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(71) Applicant: **JSR Corporation**
Tokyo (JP)

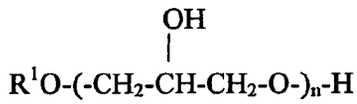
(72) Inventors:
- **Kawagishi, Seiji**
  Tokyo (JP)
- **Itoh, Katsumi**
  Tokyo (JP)

(74) Representative: **Böckelen, Rainer**
Tiedtke-Bühling-Kinne & Partner (GbR),
TBK-Patent
Bavariaring 4
80336 München (DE)

(54) Inorganic particle-containing composition, transfer film comprising the same and plasma display panel production process

(57) An inorganic particle-containing composition comprising:

(A) inorganic particles;
(B) a binder resin; and
(C) a compound represented by the following formula (I):



$$R^1O\text{-}(\text{-}CH_2\text{-}CH(OH)\text{-}CH_2\text{-}O\text{-})_n\text{-}H \qquad (I)$$

wherein R^1 represents a group represented by -CO-A, wherein A represents an alkyl group having 5-20 carbon atoms or an alkenyl group having 5-20 carbon atoms, and n is an integer of 2-20.

A transfer film and a plasma display panel production process using the composition are also described.

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Description

[0001] The present invention relates to an inorganic particle-containing composition, a transfer film comprising the same and a plasma display panel production process.

[0002] In recent years, much attention has been paid to a plasma display as a plate-like fluorescent display. Fig. 1 is a schematic view showing the sectional shape of an alternating current type plasma display panel (hereinafter sometimes referred to as "PDP" for brevity). In this drawing, 1 and 2 denote glass substrates which are opposed to each other, and 3 denotes a barrier rib. Cells are partitioned and formed by the glass substrate 1, the glass substrate 2 and the barrier rib 3. 4 denotes a transparent electrode fixed on the glass substrate 1; 5 denotes a bus electrode formed on the transparent electrode 4 for the purpose of reducing the resistance of the transparent electrode 4; 6 denotes an address electrode fixed on the glass substrate 2; 7 denotes a fluorescent material held in the cell; 8 denotes a dielectric layer formed on the surface of the glass substrate 1 so as to cover the transparent electrode 4 and the bus electrode 5; 9 denotes a dielectric layer formed on the surface of the glass substrate 2 so as to cover the address electrode 6; and 10 denotes a protective film made of, for example, magnesium oxide. Also, in color PDP, for the sake of obtaining a high-contrast image, a color filter (red, green or blue) or a black matrix may be provided between the glass substrate and the dielectric layer.

[0003] As a process of producing such PDP dielectric, barrier rib, electrode, fluorescent material, color filter or black stripe (black matrix), there is suitably employed a photolithography method of forming a photosensitive inorganic particle-containing resin layer on a substrate, irradiating this film with ultraviolet light through a photomask, developing the resulting film to retain a pattern on the substrate, and baking the pattern.

[0004] The above photolithography method is theoretically excellent in pattern accuracy, and especially in a method of using a transfer film, it is possible to form a pattern having excellent uniformity of the thickness and uniformity of the surface. However, a film forming material layer formed by coating an inorganic particle-containing composition containing an acrylic resin on a base film did not have sufficient flexibility and was insufficient in transferability.

[0005] For the purpose of solving these problems, it has been investigated to contain a plasticizer, a dispersant, etc., in the film forming material layer. However, such organic materials likely remain in the pattern after baking to cause coloration and others. In particular, in the case where a sintered glass material such as a dielectric layer is formed, there was a problem such that the light transmittance of the resulting sintered glass material is liable to lower.

[0006] Under above circumstances, the present invention has been made.

[0007] A first object of the present invention is to provide an inorganic particle-containing composition capable of suitably forming a constituent element of DPD (for example, a barrier rib, an electrode, a resistor, a dielectric layer, a phosphor, a color filter, and a black matrix) having excellent surface flatness.

[0008] A second object of the present invention is to provide an inorganic particle-containing composition capable of forming a sintered glass material (for example, a dielectric layer constituting PDP) having high light transmittance.

[0009] A third object of the present invention is to provide an inorganic particle-containing composition capable of producing a transfer film having excellent flexibility in terms of its film forming material layer.

[0010] A fourth object of the present invention is to provide an inorganic particle-containing composition capable of producing a transfer film having excellent transferability (heat adhesion to a substrate) in terms of its film forming material layer.

[0011] A fifth object of the present invention is to provide a transfer film capable of efficiently forming a constituent element of PDP having excellent surface flatness.

[0012] A sixth object of the present invention is to provide a transfer film having excellent flexibility in terms of its film forming material layer.

[0013] A seventh object of the present invention is to provide a transfer film having excellent transferability (heat adhesion to a substrate) in terms of its film forming material layer.

[0014] An eighth object of the present invention is to provide a PDP production process capable of efficiently forming a constituent element of PDP having excellent surface flatness.

[0015] A ninth object of the present invention is to provide a PDP production process capable of efficiently forming PDP having high position accuracy in terms of its constituent element.

[0016] A tenth object of the present invention is to provide a PDP production process capable of efficiently forming a dielectric layer having a large thickness.

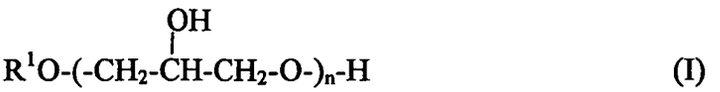
[0017] An eleventh object of the present invention is to provide a PDP production process capable of efficiently forming a dielectric layer required for a large-sized panel.

[0018] A twelfth object of the present invention is to provide a process of producing PDP having a dielectric layer having excellent uniformity in thickness.

[0019] A thirteenth object of the present invention is to provide a process of producing PDP having a dielectric layer having excellent surface flatness.

[0020] The organic particle-containing composition of the present invention comprises

(A) inorganic particles; (B) a binder resin; and (C) a compound represented by the following formula (I) (this compound is hereinafter referred to as "specific compound"):



$$R^1O\text{-}(\text{-}CH_2\text{-}CH(OH)\text{-}CH_2\text{-}O\text{-})_n\text{-}H \qquad (I)$$

wherein R^1 represents a group represented by -CO-A, wherein A represents an alkyl group having 5-20 carbon atoms or an alkenyl group having 5-20 carbon atoms, and n is an integer of 2-20.

[0021] The organic particle-containing composition of the present invention may be a composition further comprising (D) a radiation-sensitive component (this composition is hereinafter referred to as "radiation-sensitive inorganic particle-containing composition").

[0022] The transfer film of the present invention comprises a film forming material layer obtained from the above inorganic particle-containing composition.

[0023] A first production process of the present invention (hereinafter referred to as "PDP production process (1)") comprises the steps of transferring a film forming material layer obtained from the inorganic particle-containing composition according to the present invention to a surface of a substrate and baking the transferred film forming material layer to form a dielectric layer on the substrate.

[0024] A second production process of the present invention (hereinafter referred to as "PDP production process (2)") comprises the steps of transferring a film forming material layer obtained from the inorganic particle-containing composition according to the present invention to a surface of a substrate; forming a resist film on the transferred film forming material layer; exposing the resist film to form a latent image of a resist pattern; developing the resist film to form the resist pattern; etching the film forming material layer to form a pattern layer corresponding to the resist pattern; and baking the pattern layer to form a constituent element selected from a barrier rib, an electrode, a resistor, a dielectric layer, a phosphor, a color filter, and a black matrix.

[0025] A third production process of the present invention (hereinafter referred to as "PDP production process (3)") comprises the steps of forming a laminate film of a resist film and a film forming material layer obtained from the inorganic particle-containing composition according to the present invention on a base film; transferring the laminate film formed on the base film to a surface of a substrate; exposing a resist film constituting the laminate film to form a latent image of a resist pattern; developing the resist film to form the resist pattern; etching the film forming material layer to form a pattern layer corresponding to the resist pattern; and baking the pattern layer to form a constituent element selected from a barrier rib, an electrode, a resistor, a dielectric layer, a phosphor, a color filter, and a black matrix.

[0026] A fourth production process of the present invention (hereinafter referred to as "PDP production process (4)") comprises the steps of transferring a film forming material layer obtained from the inorganic particle-containing composition according to the present invention to a surface of a substrate; exposing the film forming material layer to form a latent image of a pattern; developing the film forming material layer to form a pattern layer; and baking the pattern layer to form a constituent element selected from a barrier rib, an electrode, a resistor, a dielectric layer, a phosphor, a color filter, and a black matrix.

[0027] Fig. 1 is a schematic view showing the sectional shape of an alternating current type plasma display panel.

[0028] Fig. 2A is a schematic sectional view showing a transfer film of the present invention; and Fig. 2B is a sectional view showing the layer constitution of the transfer film.

[0029] Fig. 3 is a schematic sectional view showing an example of the steps of forming a barrier rib in the production process of the present invention (transfer step, resist film forming step and exposure step).

