

DESCRIPTION

METHOD FOR PLATING WIRING BOARD, AND WIRING BOARD

5 Technical Field

[0001] The present invention relates to a plating method performed in a production process of a wiring board and to a plated wiring board and, more specifically, to a plating method performed to selectively plate a specific area such as a connecting terminal of a flexible printed board or the like and to a wiring board obtained by the method.

Background Art

[0002] As shown in Fig. 1, in the wiring board, on a conductive layer of a laminated body where conductive layers composed of a copper foil and the like via an adhesive layer at request are laminated, arbitrary circuit patterns 1, 2, and the like are formed by etching or the like on an insulating substrate 4. On the surfaces of the circuit patterns 1, 2, a plated layer is formed at request for the purpose of decrease in electric resistance, protection of the metal surfaces from oxidation and abrasion, or decoration and the like. Further, the area where a chip or an electrode is not connected of the circuit patterns 1 and 2 is subjected to an insulating treatment by attaching a coverlay film thereto as necessary.

[0003] As a method to form the aforementioned plated layer, for example, as a method for partially plating a connecting terminal portion or the like, there is performed a method where, after a masking tape is bonded to a portion

not to be plated for inhibiting a formation of plating, electrolyte plating or non-electrolyte plating is performed.

[0004] However, since the surface of a printed board or
5 flexible printed board where the masking tape is bonded has complex unevenness in the circuit pattern previously formed, it is necessary for the masking tape to follow and adhere to the unevenness to inhibit the plating solution from entering the masked portions. When the masking tape has low
10 adhesion, the plating solution enters to cause deterioration in plating accuracy and resultant malfunction and the like of the circuit. From such problems, there has been proposed a masking method for plating a wiring board, where, to selectively plate a predetermined area to be plated
15 among plating target areas of a wiring board, upon masking the other plating target areas, using a masking film sheet provided with an adhesive to surround the non-adhesive surface, and bonding the masking film sheet in such a manner that the adhesive surrounds the other plating target area
20 (Patent Document 1).

[0005] In addition, besides the aforementioned masking method, there has conventionally been employed a support made of a soft vinyl chloride based resin as a masking tape. However, in recent years, there have been proposed the
25 following mask materials since a soft vinyl chloride based resin has a problem of bad influence on the environment upon disposal (incineration). They are a method where, upon forming an electrolyte plated layer, a plating protector having an opening and made of polyimide or polyester is
30 bonded onto a conductor via an adhesive (Patent Document

2), a masking tape obtained by providing an adhesive layer containing a water-soluble or water-dispersible adhesive and a benzotriazole based compound on a substrate (Patent Document 3), a plating mask adhesive film, which is a resin
5 film containing polypropylene and polyolefin based elastomer as the main components and obtained by providing an adhesive layer on one surface of a support having a film tensile stress of 0.20 to 0.80 kg/cm² at 10% strain (Patent Document 4), a plating mask adhesive film having a low
10 density polyethylene layer having a density of 0.91 to 0.93 g/m² and an ethylene-vinyl acetate copolymer layer and characterized by providing an adhesive layer on the ethylene-vinyl acetate copolymer side of the multilayer film having two or more layers and having a film tensile
15 stress of 0.20 to 0.80 kg/m² at 10% strain (Patent Document 5), a plating mask protective film employing as the support a multilayer film having two or more layers of a soft resin layer (layer A) having a thickness of 10 to 200 μ m and a tensile elastic modulus of 0.5 to 150 kg/mm² and a resin
20 layer (layer B) having a bending strength of 5 to 30 kg/mm² and characterized by providing an adhesive layer on the A layer side (Patent Document 6), a metal plating masking tape characterized by being formed by an adhesive containing a propylene based copolymer containing as the copolymer
25 components propylene, α -olefin having a carbon number of 4 to 12, and ethylene and having no endothermic peak of 1J/g or more in measurement with a differential scanning calorimeter (DSC) in a temperature range from 0 to 200°C on one surface of the substrate (Patent Document 7), and
30 a metal plating masking tape obtained by providing, on one

surface of a substrate, an adhesive which contains a polymer obtained by cross-linking a copolymer composed of (a) 5 to 45 mass% of a methyl methacrylate monomer, (b) 0.5 to 15 mass% of a monomer containing a hydroxyl group and capable of being copolymerized with (a), and (c) an alkyl acrylate monomer copolymerizable with the aforementioned (a) and (b) with a polyfunctional isocyanate compound having two or more isocyanate groups and which has an elastic modulus of 50 to 750 N/cm² after the cross-linking (Patent Document 8).

Patent Document 1: JP-A-11-12783
Patent Document 2: JP-A-62-243791
Patent Document 3: JP-A-6-264283
Patent Document 4: JP-A-8-165592
Patent Document 5: JP-A-9-25459
Patent Document 6: JP-A-11-302611
Patent Document 7: JP-A-2003-213485
Patent Document 8: JP-A-2004-35965

Summary

[0006] However, in the masking method of Patent Document 1, operation efficiency decreases because the formation of the adhesive is complex, and there are concerns about its reliability regarding inhibition of a plating solution from entering an area not to be plated. In addition, any of the methods in the Patent documents 2, 3, 7, and 8 is still unsatisfactory in unevenness followability of the circuit pattern formed on the insulating substrate. Furthermore, there is the case of taking the air into the gap between the wiring board and the mask material upon bonding the

masking material onto the circuit pattern. In addition, because of large dimension change at high temperature, there may be caused displacement in the masking portion, and it is difficult to inhibit the mask material from being peeled off because the adhesion of the adhesive layer cannot withstand the dimension change. Therefore, there arise problems of decreasing the plating accuracy because the plating solution adheres to an area not to be plated due to peeling of the mask material by entry of the plating solution or expansion of the air taken depending on the plating treatment temperature. In addition, though each of the Patent Documents 4 to 6 proposes a method with no entry of a plating solution even in the case of using a glass epoxy printed board having an unevenness of 25 μm of a circuit pattern, it is difficult to inhibit the air from being taken into the gap at the interface between the wiring board and the mask material upon bonding the mask material onto a circuit pattern like the aforementioned one. Though the performance of inhibiting the plating solution from entering can be exhibited only when the mask material is bonded without taking the air into the gap even in a circuit pattern having large unevenness, in order to bond without taking the air, it is necessary to independently introduce care and time and further an expensive machine only for bonding, which had problems of causing decrease in production efficiency and increase in costs.

[0007] Further, as a circuit pattern gets more complex and minute, non-electrolyte plating is often employed to perform an even plating treatment applied to a complex shape. Since the non-electrolyte plating has higher plating

temperature (50 to 90°C) than plating temperature (30 to 60°C) in a general electroplating, the masking film may be contracted by the plating temperature depending on the masking film to be used, or the plating accuracy of the resultant wiring board may be decreased, or it is necessary to wipe up the adhesive component remaining on the article where the masking film was bonded because a part of the adhesive layer of the masking film may remain on the article (adhesive deposit) upon peeling off the masking film from the article, which causes problems of decrease in productivity and quality deterioration of the product.

[0008] The present disclosure aims to provide a plating method capable of improving productivity and plating accuracy by inhibiting these problems, that is, good followability to the circuit pattern and taking the air upon bonding and improving punching workability upon forming an open portion and a wiring board obtained by the plating method.

[0009] As a result of earnest study for solving the aforementioned problems, the inventors found out that there can be obtained a plating method capable of obtaining high plating accuracy and a high-quality wiring board by employing the method where by masking the areas other than the plating target area with a specific masking film in a method for selectively plating a plating target area of a wiring board having large unevenness in the circuit pattern, a masking film follows regardless of the size of the unevenness and, as a result, inhibits the plating solution from entering the area other than the plating target area and that the use of a masking film having a specific adhesive

layer as the aforementioned masking film can inhibit entry of the plating solution and deterioration in plating accuracy due to expansion of the air taken upon the plating treatment because it inhibits the air bubble from remaining between the adhesive layer of the masking film and the area for bonding in the bonding step, which led to the completion of the present disclosure.

[0009a] In a first aspect, there is provided a method for plating a wiring board, the method comprising: in order to selectively plate a plating target area on the wiring board having a circuit pattern having an unevenness of 25 μm or more formed on an insulating substrate, when areas other than the plating target area are masked, using a masking film obtained by sequentially laminating an adhesive layer and a release sheet on one surface of a polybutylene terephthalate film; removing the release sheet of the masking film; then, bonding the adhesive layer surface of the masking film to a predetermined area on the wiring board under an environment at room temperature, followed by thermocompression bonding; and then, plating the plating target area.

[0009b] In a second aspect, there is provided a wiring board plated by a plating method as defined above.

[0010] That is, the present disclosure provides the

following plating method and wiring board obtained by the method.

