity defects) can readily form in the adhesive agent, and consequently it became clear to the present inventors that the FPC defect rate would ultimately become higher.

[0006] In addition, such multilayer films have extremely poor press setup workability.

[0007] The object of the present invention is to provide a multilayer film that will offer good workability in a press setup along with being able to increase the yield rate for FPCs and the like.

MEANS TO SOLVE THE PROBLEM

[0008] (1)

A multilayer film relating to one aspect of the present invention is equipped with a first mold release layer and a cushion layer (corresponding to an intermediate layer). The first mold release layer is formed from a resin in which the main component is a polystyrene series resin having a syndiotactic structure. Furthermore, if the resin forming the first mold release layer is 100 parts by weight, the polystyrene series resin having a syndiotactic structure makes up at least 70 parts by weight or more of the resin forming the first mold release layer, and preferably 85 parts by weight or more. The cushion layer includes more than 60 parts by weight and 98 parts by weight or less of a polyolefin series resin, and 2 parts by weight or more and less than 40 parts by weight of a polystyrene series resin having a syndiotactic structure.

Furthermore, the cushion layer further preferably includes 65 parts by weight or more and 95 parts by weight or less of a polyolefin series resin, and 5 parts by weight or more and 35 parts by weight or less of a polystyrene series resin having a syndiotactic structure. Thus, this cushion layer is provided on one side of the first mold release layer. Furthermore, this cushion layer can be formed only from polyolefin series resin and polystyrene series resin having a syndiotactic structure. Additionally, within a range that is not harmful to the goal of the present invention, there is no objection to this cushion layer including resins other than polyolefin series resin and polystyrene series resin having a syndiotactic structure.

[0009] As the result of diligently conducted research by the present inventors, if the composition of the cushion layer was as described above, along with (i) the workability in a press setup being clearly better,

(ii) a multilayer film with a more moderate elastic modulus would clearly less likely to crack in the press, and furthermore (iii) it was possible to press a CL film uniformly onto a circuit exposure film during the manufacture of an FPC, voids (microcavity defects) were less likely to form in the adhesive agent, and the FPC yield rate would clearly become higher. Consequently, this multilayer film that can have good workability in a press setup along with being able to increase the yield rate for FPCs and the like.

[0010] (2)

In the multilayer film relating to one aspect of the present invention, the polyolefin series resin preferably contains 3 parts by weight or more and 40 parts by weight or less of polypropylene resin, and 20 parts by weight or more and 95 parts by weight or less of an ethylene-methyl methacrylate copolymer resin. Moreover, the polyolefin series resin further preferably contains 5 parts by weight or more and 35 parts by weight or less of polypropylene resin, and 30 parts by weight or more and 90 parts by weight or less of an ethylene-methyl methacrylate copolymer resin.

[0011] As the result of diligently conducted research by the present inventors, if the composition of the cushion layer is as described above, along with being possible to have good adhesiveness between the cushion layer and the first mold release layer without the use of primer, the elastic modulus of the cushion layer will furthermore also clearly be within the suitable range. Consequently, in this multilayer film, the cushion layer and the first mold release layer can have good bonding, and additionally a more suitable elastic modulus of the cushion layer can be maintained.

[0012] (3)

In the multilayer film relating to one aspect of the present invention, it is preferable for the ethylene-methyl methacrylate copolymer resin to have 5 wt% or more and 14 wt% or less of units derived from methyl methacrylate. Furthermore, within the scope that is not detrimental to the essence of the present invention, there is no objection to the ethylene-methyl methacrylate copolymer resin containing units derived from monomers other than ethylene and methyl methacrylate.

- [0013] As the result of diligently conducted research by the present inventors, it became clear that if the percent content of units derived from methyl methacrylate is as described above, good adhesiveness between the cushion layer and the first mold release layer could be achieved without the use of primer, and it further became clear that it would be possible to reduce the amount of the cushion layer edge face that oozes onto the heat platen in the press.
- [0014] Consequently, in this multilayer film, the cushion layer and the first mold release layer can have good bonding without the use of primer. Moreover, it is possible to reduce the amount of the cushion layer edge face that oozes onto the heat platen in the press.
- [0015] (4)
In the multilayer film relating to one aspect of the present invention, it is preferable for the degree of crystallinity of the resin forming the first mold release layer to be 14.0% or more and 30.0% or less as measured by the differential scanning calorimetry method. Furthermore, in such a case, the first mold release layer can either be integrated with the cushion layer through the primer or can be integrated with the cushion layer directly and not through the primer.
- [0016] As the result of diligently conducted research by the present inventors, it became clear that if the degree of crystallinity of the resin forming the first mold release layer is as described above, during the bonding of the CL film to the circuit exposure film, it is possible to obtain better embedding than with conventional mold release films that prevent adhesion between the CL film and the circuit exposure film of the first mold release layer.
- [0017] Consequently, if this multilayer film is used as a mold release film, during bonding of the CL film to the circuit exposure film, it is possible to obtain better embedding than with conventional mold release films that prevent the first mold release layer from being adhering the CL film and the circuit exposure film.
- [0018] Furthermore, this effect is assumed that,
(i) The degree of crystallinity of the resin that forms the first mold release layer is set to be sufficiently low during the initial bonding of the CL film to the circuit exposure film, thus to make it easier for the first mold release layer to follow the deformations in the cushion layer during the bonding process.
(ii) In the process of the CL film bonding to circuit exposure film, the resin that

forms the first mold release layer is crystallized due to being heated, and this causes the adhesiveness of the first mold release layer to be sufficiently reduced the circuit exposure film and the CL film.

[0019] (5)

The multilayer film relating to one aspect of the present invention is preferably further comprise a second mold release layer. This second mold release layer is formed on the opposite side from the side of the cushion layer on which the first mold release layer is formed. Furthermore, this second mold release layer can be formed from polymethylpentene resin, from a resin with polymethylpentene resin as the main component, from a resin with polystyrene resin having a syndiotactic structure as the main component, or from other mold release resins. When the second mold release layer is formed from "a polymethylpentene resin", "a resin with polymethylpentene resin as the main component", or "other mold release resins", the second mold release layer can be bonded to the cushion layer via a primer layer (adhesive layer). When the second mold release layer is formed from "a resin with polystyrene resin having a syndiotactic structure as the main component", the second mold release layer can be bonded to the cushion layer without the use of a primer (adhesive layer).

[0020] Thus, by forming the second mold release layer on the opposite side from the side of a cushion layer on which the first mold release layer is formed, the cushion layer can be prevented from adhering to the heat platen in the press during the bonding of the CL film to the circuit exposure film. Consequently, the time expended in the process of bonding the CL film to the circuit exposure film can be shortened.

[0021] (6)

In the multilayer film relating to one aspect of the present invention, the second mold release layer is preferably formed from a resin with polystyrene series resin having a syndiotactic structure as the main component.

[0022] When the second mold release layer is formed from such a resin with polystyrene series resin having a syndiotactic structure as the main component, said layer can be bonded to the cushion layer without the use of a primer (adhesive). Consequently, this multilayer film can be manufactured while

keeping raw materials costs and process costs low.

[0023] (7)

In the multilayer film relating to one aspect of the present invention, it is preferable for the degree of crystallinity of the resin forming the second mold release layer to be 14.0% or more and 30.0% or less as measured by the differential scanning calorimetry method.

[0024] In the case where the multilayer film relating to one aspect of the present invention is as mentioned in the above (4), when the degree of crystallinity of the resin forming the second mold release layer is as mentioned above, the second mold release layer will have the same capabilities as the first mold release layer. Consequently, when used in the present multilayer film, it is unnecessary for the user to specify a first mold release layer or second mold release layer. Consequently, if this multilayer film is utilized, along with the user being spared any difficulty in identifying the first mold release layer and second mold release layer, it is possible to avoid bonding failures due to misspecification of the first mold release layer and second mold release layer.