[0030] Fig. 4 is a schematic sectional view showing an example of the steps of forming a barrier rib in the production process of the present invention (developing step, etching step and baking step).

[0031] In the drawings:

1: Glass substrate
2: Glass substrate
3: Barrier rib
4: Transparent electrode
5: Bus electrode
6: Address electrode
7: Fluorescent material
8: Dielectric layer

9: Dielectric layer
10: Protective layer
F1: Base film
F2: Film forming material layer
F3: Cover film
11: Glass substrate
12: Electrode
13: Dielectric layer
20: Transfer film
21: Film forming material layer
22: Base film
25: Barrier rib pattern layer
25A: Material layer remaining portion
25B: Material layer removed portion
31: Resist film
35: Resist pattern
35A: Resist remaining portion
35B: Resist removed portion
40: Barrier rib
50: Panel material
M: Exposure mask
MA: Light transmitting portion
MB: Light shielding portion

[0032] The inorganic particle-containing composition of the present invention (which may hereinafter be referred to as "composition" for simplicity) is described in detail below.

[0033] The composition of the present invention comprises inorganic particles, a binder resin and a specific compound, as essential components.

Inorganic Particles

[0034] An inorganic material constituting the inorganic particles constituting the composition of the present invention is not particularly limited but can be properly selected according to the application of a sintered material formed of the composition (type of a constituent element of PDP).

[0035] The inorganic particles contained in the composition for forming a "dielectric layer" or "barrier rib" constituting PDP are, for example, glass powders having a softening point falling within a range of 350-700°C, preferably 400-620°C. When the softening point of the glass powders is lower than 350°C, the glass powders are molten at the stage that organic substances such as a binder resin have not been completely decomposed and removed in the baking step of the film forming material layer made of the composition, whereby part of the organic substances remain in the dielectric layer to be formed. As a result, the dielectric layer is apt to be colored, and its light transmittance tends to lower. On the other hand, when the softening point of the glass powders exceeds 700°C, a glass substrate is readily distorted because the glass powders must be baked at a temperature higher than 700°C.

[0036] Specific examples of glass powders which are suitably used include (1) a mixture of lead oxide, boron oxide and silicon oxide (PbO-B_2O_3-SiO_2), (2) a mixture of zinc oxide, boron oxide and silicon oxide (ZnO-B_2O_3-SiO_2), (3) a mixture of lead oxide, boron oxide, silicon oxide and aluminum oxide (PbO-B_2O_3-SiO_2-Al_2O_3), and (4) a mixture of lead oxide, zinc oxide, boron oxide and silicon oxide (PbO-ZnO-B_2O_3-SiO_2)

[0037] These glass powders may be contained in the composition for forming a constituent element (such as an electrode, a resistor, a phosphor, a color filter, and a black matrix) other than the dielectric layer and the barrier rib. The content of a glass frit in the inorganic particle-containing composition for obtaining these panel materials is usually 90% by weight or lower, and preferably 50-90% by weight, based on the whole weight of the inorganic particles.

[0038] The inorganic particles contained in the composition for forming an "electrode" constituting PDP are, for example, metal particles comprising Ag, Au, Al, Ni, Ag-Pd alloy, Cu, Cr, or the like.

[0039] These metal particles may be contained in combination with the glass powders in the composition for forming a dielectric layer. The content of the metal particles in the dielectric layer forming composition is usually 10% by weight or lower, and preferably 0.1-5% by weight, based on the whole weight of the inorganic particles.

[0040] The inorganic particles contained in the composition for forming a "resistor" constituting PDP are, for example, particles comprising RuO_2 or the like.

[0041] The inorganic particles contained in the composition for forming a "phosphor" constituting PDP are, for ex-

ample, particles comprising a red fluorescent material (such as Y_2O_3:Eu_{3+}, Y_2SiO_5:Eu_{3+}, $Y_3Al_5O_{12}$:Eu_{3+}, YVO_4:Eu_{3+}, (Y, Gd)BO_3:Eu_{3+}, and $Zn_3(PO_4)_2$:Mn), a green fluorescent material (such as Zn_2SiO_4:Mn, $BaAl_{12}O_{19}$:Mn, $BaMgAl_{14}O_{23}$:Mn, $LaPO_4$:(Ce, Tb), and $Y_3(Al, Ga)_5O_{12}$:Tb), a blue fluorescent material (such as Y_2SiO_5:Ce, $BaMgAl_{10}O_{17}$:Eu_{2+}, $BaMgAl_{14}O_{23}$:Eu_{2+}, (Ca, Sr, Ba)$_{10}(PO_4)_6Cl_2$:Eu_{2+}, and (Zn, Cd)S:Ag), or the like.

[0042] The inorganic particles contained in the composition for forming a "color filter" constituting PDP are, for example, particles comprising a red material (such as Fe_2O_3 and Pb_3O_4), a green material (such as Cr_2O_3), a blue material (such as $2(Al_2Na_2Si_3O_{10})\cdot Na_2S_4$), or the like.

[0043] The inorganic particles contained in the composition for forming a "black matrix" constituting PDP are, for example, particles comprising Mn, Fe, Cr, or the like.

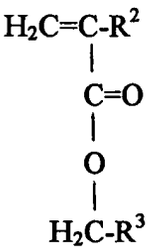
Binder Resin

[0044] The binder resin constituting the composition of the present invention is preferably an acrylic resin.

[0045] When an acrylic resin is contained as the binder resin, the formed film forming material layer exhibits excellent (heat) adhesion to a substrate. Accordingly, when the composition of the present invention is applied to a base film to produce a transfer film, the resulting transfer film has excellent transferability (heat adhesion to the substrate) in terms of the film forming material layer.

[0046] The acrylic resin constituting the composition of the present invention is selected among (co)polymers that have proper adhesion, can bind the inorganic particles and are completely oxidized and removed by baking of the film forming material (at 400-620°C).

[0047] The acrylic acid includes homopolymers of a (meth)acrylate compound represented by the following general formula (II), copolymers of two or more (meth)acrylate compounds represented by the following general formula (II), and copolymers of a (meth)acrylate compound represented by the following general formula (II) and a copolymerizable monomer.



(II)

wherein R^2 represents hydrogen atom or methyl group; and R^3 represents a monovalent organic group.

[0048] Specific examples of (meth)acrylate compounds represented by the general formula (II) include:

alkyl (meth)acrylates such as methyl (meth)acrylate, ethyl (meth)acrylate, propyl (meth)acrylate, isopropyl (meth) acrylate, butyl (meth)acrylate, isobutyl (meth)acrylate, t-butyl (meth)acrylate, pentyl (meth)acrylate, amyl (meth) acrylate, isoamyl (meth)acrylate, hexyl (meth)acrylate, heptyl (meth)acrylate, octyl (meth)acrylate, isooctyl (meth) acrylate, 2-ethylhexyl (meth)acrylate, nonyl (meth)acrylate, decyl (meth)acrylate, isodecyl (meth)acrylate, undecyl (meth)acrylate, dodecyl (meth)acrylate, lauryl (meth)acrylate, stearyl (meth)acrylate, and isostearyl (meth)acrylate;

hydroxylalkyl (meth)acrylates such as hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 2-hydroxybutyl (meth)acrylate, 3-hydroxybutyl (meth)acrylate, and 4-hydroxybutyl (meth) acrylate;

phenoxyalkyl (meth)acrylates such as phenoxyethyl (meth)acrylate and 2-hydroxy-3-phenoxypropyl (meth)acrylate;

alkoxyalkyl (meth)acrylate such as 2-methoxyethyl (meth)acrylate, 2-ethoxyethyl (meth)acrylate, 2-propoxyethyl (meth)acrylate, 2-butoxyethyl (meth)acrylate, and 2-methoxybutyl (meth)acrylate;

polyalkylene glycol (meth)acrylates such as polyethylene glycol mono(meth)acrylate, ethoxydiethylene glycol (meth)acrylate, methoxypolyethylene glycol (meth)acrylate, phenoxypolyethylene glycol (meth)acrylate, nonylphenoxypolyethylene glycol (meth)acrylate, polypropylene glycol (meth)acrylate, methoxypolypropylene glycol (meth) acrylate, ethoxypolypropylene glycol (meth)acrylate, and nonylphenoxypolypropylene glycol (meth)acrylate;

cycloalkyl (meth)acrylates such as cyclohexyl (meth)acrylate, 4-butylcyclohexyl (meth)acrylate, dicyclopentanyl (meth)acrylate, dicyclopentenyl (meth)acrylate, dicyclopentadienyl (meth)acrylate, bornyl (meth)acrylate, isobor-

nyl (meth)acrylate, and tricyclodecanyl (meth)acrylate; and
benzyl (meth)acrylate and tetrahydrofurfuryl (meth)acrylate.