[0011] [1] A method for plating a wiring board, the method comprising: in order to selectively plate a plating target area on the wiring board having a circuit pattern having an unevenness of 25 μm or more formed on an insulating substrate, when areas other than the plating target area are masked, using a masking film obtained by sequentially laminating an adhesive layer and a release sheet on one surface of a polybutylene terephthalate film; removing the release sheet of the masking film; then, bonding the adhesive layer surface of the masking film to a predetermined area on the wiring board under an environment at room temperature, followed by thermocompression bonding; and then, plating the plating target area.

[0012] [2] A method for plating a wiring board according to [1], wherein the masking film having the adhesive layer surface having a 60 degree specular gloss of 30% or less on the basis of JIS Z 8741, (a) an initial peel force of 0.1 to 1.0N/25 mm, and (b) a ball tack value of 3 or less.

[0013] (a) Initial peel force

A masking film which is subjected to neither a heating treatment nor an ultraviolet irradiation treatment after being manufactured is cut to have a width of 25 mm and a length of 250 mm to obtain a test piece, and a polyimide film (trade name: Kapton 100V, produced by DU PONT-TORAY CO., LTD.) having a thickness of 25 μ m was pressure bonded to the test piece by reciprocating a rubber roller twice under the conditions of room temperature, a bonding pressure of 2 kg, and a rate of 20 mm/s to obtain a test piece. The peel force upon peeling off the polyimide film from the test piece toward a 180° direction at a tensile rate of 300 mm/min is measured according to JIS Z 0237.

[0014] (b) Ball tack value

According to JIS Z 0237, the ball tack value of the surface of the adhesive layer at an inclined angle of 30°.

[0015] [3] A method for plating a wiring board according to [2], wherein (c) a peel force between the release sheet and the adhesive layer of the masking film is 0.04N/25 mm or more.

[0016] (c) Peel force between release sheet and adhesive layer

A masking film which is subjected to neither a heating treatment nor an ultraviolet irradiation treatment after being manufactured is cut to have a width of 25 mm and a length of 250 mm to obtain a test piece. The peel force when polyethylene terephthalate of the test piece is peeled off toward a 180° direction at a tensile rate of 300 mm/min is measured according to JIS Z 0237.

[0017] Here, the circuit pattern is formed by providing a photosensitive resin layer of a liquid resist material

or a film-shaped resist material on a surface of a conductive metal layer arranged of a laminated plate obtained by providing a metal layer having conductivity on at least one surface of an insulating substrate by means of an adhesive layer at request, exposing and developing the
5 photosensitive resin layer to form a desired masking pattern, selectively etching mainly the conductive metal layer with using the aforementioned pattern as a masking material, and continuously subjecting the exposed substrate metal layer
10 to soft etching with leaving the masking material and to a following treatment with an aqueous solution (e.g., developing liquid or rinse agent) containing an organic compound having a reducing character. In addition, the unevenness of the circuit pattern means height from the
15 surface of the insulating substrate to the surface of the pattern.

[0018] Further, bonding the aforementioned masking film in a predetermined place of a wiring board means bonding in such a manner that the open portion of the masking film
20 having the open portion at the place corresponding with the plating target area of the wiring board coincides with the plating target area of the wiring board. The bonding is generally performed at ordinary temperature (about 23°).

[0019] [4] A wiring board plated by a plating method
25 according to any one of [1] to [3].

[0020] In the present disclosure, a peel sheet of a masking film obtained by sequentially laminating an adhesive layer and a peel sheet on one surface of a polybutylene terephthalate film at the areas other than the
30 plating target area of a wiring board having a circuit

pattern having an unevenness of 25 μm or more is peeled off, and the adhesive layer is brought into contact with the circuit pattern for bonding, thereby inhibiting entry of the plating solution and, as a result, improving the plating accuracy even in a circuit pattern having an unevenness of 25 μm or more because of its excellent shape flowability.

[0021] In addition, by bonding a masking film having an adhesive layer having a specific gloss provided on a polybutylene terephthalate film and having a specific peel force, the air can be inhibited from being taken into the gap at the interface of the masking film and the wiring board. This enables to inhibit deterioration in plating accuracy such as entry of the plating solution due to expansion of the air taken upon the plating treatment.

[0022] Further, since the masking film has good punching workability, there can be inhibited entry of the plating solution due to peeling of the adhesive layer or a burr caused upon punching and adhesive deposit upon peeling off from the wiring board. Thus, improved productivity is obtained and deterioration of plating accuracy is inhibited.

Brief Description of the Drawings

[0023] [Fig. 1] Fig. 1 is a partial plan view of a wiring board used for an embodiment of the present invention.

[Fig. 2] Fig. 2 is a cross-sectional view showing an example of a punching apparatus for punching a masking film into a predetermined pattern.

Description of Reference Numeral

[0024] 1, 2: plating target area (circuit pattern), 3:

coverlay film, 4: insulating substrate, A: interval
(pitch) between circuit patterns, 5: punching apparatus,
6: press means, 7: cutter blade, 8: release paper, 9:
adhesive layer, 10: base substrate, 11: die, 12: uneven
5 portion, 13: open portion

Best Mode for Carrying Out the Invention

[0025] Hereinbelow, the best mode for carrying out a
plating method and a wiring board of the present invention
10 will specifically be described. However, the present
invention is by no means limited to the following mode.

[0026] [Method for plating a wiring board]

In a wiring board used for a plating method of the
present invention, a circuit pattern having a height of 25
15 μm or more is formed on an insulating substrate. Examples
of the insulating substrate include synthetic resins such
as polyethylene terephthalate, polyethylene naphthalate,
polyethylene, polybutylene naphthalate, polypropylene,
polyolefin, polycarbonate, triacetyl cellulose, cellophane,
20 polyimide, polyamide, polyphenylene sulfide,
polyetherimide, polyethersulfone, aromatic polyamide,
liquid crystalline polymer, polyether ether ketone, and
polysulfone; aramid paper; insulating paper; glass, and
ceramic. The thickness of the insulating substrate film is
25 generally within the range of about 4 to 250 μm .

[0027] For the circuit pattern formed on the insulating
substrate, there may be employed a method for forming a
circuit pattern (subtractive method) where an unnecessary
portion of a conductive layer of the laminated plate obtained
30 by providing a conductive layer of a copper foil or the like

on the insulating substrate by means of a bonding agent at request is selectively removed, a method for forming a circuit pattern (additive method) where a conductive material is selectively precipitated on an insulating substrate by, for example, non-electrolyte plating, a method for forming a circuit pattern on an insulating substrate using conductive ink, a method for forming a circuit pattern by, after printing a plating resist or an etching resist, a plating or etching treatment is performed, followed by peeling the resist.

[0028] The circuit pattern generally has an unevenness of about 25 to 50 μm . When the unevenness is below 25 μm , a conventional masking film can be used sufficiently. However, when the unevenness is 25 μm or more, it is difficult for a conventional masking film to follow the unevenness of the circuit pattern. Further, when the unevenness is large, the air is easily taken upon bonding the masking film on a circuit pattern. Therefore, in a plating method of the present invention, it is necessary to bond a specific masking film on a wiring board in two stages.

[0029] Further, in order to make the masking film follow the unevenness of 25 μm or more, it is necessary to use a polybutylene terephthalate film as a base substrate constituting the masking film in the present invention. The polybutylene terephthalate film has a thickness of preferably 15 to 40 μm , and, particularly the film having a thickness of 15 to 30 μm is preferable because of excellent followability along a circuit pattern having an unevenness of 25 μm or more and formability of an open portion, and particularly punching workability.

[0030] There is no particular limitation on a method for manufacturing polybutylene telephthalate, and a general manufacturing method, for example, a direct polymerization method or an ester exchange method may be employed. The
5 direct polymerization method is a method where a polybutylene telephthalate precursor is formed by a direct esterification reaction of telephthalic acid and 1,4-butanediol, followed by subjecting the polybutylene telephthalate precursor to polycondensation under reduced
10 pressure to manufacture polybutylene telephthalate. The ester exchange method is a method where lower alkyl ester of telephthalic acid and 1,4-butanediol are subjected to an ester exchange reaction to form a polybutylene telephthalate precursor, followed by subjecting the
15 polybutylene telephthalate precursor to polycondensation under reduced pressure to manufacture polybutylene telephthalate. The polybutylene telephthalate used for the manufacture of the polybutylene telephthalate film for a base substrate of the present invention may be manufactured
20 by another method. A method for manufacturing a film using the thus obtained polybutylene telephthalate will be described.

[0031] As an example of a method for manufacturing a polybutylene telephthalate film, there is a method for
25 manufacturing an unstretched film of a film by extrusion by, for example, a T die or inflation using a known nucleator, a lubricant, an antiblocking agent, a stabilizer, an antistatic agent, an antifog additive, an antioxidant, an ultraviolet absorber, a filler, a plasticizer, a colorant,
30 and the like besides the aforementioned polybutylene

telephthalate; polyester such as polyethylene telephthalate, polytrimethylene telephthalate, or poly(ethylene telephthalate / ethylene isophthalate); polycarbonate; or the like. Though the unstretched film may
5 further be subjected to monoaxial or biaxial stretching, an unstretched film is preferable from the viewpoint of unevenness followability.