BRIEF EXPLANATION OF DIAGRAMS

[0025] [Figure 1] A longitudinal section of a multilayer film relating to an embodiment of the present invention.

[Figure 2] A longitudinal section of a multilayer film relating to Alternative Embodiment (A).

[Figure 3] A diagram showing an example of a device for manufacturing a multilayer film relating to an embodiment of the present invention.

[Figure 4] A diagram showing an example of a method of use of a multilayer film relating to an embodiment of the present invention.

[Figure 5] A diagram showing a heating pattern for a hot press during the bonding of the CL film to the irregularities of the circuit pattern using a multilayer film relating to an embodiment of the present invention.

[Figure 6] A graph showing the temperature dependence of the storage elastic modulus of the mold release layer of a multilayer film relating to an embodiment of the present invention.

EXPLANATION OF SYMBOLS

[0026] 100, 100a Multilayer film
110 Mold release layer (first mold release layer)
110a First mold release layer

110b Second mold release layer
129 Cushion layer

MODES FOR IMPLEMENTING THE INVENTION

[0027] As shown in Figure 1, multilayer film 100 relating to an embodiment of the present invention is chiefly constituted from mold release layer 110 and cushion layer 120. In addition, in this embodiment of the present invention, the thickness of multilayer film 100 is preferably 25-300 μm .

Such layers are described in detail below.

[0028] <Details of the layers of the multilayer film>

[0029] 1. Mold release layer

Mold release layer 110 is formed from a resin (referred to below as "mold release layer-forming resin") with polystyrene having a syndiotactic structure (referred to below as "SPS resin") as the main component. Furthermore, such mold release layer-forming resins are available commercially from Idemitsu Kosan Co., Ltd. under the trade name XAREC[®]. The SPS resin content of mold release layer-forming resins is 70 wt% or more and 90 wt% or less, preferably 85 wt% or more and 90 wt% or less. In the present embodiment, the thickness of mold release layer 110 is preferably 5 μm or more, and further preferably 10 μm or more. In the present embodiment, the degree of crystallinity of the mold release layer-forming resin preferably 14.0% or more and less than 30.0% as measured by differential scanning calorimetry (DSC). During bonding the CL film on the circuit exposure film, as mentioned above, the degree of crystallinity of the mold release layer-forming resin can provide better embedding than the conventional mold release films that prevent bonding to the CL film and the circuit exposure film of mold release layer 110. Furthermore, the temperature dependence of the storage elastic modulus for mold release layer 110 at this time is shown in Figure 6. The composition of the mold release layer-forming resin is discussed in detail below.

[0030] (1) SPS resin

SPS resin has a syndiotactic structure, in other words the resin has a

stereoregular structure in which the phenyl groups or substituted phenyl groups that are the side chains are disposed alternately in opposite directions about the main chain formed from the carbon-carbon sigma bonds.

- [0031] Furthermore, examples of such SPS resins as disclosed in Japanese Unexamined Patent Publication No. 2000-038461 include polystyrene, poly(alkylstyrene), poly(arylstyrene), poly(halogenated styrene), poly(halogenated alkylstyrene), poly(alkoxystyrene), poly(vinylbenzoate ester), their hydrogenated polymers, mixtures thereof, copolymers of which they constitute the major component, and the like, with syndiotacticity having 75% or more racemic diads, preferably 85% or more racemic diads, as well as 30% or more racemic pentads, preferably 50% or more racemic pentads.
- [0032] Examples of poly(alkylstyrene) include poly(methylstyrene), poly(ethylstyrene), poly(isopropylstyrene), poly(t-butylstyrene), and the like.
- [0033] Examples of poly(arylstyrene) include poly(phenylstyrene), poly(vinylnaphthalene), poly(vinylstyrene), and the like.
- [0034] Examples of poly(halogenated styrene) include poly(chlorostyrene), poly(bromostyrene), poly(fluorostyrene), and the like.
- [0035] Examples of poly(halogenated alkylstyrene) include poly(chloromethylstyrene), and the like.
- [0036] Examples of poly(alkoxystyrene) include poly(methoxystyrene), poly(ethoxystyrene), and the like.
- [0037] Furthermore, among those mentioned above, polystyrene, poly(p-methylstyrene), poly(m-methylstyrene), poly(p-t-butylstyrene), poly(p-chlorostyrene), poly(m-chlorostyrene), poly(p-fluorostyrene), hydrogenated polystyrene, and copolymers containing structural units thereof are particularly preferable.
- [0038] (2) Resins other than SPS resin
Examples of mold release layer-forming resins composed of resins other than

SPS resin include elastomer resins, and polyolefin series resins, polystyrene series resins, polyester series resins, polyamide series resins, poly(phenylene ether) resins, poly(phenylene sulfide) resins(PPS), and the like. Furthermore, such resins can be used individually or in combinations of two or more.

[0039] Further examples of elastomer resins include natural rubber, polybutadiene, polyisoprene, polyisobutylene, neoprene, polysulfide rubber, thiocol rubber, acrylic rubber, urethane rubber, silicone rubber, epichlorohydrin rubber, styrene-butadiene block copolymer (SBR), hydrogenated styrene-butadiene block copolymer (SEB), styrene-butadiene-styrene block copolymer (SBS), hydrogenated styrene-butadiene-styrene block copolymer (SEBS), styrene-isoprene block copolymer (SIR), hydrogenated styrene-isoprene block copolymer (SEP), styrene-isoprene-styrene block copolymer (SIS), hydrogenated styrene-isoprene-styrene block copolymer (SEPS); or, olefin rubbers such as ethylene-propylene rubber (EPM), ethylene-propylene-diene rubber (EPDM), straight-chain low-density polyethylene elastomer, and the like; as well as butadiene-acrylonitrile-styrene core-shell rubber (ABS), methyl methacrylate-butadiene-styrene core-shell rubber (MBS), methyl methacrylate-butyl acrylate-styrene core-shell rubber (MAS), octyl acrylate-butadiene-styrene core-shell rubber (MABS), alkyl acrylate-butadiene-acrylonitrile-styrene core-shell rubber (AABS), butadiene-styrene core-shell rubber (SBR), core-shell type granular elastomers such as siloxane-containing core-shell rubbers such as methyl methacrylate-butyl acrylate-siloxane, and the like, as well as modified rubbers thereof.

[0040] Examples of polyolefin series resins include straight-chain high-density polyethylene, straight-chain low-density polyethylene, high-pressure method low-density polyethylene, isotactic polypropylene, syndiotactic polypropylene, block polypropylene, random polypropylene, polybutene, 1,2-polybutadiene,

poly(4-methylpentene), cyclic polyolefins, and copolymers thereof (for example, ethylene-methyl methacrylate copolymer, and the like), and the like.

[0041] Examples of polystyrene series resins include atactic polystyrene, isotactic polystyrene, high impact resistant polystyrene (HIPS), acrylonitrile-butadiene-styrene copolymer (ABS), acrylonitrile-styrene copolymer (AS), styrene-methacrylic acid copolymer, styrene-methacrylic acid alkyl ester copolymer, styrene-methacrylic acid glycidyl ester copolymer, styrene-acrylic acid copolymer, styrene-acrylic alkyl ester copolymer, styrene-maleic acid copolymer, styrene-fumaric acid copolymer, and the like.

[0042] Examples of polyester series resins include polycarbonate, poly(ethylene terephthalate), poly(butylene terephthalate), and the like.

[0043] Examples of polyamide series resins include Nylon[®] 6, Nylon[®] 66, and the like.