[0049] Of these, (meth)acrylate compounds represented by the general formula (II) wherein R^3 represents a group containing an alkyl group or an oxyalkylene group are preferred. Particularly preferred (meth)acrylate compounds are butyl (meth)acrylate, ethylhexyl (meth)acrylate, lauryl (meth)acrylate, isodecyl (meth)acrylate, and 2-ethoxyethyl (meth)acrylate.

[0050] The other copolymerizable monomer is not particularly limited if it is a compound copolymerizable with the (meth)acrylate compound. Examples of the other copolymerizable monomer include unsaturated carboxylic acids such as (meth)acrylic acid, vinylbenzoic acid, maleic acid, and vinylphthalic acid; and vinyl group-containing radical polymerizable compounds such as vinylbenzyl methyl ether, vinyl glycidyl ether, styrene, α-methylstyrene, butadiene, and isoprene.

[0051] The proportion of the comonomer derived from the (meth)acrylate compound represented by the general formula (II) in the acrylic resin constituting the composition of the present invention is usually 70% by weight or more, and preferably 90% by weight or more.

[0052] Specific examples of preferred acrylic resins include polymethyl methacrylate, polybutyl methacrylate, and a methyl methacrylate-butyl methacrylate copolymer.

[0053] In the formation of constituent elements of PDP utilizing a photoresist method as described later, when the film forming material layer needs to be alkali-soluble for etching, it is preferable that a carboxyl group-containing monomer is contained as the above other copolymerizable monomer (comonomer). Specific examples of the carboxyl group-containing monomer include acrylic acid, methacrylic acid, maleic acid, fumaric acid, crotonic acid, itaconic acid, citraconic acid, mesaconic acid, cinnamic acid, mono(2-(meth)acryloyloxyethyl) succinate, and ω-carboxy-polycaprolactone mono(meth)acrylate. Of these, methacrylic acid is especially preferable.

[0054] Specific examples of preferred alkali-soluble resins include:

alkyl methacrylates such as methyl methacrylate, ethyl methacrylate, propyl methacrylate, isopropyl methacrylate, butyl methacrylate, isobutyl methacrylate, t-butyl methacrylate, pentyl methacrylate, amyl methacrylate, isoamyl methacrylate, hexyl methacrylate, heptyl methacrylate, octyl methacrylate, isooctyl methacrylate, ethylhexyl methacrylate, nonyl methacrylate, decyl methacrylate, isodecyl methacrylate, undecyl methacrylate, dodecyl methacrylate, lauryl methacrylate, stearyl methacrylate, and isostearyl methacrylate;
hydroxylalkyl methacrylates such as hydroxyethyl methacrylate, 2-hydroxypropyl methacrylate, 3-hydroxypropyl methacrylate, 2-hydroxybutyl methacrylate, 3-hydroxybutyl methacrylate, and 4-hydroxybutyl methacrylate;
phenoxyalkyl methacrylates such as phenoxyethyl methacrylate and 2-hydroxy-3-phenoxypropyl methacrylate;
alkoxyalkyl methacrylate such as 2-methoxyethyl methacrylate, 2-ethoxyethyl methacrylate, 2-propoxyethyl methacrylate, 2-butoxyethyl methacrylate, and 2-methoxybutyl methacrylate;
polyalkylene glycol methacrylates such as polyethylene glycol monomethacrylate, ethoxydiethylene glycol methacrylate, methoxypolyethylene glycol methacrylate, phenoxypolyethylene glycol methacrylate, nonylphenoxypolyethylene glycol methacrylate, polypropylene glycol methacrylate, methoxypolypropylene glycol methacrylate, ethoxypolypropylene glycol methacrylate, and nonylphenoxypolypropylene glycol methacrylate;
cycloalkyl methacrylates such as cyclohexyl methacrylate, 4-butylcyclohexyl methacrylate, dicyclopentanyl methacrylate, dicyclopentenyl methacrylate, dicyclopentadienyl methacrylate, bornyl methacrylate, isobornyl methacrylate, and tricyclodecanyl methacrylate; and
benzyl methacrylate and tetrahydrofurfuryl methacrylate.

[0055] Molecular weight of the acrylic resin constituting the composition of the present invention is preferably 4,000-300,000, and more preferably 10,000-200,000; in terms of weight average molecular weight as reduced into polystyrene by gel permeation chromatography (hereinafter referred to as "GPC") (the molecular weight is hereinafter referred to as "weight average molecular weight" for simplicity).

[0056] The proportion of the binder resin in the composition of the present invention is preferably 5-80 parts by weight, and more preferably 10- 50 parts by weight, per 100 parts by weight of the inorganic particles. When the proportion of the binder resin is too small, the binder resin cannot surely bind and hold the inorganic particles. On the other hand, when the proportion is too large, the baking step may take a long period of time, or the formed sintered material (for example, a dielectric layer) may not have a sufficient strength or thickness.

Specific Compound

[0057] The specific compound is used as an additive having both effects of a plasticizer and a dispersant. The composition of the present invention containing the specific compound can reveal excellent surface flatness. Even when

the obtained transfer film is bent, the surface of the film forming material layer is finely cracked, and the transfer film has excellent suppleness and can be rolled easily. Moreover, since the specific compound is easily decomposed and removed by heat, a panel material obtained by baking the film forming material layer is free from coloration, and in particular, the light transmittance of a dielectric layer is not reduced.

[0058] In the formula (I) representing the specific compound, R^1 represents a group represented by -CO-A, wherein A represents an alkyl group having 5-20 carbon atoms or an alkenyl group having 5-20 carbon atoms, and n is an integer of 2-20.

[0059] The alkyl group or alkenyl group represented by A has 5-20 carbon atoms, and preferably 9-18 carbon atoms. When the number of carbon atoms is less than 5, the function as the additive may become insufficient. When it exceeds 20, the solubility in a solvent of the additive constituting the inorganic particle-containing composition may lower, and good flexibility may not be obtained.

[0060] Specific examples of the alkyl group include n-pentyl group, n-hexyl group, n-heptyl group, n-octyl group, n-nonyl group, n-decyl group, n-undecyl group, n-dodecyl group, n-pentadecyl group, n-hexadecyl group, n-heptadecyl group, n-octadecyl group, n-nonadecyl group, and n-eicosyl group.

[0061] Specific examples of the alkenyl group include 2-pentenyl group, 2-hexenyl group, 2-heptenyl group, 2-octenyl group, 2-decenyl group, 10-undecenyl group, 9-octadecenyl group, and 9-octadecenyl group.

[0062] Of these, n-octyl group, n-dodecyl group, n-octadecyl group, and 9-octadecenyl group are preferable, and 9-octadecenyl group is especially preferable.

[0063] In the formula (I), R^1 represents a group represented by -CO-A; and n is an integer of 2-20.

[0064] Specific examples of the specific compound include diglycerin monolaurate, diglycerin monostearate, diglycerin monooleate, and diglycerin monocaprylate. Of these, diglycerin monooleate is especially preferable.

[0065] The proportion of the specific compound in the composition of the present invention is preferably 0.1-20 parts by weight, and more preferably 0.5-10 parts by weight, per 100 parts by weight of the inorganic particles. When the proportion of the specific compound is too small, the surface flatness and flexibility of the film forming material layer to be formed using the resulting composition cannot be sufficiently improved. On the other hand, when it is too large, adhesion (tackiness) of the film forming material layer to be formed using the resulting composition becomes too high so that a transfer film comprising the film forming material layer may become inferior in handling properties.

Radiation-Sensitive Component

[0066] The inorganic particle-containing composition of the present invention may be a radiation-sensitive inorganic particle-containing composition containing a radiation-sensitive component. Preferred examples of the radiation-sensitive component include (a) a combination of a polyfunctional monomer and a radiation polymerization initiator and (b) a combination of a melamine resin and a photo acid generator of forming an acid upon irradiation with radiations. With respect to the combination (a), a combination of a polyfunctional (meth)acrylate and a radiation polymerization initiator is especially preferable.

[0067] Specific examples of the polyfunctional (meth)acrylate constituting the radiation-sensitive component include di(meth)acrylates of an alkylene glycol such as ethylene glycol and propylene glycol; di(meth)acrylates of a polyalkylene glycol such as polyethylene glycol and polypropylene glycol; di(meth)acrylates of a both terminal-hydroxylated polymer such as both terminal-hydroxylpolybutadiene, both terminal-hydroxypolyisoprene, and both terminal-hydroxypolycaprolactone; poly(meth)acrylates of a polyhydric alcohol having a valency of 3 or more such as glycerin, 1,2,4-butanetriol, trimethylolalkanes, tetramethylolalkanes, pentaerythritol, and dipentaerythritol; poly(meth)acrylates of a cyclic polyol such as 1,4-cyclohexanediol and 1,4-benzenediol; and oligo (meth)acrylates such as polyester (meth)acrylates, epoxy (meth)acrylate, urethane (meth)acrylate, alkyd resin (meth)acrylate, silicone resin (meth)acrylate, and spiran resin (meth)arylate. These polyfunctional (meth)acrylates can be used alone or in combination of two or more thereof.