[0032] In addition, polybutylene telephthalate film may be subjected to a surface treatment, and there may be
10 employed, for example, a discharge treatment such as a corona discharge treatment or a glow discharge treatment; a plasma treatment; a flame treatment; an ozone treatment; an ionization active ray treatment such as an ultraviolet ray treatment, an electron-beam treatment, or a radiation
15 treatment; a roughen treatment such as a sand mat treatment, an anchoring treatment, or a hairline treatment; a chemical agent treatment; or an easily adhesive layer application treatment for the purpose of improving adhesiveness with the adhesive layer.

[0033] Examples of the release sheet constituting the
20 masking film include paper, fabric, nonwoven fabric, metal foil, a plastic laminate of them, and a laminate of plastics besides a plastic film and a plastic sheet, and various sheet-shaped articles may be used as the substrate. Above
25 all, paper, a plastic film, or a plastic sheet is preferable from the viewpoint of a surface processability and their cost. The material for the plastic film can be selected as necessary from the viewpoint of strength, thermal resistance, and the like. For example, there may be
30 employed olefin based resin containing α -olefin as a monomer

component such as polyethylene, polypropylene, ethylene-propylene copolymer, and ethylene-vinyl acetate copolymer; polyester such as polyethylene terephthalate; polyethylene naphthalate, and polybutylene terephthalate; 5 polyvinyl chloride; polyphenylene sulfide; amide based resin such as polyamide and full aromatic polyamide; polyether ether ketone; polyimide; polyetherimide; polystyrene; or acrylic resin. These materials may be used alone or as a combination of two or more kinds. In addition, 10 as the plastic film, there may be used either an unstretched film, a monoaxially oriented film or a biaxially oriented film. These films may be laminated films of two or more film layers. Alternatively, a film where a lubricant such as an inert particle is added may suitably be used from the 15 viewpoint of handleability. Though the thickness of the aforementioned substrate is not particularly limited, it is preferably 5 to 250 μm from the viewpoint of handleability and the like.

[0034] Further, in order to improve releasability, a 20 release layer may be formed on the substrate at request. The release layer can be formed by, for example, preparing an application liquid containing fluorine based resin; waxes such as paraffin wax, a montan wax, and a synthetic wax; a release agent such as silicone; and a binder of acrylic 25 resin, cellulose based resin, or a vinyl based resin and applying the application liquid on the substrate, followed by drying. Alternatively, a coated film may be formed by applying resin such as fluorine based resin, silicone, polysiloxane, melamine based resin, urethane based resin, 30 polyolefin based resin, polyfunctional acrylate, polyester,

epoxy, titanium chelate, and polyimine on the
aforementioned substrate, or a release layer may be formed
by laminating the aforementioned resin on the substrate by
extrusion coating or the like. The thickness of the release
5 layer is generally within the range from about 0.1 to about
2 μ m.

[0035] As the adhesive forming the adhesive layer formed
on the aforementioned polybutylene terephthalate film,
there may be used rubber based resin, acryl based resin,
10 silicone based resin, or a mixture thereof. Above all,
acryl based resin is preferable from the viewpoint of weather
resistance and thermal resistance. An acryl based resin
obtained by copolymerizing a vinyl monomer having an alkyl
group as the main component and various vinyl monomers having
15 a functional group can be used. Examples of the vinyl
monomer having an alkyl group include (meth)acrylic acid
esters each having an alkyl group having a carbon number
of 1 to 18, for example, methyl (meth)acrylate, ethyl
(meth)acrylate, isopropyl (meth)acrylate, lauryl
20 (meth)acrylate, butyl (meth)acrylate, hexyl (meth)acrylate,
octyl (meth)acrylate, dodecyl (meth)acrylate, and stearyl
(meth)acrylate. In addition, examples of the vinyl monomer
having a functional group include a vinyl monomer having
a hydroxyl group, a vinyl monomer having a carboxyl group,
25 a vinyl monomer having an amide group, a vinyl monomer having
an amino group, a vinyl monomer having an alkoxy group, and
a vinyl monomer having an ethylene oxide group.

[0036] Here, examples of the vinyl monomer having a
hydroxyl group include 2-hydroxyethyl (meth)acrylate,
30 2-hydroxypropyl (meth)acrylate, and 2-hydroxybutyl

(meth)acrylate. Examples of the vinyl monomer having a carboxyl group include acrylic acid, methacrylic acid, itaconic acid, maleic acid, and fumaric acid. Further, examples of the vinyl monomer having an amide group include
5 (meth)acrylamide, N-methylol (meth)acrylamide, N-methoxymethyl (meth)acrylamide, and N,N'-methylenebis(meth)acrylamide. In addition, examples of the vinyl monomer having an amino group include dimethylaminoethyl (meth)acrylate and diethylaminoethyl
10 (meth)acrylate. Examples of the vinyl monomer having an alkoxy group include methoxyethyl (meth)acrylate, ethoxyethyl (meth)acrylate, butoxyethyl (meth)acrylate, and phenoxyethyl (meth)acrylate. Examples of the vinyl monomer having an ethylene oxide group include diethylene
15 glycol (meth)acrylate, methoxydiethylene glycol (meth)acrylate, and methoxypolyethylene glycol (meth)acrylate.

[0037] Further, as necessary, monomers such as styrene, chlorostyrene, α -methylstyrene, vinyl toluene, vinyl
20 chloride, vinyl acetate, and acrylonitril can be copolymerized.

[0038] To these acrylic resin can be added a tackifier such as rhodine, dammar, polymerized rhodine, partially hydrogenated rhodine, ester rhodine, polyterpene resin,
25 terpene denatured body, petroleum resin, cyclopentadiene resin, phenol resin, styrene resin, xylene resin, and coumarone-indene resin; a softener; and a filler at request.

[0039] In addition, when an acrylic resin containing a hydroxyl group or a carboxyl group is used, it is preferable
30 to use a polyepoxide compound or a polyisocyanate compound

as a cross-linking agent. Examples of the polyepoxide compound include sorbitol polyglycidyl ether, polyglycerol polyglycidyl ether, pentaerythritol polyglycidyl ether, diglycerol polyglycidyl ether,

5 triglycidyl-tris(2-hydroxyethyl)isocyanurate, glycerol polyglycidyl ether, trimethylol propane polyglycidyl ether, resorcin glycidyl ether, neopenthylglycol diglycidyl ether, 1,6-hexanediol diglycidyl ether, bisphenol-S-diglycidyl ether, ethyleneglycol diglycidyl ether, polyethyleneglycol
10 diglycidyl ether, and propyleneglycol diglycidyl ether. In addition, examples of the polyisocyanate compound include toluylene diisocyanate, 2,4-toluylene diisocyanate dimer, naphthylene-1,5-diisocyanate, o-toluylene diisocyanate, diphenylmethane diisocyanate, triphenylmethane
15 triisocyanate, tri-(p-isocyanate phenyl)thiophosphite, polymethylene polyphenyl isocyanate, hexamethylene diisocyanate, trimethylhexanemethylene diisocyanate, isophorone diisocyanate, and trimethylhexamethylene diisocyanate.

20 [0040] As a method for forming the aforementioned adhesive layer, there is prepared an adhesive layer-forming application liquid having a solid content of 20 to 50 mass% by dissolving or dispersing the aforementioned adhesive, a cross-linking agent used at request, an organic and/or
25 inorganic particle, and various additives, for example, a surfactant, a lubricant, a stabilizer, and a viscosity adjuster in an appropriate solvent. Next, the adhesive layer-forming application liquid prepared above is applied onto the aforementioned release sheet and dried, and the
30 base substrate is laminated and pressure-bonded.

Alternatively, the liquid is applied onto the base substrate and dried, and the release sheet is laminated and pressure bonded to form the adhesive layer. It is desirable to form an adhesive layer having a thickness of 5 to 50 μm . When
5 the thickness is smaller than this range, followability along the circuit pattern deteriorates, and it is difficult to inhibit the entry of the plating solution, which may cause deterioration in plating accuracy. When the thickness is larger than this range, it easily causes insufficient drying
10 and insufficient cross-linking in a solvent type adhesive. As a result, production rate is lowered, and a large amount of an adhesive is used, which tends to be a disadvantage in productivity and cost. Further, when a masking film is produced in a rolled state, protrusion of starch on the side
15 face of the film tends to be caused by wrapping around the wrapping core. It is preferably 5 to 50 μm , further preferably 10 to 30 μm from the viewpoint of plating accuracy and productivity.