[0044] (3) Miscellaneous

Various types of additives can be blended into mold release layer-forming resins, such as antiblocking agents, antioxidants, nucleating agents, antistatic agents, processing oils, plasticizers, mold release agents, flame retardants, flame retardant auxiliaries, pigments and the like.

[0045] Furthermore, examples of antiblocking agents include the inorganic particles or organic particles as described below. Examples of inorganic particles include oxides, hydroxides, sulfides, nitrides, halides, carbonates, sulfates, acetates, phosphates, phosphites, organic carboxylates, silicates, titanates, and borates of the elements of the 1, 2, 4, 6, 7, 8, 9, 10, 11, 12, 13, and 14 families (IUPAC), and their hydrates, as well as complex compounds focused thereon and natural mineral particles.

[0046] Specific examples of such inorganic particles include family 1 element compounds such as lithium fluoride, borax (sodium borate hydrate), and the like;

family 2 element compounds such as magnesium carbonate, magnesium phosphate, magnesium oxide (magnesia), magnesium chloride, magnesium acetate, magnesium fluoride, magnesium titanate, magnesium silicate, magnesium silicate hydrate (talc), calcium carbonate, calcium phosphate, calcium phosphite, calcium sulfate (gypsum), calcium acetate, calcium terephthalate, calcium hydroxide, calcium silicate, calcium fluoride, calcium titanate, strontium titanate, barium carbonate, barium phosphate, barium sulfate, barium sulfite, and the like; family 4 element compounds such as, titanium dioxide (titania), titanium monoxide, titanium nitride, zirconium dioxide (zirconia), zirconium monoxide and the like; family 6 element compounds such as molybdenum dioxide, molybdenum trioxide, molybdenum sulfide, and the like; family 7 element compounds such as manganese chloride, manganese acetate, and the like; family 9 element compounds such as cobalt chloride, cobalt acetate, and the like; family 11 element compounds such as copper(I) iodide and the like; family 12 element compounds such as zinc oxide, zinc acetate, and the like; family 13 element compounds such as aluminum oxide (alumina), aluminum hydroxide, aluminum fluoride, aluminosilicates (alumina silicate, kaolin, kaolinite), family 14 element compounds such as silicon oxide (silica, silica gel), plumbago, carbon, graphite, glass, and the like; and natural mineral particles such as carnallite, kainite, isinglass (mica, phlogopite), roasted ore, and the like.

- [0047] Examples of organic particles include fluororesins, melamine series resins, styrene-divinylbenzene copolymers, acrylic silicone, and cross-linked forms thereof.
- [0048] The mean particle diameter of the aforementioned inorganic particles and organic particles is preferably 0.1-10 μm , and the amount added is preferably 0.01-15 wt%.
- [0049] Furthermore, such antiblocking agents can be used individually or in combinations of two or more.
- [0050] Examples of antioxidant include phosphorus-type oxidation-inhibiting agents, phenolic-type oxidation-inhibiting agents, sulfur-type oxidation-inhibiting agents, 2-[1-(2-hydroxy-3, 5-di-t-pentylphenyl)ethyl]-4,6-di-t-pentylphenyl acrylate, and

the like. Furthermore, such antioxidant can be used individually or in combinations of two or more.

- [0051] Examples of nucleating agents include metal carboxylates such as aluminum (p-t-butylbenzoate), and the like; metal phosphates such as sodium methylene-bis-(2,4-di-t-butylphenol) acid phosphate and the like; talc, phthalocyanine derivatives, and the like. Furthermore, such nucleating agents can be used individually or in combinations of two or more.
- [0052] Examples of plasticizers include poly(ethylene glycol), polyamide oligomers, ethylene bis(stearamide), phthalate esters, polystyrene oligomers, polyethylene waxes, silicone oils, and the like. Furthermore, such plasticizers can be used individually or in combinations of two or more.
- [0053] Examples of mold release agents include polyethylene waxes, silicone oils, long-chain carboxylic acids, metal long-chain carboxylates, and the like. Furthermore, such mold release agents can be used individually or in combinations of two or more.
- [0054] Examples of processing oils include paraffin type oils, naphtha type oils, aromatic type oils, and the like. Furthermore, among these, paraffin series oils with a C_p of 60% or greater for the number of carbons associated with paraffin (straight chain) as a percentage of the total number of carbons as calculated by the n-d-M method are preferred.
- [0055] The viscosity of the process oils is preferably 15-600 cS for the kinetic viscosity at 40 °C, and further preferably 15-500 cS. Moreover, based on 100 parts by weight of mold release layer-forming resin, the amount of processing oil added is preferably 0.01-1.5 parts by weight, more preferably 0.05-1.4 parts by weight, and further preferably 0.1-1.3 parts by weight. Furthermore, such processing oils can be used individually or in combinations of two or more.
- [0056] 2. Cushion layer
- In the present embodiment, cushion layer 120 is predominantly formed from a blend of more than 60 parts by weight and 98 parts by weight or less of polyolefin series resin, and 2 parts by weight or more and less than 40 parts by weight of SPS resin. Furthermore, this resin blend can be prepared by the pre-

kneading dry-blending method, and the preprocessing can be carried out using a biaxial kneading machine. In addition, in the present embodiment, the thickness of cushion layer 120 is preferably three-fold or more the thickness of mold release layer 110, more preferably five-fold or more, and further preferably eight-fold or more.

- [0057] Furthermore, examples of polyolefin series resins include long-chain high-density polyethylene, long-chain low-density polyethylene, high-pressure low-density polyethylene, isotactic polypropylene, syndiotactic polypropylene, block polypropylene, random polypropylene, polybutene, 1,2-polybutadiene, poly(4-methylpentene), cyclic polyolefins, and copolymers thereof (for example, ethylene-methyl methacrylate copolymer, and the like), and the like.
- [0058] The SPS resin is the same as the SPS resin mentioned above,
- [0059] This cushion layer 120 is more preferably formed from a resin blend that includes 2 parts by weight or more and less than 40 parts by weight of SPS resin, 3 parts by weight or more and 40 parts by weight or less of polypropylene resin, and more than 20 parts by weight and 95 parts by weight or less of ethylene-methyl methacrylate copolymer resin. In this case, the ethylene-methyl methacrylate copolymer resin preferably contains 5 wt% or more and 14 wt% or less of units derived from methyl methacrylate. When the composition of cushion layer 120 and the composition of the ethylene-methyl methacrylate copolymer resin are as described above, along with (i) being able to achieve good adhesion between cushion layer 120 and mold release layer 110 without the use of primer, (ii) it is possible to reduce the amount of the edge face of cushion layer 120 that oozes onto the heat platen in the press.
- [0060] Furthermore, according to need and within the scope that is not detrimental to the essence of the present invention, the abovementioned elastomer resins or additives can also be blended into this resin blend.
- [0061] <Method for manufacturing a multilayer film>
Multilayer film 100 relating to the present embodiment can be manufactured by methods such as the co-extrusion method, extrusion lamination method, and

the like.