[0068] Specific examples of the radiation polymerization initiator constituting the radiation-sensitive component include carbonyl compounds such as benzil, benzoin, benzophenone, camphorquinone, 2-hydroxy-2-methyl-1-phenylpropan-1-one, 1-hydroxycyclohexyl phenyl ketone, 2,2-dimethoxy-2-phenylacetophenone, 2-methyl-[4'-(methylthio) phenyl]-2-morpholino-1-propanone, and 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)-butan-1-one; azo compounds or azide compounds such as azoisobutyronitrile and 4-azidobenzaldehyde; organic sulfur compounds such as mercaptan disulfide; organic peroxides such as benzoyl peroxide, di-tert-butyl peroxide, tert-butyl hydroperoxide, cumene hydroperoxide, and p-methane hydroperoxide; trihalomethanes such as 1,3-bis(trichloromethyl)-5-(2'-chlorophenyl)-1,3,5-triazine and 2-[2-(2-furanyl)ethylenyl]-4,6-bis(trichloromethyl)-1,3,5-triazine; and imidazole dimers such as 2,2'-bis(2-chlorophenyl)-4,5,4',5'-tetraphenyl-1,2'-biimidazole. These radiation polymerization initiators can be used alone or in combination of two or more thereof.

Solvent

[0069] The composition of the present invention generally contains a solvent. Preferable solvents are those that have good affinity with the inorganic particles and good solubility of the binder resin, can impart appropriate viscosity to the resulting composition and can be easily vaporized and removed upon drying.

[0070] Specific examples of the solvent include ketones such as diethyl ketone, methyl butyl ketone, dipropyl ketone, and cyclohexanone; alcohols such as n-pentanol, 4-methyl-2-pentanol, cyclohexanol, and diacetone alcohol; ether based alcohols such as ethylene glycol monomethyl ether, ethylene glycol monoethyl ether, ethylene glycol monobutyl ether, propylene glycol monomethyl ether, and propylene glycol monoethyl ether; unsaturated aliphatic monocarboxylic acid alkyl esters such as n-butyl acetate and amyl acetate; lactic acid esters such as ethyl lactate and n-butyl lactate; and ether based esters such as methyl cellosolve acetate, ethyl cellosolve acetate, propylene glycol monomethyl ether acetate, and ethyl 3-ethoxypropionate. These solvents can be used alone or in combination of two or more thereof.

[0071] The proportion of the solvent in the composition of the present invention is preferably 40 parts by weight or less, and more preferably 5-30 parts by weight, per 100 parts by weight of the inorganic particles from the standpoint of maintaining the viscosity of the composition within a preferred range.

[0072] The composition of the present invention may contain a variety of additives such as a tackifier, a surface tension control agent, a stabilizer, and an antifoaming agent as optional components, in addition to the above essential components.

[0073] Preferred examples of the composition for forming a dielectric layer as an example of the inorganic particle-containing composition include a composition comprising

100 parts by weight of a mixture comprising 50-80% by weight of lead oxide, 5-30% by weight of boron oxide, 0-20% by weight of zinc oxide, 0-10% by weight of aluminum oxide and 0-10% by weight of silicon oxide, as inorganic particles (glass powders);

10-30 parts by weight of a butyl methacrylate/2-ethylhexyl methacrylate/hydroxypropyl methacrylate copolymer as a binder resin;

0.1-10 parts by weight of diglycerin oleate as a specific compound; and

5-30 parts by weight of propylene glycol monomethyl ether and/or ethyl 3-ethoxypropionate as a solvent.

[0074] The composition of the present invention can be prepared by kneading the above-described inorganic particles, binder resin, specific compound, solvent and optional components using a kneader such as a roll kneader, a mixer or a homomixer.

[0075] The thus prepared composition of the present invention is a pasty composition having fluidity suitable for coating and usually has a viscosity of 1,000-30,000 cp, and preferably 3,000-10,000 cp.

[0076] The composition of the present invention can be particularly advantageously used for producing a transfer film (transfer film of the present invention) as described in detail below.

[0077] The composition of the present invention can also be advantageously used in the conventional method of forming a film forming material layer, that is, a method of forming a film forming material layer by directly coating the composition on the surface of a substrate by a screen printing method or the like and drying the coating film. Transfer Film

[0078] The transfer film of the present invention is a composite film that is advantageously used in the step of forming a constituent element of PDP, especially the step of forming a dielectric layer and is provided with a film forming material layer formed by coating the composition of the present invention on a base film and drying the coating film.

[0079] That is, the transfer film of the present invention is constituted of a base film having formed thereon a film forming material layer containing inorganic particles, a binder resin and a specific compound.

[0080] The transfer film of the present invention may be a film (stack) obtained by forming a resist film as described later on a base film, coating the composition of the present invention on the resist film and drying the coating film.

[0081] Further, the transfer film of the present invention may be a radiation-sensitive transfer film constituted using a radiation-sensitive inorganic particle-containing composition.

(1) Constitution of transfer film:

[0082] Fig. 2A is a schematic sectional view showing the rolled transfer film of the present invention, and Fig. 2B is a sectional view showing the layer constitution of the transfer film (detail view of a portion (X)).

[0083] The transfer film shown in Fig. 2 is a composite film used for forming a dielectric layer constituting PDP as an example of the transfer film of the present invention. Usually, the transfer film is constituted of a base film F1, a film forming material layer F2 that is formed on the surface of the base film F1 and can be peeled off, and a cover film F3 that is provided on the surface of the film forming material layer F2 and can be easily peeled off. The cover film F3 may not be used according to the properties of the film forming material layer F2.

[0084] The base film F1 constituting the transfer film is preferably a resin film having heat resistance and solvent

resistance and having flexibility. When the base film F1 has flexibility, the pasty composition (composition of the present invention) can be coated using a roll coater, a blade coater, or the like, thereby making it possible to form a film forming material layer having a uniform thickness and to store and supply the formed film forming material layer in the form of a roll.

[0085] Examples of resins constituting the base film F1 include polyethylene terephthalate, polyesters, polyethylene, polypropylene, polystyrene, polyimides, polyvinyl alcohol, polyvinyl chloride, fluorine-containing resins such as polyfluoroethylene, nylon, and cellulose. The base film F1 has a thickness of, for example, 20-100 μm.

[0086] The film forming material layer F2 constituting the transfer film is a layer that becomes a sintered glass material (dielectric layer) upon baking and contains glass powders (inorganic particles), a binder resin and a specific compound as essential components.

[0087] The thickness of the resin forming material layer F2 varies depending upon the content of the glass powders and the type and size of a panel but is, for example, 5-200 μm, and preferably 10-100 μm. When the thickness is less than 5 μm, the thickness of the finally formed dielectric layer becomes too small so that the prescribed dielectric characteristics may not be ensured. Usually, when the thickness is 10-100 μm, the thickness of the dielectric layer required for a large-sized panel can be sufficiently ensured.

[0088] The cover film F3 constituting the transfer film is a film for protecting the surface of the film forming material layer F2 (contact surface with the glass substrate). This cover film F3 is preferably a resin film having flexibility. A resin forming the cover film F3 is, for example, the resins for forming the base film F1 as described above. The thickness of the cover film F3 is, for example, 20-100 μm.

(2) Production process of transfer film:

[0089] The transfer film of the present invention can be produced by forming the film forming material layer (F2) on the base film (F1) and providing (press bonding) the cover film (F3) on the film forming material layer (F2).

[0090] A method of forming the film forming material layer is, for example, a method of coating the composition of the present invention containing inorganic particles, a binder resin, a specific compound and a solvent on a base film and drying the coating film to remove a part or the whole of the solvent.

[0091] Preferred examples of the method of coating the composition of the present invention on the base film include a coating method using a roll coater, a coating method using a blade coater such as a doctor blade, a coating method using a curtain coater, and a coating method using a wire coater from the viewpoints that the thickness is large (for example, 20 μm or more) and that a coating film having excellent uniformity in thickness can be efficiently formed.

[0092] It is preferable that the surface of the base film on which the composition of the present invention is coated is subjected to release treatment. Thus, the base film can be easily peeled off from the film forming material layer after transferring the film forming material layer.

[0093] The coating film of the composition of the present invention formed on the base film is dried to remove a part or the whole of the solvent and turns into a film forming material layer constituting the transfer film. Conditions for drying the coating film made of the composition of the present invention include a temperature of 40-150°C and a time of about 1-30 minutes. The proportion ofthe residual solvent after drying (content of the solvent in the film forming material layer) is usually 10% by weight or less, and preferably 0.1-5% by weight, from the viewpoint of revealing the tackiness to the substrate and appropriate shape retention properties on the film forming material layer.

[0094] It is preferable that the surface of the cover film provided (usually press bonded under heating) on the thus formed film forming material layer is subjected to release treatment as well. Thus, the cover film can be easily peeled off from the film forming material layer prior to transferring the film forming material layer.