[0041] Regarding the surface glossiness of the adhesive
20 layer of the aforementioned polybutylene terephthalate film constituting the masking film provided at request on the surface-treated face, the 60° specular gloss is preferably 30% or less. When the 60° specular gloss is above 30%, in the case that the air is taken into the gap between the
25 adhesive layer and the adhesion target article such as a substrate, the air tends not to be discharged outside the substrate in bonding by the following thermocompression bonding. As a result, the air taken into the gap expands at plating temperature upon the plating treatment, and
30 therefore, uplift or exfoliation tends to be caused in the

masking film. The plating solution enters an area not to be plated by the uplift or exfoliation, and the entry tends to cause deterioration in plating accuracy and contamination on the substrate. Also for inhibiting the air from being taken upon bonding the masking film, it is preferably 25% or less, particularly preferably 20% or less.

[0042] As a method for adjusting the 60° specular gloss to be 30% or less, a method can suitably be selected from the methods including a method using a release sheet having a specific surface roughness, surface processing using a roll having a specific shape, a sand mad treatment, and a chemical agent treatment. However, a method using a release sheet is preferable from the viewpoint of productivity and specular gloss adjustability.

[0043] As the release sheet used for the method using a release sheet, a sheet having unevenness on the surface thereof is used among the aforementioned release sheets. At this time, in order to control 60° specular gloss of the adhesive layer to be 30% or less, the surface of the release sheet preferably has unevenness having a centerline average roughness (Ra) of 2.5 μm or more and an unevenness average interval of 1.0 mm or less.

[0044] When the release sheet surface has a center line average roughness (Ra) of below 2.5 μm or when the unevenness average interval is above 1.0 mm, the contact area with the adhesion target article increases, which makes the masking film easily take the air when the masking film is bonded, and, as a result, laminate becomes insufficient, which is not preferable. The preferable ranges of the center line average roughness (Ra) and the unevenness average interval

are 2.6 to 3.0 μm and 1.0 mm or less, respectively in view of ease for air-taking.

[0045] In a method using a release sheet, an adhesive layer is formed on the uneven surface of the release sheet having such a surface, and a polybutylene terephthalate film is laminated on a surface on the opposite side to the release sheet to obtain a masking film. At this time, the unevenness of the release sheet surface is transcribed on the adhesive layer surface to obtain an adhesive layer having a 60° specular gloss of 30% or less.

[0046] In addition, the masking film where an adhesive layer is formed on the base substrate preferably has an initial peel force of 0.1 to 1.0N/25mm. When it is below this range, adhesion to a wiring board having a circuit pattern thereon at room temperature is small to serve as a cause of difficult workability, while, when it is above this range, adhesion is too strong, thereby lowering removability. As a result, it becomes difficult to reattach the masking film to the adhesion target article without any damage. When the masking film is bonded at room temperature, wetting proceeds to make the masking film take the air easily, thereby laminate tends to be insufficient by the air-taking. It is particularly preferably 0.4 to 0.6N/25mm from the viewpoints of working efficiency, product yield, and product quality improvement.

[0047] Further, in the adhesive layer constituting the masking film used in a plating method of the present invention, it is preferable that adhesive layer surface has a ball tack value of 3 or less measured in accordance with JIS Z 0237. When the ball tack value is above 3, since

wetting proceeds when the masking film is bonded at room temperature, it is not preferable because it is difficult to inhibit the masking film from taking the air therein. When the masking film is bonded to the adhesion target article by thermocompression bonding with the air being taken between them, the air is not released, and, as a result, uplift is caused in the masking portion by the insufficient laminate or by expansion of the air by the heating upon the plating treatment to cause deterioration in plating accuracy, which is not preferable.

[0048] In a plating method of the present invention, the aforementioned masking film is bonded to the areas other than the plating target area of the circuit pattern. The masking film has an open portion in a position corresponding to the plating target area as necessary. As a method for forming the open portion, the method may suitably be selected from the methods such as a method where a masking film is subjected to punching, a method where a masking film is cut out by a cutter or the like, and a method where the portion is burnt off by a laser. Though punching is preferable from the viewpoints of productivity and cost, punching had a difficult side because a polybutylene terephthalate film is used as the base substrate as the masking film used in the present invention from the viewpoints of unevenness flowability of the circuit pattern and dimension stability in the heating step. Therefore, in order to improve the punching workability even when a polybutylene terephthalate film is used, it is preferable to set the peel force between the adhesive layer and the release sheet constituting the masking film to 0.04N/25mm or more. When the peel force is

below 0.04N/25mm, through there is no problem as a masking film, a defect in appearance of a punched end face portion or a burr is caused by the deterioration in punching workability to cause problems in productivity and plating accuracy, which is not preferable.

[0049] A method for forming an open portion corresponding with the plating target area of the masking film by punching will be described on the basis of Fig. 2. The punching apparatus 5 has a press means 6, a cutter blade 7, and a die 11. A masking film is put on the die 11, and the cutter blade 7 is pressed into the masking film by the press means 6, thereby forming an open portion by the cutter blade 7. The masking film is constituted of a base substrate 10, an adhesive layer 9, and a release paper 8. Besides the method (1) where punching is performed from the base substrate 10 side with the cutter blade 7 as shown in Fig. 2, there is a method (2) where the masking film is disposed contrarily to Fig. 2 to punch from the release paper 8. Further, there may be employed a method (3) where punching is performed with laminating a cushion material or the like between the die 11 and the masking film (base substrate 10 or release paper 8). Of these, the method (1) is preferable from the viewpoint of punching accuracy (less occurrence of a burr or peeling of the adhesive layer).

[0050] In a plating method of the present invention, thermocompression bonding is necessary after bonding the aforementioned masking film in a predetermined position of the wiring board. As a method for bonding in a predetermined position, the operator may bond it manually or use a bonding machine such as a laminator. The bonding temperature may

be temperature upon operation, for example, ordinary temperature (about 23°C), where a masking film can be bonded to a wiring board. By the operation, positioning of the wiring board and the masking film can be performed precisely.

5 [0051] In addition, the thermocompression bonding performed after the aforementioned bonding is preferably performed by the use of a bonding machine such as a laminator having a pair of laminating rolls to subject the wiring board having a masking film bonded thereto at thermocompression
10 bonding temperature. Though the thermocompression bonding conditions may suitably be selected in accordance with properties of the masking film to be used, it is preferable to set the heating condition to 80 to 120°C and the pressurization condition to 200 to 2000kPa because the
15 masking film can follow even the unevenness of a circuit board having a height of 25 µm or more. When the heating condition is below 80°C, flowability becomes insufficient to cause generation of entry of the plating solution and deterioration in plating accuracy. When it is above 120°C,
20 starch exudes from an end face of the open portion of the masking film, and the exuding starch may remain on the adhesion target article. In addition, when the pressurization condition is below 200kPa, followability easily becomes insufficient to make the inhibition of the
25 entry of the plating solution difficult, thereby causing deterioration in plating accuracy. When it is above 2000kPa, starch exudes from an end face of the open portion of the masking film, and the exuding starch may remain on the adhesion target article. In addition, though the
30 thermocompression bonding rate of about 1 m/min is

sufficient, the rate can suitably be adjusted from the condition of the masking film after the thermocompression bonding.

[0052] Thus, by subjecting the wiring board having the
5 masking film bonded thereto to plating, the plating target area can be plated. As the plating method at this time, non-electrolyte plating or electroplating can be employed. The non-electrolyte plating is a method where metal is reduced by a reducing agent without applying a current on
10 a surface of a metal or a non-metal or a method of precipitating on the surface of the plate target material by substitution of a metal. Electroplating is a method using an electrochemical reaction where precipitation is caused by direct current electrolysis with the plate target
15 material as the cathode in an electrolyte solution containing metal ion for plating to cause discharge of the metal ion on the surface of the plate target material as the cathode. Regarding the plating seed used in these plating methods, examples of the plating seed for
20 non-electrolyte plating include gold plating, nickel plating, tin plating, nickel-gold plating, nickel-boron plating, nickel-boron-tungsten plating, nickel-teflon plating, nickel-phosphorous plating, nickel-chrome plating, nickel-iron-phosphorous plating, palladium plating, silver
25 plating, nickel-palladium plating, nickel-silver plating, nickel-palladium-gold plating and the like. In the case of electroplating, examples include copper plating, nickel plating, chrome plating, zinc plating, tin plating, lead plating, gold plating, silver plating, platinum plating,
30 copper-zinc plating, copper-tin plating, lead-tin plating,

tin-zinc alloy plating, tin-cobalt alloy plating, tin-silver plating, zinc-nickel alloy plating, and iron-nickel alloy plating.

[0053] Though plating is performed after the masking
5 film is bonded directly on the insulating substrate in the
aforementioned plating method, besides the plating, a
plating treatment may be performed in a desired area by
bonding a masking film on a circuit pattern or a coverlay
after an insulating material such as a coverlay film is
10 bonded on a circuit pattern by means of an adhesive at
request.

Example

[0054] Next, the present invention will be described by
15 Examples. However, the present invention is by no means
limited to these Examples.