- [0062] In the co-extrusion method, multilayer film 100 is manufactured by simultaneous extrusion of mold release layer 110 and cushion layer 120 using a feed block and multi-manifold die. Furthermore, in the co-extrusion method, melt M is passed through dies 210 as shown in Figure 3, is led between first roller 230 and touch roller 220, and is cooled by first roller 230 and touch roller 220 during the period from first roller 230 until it is discharged to give multilayer film 100. Thereafter, this multilayer film 100 is led in the film feed direction (see arrow in Figure 3) to the downstream side by second roller 240, and finally is taken up on a take-up reel (not shown). Furthermore, at this time, the temperature of first roller 230 is preferably 30-100 °C, the temperature of touch roller 220 is preferably 50-120 °C, and the tip-speed ratio of second roller 240 vs. first roller 230 is preferably 0.990-0.998.
- [0063] In the extrusion lamination method, the temperature of the extruder cylinder is set to 270-300 °C, the mold release layer 110 is extruded, and multilayer film 100 is manufactured by lamination of mold release layer 110 and cushion layer 120 by merging this mold release layer 110 with cushion layer 120. Furthermore, in the extrusion lamination method, melt M of the mold release layer-forming resin is passed through dies 210 as shown in Figure 3, is led between first roller 230 and touch roller 220, and is cooled by touch roller 220 and first roller 230 during the period from first roller 230 until it is discharged to give mold release film F. Thereafter, this mold release film F is led in the film feed direction (see arrow in Figure 3) to the downstream side by second roller 240. Then, the resin blend melt (not shown in the Figure) that forms cushion layer 120 is merged with mold release film F that is passed to the downstream side in the film feed direction and is integrated therewith to manufacture multilayer film 100. Furthermore, such a manufactured multilayer film 100 is furthermore taken up on the take-up reel (not shown in the Figure) provided at the downstream side in the film feed direction. Furthermore, at this time, the temperature of first roller 230 is preferably 30-100 °C, and the temperature of touch roller 220 is

preferably 50-120 °C, and the tip-speed ratio of second roller 240 vs. first roller 230 is preferably 0.990-0.998.

[0064] Furthermore, according to need, the degree of crystallinity of the SPS resin in mold release layer 110 of multilayer film 100 obtained as described above can be adjusted using a known heat treatment device. For example, the heat treatment in the vicinity of 50-220 °C can be carried out on multilayer film 100 using a heat fixation method in a drying machine using a tenter device or a heat treatment roller.

[0065] <An example of use of the multilayer film>

Since the CL film adheres to the irregularities of the circuit pattern during the bonding of the CL film to the circuit exposure film, multilayer film 100 relating to an embodiment of the present invention is arranged so as to envelope the CL film, and multilayer film is pressurized by the press device, along with the circuit exposure film and the CL film. Specifically, as shown in Figure 4, after the circuit exposure film and the CL film are temporarily bonded with adhesive to give 340, multilayer films 100 are inserted so as to be opposite to mold release layer 110, Teflon[®] sheets 330, rubber cushions 320, and stainless steel plates 310 are sequentially inserted, and hot platens 300 are pressed together (hollow arrow in Figure 4). Furthermore, the heating method using these heat platens 300 is as shown in Figure 5. In other words, after rapidly increasing the temperature from room temperature up to 185 °C in 10 seconds from when pressure application begins, heat platens 300 remain at this temperature for 60 seconds. Furthermore, the pressure applied by heat platens 300 begins at 0 seconds and is released at 70 seconds. Furthermore, the applied pressure of the press at this time is suitably adjusted to be 5-15 MPa.

[0066] <Alternative embodiments>

[0067] (A)

In the previous embodiment, multilayer film 100 was introduced with mold release layer 110 provided only on one side of cushion layer 120, but as shown in Figure 2, the present invention also includes an embodiment in which multilayer film 110A is provided with mold release layers 110a, 110b on both sides of cushion layer 120. Furthermore, as explained below, the mold release layer with the symbol 110a is called the "first mold release layer", and the mold

release layer with the symbol 110b is called the "second mold release layer".

[0068] First mold release layer 110a has the same structure as mold release layer 110 relating to the previous embodiment. On the other hand, second mold release layer 110b can have the same structure as first mold release layer 110a, or it can have a structure different than that of first mold release layer 110a. In the latter case, second mold release layer 110b can, for example, be formed from a resin that has a polymethylpentene resin or a polymethylpentene- α -olefin copolymer as the main component. Furthermore, such resins are available commercially from Mitsui Chemical Co., Ltd. under the trade name TPX[®]. In this case, the adhesive strength between second mold release layer 110b and cushion layer 120 would be reduced, but in such a case, an anchor layer or primer layer (adhesive layer) can be introduced between second mold release layer 110b and cushion layer 120.

[0069] (B)

In an example using the multilayer film relating to the previous embodiment, Teflon[®] sheets 330, rubber cushions 320, and stainless steel plates 310 were sequentially inserted between multilayer films 100 and hot platens 300, but Teflon[®] sheets 330, rubber cushions 320, and stainless steel plates 310 can optionally be omitted.

[0070] <Working Examples>

The present invention is explained below in further detail using working examples.

Working Example 1

[0071] 1. Manufacture of multilayer films

[0072] (1) Raw material for the mold release layer

The SPS resin XAREC[®] S104 (Idemitsu Kosan Co., Ltd.) was used as the raw material for the mold release layer.

[0073] (2) Raw materials for the cushion layer

The raw materials for the cushion layer included 20 parts by weight of the SPS resin XAREC[®] S104 (Idemitsu Kosan Co., Ltd.), 75 parts by weight of the

ethylene-methyl methacrylate copolymer Acryft® WD106 (methyl methacrylate-derived unit content: 5 wt%; Sumitomo Chemical Co., Ltd.), and 5 parts by weight of the polypropylene Noblen FH1016 (Sumitomo Chemical Co., Ltd.), which were dry blended (referred to below as the "cushion layer-forming resin blend").

[0074] (3) Manufacture of multilayer films

Using a co-extruder, a multilayer film having the same mold release layer on both sides of the cushion layer was manufactured (see Figure 2).

[0075] Furthermore, more specifically, the multilayer film was manufactured by simultaneously extruding an SPS resin (XAREC® S104, Idemitsu Kosan Co., Ltd.), a cushion layer-forming resin, and an SPS resin (XAREC® S104, Idemitsu Kosan Co., Ltd.) using a feed block and a multi-manifold die. Furthermore, the device shown in Figure 3 was used for this, but the temperature of first roller 230 was 30 °C, the temperature of touch roller 220 was 70 °C, and the tip-speed ratio of second roller 240 vs. first roller 230 was 0.990.

[0076] The thickness of the mold release layers on both sides of this multilayer film was 25 µm, and the thickness of the cushion layer was 70 µm.

[0077] 2. Evaluation of multilayer films

[0078] (1) Press setup workability

Sensory tests were conducted by the technicians. These results showed the abovementioned multilayer film to have good press setup workability (see Table 1).

[0079] (2) Observation for voids

Observation of the FPC by optical microscope after pressing showed no evidence of voids in these FPCs (see Table 1).

[0080] (3) CL film bonding test

In practical terms, the CL film was temporarily bonded to the circuit exposure film through an adhesive, and with both sides enclosed by the abovementioned multilayer film, this was hot-pressed with the heating pattern shown in Figure 5 using a hot platen press. These results showed that the multilayer film did not

develop any cracks (see Table 1). The amount of adhesive between the circuit exposure film and the CL film that oozed onto the circuit pattern was less than 100 μm , which is within the permissible range (see Table 1). The amount of cushion layer edge face that oozed out was less than 5 mm, which is within the permissible range (see Table 1).

Working Example 2

- [0081] A multilayer film was prepared by dry-blending in the same manner as for Working Example 1, except for using 20 parts by weight of the SPS resin XAREC[®] S104 (Idemitsu Kosan Co., Ltd.), 70 parts by weight of the ethylene-methyl methacrylate copolymer Acryft[®] WD106 (methyl methacrylate-derived unit content: 5 wt%; Sumitomo Chemical Co., Ltd.), and 10 parts by weight of the polypropylene Noblen FH1016 (Sumitomo Chemical Co., Ltd.) as the cushion layer-forming resin blend, and this multilayer film was evaluated.
- [0082] The evaluation results showed this multilayer film to have good press setup workability (see Table 1). After pressing, there was no evidence of voids in the FPC (see Table 1). No cracks developed in this multilayer film after hot pressing (see Table 1). The amount of adhesive between the circuit exposure film and the CL film that oozed onto the circuit pattern was less than 100 μm , which is within the permissible range (see Table 1). The amount of cushion layer edge face that oozed out was less than 5 mm, which is within the permissible range (see Table 1).