(3) Transfer of film forming material layer (method of use of transfer film):

[0095] The film forming material layer on the base film is transferred to the surface of the substrate en bloc. According to the transfer film of the present invention, the film forming material layer can be surely formed on the glass substrate through such a simple operation. Accordingly, not only it is possible to make an improvement (enhance efficiency) in the step of forming a constituent element of PDP such as a dielectric layer, but also it is possible to improve the quality of the formed constituent element (for example, to reveal stable dielectric characteristics in the dielectric layer).

PDP Production Process (1) (Formation of Dielectric Layer)

[0096] The PDP production process (1) of the present invention comprises the steps of transferring a film forming material layer constituting the transfer film of the present invention to the surface of a substrate and baking the transferred film forming material layer to form a dielectric layer on the surface of the substrate.

[0097] An example of the step of transferring the film forming material layer of the transfer film constituted as shown

in Fig. 2 is as follows.

(1) The transfer film in the form of a roll is cut to a size corresponding to the area of the substrate.
(2) After peeling off the cover film (F3) from the surface of the film forming material layer (F2) of the cut transfer film, the transfer film is overlaid on the surface of the substrate in such a manner that the surface of the film forming material layer (F2) comes into contact with the substrate.
(3) A heating roll is moved over the transfer film overlaid on the substrate to press bond the transfer film under heating.
(4) The base film (F1) is peeled off and removed from the film forming material layer (F2) fixed to the substrate by press bonding under heating.

[0098] The film forming material layer (F2) on the base film (F1) is transferred to the substrate by the above operation. Transfer conditions include a heating roll surface temperature of 60-120°C, a heating roll pressure of 1-5 kg/cm^2, and a heating roll moving speed of 0.2-10.0 m/min. This operation (transfer step) can be carried out using a laminator. The substrate may be preheated, and the preheating temperature can be set up at, for example, 40-100°C.

[0099] The film forming material layer (F2) transferred to the surface of the substrate turns into a sintered inorganic material (dielectric layer) by baking. The baking method is, for example, a method of placing the substrate to which the film forming material layer (F2) has been transferred in a high-temperature atmosphere. Thus, the organic materials (for example, the binder resin, residual solvent, specific compound and various additives) contained in the film forming material layer (F2) are decomposed and removed, and the inorganic particles are molten and sintered. The sintering temperature varies depending upon the melting temperature of the substrate, the constituent components in the film forming material layer, and the like, but is, for example, 300-800°C, and preferably 400-620°C.

PDP Production Process (2) (Formation of Constituent Element Utilizing Photoresist Method)

[0100] The PDP production process (2) of the present invention includes the steps of transferring a film forming material layer constituting the transfer film of the present invention to a substrate; forming a resist film on the transferred film forming material layer; exposing the resist film to form a latent image of a resist pattern; developing the resist film to form the resist pattern; etching the film forming material layer to form a pattern layer corresponding to the resist pattern; and baking the pattern layer to form a constituent element selected from a barrier rib, an electrode, a resistor, a dielectric layer, a phosphor, a color filter, and a black matrix.

[0101] Alternatively, the production process (2) of the present invention includes the steps of forming a laminate film of a resist film and a film forming material layer obtained from the inorganic particle-containing composition of the present invention on a base film; transferring the laminate film formed to a surface of the base film on a substrate; exposing a resist film constituting the laminate film to form a latent image of a resist pattern; developing the resist film to form the resist pattern; etching the film forming material layer to form a pattern layer corresponding to the resist pattern; and baking the pattern layer to form a constituent element selected from a barrier rib, an electrode, a resistor, a dielectric layer, a phosphor, a color filter, and a black matrix.

[0102] A method of forming a "barrier rib" as the constituent element of PDP on the rear surface of a substrate will be described below. This method comprises (1) the step of transferring a film forming material layer, (2) the step of forming a resist film, (3) the step of exposing the resist film, (4) the step of developing the resist film, (5) the step of etching the film forming material layer, and (6) the step of baking a barrier rib pattern, thereby forming a barrier rib on the surface of the substrate.

[0103] Fig. 3 and Fig. 4 are each a schematic sectional view showing a series of steps of forming the barrier rib. In Fig. 3 and Fig. 4, 11 denotes a glass substrate on which electrodes 12 for generating plasma are aligned at equal intervals, and a dielectric layer 13 is formed on the surface of the glass substrate 11 so as to cover the electrodes 12.

[0104] In the present invention, the embodiment of "transferring a film forming material layer to a substrate" includes not only an embodiment of transferring the film forming material layer to the surface of the glass substrate 11 but also an embodiment of transferring the film forming material layer to the surface of the dielectric layer 13.

(1) Step of transferring film forming material layer:

[0105] An example of the step of transferring a film forming material layer will be shown as follows.

[0106] After peeling off a cover film (not shown) of the transfer film, as shown in Fig. 3B, a transfer film 20 is overlaid on the surface of the dielectric layer 13 in such a manner that the surface of a film forming layer 21 comes into contact with the surface of the dielectric layer 13, the transfer film 20 is press bonded under heating by a heating roll, etc., and a base film 22 is then peeled off and removed from the film forming material layer 21. Thus, as shown in Fig. 3C, the film forming material layer 21 is transferred and close bonded to the surface of the dielectric layer 13. Transfer conditions

include a heating roll surface temperature of 80-140°C, a heating roll pressure of 1-5 kg/cm^2, and a heating roll moving speed of 0.1-10.0 m/min. The glass substrate 11 may be preheated, and the preheating temperature can be set up at, for example, 40-100°C.

(2) Step of forming resist film:

[0107] In this step, as shown in Fig. 3D, a resist film 31 is formed on the surface of the transferred film forming material layer 21. A resist constituting the resist film 31 may be any of a positive working resist and a negative working resist.

[0108] The resist film 31 can be formed by coating a resist by a variety of methods including a screen printing method, a roll coating method, a rotation coating method, and a cast coating method and drying the coating film. The drying temperature of the coating film is generally about 60-130°C.

[0109] A resist film formed on the base film may be formed by transferring onto the surface of the film forming material layer 21. According to this formation method, not only the number of steps of forming the resist film can be reduced, but also the resulting resist has excellent uniformity in the thickness. Accordingly, the development of the resist film and the etching of the film forming material layer are uniformly carried out, whereby the formed barrier rib becomes uniform in height and shape.

[0110] The resist film 31 usually has a thickness of 0.1-40 μm, and preferably 0.5-20 μm.

(3) Step of exposing resist film:

[0111] In this step, as shown in Fig. 3E, the surface of the resist film 31 formed on the film forming material layer 21 is selectively irradiated (exposed) with radiations such as ultraviolet light through an exposure mask M to form a latent image of a resist pattern. In this drawing, MA and MB denote a light transmitting portion and a light shielding portion formed by the exposure mask M, respectively.

[0112] An ultraviolet irradiation device is not particularly limited but may be an ultraviolet irradiation device used for photolithography and an exposure device used for the production of semiconductors and liquid crystal display devices.

[0113] When the resist film is formed by transfer, it is preferable to carry out the exposure step in the state that the base film covered on the resist film is not peeled off.

(4) Step of developing resist film:

[0114] In this step, the exposed resist film is developed to form a resist pattern (latent image).

[0115] Regarding developing conditions, the type, formulation and concentration of a developing solution, the developing time, the developing temperature, the developing method (such as immersion, rocking, shower, spray and puddling methods), the developing device, and others can appropriately be selected according to the type of the resist film 31 and others.

[0116] A resist pattern 35 (pattern corresponding to the exposure mask M) constituted of resist remaining portion 35A and resist removed portion 35B is formed by this developing step as shown in Fig. 4F.

[0117] This resist pattern 35 serves as an etching mask in the subsequent step (etching step), and the constituent material (photo-cured resist) of the resist remaining portions 35 must have a lower dissolution speed in an etching solution than the constituent material of the film forming material layer 21.

(5) Step of etching film forming material layer:

[0118] In this step, the film forming material layer is etched to form a barrier rib pattern layer corresponding to the resist pattern.

[0119] That is, as shown in Fig. 4G, portions corresponding to the resist removed portions 35B of the resist material 35 of the film forming material layer 21 are dissolved in the etching solution and selectively removed. Fig. 4G shows the state during etching.

[0120] When etching is further continued, as shown in Fig. 4H, predetermined portions of the film forming material layer 21 are completely removed, whereby the dielectric layer 13 is exposed. Thus, a barrier rib pattern layer 25 constituted of material layer remaining portions 25A and material layer removed portions 25B is formed.

[0121] Regarding the etching conditions, the type, formulation and concentration of the etching solution, the treatment time, the treatment temperature, the treatment method (such as immersion, rocking, shower, spray and puddling methods), the treatment device, and others can appropriately be selected according to the type of the film forming material layer 21 and others.

[0122] The type of the resist film 31 and the type of the film forming material layer 21 are selected such that the same

solution as the developing solution used in the developing step can be used as the etching solution, whereby it is possible to carry out the developing step and the etching step continuously and to improve production efficiency due to simplification of the steps.