[0055] With regard to the masking films in Examples and
Comparative Examples, nine items of substrate elastic
modulus in the 90°C atmosphere, heating shrinkage ratio,
20 adhesive layer surface glossiness, initial peel force, ball
tack, peel force between the release sheet and the adhesive
layer, bondability, followability, and plating solution
entry state were measured by the following methods.

[0056] (Substrate elastic modulus (Pa) in 90°C
25 atmosphere)

The elastic modulus (Pa) at 90°C was measured.
Specifically, a sample having a width of 3.0 mm and a length
of 15.0 mm of a base substrate having no adhesive layer
thereon was manufactured. One end portion in the
30 longitudinal direction of the sample was held by a fixed

chuck, and the other end portion of the sample was held by a movable chuck, and measurement was performed with applying a load of -1.0g to -2.0g under each set temperature condition by a TMA tensile mode method using TMA4000S (produced by
5 MAC Science Company Ltd.). The temperature rise rate upon measurement was 5°C/min., and the measurement atmosphere was the air atmosphere.

[0057] (Heating shrinkage ratio)

In accordance with JIS C 2318, a masking film subjected
10 to neither a heating treatment nor an ultraviolet irradiation treatment after manufacturing was cut to have a width of 20 mm and a length of 150 mm, and the release sheet was peeled off to obtain a test piece. Reference points were marked in the central portion of the test piece
15 at an interval of about 100 mm, and then the test piece was hung in a thermostatic chamber whose temperature was kept at 90°C. After the test piece was heated for 30 minutes, it was taken out and left at room temperature for 30 minutes, followed by measuring the distance between the reference
20 points with a caliper (product name: Digimatic Caliper produced by Mitutoyo Corporation) to calculate the heating shrinkage ratio from the following formula:

Heating shrinkage ratio (%) = [(Test piece length before heating - Test piece length after heating) / Test piece
25 length before heating] × 100

[0058] (Adhesive layer surface glossiness)

In accordance with JIS Z 8741, the release sheet was peeled off from the making film with a handy glossimeter (product name: PG-1M produced by Nippon Denshoku Industries
30 Co., Ltd.) to measure the 60° specular gloss of the adhesive

layer surface.

[0059] (Initial peel force)

A masking film subjected to neither a heating treatment nor an ultraviolet irradiation treatment after manufacturing was cut to obtain a test piece having a width of 25 mm and a length of 250 mm. To the test piece, a polyimide film (trade name: Kapton 100V produced by DU PONT-TORAY CO, LTD.) having a thickness of 25 μ m was pressure bonded at room temperature by reciprocating a rubber roller twice under the conditions of a bonding pressure force of 2 kg and a rate of 20 mm/s to obtain a test piece. The peel force upon peeling off the polyimide film from the test piece at a tensile rate of 300 mm/min in the 180° direction was measured in accordance with JIS Z 0237.

15 [0060] (Ball tack)

The ball tack value of an adhesive layer surface at an inclined angle of 30° was measured in accordance with JIS Z 0237.

[0061] (Peel force between release sheet and adhesive layer)

A masking film subjected to neither a heating treatment nor an ultraviolet irradiation treatment after manufacturing was cut to obtain a test piece having a width of 25 mm and a length of 250 mm. The peel force upon peeling off the base substrate from the test piece at a tensile rate of 300 mm/min in the 180° direction was measured in accordance with JIS Z 0237.

[0062] (Bondability)

An open portion (A=1.5mm) of Reference Numeral 13 of Fig. 1 was formed in a masking film subjected to neither

a heating treatment nor an ultraviolet irradiation treatment after manufacturing by a cutter knife. Next, after the manual bonding in such a manner that the open portion matches the plating target area by the use of two wiring boards, one of them having an unevenness pattern of 30 μm and the other having an unevenness pattern of 50 μm , in a 23°C environment, thermocompression bonding was performed by the use of a laminator (ASL-24MII produced by Somar Corporation) with the laminating roll having a heating temperature of 90°C, a pressure of 500kPa, and a transport (thermocompression bonding) rate of 1 m/min. to pressure bond a masking film to the wiring board. The state of taking the air at this time was visually observed and evaluated by the following standards.

Good: no air-taking (bubble) found

Bad: air-taking (bubbles) found

[0063] (Followability)

A masking film subjected to neither a heating treatment nor an ultraviolet irradiation treatment after

manufacturing was thermocompression bonded to each wiring board having 30 μm or 50 μm in the same manner as (bondability) described above. With respect to the

Reference Numeral 12 [a depth of 30 or 50 μm and a bottom area of 18 mm^2 (3mm $\times$ 6mm)] of Fig. 1 at this time, observation

was performed at 25-fold magnification using a microscope (product name: VH-8000 produced by Keyence Corporation) to obtain the ratio of the contact area with respect to the bottom area of the Reference Numeral 12 of Fig. 1 after the thermocompression bonding. The value of the followability

(%) can be obtained from the following formula.

Followability (%) = [(contact area: mm²) / 18 mm²] × 100
[0064] (Plating solution entry state)

A masking film subjected to neither a heating treatment nor an ultraviolet irradiation treatment after
5 manufacturing was thermocompression bonded to each wiring board having 30 μm or 50 μm in the same manner as described above. The wiring board was immersed in a non-electrolyte nickel plating aqueous solution (bath composition: 25 g/L of nickel sulfate, 30 g/L of sodium hydrophosphite, and 30
10 g/L of sodium acetate) having a temperature of 90°C for 20 minutes for plating with nickel, and a plating treatment was performed by washing with tap water to obtain a wiring board. The entry of plating solution in the wiring board at this time was visually observed and evaluated by the
15 following standards.

Good: no entry of plating solution in masked portion present

Bad: entry of plating solution in masked portion present

20 [0065] In Example and Comparative Example, the following polymer (A component) and cross-linking agent (B component) were used.

[0066] (A-1 component)

It is an acrylic copolymer having a weight-average
25 molecular weight of 300,000 and a glass-transition temperature of -10°C. As constituent monomers, butyl acrylate, methyl acrylate, vinyl acetate, and 2-hydroxyethyl methacrylate were contained, and the constitution mass ratio was 40:15:37:8. The acrylic
30 copolymer had a hydroxyl value of 35 mgKOH/g.

[0067] (A-2 component)

It is an acrylic copolymer having a weight-average molecular weight of 300,000 and a glass-transition temperature of -33°C. As constituent monomers, butyl acrylate, methyl acrylate, vinyl acetate, and 2-hydroxyethyl methacrylate were contained, and the constitution mass ratio was 68:5:20:7. The acrylic copolymer had a hydroxyl value of 30 mgKOH/g.

[0068] (A-3 component)

It is an acrylic copolymer having a weight-average molecular weight of 390,000 and a glass-transition temperature of -42°C. 2-ethylhexyl acrylate, vinyl acetate, and 2-hydroxyethyl methacrylate were contained, and the constitution mass ratio was 64:35:1. The acrylic copolymer had a hydroxyl value of 6 mgKOH/g.

[0069] (A-4 component)

It is an acrylic copolymer having a weight-average molecular weight of 700,000 and a glass-transition temperature of 15°C. As constituent monomers, ethyl acrylate, methyl acrylate, methyl methacrylate, 2-hydroxyethyl methacrylate, and acrylonitrile were contained, and the constitution mass ratio was 43.7:25:20:1.3:10. The acrylic copolymer had a hydroxyl value of 6 mgKOH/g.

[0070] (B-1 component)

It is an isocyanate based cross-linking agent, and its constituent component is a tolylene-di-isocyanate TMP (trimethylolpropane) adduct type, and the content of NCO is 18%.

[0071] (Example 1)

There were added 100 parts by mass of A-1 component as the adhesive component, 5 parts by mass of B-1 component as the cross-linking agent, and 158 parts by mass of mixed solvent where methylethyl ketone and toluene were mixed together at a mass ratio of 1:1. They were stirred and mixed to prepare an adhesive layer-forming application liquid having a solid content of about 40%.

[0072] Next, an adhesive layer was formed by applying the adhesive layer-forming application liquid by an ordinary method to have a thickness of 10 μm on a release sheet having a thickness of 130 μm and obtained by forming a release layer of a silicone based resin on one surface of a substrate having a polyethylene resin layer on both the surfaces of a piece of paper with a center line average roughness (R_a) of a release layer surface of 2.6 μm , an uneven surface having an unevenness average interval of 1.0 mm, and a peel force (adhesion method of ORIBINE BPS-8170 produced by Sumika-Kakoushi Co., Ltd.) of a silicone based resin of 110 N/m, followed by drying. Next, one surface of an unstretched polybutylene terephthalate film having a thickness of 25 μm was subjected to a corona treatment, and the treated surface and the adhesive layer were laminated and thermocompression bonded using ASL-24MII under conditions of 40°C, 350 kPa, and a rate of 1 m/min., followed by storing for maturation at 35°C for one week to obtain a masking film. The adhesive layer surface had a 60° specular gloss of 11%. At this time, the initial peel force was 0.9N/25mm, the ball tack value was 2 or less, the peel force between the release sheet and the adhesive layer was 0.07N/25mm. The other properties of the masking film

obtained above and evaluation on the state of entry of the plating solution are shown in Tables 1 to 3.