Working Example 3

- [0083] A multilayer film was prepared by dry-blending in the same manner as for Working Example 1, except for using 20 parts by weight of the SPS resin XAREC[®] S104 (Idemitsu Kosan Co., Ltd.), 60 parts by weight of the ethylene-methyl methacrylate copolymer Acryft[®] WD106 (methyl methacrylate-derived unit content: 5 wt%; Sumitomo Chemical Co., Ltd.), and 20 parts by weight of the polypropylene Noblen FH1016 (Sumitomo Chemical Co., Ltd.) as the cushion layer-forming resin blend, and this multilayer film was evaluated. Furthermore, the thickness of the mold release layers on both sides of this

multilayer film was 25 μm , and the thickness of the cushion layer was 70 μm .

- [0084] The evaluation results showed this multilayer film to have good press setup workability (see Table 1). After pressing, there was no evidence of voids in the FPC (see Table 1). No cracks developed in this multilayer film after hot pressing (see Table 1). The amount of adhesive between the circuit exposure film and the CL film that oozed onto the circuit pattern was less than 100 μm , which is within the permissible range (see Table 1). The amount of cushion layer edge face that oozed out was less than 5 mm, which is within the permissible range (see Table 1).

Working Example 4

- [0085] A multilayer film was prepared by dry-blending in the same manner as for Working Example 1, except for using 20 parts by weight of the SPS resin XAREC[®] S104 (Idemitsu Kosan Co., Ltd.), 50 parts by weight of the ethylene-methyl methacrylate copolymer Acryft[®] WD106 (methyl methacrylate-derived unit content: 5 wt%; Sumitomo Chemical Co., Ltd.), and 30 parts by weight of the polypropylene Noblen FH1016 (Sumitomo Chemical Co., Ltd.) as the cushion layer-forming resin blend, and this multilayer film was evaluated. Furthermore, the thickness of the mold release layers on both sides of this multilayer film was 25 μm , and the thickness of the cushion layer was 70 μm .
- [0086] The evaluation results showed this multilayer film to have good press setup workability (see Table 1). After pressing, there was no evidence of voids in the FPC (see Table 1). No cracks developed in this multilayer film after hot pressing (see Table 1). The amount of adhesive between the circuit exposure film and the CL film that oozed onto the circuit pattern was less than 100 μm , which is within the permissible range (see Table 1). The amount of cushion layer edge face that oozed out was less than 5 mm, which is within the permissible range (see Table 1).

Working Example 5

- [0087] A multilayer film was prepared by dry-blending in the same manner as for Working Example 1, except for using 20 parts by weight of the SPS resin

XAREC[®] S104 (Idemitsu Kosan Co., Ltd.), 70 parts by weight of the ethylene-methyl methacrylate copolymer Acryft[®] WD201 (methyl methacrylate-derived unit content: 10 wt%; Sumitomo Chemical Co., Ltd.), and 10 parts by weight of the polypropylene Noblen FH1016 (Sumitomo Chemical Co., Ltd.) as the cushion layer-forming resin blend, and this multilayer film was evaluated. Furthermore, the thickness of the mold release layers on both sides of this multilayer film was 25 μm , and the thickness of the cushion layer was 70 μm .

- [0088] The evaluation results showed this multilayer film to have good press setup workability (see Table 2). After pressing, there was no evidence of voids in the FPC (see Table 2). No cracks developed in this multilayer film after hot pressing (see Table 2). The amount of adhesive between the circuit exposure film and the CL film that oozed onto the circuit pattern was less than 100 μm , which is within the permissible range (see Table 2). The amount of cushion layer edge face that oozed out was less than 5 mm, which is within the permissible range (see Table 2).

Working Example 6

- [0089] A multilayer film was prepared by dry-blending in the same manner as for Working Example 1, except for using 20 parts by weight of the SPS resin XAREC[®] S104 (Idemitsu Kosan Co., Ltd.), 70 parts by weight of the ethylene-methyl methacrylate copolymer Acryft[®] CM8033 (methyl methacrylate-derived unit content: 14 wt%; Sumitomo Chemical Co., Ltd.), and 10 parts by weight of the polypropylene Noblen FH1016 (Sumitomo Chemical Co., Ltd.) as the cushion layer-forming resin blend, and this multilayer film was evaluated. Furthermore, the thickness of the mold release layers on both sides of this multilayer film was 25 μm , and the thickness of the cushion layer was 70 μm .
- [0090] The evaluation results showed this multilayer film to have good press setup workability (see Table 2). After pressing, there was no evidence of voids in the FPC (see Table 2). No cracks developed in this multilayer film after hot pressing (see Table 2). The amount of adhesive between the circuit exposure film and

the CL film that oozed onto the circuit pattern was less than 100 μm , which is within the permissible range (see Table 2). The amount of cushion layer edge face that oozed out was less than 5 mm, which is within the permissible range (see Table 2).

Working Example 7

- [0091] A multilayer film was prepared by dry-blending in the same manner as for Working Example 1, except for using 39 parts by weight of the SPS resin XAREC[®] S104 (Idemitsu Kosan Co., Ltd.), 21 parts by weight of the ethylene-methyl methacrylate copolymer Acryft[®] CM8033 (methyl methacrylate-derived unit content: 14 wt%; Sumitomo Chemical Co., Ltd.), and 40 parts by weight of the polypropylene Noblen FH1016 (Sumitomo Chemical Co., Ltd.) as the cushion layer-forming resin blend, and this multilayer film was evaluated. Furthermore, the thickness of the mold release layers on both sides of this multilayer film was 25 μm , and the thickness of the cushion layer was 70 μm .
- [0092] The evaluation results showed this multilayer film to have good press setup workability (see Table 2). After pressing, there was no evidence of voids in the FPC (see Table 2). No cracks developed in this multilayer film after hot pressing (see Table 2). The amount of adhesive between the circuit exposure film and the CL film that oozed onto the circuit pattern was less than 100 μm , which is within the permissible range (see Table 2). The amount of cushion layer edge face that oozed out was less than 5 mm, which is within the permissible range (see Table 2).

Working Example 8

- [0093] A multilayer film was prepared by dry-blending in the same manner as for Working Example 1, except for using 5 parts by weight of the SPS resin XAREC[®] S104 (Idemitsu Kosan Co., Ltd.), 90 parts by weight of the ethylene-methyl methacrylate copolymer Acryft[®] CM8033 (methyl methacrylate-derived unit content: 14 wt%; Sumitomo Chemical Co., Ltd.), and 5 parts by weight of the polypropylene Noblen FH1016 (Sumitomo Chemical Co., Ltd.) as the cushion layer-forming resin blend, and this multilayer film was evaluated.

Furthermore, the thickness of the mold release layers on both sides of this multilayer film was 25 μm , and the thickness of the cushion layer was 70 μm .

- [0094] The evaluation results showed this multilayer film to have good press setup workability (see Table 2). After pressing, there was no evidence of voids in the FPC (see Table 2). No cracks developed in this multilayer film after hot pressing (see Table 2). The amount of adhesive between the circuit exposure film and the CL film that oozed onto the circuit pattern was less than 100 μm , which is within the permissible range (see Table 2). The amount of cushion layer edge face that oozed out was less than 5 mm, which is within the permissible range (see Table 2).