[0123] It is preferable that the resist remaining portions 35A constituting the resist pattern 35 are gradually dissolved by etching and completely removed when the barrier rib pattern layer 25 is formed (at the time of completion of etching).

[0124] Even when a part or the whole of the resist remaining portions 35A remain after etching, the resist remaining portions 35A are removed in the subsequent baking step.

(6) Step of baking barrier rib pattern layer:

[0125] In this step, barrier ribs are formed by baking the barrier rib pattern layer 25. Thus, the organic substances in the material layer remaining portions 25A are burnt out to form barrier ribs. As shown in Fig. 4I, in a panel material 50 having barrier ribs 40 formed on the surface of the dielectric layer 13, spaces partitioned by the barrier ribs 40 (barrier ribs derived from the material layer removed portions 25B) serve as plasma working spaces.

[0126] The baking temperature must be a temperature at which the organic substances in the material layer remaining portions 25A are burnt out and is generally 400-600°C. The baking time is generally 10-90 minutes.

PDP Production Process (3) (Preferred Embodiment Utilizing Photoresist Method)

[0127] The PDP production process (3) in the present invention is not limited to the process shown in Fig. 3 and Fig. 4.

[0128] Other preferred process for forming the constituent element of PDP (PDP production process (3)) is, for example, a forming method comprising the following steps (1) to (3).

(1) After forming a resist film on a base film, the inorganic particle-containing composition of the present invention is coated on the resist film and dried to laminate and form a film forming material layer. In forming the resist film and the film forming material layer, a roll coater or the like can be used, thereby making it possible to form a laminate film having excellent uniformity in thickness on the base film.

(2) The laminate film consisting of the resist film and the film forming material layer on the base film is transferred to a substrate. Transfer conditions may be the same as those in the above-described "step of transferring film forming material layer".

(3) The same operations as described in the above-described "step of exposing resist film", "step of developing resist film", "step of etching film forming material layer" and "step of baking barrier rib pattern layer" are carried out. During these operations, as described previously, it is preferable that the developing solution of the resist film is made the same as the etching solution of the film forming material layer and that the "step of developing resist film" and the "step of etching film forming material layer" are carried out continuously.

[0129] According to the above method, since the film forming material layer and the resist film are transferred to the substrate en bloc, production efficiency can be further improved by simplification of the steps.

PDP Production Process (4) (Formation of Constituent Element Using Radiation-Sensitive Transfer Film)

[0130] The PDP production process (4) of the present invention includes the steps of transferring a film forming material layer constituting the radiation-sensitive transfer film of the present invention to a substrate; exposing the film forming material layer to form a latent image of a resist pattern; developing the film forming material layer to form a pattern layer; and baking the pattern layer to form a constituent element selected from a barrier rib, an electrode, a resistor, a dielectric layer, a phosphor, a color filter, and a black matrix.

[0131] In this method, for example, when an example of the method of forming a barrier rib is taken, after the above-described "step of transferring film forming material layer", a pattern layer is formed under conditions according to the "step of exposing resist film" and "step of developing resist film". Thereafter, a barrier rib is formed on the surface of the substrate by the "step of baking barrier rib pattern".

[0132] The method of forming "barrier rib" as a constituent element of PDP has been described in the explanation of the respective steps of the PDP production processes (1) to (4). An electrode, a resistor, a dielectric layer, a phosphor, a color filter, and a black matrix each constituting PDP can be formed according to this method.

[0133] The present invention will be described in more detail with reference to the following Example, but it should be understood that the invention is not construed as being limited thereto. In the Example and Comparative Examples, all "parts" are "parts by weight".

EXAMPLE

(1) Preparation of glass paste composition (inorganic particle-containing composition):

[0134] A composition of the present invention having a viscosity of 3,400 cp (measured by a B-type viscometer at 30 rpm) was prepared by kneading 100 parts of a PbO-B_2O_3-SiO_2 based mixture (softening point: 500°C) having a formulation consisting of 70% by weight of lead oxide, 10% by weight of boron oxide and 20% by weight of silicon oxide, 15 parts of a butyl methacrylate/2-ethylhexyl methacrylate/hydroxypropyl methacrylate copolymer (weight ratio: 30/60/10, weight average molecular weight: 150,000) as a binder resin, 5 parts of diglycerin oleate as a specific compound, 8.7 parts of propylene glycol monomethyl ether as a solvent, and 13.1 parts of ethyl 3-ethoxypropionate using a dispersion mixer.

(2) Production and evaluation (flexibility and handling properties) of transfer film:

[0135] The composition of the present invention prepared in (1) above was coated on a base film made of polyethylene terephthalate (PET) having been previously subjected to release treatment (width: 400 mm, length: 30 m, thickness: 38 μm) using a blade coater, and the formed coating film was dried at 80°C for 5 minutes to remove the solvent. There was thus formed a film forming material layer having a thickness of 50 μm on the base film. A cover film made of PET having been previously subjected to release treatment (width: 400 mm, length: 30 m, thickness: 38 μm) was adhered to the film forming material layer to produce a transfer film of the present invention having the constitution shown in Fig. 2.

[0136] The resulting transfer film had suppleness and could be easily rolled. Further, even when the transfer film was bent, it did not cause cracking (flex cracking) on the surface of the film forming material layer, and the film forming material layer had excellent flexibility.

[0137] The cover film was peeled off from the transfer film, the transfer film (laminate consisting of the base film and the film forming material layer) was overlaid on a glass substrate without applying pressure in such a manner that the surface of the film forming material layer came into contact with the surface of the glass substrate, and the transfer film was then peeled off from the surface of the glass substrate. As a result, the film forming material layer showed appropriate tackiness to the glass substrate, and the transfer film could be peeled off without causing cohesive failure in the film forming material layer. Therefore, the transfer film had good handling properties.

(3) Transfer of film forming material layer:

[0138] After peeling off the cover film from the transfer film obtained in (2) above, the transfer film (laminate consisting of the base film and the film forming material layer) was overlaid on a glass substrate for a 21-inch panel in such a manner that the surface of the film forming material layer came into contact with the surface (bus electrode fixed surface) of the glass substrate and press bonded under heating using a heating roll. Press bonding conditions included a heating roll surface temperature of 90°C, a roll pressure of 2 kg/cm^2, and a heating roll moving speed of 0.6 m/min.

[0139] After completion of the press bonding under heating, the base film was peeled off and removed from the film forming material layer fixed (bonded under heating) to the surface of the glass substrate, thereby completing transfer of the film forming material layer.

[0140] In this transfer step, when the base film was peeled off, the film forming material layer did not cause cohesive failure and had sufficiently large film strength. Further, the transferred film forming material layer had good adhesion to the surface of the glass substrate.

(4) Baking of film forming material layer (formation of dielectric layer):

[0141] The glass substrate on which the film forming material layer had been transferred and formed in (3) above was placed in a kiln and baked by elevating the temperature inside the kiln to 620°C to form an achromatic transparent dielectric layer made of a sintered glass material on the surface of the glass substrate.

[0142] The thickness (average thickness and tolerance) of this dielectric layer was measured and found to be in the range of 30 μm ± 0.4 μm. Thus, the dielectric layer had excellent uniformity in thickness.

[0143] The surface of the resulting dielectric layer was subjected to three-dimensional measurement using a non-contact thickness meter (NH-3, manufactured by Ryokosha Co., Ltd.) to determine the surface roughness (Ra, Ry, Rz) according to the JIS standards (B0601). As a result, the dielectric layer had Ra = 0.08 μm, Ry = 0.56 μm and Rz = 0.28 μm so that it had excellent surface flatness.

[0144] Further, the light transmittance of the thus obtained dielectric layer was measured (measurement wavelength: 550 nm) and found to be 93%. Thus, it was confirmed that the dielectric layer had good transparency.

COMPARATIVE EXAMPLE

[0145] A composition having a viscosity of 3,000 cp (measured using a B-type viscometer at 30 rpm) was prepared in the same manner as in the Example, except for changing the proportion of the binder resin to 17 parts and using 4 parts of di-2-ethylhexyl azelate in place of the specific compound. Using the resulting composition, a transfer film was produced and evaluated in the same manners as in the Example. As a result, the transfer film had good flexibility and handling properties. However, a dielectric layer was formed in the same manner as in the Example and measured for surface roughness (Ra, Ry, Rz). As a result, the dielectric layer had Ra = 0.65 μm, Ry = 2.51 μm and Rz = 1.73 μm so that it was inferior in surface flatness.

[0146] The composition of the present invention gives rise to the following effects.

(1) It can suitably form a constituent element (for example, a barrier rib, an electrode, a resistor, a dielectric layer, a phosphor, a color filter, and a black matrix) of PDP having excellent surface flatness.
(2) It can suitably form a sintered glass material (for example, a dielectric layer or barrier rib constituting PDP) having high light transmittance.
(3) It can produce a transfer film having excellent flexibility in terms of its film forming material layer.
(4) It can produce a transfer film having excellent transferability (heat adhesion to a substrate) in terms of its film forming material layer.