[0073] (Comparative Example 1)

There were manufactured a masking film and a wiring
5 board using the masking film in the same manner as in Example
1 except that a vinyl chloride film was used in place of
the unstretched polybutylene telephthalate constituting
the masking film in Example 1. The adhesive layer surface
had a 60° specular gloss of 11%. At this time, the initial
10 peel force was 0.9N/25mm, the ball tack value was 2 or less,
the peel force between the release sheet and the adhesive
layer was 0.07N/25mm. Evaluation of the properties of the
masking film and the wiring board is shown in Table 1.

[0074] (Comparative Example 2)

15 There were manufactured a masking film and a wiring
board using the masking film in the same manner as in Example
1 except that a biaxially stretched polyethylene
telephthalate film was used in place of the unstretched
polybutylene telephthalate film constituting the masking
20 film in Example 1. The adhesive layer surface had a 60°
specular gloss of 11%. At this time, the initial peel force
was 0.9N/25mm, the ball tack value was 2 or less, the peel
force between the release sheet and the adhesive layer was
0.07N/25mm. Evaluation of the properties of the masking
25 film and the wiring board is shown in Table 1.

[0075] (Comparative Example 3)

There were manufactured a masking film and a wiring
board using the masking film in the same manner as in Example
1 except that an unsretched polypropylene film was used in
30 place of the unstretched polybutylene telephthalate film

constituting the masking film in Example 1. The adhesive layer surface had a 60° specular gloss of 11%. At this time, the initial peel force was 0.9N/25mm, the ball tack value was 2 or less, the peel force between the release sheet and
5 the adhesive layer was 0.07N/25mm. Evaluation of the properties of the masking film and the wiring board is shown in Table 1.

[0076] [Table 1]

	Substrate elastic modulus in 90°C atmosphere	Heating shrinkage ratio (%)	Unevenness (μm)	Followability (%)	Plating solution entry state
Example 1	$1.8 \times 10^8 \text{ Pa}$	MD: 1.1 TD: -0.5	30	85	Good
			50	74	Good
Comp. Ex. 1	$4.0 \times 10^6 \text{ Pa}$	MD: 10 TD: -2	30	88	Bad
			50	76	Bad
Comp. Ex. 2	$1.7 \times 10^9 \text{ Pa}$	MD: 0.4 TD: -0.2	30	50	Bad
			50	40	Bad
Comp. Ex. 3	$1.1 \times 10^8 \text{ Pa}$	MD: 5 TD: -2	30	65	Bad
			50	55	Bad

[0077] In Example 1 and Comparative Examples 1 to 3, masking films were produced with changing only the base substrate with employing the same adhesive layer and the same release sheet. The elastic modulus, heating shrinkage ratio, followability, and evaluation on plating solution entry state of the substrate in 90°C atmosphere of each masking film are shown in Table 1. From the results, the influences of the base substrate are shown. Regarding bondability, any of them showed a good result. However, different results were shown in the followability and the plating solution entry state.

[0078] The wiring board of Comparative Example 1 shows entry of the plating solution upon the plating treatment through it has an excellent followability of 76% with respect to the 50 μm unevenness. This is because the base substrate used for the masking film is a vinyl chloride film, which follows the wiring board because of a sufficiently low substrate elastic modulus of $4.0 \times 10^6 \text{ Pa}$ in the 90°C atmosphere for the thermocompression bonding, while the film does not have excellent dimension stability because

of a very high heating shrinkage ratio of MD: 10% and TD: -2%, thereby deforming the open portion of the masking film while heating upon plating to have entry of the plating solution. In addition, since the plasticizer contained in the vinyl chloride film moved into the adhesive agent while heating upon plating to soften the adhesive, adhesive deposit and adhesion of plasticizer to the wiring board were confirmed upon peeling off the masking film.

[0079] The wiring board of Comparative Example 2 has a low followability of 40% with respect to the unevenness of 50 μm , and entry of the plating solution was found to deteriorate the plating accuracy. This is because the base substrate used for the masking film is a biaxially stretched polyethylene terephthalate, which shows high dimension stability because of low heating shrinkage ratios of MD: 0.4% and TD: -0.2%, while the substrate elastic modulus in 90°C atmosphere for the thermocompression bonding is so high as 1.7×10^9 Pa, and the masking film is hard and not stretched, thereby insufficiently following the unevenness of the wiring board to allow the plating solution to enter an area not to be plated.

[0080] The wiring board of Comparative Example 3 has a somewhat low followability of 55% with respect to the unevenness of 50 μm , and entry of the plating solution was found to deteriorate the plating accuracy. The base substrate used for the masking film was a unstretched polypropylene film, which has a low substrate elastic modulus of 1.1×10^8 Pa in 90°C atmosphere for the thermocompression bonding, while the heating shrinkage ratio was MD: 5%, TD: -2%. This is a film which is slightly

hard and inferior in flexibility to a vinyl chloride film, but has high dimension stability. However, the masking film did not follow the unevenness of the wiring board sufficiently to allow the plating solution to enter an area not to be plated.

[0081] The wiring board of Example 1 has an excellent low followability of 74% with respect to the unevenness of 50 μm , and entry of the plating solution was not found to show no deterioration in the plating accuracy. The base substrate used for the masking film was a unstretched polybutylene telephthalate film, which has a low substrate elastic modulus of 1.7×10^8 Pa in 90°C atmosphere for the thermocompression bonding and has a low heating shrinkage ratio of MD: 1.1%, TD: -0.5%. The film is slightly hard and inferior in flexibility to a vinyl chloride film like the unstretched polypropylene film of Comparative Example 3, but has higher dimension stability than the unstretched polypropylene film.

[0082] The unevenness followability of the masking film using a polybutylene telephthalate was dramatically improved from 55% to 74% in comparison with the case using a polypropylene film. This shows that, in the masking film having a substrate elastic modulus of 10^8 Pa order in 90°C atmosphere for the thermocompression bonding, high dimension stability has an effect in increasing the unevenness followability. By the high dimension stability and the substrate elastic modulus of 10^8 Pa order, the masking film sufficiently followed the unevenness of the wiring board with no deformation in the open portion of the masking film upon plating heating, and no entry of the

plating solution was confirmed, and thereby the plating accuracy was not deteriorated. In addition, since the polybutylene telephthalate film does not contain a low molecular weight component such as a plasticizer contained in a vinyl chloride film, neither adhesive deposition nor adhesion of a plasticizer to the wiring board was confirmed upon peeling off the masking film even after heating upon plating.

[0083] From the results of Table 1, it was found that, as a base substrate of a masking film used for a plating method of the present invention, polybutylene telephthalate film is excellent in followability and the plating solution entry state. Next, other properties, in particular, bondability and the plating solution entry state in the case of using a polybutylene telephthalate film as the base substrate will be examined.

[0084] (Example 2)

An adhesive layer-forming application liquid was prepared in the same manner as in Example 1 except that the blend ratio of the B-1 component used as the cross-linking agent was 7 parts by mass as the adhesive layer-forming application liquid, and a masking film was manufactured in the same manner as in Example 1 by the use of the adhesive layer-forming application liquid. The surface of the adhesive layer had a 60° specular gloss of 11%. The layer had an initial peel force of 0.7N/25mm, a ball tack value of 2 or less, and a peel force between the release sheet and the adhesive layer of 0.05N/25mm. The other property evaluations are shown in Table 1. Further, a wiring board was manufactured by the use of the masking film in the same

manner as in Example 1. The properties of the board are shown in Tables 2 and 3.

[0085] (Example 3)

5 An adhesive layer-forming application liquid was prepared in the same manner as in Example 1 except that the blend ratio of the B-1 component used as a cross-linking agent was 10 parts by mass as the adhesive layer-forming application liquid, and there were manufactured a masking film and a wiring board using the masking film in the same
10 manner as in Example 1 by the use of the adhesive layer-forming application. The surface of the adhesive layer had a 60° specular gloss of 11%. The layer had an initial peel force of 0.1N/25mm, a ball tack value of 2 or less, and a peel force between the release sheet and the
15 adhesive layer of 0.04N/25mm. The other property evaluations of the masking film and the wiring board are shown in Tables 2 and 3.

[0086] (Example 4)

20 An adhesive layer-forming application liquid was prepared in the same manner as in Example 1 except that 100 parts by mass of the A-2 component was used as the adhesive component and that 2 parts by mass of the B-1 component was used as the cross-linking agent, and there were manufactured a masking film and a wiring board using the masking film
25 in the same manner as in Example 1 by the use of the adhesive layer-forming application liquid. The surface of the adhesive layer had a 60° specular gloss of 11%. The layer had an initial peel force of 0.6N/25mm, a ball tack value of 3, and a peel force between the release sheet and the
30 adhesive layer of 0.05N/25mm. The other property

evaluations of the masking film and the wiring board are shown in Tables 2 and 3.