Working Example 9

- [0095] A multilayer film was prepared by dry-blending in the same manner as for Working Example 1, except for using 20 parts by weight of the SPS resin XAREC[®] S104 (Idemitsu Kosan Co., Ltd.), and 80 parts by weight of the ethylene-methyl methacrylate copolymer Acryft[®] WD106 (methyl methacrylate-derived unit content: 5 wt%; Sumitomo Chemical Co., Ltd.) as the cushion layer-forming resin blend, and this multilayer film was evaluated. Furthermore, the thickness of the mold release layers on both sides of this multilayer film was 25 μm , and the thickness of the cushion layer was 70 μm .
- [0096] The evaluation results showed this multilayer film to have good press setup workability (see Table 3). After pressing, there was no evidence of voids in the FPC (see Table 3). No cracks developed in this multilayer film after hot pressing (see Table 3). The amount of adhesive between the circuit exposure film and the CL film that oozed onto the circuit pattern was less than 100 μm , which is within the permissible range (see Table 3). The amount of cushion layer edge face that oozed out was less than 5 mm, which is within the permissible range (see Table 3).

Working Example 10

- [0097] A multilayer film was prepared by dry-blending in the same manner as for Working Example 1, except for using 20 parts by weight of the SPS resin

XAREC[®] S104 (Idemitsu Kosan Co., Ltd.), 70 parts by weight of the ethylene-methyl methacrylate copolymer Acryft[®] WD206 (methyl methacrylate-derived unit content: 20 wt%; Sumitomo Chemical Co., Ltd.), and 10 parts by weight of the polypropylene Noblen FH1016 (Sumitomo Chemical Co., Ltd.) as the cushion layer-forming resin blend, and this multilayer film was evaluated.

Furthermore, the thickness of the mold release layers on both sides of this multilayer film was 25 μm , and the thickness of the cushion layer was 70 μm .

- [0098] The evaluation results showed this multilayer film to have good press setup workability (see Table 3). After pressing, there was no evidence of voids in the FPC (see Table 3). No cracks developed in this multilayer film after hot pressing (see Table 3). The amount of adhesive between the circuit exposure film and the CL film that oozed onto the circuit pattern was less than 100 μm , which is within the permissible range (see Table 3). The amount of cushion layer edge face that oozed out was less than 5 mm, which is within the permissible range (see Table 3).

Working Example 11

- [0099] A multilayer film was prepared by dry-blending in the same manner as for Working Example 1, except for using 20 parts by weight of the SPS resin XAREC[®] S104 (Idemitsu Kosan Co., Ltd.), 70 parts by weight of the ethylene-methyl methacrylate copolymer Acryft[®] CM8014 (methyl methacrylate-derived unit content: 17.5 wt%; Sumitomo Chemical Co., Ltd.), and 10 parts by weight of the polypropylene Noblen FH1016 (Sumitomo Chemical Co., Ltd.), and this multilayer film was evaluated. Furthermore, the thickness of the mold release layers on both sides of this multilayer film was 25 μm , and the thickness of the cushion layer was 70 μm .

- [0100] The evaluation results showed this multilayer film to have good press setup workability (see Table 3). After pressing, there was no evidence of voids in the FPC (see Table 3). No cracks developed in this multilayer film after hot pressing (see Table 3). The amount of adhesive between the circuit exposure film and

the CL film that oozed onto the circuit pattern was less than 100 μm , which is within the permissible range (see Table 3). The amount of cushion layer edge face that oozed out was less than 5 mm, which is within the permissible range (see Table 3).

Working Example 12

[0101] 1. Manufacture of multilayer films

[0102] (1) Raw material for the mold release layer

The SPS resin XAREC[®] S104 (Idemitsu Kosan Co., Ltd.) was used as the raw material for the mold release layer.

[0103] (2) Raw materials for the cushion layer

A dry blend of 20 parts by weight of the SPS resin XAREC[®] S104 (Idemitsu Kosan Co., Ltd.), 70 parts by weight of the ethylene-methyl methacrylate copolymer Acryft[®] WD106 (methyl methacrylate-derived unit content: 5 wt%; Sumitomo Chemical Co., Ltd.), and 10 parts by weight of the polypropylene Noblen FH1016 (Sumitomo Chemical Co., Ltd.) was used as raw materials for the cushion layer (referred to below as the "cushion layer-forming resin blend").

[0104] (3) Manufacture of multilayer films

Using a co-extruder, a multilayer film having the same mold release layer on both sides of the cushion layer was manufactured (see Figure 2).

[0105] Furthermore, more specifically, a multilayer film was manufactured by simultaneously extruding an SPS resin, a cushion layer-forming resin blend, and an SPS resin using a multi-manifold die. Furthermore, the device shown in Figure 3 was used for this, but the temperature of first roller 230 was 35 °C, the temperature of touch roller 220 was 70 °C, and the tip-speed ratio of second roller 240 vs. first roller 230 was 0.998.

[0106] The thickness of the mold release layers on both sides of this multilayer film was 25 μm , and the thickness of the cushion layer was 70 μm .

[0107] 2. Evaluation of multilayer films

[0108] (1) Press setup workability

Sensory tests were conducted by the technicians. These results showed the abovementioned multilayer film to have good press setup workability (see Table 4).

[0109] (2) Observation for voids

Observation of the FPC by optical microscope after pressing showed no evidence of voids in these FPCs (see Table 4).

[0110] (3) CL film bonding test

In practical terms, the CL film was temporarily bonded to the circuit exposure film through an adhesive, and with both sides enclosed by the abovementioned multilayer film, this was hot-pressed with the heating pattern shown in Figure 5 using a hot platen press. Thereafter, the abovementioned multilayer film could be easily delaminated from the circuit exposure film and the CL film (see Table 4). In addition, these results showed that the multilayer film did not develop any cracks (see Table 4). The amount of adhesive between the circuit exposure film and the CL film that oozed onto the circuit pattern was less than 80 μm , which is superior to that obtained with a conventional mold release layer (see Table 4). The amount of cushion layer edge face that oozed out was less than 5 mm, which is within the permissible range (see Table 4).

(4) Test of degree of crystallinity of the mold release layer

The mold release layer was peeled off from the abovementioned laminate film, and the enthalpy of fusion (ΔH_f) and enthalpy of cold crystallization (ΔH_{cc}) of this mold release layer portion were measured using a differential scanning calorimeter at a heating rate of 20 °C/min. Then, when these enthalpy of fusion (ΔH_f) and enthalpy of cold crystallization (ΔH_{cc}) values were substituted into the equation below, the value of 15.8% was obtained (see Table 4).

$$\text{Degree of crystallinity (\%)} = 100 \times (\Delta H_f - \Delta H_{cc}) / 53 \text{ (J/g)}$$

Working Example 13

- [0111] A multilayer film was prepared in the same manner as in Working Example 12, except that the temperature of first roller 230 was set to 98 °C, the temperature of touch roller 220 was set to 120 °C, and the tip-speed ratio of second roller 240 vs. first roller 230 was 0.998, and this multilayer film was evaluated. Furthermore, the thickness of the mold release layers on both sides of this

- multilayer film was 25 μm , and the thickness of the cushion layer was 70 μm .
- [0112] The evaluation results showed this multilayer film to have good press setup workability (see Table 4). After pressing, there was no evidence of voids in the FPC (see Table 4). No cracks developed in this multilayer film after hot pressing (see Table 4). The amount of adhesive between the circuit exposure film and the CL film that oozed onto the circuit pattern was less than 80 μm , which is superior to that obtained with a conventional mold release layer (see Table 4). The amount of cushion layer edge face that oozed out was less than 5 mm, which is within the permissible range (see Table 4). The degree of crystallinity of the mold release layer of this multilayer film was 17.3% (see Table 4). The multilayer film could be easily delaminated from the circuit exposure film and the CL film (see Table 4).