[0147] The transfer film of the present invention gives rise to the following effects.

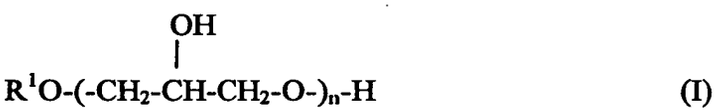
(1) It can efficiently form a constituent element (especially a dielectric layer) having excellent surface flatness of PDP.
(2) It is excellent in flexibility in terms of its film forming material layer, and the surface of the film forming material layer is free from flex cracking (cracking).
(3) It has excellent suppleness and can be easily rolled.
(4) It is appropriate in adhesion and good in handling properties in terms of its film forming material layer.
(5) It is excellent in transferability (heat adhesion to a substrate) in terms of its film forming material layer.

[0148] The production process of the present invention gives rise to the following effects.

(1) It can efficiently form a constituent element (for example, a barrier rib, an electrode, a resistor, a dielectric layer, a phosphor, a color filter, and a black matrix) of PDP having excellent surface flatness.
(2) It can efficiently form PDP having high position accuracy of a constituent element.
(3) It can efficiently form a dielectric layer having a large thickness.
(4) It can efficiently form a dielectric layer required for a large-sized panel.
(5) It can efficiently form PDP provided with a dielectric layer having excellent uniformity in thickness and surface flatness.

[0149] An inorganic particle-containing composition comprising:

(A) inorganic particles;
(B) a binder resin; and
(C) a compound represented by the following formula (I):



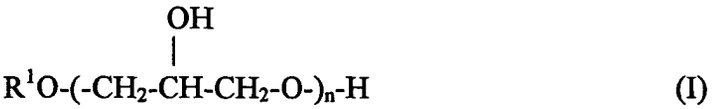
$$R^1O\text{-}(\text{-}CH_2\text{-}CH(OH)\text{-}CH_2\text{-}O\text{-})_n\text{-}H \qquad (I)$$

wherein R^1 represents a group represented by -CO-A, wherein A represents an alkyl group having 5-20 carbon atoms or an alkenyl group having 5-20 carbon atoms, and n is an integer of 2-20.
A transfer film and a plasma display panel production process using the composition are also described.

Claims

1. An inorganic particle-containing composition comprising:

   (A) inorganic particles;
   (B) a binder resin; and
   (C) a compound represented by the following formula (I):



$$R^1O\text{-}(\text{-}CH_2\text{-}CH(OH)\text{-}CH_2\text{-}O\text{-})_n\text{-}H \qquad (I)$$

   wherein R^1 represents a group represented by -CO-A, wherein A represents an alkyl group having 5-20 carbon atoms or an alkenyl group having 5-20 carbon atoms, and n is an integer of 2-20.

2. The inorganic particle-containing composition as claimed in claim 1, further comprising (D) a radiation-sensitive component.

3. A transfer film comprising a film forming material layer obtained from the inorganic particle-containing composition as claimed in claim 1.

4. A transfer film comprising a film forming material layer obtained from the inorganic particle-containing composition as claimed in claim 2.

5. A transfer film comprising a laminate of a resist film and a film forming material layer obtained from the inorganic particle-containing composition as claimed in claim 1.

6. A process of producing a plasma display panel comprising the steps of transferring a film forming material layer obtained from the inorganic particle-containing composition as claimed in claim 1 to a surface of a substrate and baking the transferred film forming material layer to form a dielectric layer on the substrate.

7. A process of producing a plasma display panel comprising the steps of transferring a film forming material layer obtained from the inorganic particle-containing composition as claimed in claim 1 to a surface of a substrate; forming a resist film on the transferred film forming material layer; exposing the resist film to form a latent image of a resist pattern; developing the resist film to form the resist pattern; etching the film forming material layer to form a pattern layer corresponding to the resist pattern; and baking the pattern layer to form a constituent element selected from a barrier rib, an electrode, a resistor, a dielectric layer, a phosphor, a color filter, and a black matrix.

8. A process of producing a plasma display panel comprising the steps of forming a laminate film of a resist film and a film forming material layer obtained from the inorganic particle-containing composition as claimed in claim 1 on a base film; transferring the laminate film formed on the base film to a surface of a substrate; exposing a resist film constituting the laminate film to form a latent image of a resist pattern; developing the resist film to form the resist pattern; etching the film forming material layer to form a pattern layer corresponding to the resist pattern; and baking the pattern layer to form a constituent element selected from a barrier rib, an electrode, a resistor, a dielectric layer, a phosphor, a color filter, and a black matrix.

9. A process of producing a plasma display panel comprising the steps of transferring a film forming material layer obtained from the inorganic particle-containing composition as claimed in claim 2 to a surface of a substrate; exposing the film forming material layer to form a latent image of a pattern; developing the film forming material layer to form a pattern layer; and baking the pattern layer to form a constituent element selected from a barrier rib, an electrode, a resistor, a dielectric layer, a phosphor, a color filter, and a black matrix.

FIG. 1

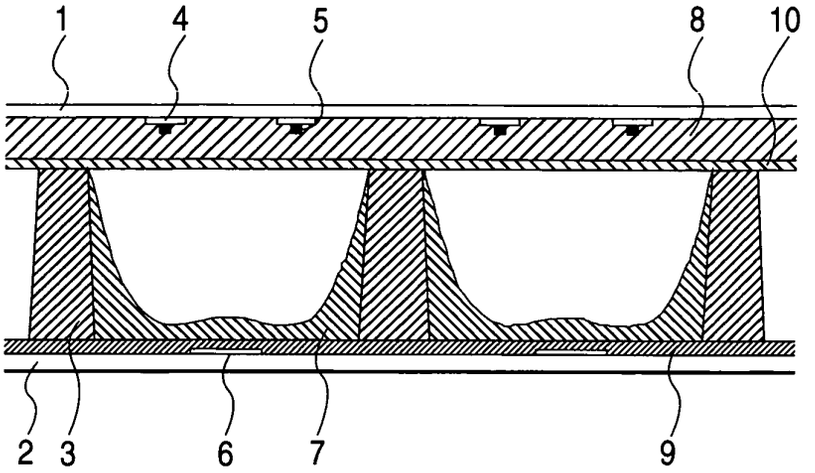


FIG. 2A

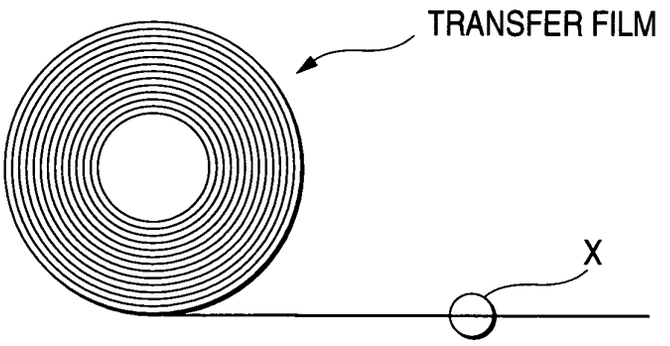
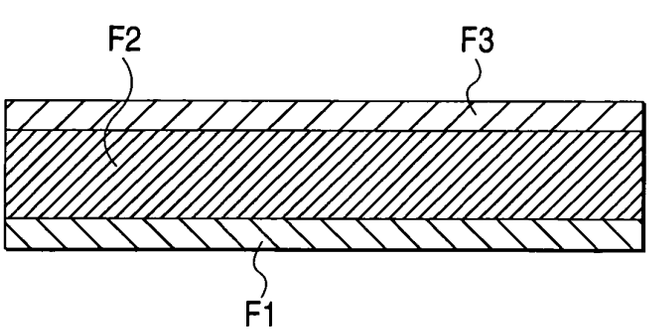