[0087] (Example 5)

5 An adhesive layer-forming application liquid was prepared in the same manner as in Example 4 except that the blend ratio of the B-1 component was 4 parts by mass as the adhesive layer-forming application liquid, and there were manufactured a masking film and a wiring board using the masking film in the same manner as in Example 1 by the use
10 of the adhesive layer-forming application liquid. The surface of the adhesive layer had a 60° specular gloss of 11%. The layer had an initial peel force of 0.3N/25mm, a ball tack value of 3, and a peel force between the release sheet and the adhesive layer of 0.04N/25mm. The other
15 property evaluations of the masking film and the wiring board are shown in Tables 2 and 3.

[0088] (Example 6)

An adhesive layer-forming application liquid was prepared in the same manner as in Example 1 except that 100
20 parts by mass of the A-3 component was used as the adhesive component and that 1 parts by mass of the B-1 component was used as the cross-linking agent as the adhesive layer-forming application liquid, and there were manufactured a masking film and a wiring board using the
25 masking film in the same manner as in Example 1 by the use of the adhesive layer-forming application liquid. The surface of the adhesive layer had a 60° specular gloss of 11%. The layer had an initial peel force of 2.5N/25mm, a ball tack value of 10, and a peel force between the release
30 sheet and the adhesive layer of 0.12N/25mm. The property

evaluations of the masking film and the wiring board are shown in Table 2.

[0089] (Example 7)

5 An adhesive layer-forming application liquid was prepared in the same manner as in Example 1 except that 100 parts by mass of the A-3 component was used as the adhesive component and that 5 parts by mass of the B-1 component was used as the cross-linking agent as the adhesive layer-forming application liquid, and there were
10 manufactured a masking film and a wiring board using the masking film in the same manner as in Example 1 by the use of the adhesive layer-forming application liquid. The surface of the adhesive layer had a 60° specular gloss of 11%. The layer had an initial peel force of 0.8N/25mm, a
15 ball tack value of 4, and a peel force between the release sheet and the adhesive layer of 0.06N/25mm. The other property evaluations of the masking film and the wiring board are shown in Table 2.

[0090] (Example 8)

20 An adhesive layer-forming application liquid was prepared in the same manner as in Example 1 except that 100 parts by mass of the A-4 component was used and that 5 parts by mass of the B-1 component was used as the cross-linking agent as the adhesive layer-forming application liquid, and
25 there were manufactured a masking film and a wiring board using the masking film in the same manner as in Example 1 by the use of the adhesive layer-forming application liquid. The surface of the adhesive layer had a 60° specular gloss of 11%. The layer had an initial peel force of 0.08N/25mm,
30 a ball tack value of 2 or less, and a peel force between

the release sheet and the adhesive layer of 0.01N/25mm. The other property evaluations of the masking film and the wiring board are shown in Tables 2 and 3.

[0091] (Example 9)

5 An adhesive layer-forming application liquid was prepared in the same manner as in Example 1 except that 2 parts by mass of the B-1 component was used as the cross-linking agent as the adhesive layer-forming application liquid, and there were manufactured a masking
10 film and a wiring board using the masking film in the same manner as in Example 1 by the use of the adhesive layer-forming application liquid. The surface of the adhesive layer had a 60° specular gloss of 11%. The layer had an initial peel force of 1.2N/25mm, a ball tack value
15 of 2 or less, and a peel force between the release sheet and the adhesive layer of 0.05N/25mm. The other property evaluations of the masking film and the wiring board are shown in Table 2.

[0092] (Example 10)

20 A masking film and a wiring board using the masking film were manufactured in the same manner as in Example 1 except that a release sheet having a thickness of 130 μm and obtained by providing a release layer having a surface having a center line average roughness (Ra) of 2.0 μm and
25 having unevenness having an unevenness average interval of 2.0 mm on a paper substrate as the release sheet was used. The surface of the adhesive layer had a 60° specular gloss of 56%. The layer had an initial peel force of 0.9N/25mm, a ball tack value of 2 or less, and a peel force between
30 the release sheet and the adhesive layer of 0.07N/25mm. The

other property evaluations of the masking film and the wiring board are shown in Table 2.

[0093] (Example 11)

5 A masking film and a wiring board using the masking film were manufactured in the same manner as in Example 1 except that a release sheet having a thickness of 130 μm and obtained by providing a release layer having a surface having a center line average roughness (Ra) of 2.4 μm and having unevenness having an unevenness average interval of 10 1.6 mm on a paper substrate as the release sheet was used. The surface of the adhesive layer had a 60° specular gloss of 35%. The layer had an initial peel force of 0.9N/25mm, a ball tack value of 2 or less, and a peel force between the release sheet and the adhesive layer of 0.07N/25mm. The 15 other property evaluations of the masking film and the wiring board are shown in Table 2.

[0094] In Examples 1 to 5 and Examples 6 to 9, a polybutylene terephthalate film was used for the base substrate, the same release sheet was used, and masking films 20 having different adhesives where the surface of each adhesive layer had 60° specular gloss of 11%. In addition, in Examples 10 and 11, a polybutylene terephthalate film was used for the base substrate, the same adhesive was used, and masking films having different 60° specular glosses of 25 the surfaces of the release sheet and the surfaces of the adhesive layers were prepared. Evaluations on punching workability, bondability, followability, and the plating solution entry state of each of the masking films are shown in Table 2. From the results, the influences of 60° specular 30 gloss of the surface of the adhesive layer, the initial peel

force, and the ball tack value of each of the masking films were shown.

[0095] [Table 2]

	Punching workability	Unevenness (μm)	Bondability	Followability (%)	Plating solution entry state
Example 1	Good	30	Good	85	Good
		50	Good	74	Good
Example 2	Good	30	Good	83	Good
		50	Good	73	Good
Example 3	Good	30	Good	82	Good
		50	Good	70	Good
Example 4	Good	30	Good	86	Good
		50	Good	78	Good
Example 5	Good	30	Good	84	Good
		50	Good	77	Good
Example 6	Good	30	Bad	86	Bad
		50	Bad	75	Bad
Example 7	Good	30	Bad	85	Bad
		50	Bad	74	Bad
Example 8	Bad	30	Bad	84	Bad
		50	Bad	75	Bad
Example 9	Good	30	Bad	87	Bad
		50	Bad	75	Bad
Example 10	Good	30	Bad	86	Bad
		50	Bad	75	Bad
Example 11	Good	30	Bad	86	Bad
		50	Bad	75	Bad

[0096] In Example 1 and Example 10 to 11, a polybutylene
telephthalate film was used for the base substrate, the same
5 adhesive layer was used, and masking films were produced
by varying only the center line average roughness (Ra) and
the unevenness average interval of the surface of the release
sheet. Evaluations for the punching workability,
bondability, followability, and the plating solution entry
10 state were shown in Table 2. From the results, the influence
of the 60° specular gloss on the surface of the adhesive layer
was shown. Though the flowability was good in any of the
cases, different results were shown in bondability and the

plating solution entry state.

[0097] As the adhesive properties in Examples 1, 10 and 11, the initial peel force was 0.9N/25mm, the ball tack value was 2 or less, the peel force between the release sheet and the adhesive layer was 0.07N/25mm, which were the same, with only the 60° specular gloss on the surface of the adhesive layer was different.

[0098] In a masking film of Example 1, no air-taking was confirmed when it was manually bonded to the wiring board in the 23°C environment. In addition, no air-taking was confirmed even in the wiring substrate after the thermocompression bonding, and good results were shown. Further, entry of the plating solution was not confirmed upon the plating treatment, and no deterioration in plating accuracy was caused.

[0099] In contrast, in the masking film of each of Examples 10 and 11, air-taking was confirmed when it was manually bonded on the wiring substrate in the 23°C environment. In addition, air-taking was confirmed even in the wiring substrate after the thermocompression bonding, and it was shown that the air taken upon the manual bonding in the 23°C environment was not discharged by the thermocompression bonding. Due to the air-taking, entry of the plating solution was caused to deteriorate the plating accuracy.

[0100] It is presumed that the bondability of this wiring board is due to the low 60° specular gloss of the surface of the adhesive layer of Example 1 was 11% and the high 60° specular glosses of the surfaces of the adhesive layers of Examples 10 and 11 as 56% and 35%, respectively.

Since a polybutylene telephthalate film is laminated and pressure bonded with applying the adhesive to the release sheet, the surface shape of the release sheet is transcribed on the surface of the adhesive layer. From the fact that
5 an adhesive layer surface having a small 60° specular gloss is obtained when a release sheet having a large central line average roughness (Ra) and a small unevenness average interval, it can easily be presumed that the adhesive layer surface having a smaller 60° specular gloss has a rougher
10 adhesive layer surface.