Working Example 14

- [0113] A multilayer film was prepared in the same manner as in Working Example 12, except that the temperature of first roller 230 was set to 35 °C, the temperature of touch roller 220 was set to 70 °C, and the tip-speed ratio of second roller 240 vs. first roller 230 was 0.998, and furthermore, this multilayer film was evaluated after an annealing heat treatment wherein this multilayer film was inserted between stainless steel plates with a surface temperature of 120 °C and a pressure of 10 MPa was applied for a duration of 10 minutes. Furthermore, the thickness of the mold release layers on both sides of this multilayer film was 25 μm , and the thickness of the cushion layer was 70 μm .
- [0114] The evaluation results showed this multilayer film to have good press setup workability (see Table 4). After pressing, there was no evidence of voids in the FPC (see Table 4). No cracks developed in this multilayer film after hot pressing (see Table 4). The amount of adhesive between the circuit exposure film and the CL film that oozed onto the circuit pattern was less than 80 μm , which is superior to that obtained with a conventional mold release layer (see Table 4). The amount of cushion layer edge face that oozed out was less than 5 mm, which is within the permissible range (see Table 4). The degree of crystallinity of the mold release layer of this multilayer film was 20.5% (see Table 4). The multilayer film could be easily delaminated from the circuit exposure film and the CL film (see Table 4).

Working Example 15

- [0115] A multilayer film was prepared in the same manner as in Working Example 12, except that the temperature of first roller 230 was set to 35 °C, the temperature of touch roller 220 was set to 70 °C, and the tip-speed ratio of second roller 240 vs. first roller 230 was 0.998, and furthermore, this multilayer film was evaluated after an annealing heat treatment wherein this multilayer film was inserted between stainless steel plates with a surface temperature of 125 °C and a pressure of 10 MPa was applied for a duration of 10 minutes. Furthermore, the thickness of the mold release layers on both sides of this multilayer film was 25 µm, and the thickness of the cushion layer was 70 µm.
- [0116] The evaluation results showed this multilayer film to have good press setup workability (see Table 4). After pressing, there was no evidence of voids in the FPC (see Table 4). No cracks developed in this multilayer film after hot pressing (see Table 4). The amount of adhesive between the circuit exposure film and the CL film that oozed onto the circuit pattern was less than 80 µm, which is superior to that obtained with a conventional mold release layer (see Table 4). The amount of cushion layer edge face that oozed out was less than 5 mm, which is within the permissible range (see Table 4). The degree of crystallinity of the mold release layer of this multilayer film was 23.4% (see Table 4). The multilayer film could be easily delaminated from the circuit exposure film and the CL film (see Table 4).

Working Example 16

- [0117] A multilayer film was prepared in the same manner as in Working Example 12, except that the temperature of first roller 230 was set to 35 °C, the temperature of touch roller 220 was set to 70 °C, and the tip-speed ratio of second roller 240 vs. first roller 230 was 0.998, and furthermore, this multilayer film was evaluated after an annealing heat treatment wherein this multilayer film was inserted between stainless steel plates with a surface temperature of 130 °C and a pressure of 10 MPa was applied for a duration of 10 minutes. Furthermore, the thickness of the mold release layers on both sides of this multilayer film was 25 µm, and the thickness of the cushion layer was 70 µm.
- [0118] The evaluation results showed this multilayer film to have good press setup workability (see Table 4). After pressing, there was no evidence of voids in the FPC (see Table 4). No cracks developed in this multilayer film after hot pressing (see Table 4). The amount of adhesive between the circuit exposure film and

the CL film that oozed onto the circuit pattern was less than 80 μm , which is superior to that obtained with a conventional mold release layer (see Table 4). The amount of cushion layer edge face that oozed out was less than 5 mm, which is within the permissible range (see Table 4). The degree of crystallinity of the mold release layer of this multilayer film was 28.7% (see Table 7). The multilayer film could be easily delaminated from the circuit exposure film and the CL film (see Table 4).

(Comparative Example 1)

[0119] A multilayer film was prepared by dry-blending in the same manner as for Working Example 1, except for using 80 parts by weight of the ethylene-methyl methacrylate copolymer Acryft® WD106 (methyl methacrylate-derived unit content: 5 wt%; Sumitomo Chemical Co., Ltd.) and 20 parts by weight of the polypropylene Noblen FH1016 (Sumitomo Chemical Co., Ltd.) as the cushion layer-forming resin blend, and this multilayer film was evaluated. Furthermore, the thickness of the mold release layers on both sides of this multilayer film was 25 μm , and the thickness of the cushion layer was 70 μm .

[0120] The evaluation results showed this multilayer film to have good press setup workability (see Table 5). After pressing, there was no evidence of voids in the FPC (see Table 5). No cracks developed in this multilayer film after hot pressing (see Table 5). The amount of adhesive between the circuit exposure film and the CL film that oozed onto the circuit pattern was less than 100 μm , which is within the permissible range (see Table 5). The amount of cushion layer edge face that oozed out was less than 5 mm, which is within the permissible range (see Table 5). However, when the multilayer film was peeled off from the completed FPC, the cushion layer had delaminated from the mold release layer on the side on which it was in contact with the circuit exposure film and the CL film, and it was not possible to recover an FPC in satisfactory condition.

(Comparative Example 2)

[0121] A multilayer film was prepared by dry-blending in the same manner as for Working Example 1, except for using 40 parts by weight of the SPS resin XAREC® S104 (Idemitsu Kosan Co., Ltd.), 50 parts by weight of the ethylene-

methyl methacrylate copolymer Acryft® WD106 (methyl methacrylate-derived unit content: 5 wt%; Sumitomo Chemical Co., Ltd.), and 10 parts by weight of the polypropylene Noblen FH1016 (Sumitomo Chemical Co., Ltd.) as the cushion layer-forming resin blend, and this multilayer film was evaluated. Furthermore, the thickness of the mold release layers on both sides of this multilayer film was 25 µm, and the thickness of the cushion layer was 70 µm.

[0122] The evaluation results showed that the press setup workability for this multilayer film could not be described as good (see Table 5). After pressing there was evidence for voids in the FPC, although they were extremely small (see Table 5). Microscopic cracks developed in this multilayer film after hot pressing (see Table 5). The amount of adhesive between the circuit exposure film and the CL film that oozed onto the circuit pattern was 100 µm or greater, which is outside the permissible range (see Table 5). The amount of cushion layer edge face that oozed out was less than 5 mm, which is within the permissible range (see Table 5).

(Comparative Example 3)

[0123] A multilayer film was prepared by dry-blending in the same manner as for Working Example 1, except for using 70 parts by weight of the SPS resin XAREC® S104 (Idemitsu Kosan Co., Ltd.), 20 parts by weight of the ethylene-methyl methacrylate copolymer Acryft® WD106 (methyl methacrylate-derived unit content: 5 wt%; Sumitomo Chemical Co., Ltd.), and 10 parts by weight of the polypropylene Noblen FH1016 (Sumitomo Chemical Co., Ltd.) as the cushion layer-forming resin blend, and this multilayer film was evaluated. Furthermore, the thickness of the mold release layers on both sides of this multilayer film was 25 µm, and the thickness of the cushion layer was 70 µm.

[0124] The evaluation results showed this multilayer film to have poor press setup workability (see Table 5). After pressing there was evidence for quite a few voids in the FPC (see Table 5). Relatively large cracks developed in this multilayer film after hot pressing (see Table 5). The amount of adhesive between the circuit exposure film and the CL film that oozed onto the circuit pattern was 100 µm or greater, which is outside the permissible range (see

Table 5). The amount of cushion layer edge face that oozed out was less than 5 mm, which is within the permissible range (see Table 5).