FIG. 2B



DETAILS OF X PORTION

FIG. 3A

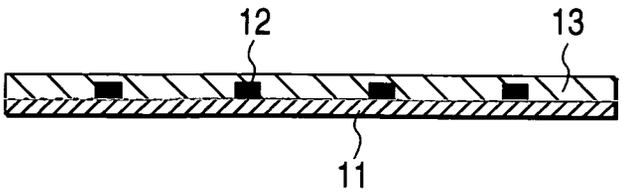


FIG. 3B

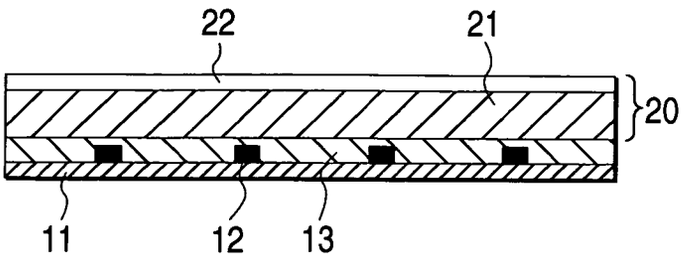


FIG. 3C

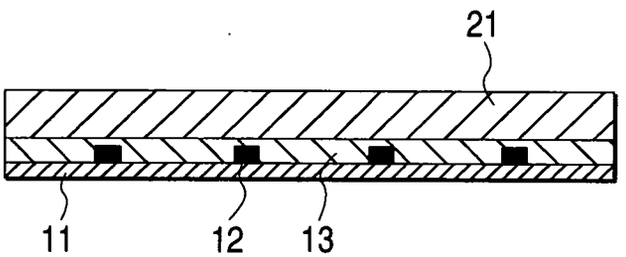


FIG. 3D

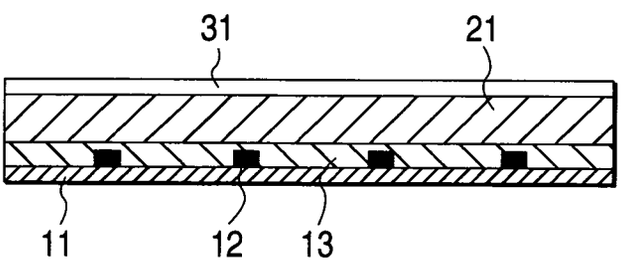


FIG. 3E

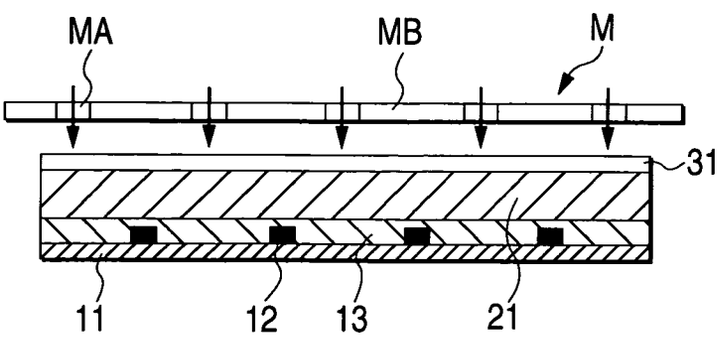


FIG. 4F

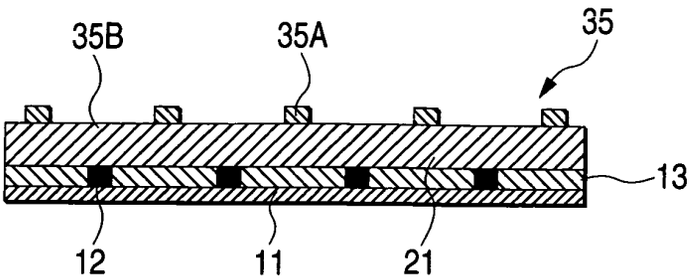


FIG. 4G

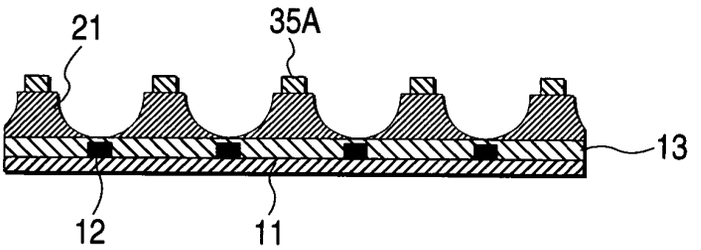


FIG. 4H

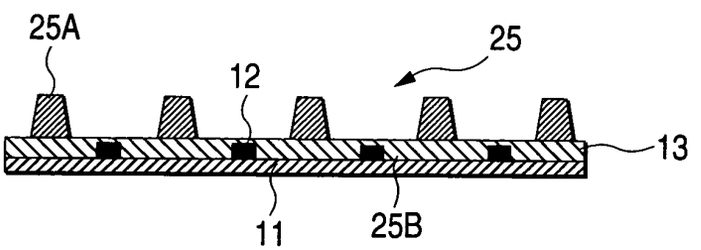
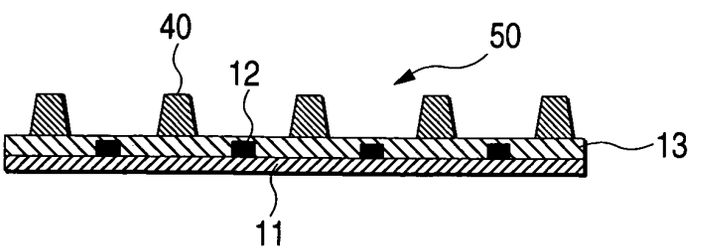


FIG. 4I



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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	US 6 339 118 B1 (OKAMOTO KENJI ET AL) 15 January 2002 (2002-01-15) * the whole document * ---	1-9	C08K5/10 C08K5/103 H01J9/20
A	EP 0 987 228 A (JSR CORP) 22 March 2000 (2000-03-22) * example 2 * * claims 1,12 * ---	1-9	
A	PATENT ABSTRACTS OF JAPAN vol. 017, no. 636 (E-1464), 25 November 1993 (1993-11-25) -& JP 05 205627 A (DAINIPPON PRINTING CO LTD), 13 August 1993 (1993-08-13) * abstract * ---	1-9	
X	US 6 147 148 A (TANAKA HIROYUKI ET AL) 14 November 2000 (2000-11-14) * table 1 * * examples 26-41; table 4 * ---	1,2	
X	US 6 278 008 B1 (ENDO TOSHIO ET AL) 21 August 2001 (2001-08-21) * column 30, line 21 - line 22 * * examples 20-29; table 7 * ---	1-4	TECHNICAL FIELDS SEARCHED (Int.Cl.7) C08K H01J
X	DATABASE WPI Section Ch, Week 198724 Derwent Publications Ltd., London, GB; Class A26, AN 1987-167585 XP002279738 -& JP 62 100554 A (TOSHIBA SILICONE KK), 11 May 1987 (1987-05-11) * abstract * --- -/--	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	12 May 2004	Russell, G

CATEGORY OF CITED DOCUMENTS

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Application Number
EP 04 00 4229

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	DATABASE WPI Section Ch, Week 198117 Derwent Publications Ltd., London, GB; Class A17, AN 1981-29654D XP002279739 -& JP 56 021829 A (MITSUBISHI CHEM IND LTD), 28 February 1981 (1981-02-28) * abstract * -----	1-4	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	12 May 2004	Russell, G

CATEGORY OF CITED DOCUMENTS

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12-05-2004

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6339118 B1	15-01-2002	JP 2000109341 A	18-04-2000
		EP 1003199 A2	24-05-2000
		KR 2000028762 A	25-05-2000
		TW 429266 B	11-04-2001
		US 2002016401 A1	07-02-2002
		US 2002035183 A1	21-03-2002
EP 0987228 A	22-03-2000	JP 2000053444 A	22-02-2000
		EP 0987228 A2	22-03-2000
		KR 2000017116 A	25-03-2000
JP 05205627 A	13-08-1993	JP 3229641 B2	19-11-2001
US 6147148 A	14-11-2000	JP 11080561 A	26-03-1999
		JP 11189674 A	13-07-1999
		JP 11189673 A	13-07-1999
		DE 69811593 D1	03-04-2003
		DE 69811593 T2	18-12-2003
		DE 69819043 D1	20-11-2003
		EP 1086985 A2	28-03-2001
		EP 0908491 A2	14-04-1999
		US 6576695 B1	10-06-2003
US 6278008 B1	21-08-2001	JP 3312830 B2	12-08-2002
		JP 8109153 A	30-04-1996
		JP 3436450 B2	11-08-2003
		JP 9157384 A	17-06-1997
		JP 9194428 A	29-07-1997
		JP 9194660 A	29-07-1997
		JP 9194655 A	29-07-1997
		JP 9194586 A	29-07-1997
		JP 9194683 A	29-07-1997
		JP 9208803 A	12-08-1997
		JP 9208804 A	12-08-1997
		JP 9208790 A	12-08-1997
		JP 9208443 A	12-08-1997
		JP 9208444 A	12-08-1997
		JP 9208770 A	12-08-1997
		JP 3447879 B2	16-09-2003
		JP 9217088 A	19-08-1997
		JP 9216811 A	19-08-1997
		JP 9216813 A	19-08-1997
		DE 69610050 D1	05-10-2000
		DE 69610050 T2	12-04-2001
		EP 0758641 A1	19-02-1997
		US 2004024233 A1	05-02-2004

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 04 00 4229

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6278008 B1		US 6339165 B1	15-01-2002
		US 6693150 B1	17-02-2004
		JP 9117258 A	06-05-1997
		JP 9272893 A	21-10-1997
JP 62100554 A	11-05-1987	JP 5033272 B	19-05-1993
JP 56021829 A	28-02-1981	JP 1270994 C	25-06-1985
		JP 57060129 B	17-12-1982

EPO FORM P0459

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