[0101] In Example 1, 60° specular gloss of the adhesive layer surface is 11%, which is sufficiently small, and the adhesive surface is highly rough. Therefore, the contact of the wiring board surface to the adhesive layer surface
15 is closer to point contact than face contact upon manual bonding, and air-taking was not visually confirmed. In addition, in the subsequent thermocompression bonding, by the point contact of the adhesive interface, the air between the adhesive layer surface and the wiring board was
20 discharged without causing air-taking, and no air-taking was confirmed also in the wiring board after thermocompression bonding to show a good result. Further, entry of the plating solution upon the plating treatment was not confirmed, and the plating accuracy was not
25 deteriorated.

[0102] In contrast, the 60° specular glosses of the adhesive layer surfaces of the Examples 10 and 11 were 56% and 35%, respectively, which is high in comparison with Example 1. That is, it is shown that the adhesive layer
30 surfaces of the Examples 10 and 11 each has a small roughness

in comparison with that of Example 1. Therefore, air-taking was visually observed upon the manual bonding in the 23°C environment. It is presumed that it was because the contact of the wiring board surface with the adhesive layer surface was closer to face contact than point contact to increase the contact area. In addition, even in the subsequent thermocompression bonding, it was shown that the air taken upon the manual bonding was not discharged by the thermocompression bonding. Further, upon the plating treatment, the air expands by the plating temperature to cause uplift or peeling of the masking film. Due to the uplift or peeling, entry of the plating solution was found, and the plating accuracy was deteriorated.

[0103] From the above, in order to inhibit deterioration in the plating accuracy without entry of the plating solution confirmed upon the plating treatment, it is preferable that no air-taking is confirmed in the wiring board after thermocompression bonding and that no air-taking is visually observed upon the manual bonding to the wiring board in the 23°C environment. In order to inhibit visual air-taking upon the manual bonding in the 23°C environment, it is preferable that the 60° specular gloss of the adhesive layer surface is 30% or less.

[0104] Examples 1 to 5 are masking films each having an initial peel force of 0.9 to 0.1N/25mm and a ball tack value of 2 or less and 3. Regarding the bondability, followability, and the plating solution entry state, respectively showed good results with no deterioration in the plating accuracy. In contrast, in Examples 6 to 9, air-taking was confirmed in the wiring board after the

thermocompression bonding in the bondability test at this time though each of them had a 60° specular gloss of the adhesive layer surface of 11%. Regarding followability, good results were shown because a polybutylene

5 telephthalate film is used for the base substrate. However, due to the air-taking, entry of the plating solution may be caused upon the plating treatment, and there was a case of deteriorating the plating accuracy by this.

[0105] Example 6 is a masking film having an initial peel
10 force of 2.5N/25mm and a ball tack value of 10. Example 7 is a masking film having an initial peel force of 0.8N/25mm and a ball tack value of 4. In addition, Example 8 is a masking film having an initial peel force of 0.08N/25mm and a ball tack value of 2 or less. Example 9 is a masking film
15 having an initial peel force of 1.2N/25mm and a ball tack value of 2 or less.

[0106] In Examples 6, 7, and 9, no air-taking was confirmed right after the bonding upon the manual bonding to the wiring board in the 23°C environment. However,
20 wetting between the wiring board and the masking film immediately proceeded to increase the contact area and cause air-taking. It was shown that an adhesive having a large initial peel force and a low elastic modulus with a high ball tack value tends to have an increased contact area.
25 It was also shown that, even in the subsequent thermocompression bonding, the air taken upon the manual bonding in the 23°C environment was not discharged.

[0107] In Example 8, no air-taking was visually observed upon the manual bonding in the 23°C environment. However,
30 it had low adhesion to the wiring board to be peeled off

easily. Since it had low adhesion with the wiring board, and a flexible polybutylene telephthalate film is used for the base substrate, the masking film was partially peeled off from the wiring board by the stress due to the

5 thermocompression bonding roll upon the subsequent thermocompression bonding, and a ruck was formed to easily take the air. Upon the plating treatment at this time, uplift or peeling was caused by the expansion of the air taken at the plating temperature, and, as a result, entry
10 of the plating solution was caused, and the plating accuracy was deteriorated.

[0108] From Examples 1 to 5 and 6 to 9, in order to obtain a good result of the bonding test, it is preferable that the 60° specular gloss of the adhesive layer surface is 30%
15 or less, that the initial peel force is 0.1 to 1.0N/25 mm, and that the ball tack value of 3 or less.

[0109] Further, the masking films used in Examples 1 to 5, 8, and 12 were evaluated for punching workability by the following method. Evaluations for punching workability of
20 each masking film and peel force between the release sheet and the adhesive layer are shown in Table 3.

[0110] (Punching workability)

An external appearance of the portion subjected to punching when a masking film subjected to neither a heating
25 treatment nor an ultraviolet irradiation treatment after manufacturing was punched from the base substrate side with a punching apparatus (product name: Two-Hole Punch UB-85 produced by Carl MFG. CO., Ltd.) was visually observed from both sides of the base substrate side and the release sheet
30 side for evaluations with "good" as a film which could be

punched out and "bad" as a film which could not be punched out.

[0111] (Example 12)

A masking film and a wiring board using it were
5 manufactured in the same manner as in Example 1 except that
the peel force of a silicone based resin is 20N/m as the
release sheet. The 60° specular gloss of the adhesive layer
surface was 11%. The initial peel force of the masking film
was 0.9N/25 mm, the ball tack value was 2 or less, and the
10 peel force between the release sheet and the adhesive layer
was 0.02N/25mm. The punching workability of the masking
film is shown in Table 3.

[0112] [Table 3]

	Punching workability	Peel force between release sheet and adhesive layer
Example 1	Good	0.07N/25mm
Example 2	Good	0.05N/25mm
Example 3	Good	0.04N/25mm
Example 4	Good	0.05N/25mm
Example 5	Good	0.04N/25mm
Example 8	Bad	0.01N/25mm
Example 12	Bad	0.02N/25mm

15 [0113] From the results of Table 3, it is shown that the
masking films of the Examples 1 to 5 can be punched out by
a punching apparatus, while the masking films of Examples
8 and 12 cannot be punched out. This is because the masking
films of the Examples 8 and 12 each has a weak peeling force
20 between the release sheet and the adhesive layer of below
0.04N/25 mm (0.01 and 0.02N/25mm, respectively), thereby
peeling the release sheet from the adhesive layer upon
punching to extend the polybutylene telephthalate film as

the base substrate.

[0114] In comparison with the masking films used in Examples 1 to 5, in the case of manufacturing a wiring board by the use of a masking film of Example 8 or 12, it is anticipated that entry of the plating solution or adhesive deposition upon peeling from the wiring board is caused to deteriorate productivity and plating accuracy because of a defect in punching workability where the masking film cannot be punched out, the masking film is punched with peeling the adhesive layer of the masking film even if the masking film can be punched out, or a burr or the like is caused in the punched portion.

[0015] Incidentally, since a masking film used in Example 12 is the same as Example 1 except that the peel force of the silicone based resin was decreased, it is not shown in Table 3, and it had good bondability, followability, and the plating solution entry state like Example 1.

Industrial Applicability

[0116] The present invention can be used for manufacturing various kinds of wiring boards and contributes to performance of an effective plating treatment with high plating accuracy in a plating area of a circuit pattern.

CLAIMS

1. A method for plating a wiring board, the method comprising: in order to selectively plate a plating target
5 area on the wiring board having a circuit pattern having an unevenness of 25 μm or more formed on an insulating substrate, when areas other than the plating target area are masked, using a masking film obtained by sequentially laminating an adhesive layer and a release sheet on one
10 surface of a polybutylene terephthalate film; removing the release sheet of the masking film; then, bonding the adhesive layer surface of the masking film to a predetermined area on the wiring board under an environment at room temperature, followed by thermocompression bonding;
15 and then, plating the plating target area.
2. A method for plating a wiring board according to Claim 1, wherein (c) a peel force between the release sheet and the adhesive layer of the masking film is 0.04N/25 mm or more.
- 20 3. A wiring board plated by a plating method according to any one of Claims 1 to 2.

ABSTRACT

There are provided a method for plating a wiring board, characterized in that: in order to selectively plate a plating target area on the wiring board having a circuit pattern having an unevenness of 25 μm or more formed on an insulating substrate, when areas other than the plating target area are masked, using a masking film obtained by sequentially laminating an adhesive layer and a release sheet on one surface of a polybutylene terephthalate film; removing the release sheet of the masking film; then, bonding the adhesive layer surface of the masking film to a predetermined area on the wiring board under an environment at room temperature, followed by thermocompression bonding; and then, plating the plating target area; and a wiring board using the method. An area not to be plated is not plated by entry of a plating solution even if the wiring board has a large unevenness is the circuit pattern. Furthermore, punching workability of the masking film, and, in particular, generation of a burr, unsuccessful hole-making, and the like is inhibited.