[0125]

[Table 1]

	Working Example 1	Working Example 2	Working Example 3	Working Example 4
Top surface mold release layer	Layer thickness (μm) 25	25	25	25
Cushion layer	Resin composition Blend ratio (pts by wt) Layer thickness (μm) EMMA PP XAREC 75 5 20 70	EMMA PP XAREC 70 10 20 70	EMMA PP XAREC 60 20 20 70	EMMA PP XAREC 50 30 20 70
Bottom surface mold release layer	MMA blend amt (wt%) Layer thickness (μm) 25	5 — — 25	5 — — 25	5 — — 25
Total thickness of multilayer film (μm)	120	120	120	120
Evaluation results	Press setup workability Voids present Cracks developed Amt adhesive oozed Amt edge face oozed	Good No No w/in permissible range w/in permissible range	Good No No w/in permissible range w/in permissible range	Good No No w/in permissible range w/in permissible range

[0126] [Table 2]

		Working Example 5					Working Example 6					Working Example 7					Working Example 8				
Top surface mold release layer	Layer thickness (μm)	25					25					25					25				
	Resin composition	EMMA	PP	XAREC	EMMA	PP	XAREC	EMMA	PP	XAREC	EMMA	PP	XAREC	EMMA	PP	XAREC					
	Blend ratio (pts by wt)	70	10	20	70	10	20	70	10	20	21	40	39	90	5	5					
	Layer thickness (μm)	70					70					70					70				
Cushion layer	MMA blend amt (wt%)	10	—	—	14	—	—	14	—	—	14	—	—	14	—	—					
	Layer thickness (μm)	25					25					25					25				
Bottom surface mold release layer	Total thickness of multilayer film (μm)	120					120					120					120				
Evaluation results	Press setup workability	Good					Good					Good					Good				
	Voids present	No					No					No					No				
	Cracks developed	No					No					No					No				
	Amt adhesive oozed	w/in permissible range					w/in permissible range					w/in permissible range					w/in permissible range				
	Amt edge face oozed	w/in permissible range					w/in permissible range					w/in permissible range					w/in permissible range				

[0127] [Table 3]

		Working Example 9				Working Example 10				Working Example 11			
Top surface mold release layer	Layer thickness (μm)	25				25				25			
Cushion layer	Resin composition	EMMA	PP	XAREC		EMMA	PP	XAREC		EMMA	PP	XAREC	
	Blend ratio (pts by wt)	80	0	20		70	10	20		70	10	20	
	Layer thickness (μm)	70				70				70			
	MMA blend amt (wt%)	5	—	—		20	—	—		17.5	—	—	
Bottom surface mold release layer	Layer thickness (μm)	25				25				25			
Total thickness of multilayer film (μm)		120				120				120			
Evaluation results	Press setup workability	Good				Good				Good			
	Voids present	No				No				No			
	Cracks developed	No				No				No			
	Amt adhesive oozed	w/in permissible range				w/in permissible range				w/in permissible range			
	Amt edge face oozed	exceeds permissible range				exceeds permissible range				exceeds permissible range			

[0129] [Table 5]

		Comparative Example 1				Comparative Example 2				Comparative Example 3			
Top surface release layer	Layer thickness (μm)	25				25				25			
Cushion layer	Resin composition	EMMA	PP	XAREC		EMMA	PP	XAREC		EMMA	PP	XAREC	
	Blend ratio (pts by wt)	80	20	0		50	10	40		20	10	70	
	Layer thickness (μm)	70				70				70			
	MMA blend amt (wt%)	5	—	—		5	—	—		5	—	—	
Bottom surface release layer	Layer thickness (μm)	25				25				25			
Total thickness of multilayer film (μm)		120				120				120			
Evaluation results	Press setup workability	Good				Poor				Poor			
	Voids present	No				Yes				Yes			
	Cracks developed	No				Yes				Yes			
	Ant adhesive oozed	w/in permissible range				exceeds permissible range				exceeds permissible range			

INDUSTRIAL APPLICABILITY

- [0130] Along with being able to obtain good press setup workability, the multilayer film relating to the present invention has the characteristic of being able to increase the yield rate for FPCs, and is particularly useful as a mold release film that can be used to envelope the CL film during the bonding of the CL film to the circuit exposure film by the press so that the cover lay film adheres to the irregularities of the circuit pattern.
- [0131] In addition to being known for use as mold release films (1) during the manufacture of laminated boards, (2) during the manufacture of cutting edge composite materials, and (3) during the manufacture of sports and leisure products, the multilayer films relating to the present invention are also useful as such mold release films. Furthermore, mold release films are used during the manufacture of laminated boards, in the press-molding for manufacturing multilayer printed circuit boards, and the films can be interposed between such for preventing bonding between printed circuit boards and separator plates or other printed circuit boards. The films can be used as mold release films during the manufacture of cutting edge composite material products, for example, as films for use in the manufacture of various products from cured pre-pregs including glass cloth, carbon fibers or aramid fibers, and epoxy resins. As mold release films used during the manufacture of sports and leisure products, for example, in the manufacture of fishing rods, golf club shafts, wind surfing poles, and the like, when the pre-preg is rolled into a cylindrical shape and cured in an autoclave, the film can be wound onto the pre-preg.
- [0132] In addition, this multilayer film can be used as a release film in adhesive tape, double-sided tape, masking tape, labels, seals, stickers, moisturizing skin patches, and the like.
- [0133] These multilayer films can be used as processing films for use during the manufacture of printed circuits or ceramic electronic components, heat-curable resin products, decorative panels, and the like. Furthermore, during the manufacture of printed circuits or ceramic electronic components, heat-curable resin products, decorative panels, and the like, the processing films mentioned here can prevent bonding between metallic plate parts and resin parts, where

the film would be interposed in between the metal parts or the resin parts, and in particular are suitable for use during the manufacture of laminated boards, during the manufacture of flexible printed circuits, during the manufacture of cutting edge composite material products, and during the manufacture of sports and leisure products.

These multilayer films are also useful as packaging films.

Claims

1. Multilayer film comprising a first mold release layer formed from a resin of which the main component is a polystyrene series resin that has a syndiotactic structure; and
cushion layer containing greater than 60 parts by weight and 98 parts by weight or less of a polyolefin series resin, and 2 parts by weight or more and less than 40 parts by weight of a polystyrene series resin that has a syndiotactic structure and is provided on one side of the first mold release layer, wherein
the polyolefin series resin contains 3 parts by weight or more and 40 parts by weight or less of polypropylene resin, and greater than 20 parts by weight and 95 parts by weight or less of an ethylene-methyl methacrylate copolymer resin.
2. The multilayer film as recited in Claim 1, wherein the ethylene-methyl methacrylate copolymer resin contains 5 wt% or more and 14 wt% or less of units derived from methyl methacrylate.
3. The multilayer film as recited in Claim 1 or 2, wherein the first mold release layer contains a polystyrene series resin having a syndiotactic structure as the main component, and is formed from a resin that exhibits a degree of crystallinity of 14.0% or more and less than 30.0% as measured by the differential scanning calorimetry method.
4. The multilayer film as recited in any Claims 1 through 3 further comprising a second mold release layer formed on the opposite side from the first mold release layer formed side of the aforementioned cushion layer.
5. The multilayer film as recited in Claim 4, wherein the second mold release layer is formed from a resin of which the main component is the polystyrene series resin having a syndiotactic structure.
6. The multilayer film as recited in Claim 5, wherein the resin that forms the second mold release layer has a degree of crystallinity of 14.0% or greater and less than 30.0% as measured by the differential scanning calorimetry method.