Title: ADHESIVE FILM FUNCTIONALIZING COLOR COMPENSATION AND NEAR INFRARED RAY (NIR) BLOCKING AND PLASMA DISPLAY PANEL FILTER USING THE SAME

Abstract: The present invention relates to an adhesive film functionalizing color compensation and near infrared ray blocking and a plasma display panel filter employing the same. The present invention provides a multifunctional adhesive film for a plasma display panel comprising an acryl-based adhesive and a near infrared ray blocking dye. The present invention also provides a multifunctional adhesive film for a plasma display panel comprising an acryl-based adhesive and a neon-cut dye. The adhesive film may further comprise a near infrared ray blocking dye. The multifunctional adhesive film of the present invention has superior durability at high temperature and humidity with little transmittance change and superior thermal stability. When further comprising a near infrared ray blocking dye, it exerts both color compensation and near infrared ray blocking performances. Because the film has superior adhesivity in itself, an additional adhesive layer is unnecessary, which simplifies the manufacturing process of a plasma display panel filter and a plasma display panel.
Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SI, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
ADHESIVE FILM FUNCTIONALIZING COLOR COMPENSATION AND NEAR INFRARED RAY (NIR) BLOCKING AND PLASMA DISPLAY PANEL FILTER USING THE SAME

CROSS-REFERENCE TO RELATED APPLICATION


BACKGROUND OF THE INVENTION

(a) Field of the Invention

The present invention relates to an adhesive film functionalizing such color compensation as neon-cut as well as near infrared ray blocking and a plasma display filter comprising the same, and more particularly to an adhesive film having superior durability, thermal stability, and adhesivity because of little transmittance change at high temperature and humidity and a plasma display filter using the same.

(b) Description of the Related Art

Recently, the plasma display panel (PDP) has been recognized as the primary flat display panel offering a wide screen.

Thus far, a plasma display panel offering a screen as wide as about 70 inches has been developed. For reference, FIG. 1 is a schematic diagram showing the general structure of a plasma display panel. In FIG. 1, numeral 11 indicates a case, numeral 12 indicates a driving circuit board, numeral 13 indicates a panel assembly, numeral 14 indicates a PDP filter, and numeral 15 indicates a cover.

The PDP filter compensates for purity lowering of the red spectrum caused by the unique orange spectrum emitted from the panel, and blocks near infrared rays that
cause malfunctions of the remote controller and electromagnetic radiation that is harmful to the human body. In order to accomplish such tasks, the PDP filter comprises such functional layers as an anti-reflection layer, a color compensation layer compensating for color purity, a near infrared absorbing layer, an electromagnetic radiation shielding layer, etc. In general, these functional layers are made of common films and are stacked using an adhesive therebetween.

If a sheet of film has both the color compensation and the near infrared ray blocking functions or if the number of films can be reduced, quality problems related with stacking can be reduced and consumption of materials can be curtailed. For example, if a film is endowed with three functions by forming two functional layers on each side of the film, the number of layers of a PDP filter can be reduced by half. Alternately, the structure may be simplified by using an adhesive capable of exerting such functions. Typically, dyes are used for near infrared ray blocking and color compensation. Examples of such dyes are a neon-cut dye and a near infrared ray blocking dye, which absorb light in the specific wavelength region. In general, a layer comprising a mixture of a binder polymer is coated on a transparent substrate. In this case, the substrate on which the dye layer has been coated should be inserted into the PDP filter using an adhesive.

Adhesives commonly used for this purpose are rubbers, poly(vinyl ether)s, acryls, silicones, etc. However, the rubber adhesives have poor aging resistance, the poly(vinyl ether) adhesives have poor heat resistance, and the silicone adhesives have a disadvantage in adhesivity. On the other hand, acryl-based adhesives are widely used in preparing adhesive compositions because of superior melting
properties, and they generally offer superior adhesivity when a light pressure is applied thereto at room temperature because the polymer molecules comprising the adhesive are fluid and sensitive to pressure. But this fluidity tends to lower heat resistance or moisture resistance of the dye included in the adhesive to improve color compensation or near infrared ray blocking performance. Therefore, it is important to select a durable dye capable of enduring high temperature and high humidity.

The prior arts using the color compensation dye and the near infrared ray dye are as follows.

Japan Patent Publication No. 2001-248721 discloses an optical filter employing an azaporphyrin dye in the 570-605 nm region. Although this patent mentions that a transparent adhesive (acryl-based adhesive) may be included to improve adhesivity, the adhesive structure used, the crosslinking agent, and the coupling agent are not mentioned in detail. In addition, although an initial transmittance of 15.9% at 584 nm is stated, there is no mention of transmittance maintenance regarding before and after durability test.

Publication No. 2004-107566 discloses an adhesive comprising an acryl resin having a specific acid value and a polymethine neon-cut dye.


Also, the color compensation films and the near infrared ray blocking films prepared according to the conventional methods show difference in durability at high temperature and humidity depending on the kind of binder, coating condition, etc. In addition, it is costly and ineffective to stack these films to manufacture a PDP filter. Thus, there have been attempts to develop multifunctional adhesive layers, such as an adhesive layer including a neon-cut layer and an adhesive layer including a near infrared ray blocking layer, but durability at high temperature and humidity has been shown to be unsatisfactory.

SUMMARY OF THE INVENTION

It is an aspect of the present invention to provide a multifunctional adhesive film functionalizing color compensation and near infrared ray blocking, having superior durability with little transmittance change at high temperature and humidity, having superior thermal stability, being capable of maintaining transmittance in the visible region for an extended time, and having good near infrared ray blocking performance.
It is another aspect of the present invention to provide a plasma display panel filter comprising a multifunctional adhesive film having color compensation and near infrared ray blocking performance without an additional adhesive layer and thus being capable of simplifying the film, and a plasma display panel comprising the same.

To attain these aspects, the present invention provides a multifunctional adhesive film for a plasma display panel comprising an acryl-based adhesive, and a near infrared ray blocking dye.

The present invention also provides a multifunctional adhesive film for a plasma display panel comprising an acryl adhesive and a neon-cut dye. Preferably, the adhesive film further comprises a near infrared ray blocking dye.

The present invention further provides a plasma display panel filter comprising at least one of the above-mentioned multifunctional adhesive films on at least one side of a substrate.

The present invention further provides a plasma display panel comprising the plasma display panel filter.

**BRIEF DESCRIPTION OF THE DRAWINGS**

FIG. 1 is a schematic diagram showing the structure of a plasma display panel.

FIG. 2 shows a spectrum change of a multifunctional adhesive film prepared in Example 4 according to the present invention.

FIG. 3 shows the spectrum change of a multifunctional adhesive film prepared in Example 5 according to the present invention.

FIG. 4 shows the spectrum change of a multifunctional adhesive film
prepared in Example 6 according to the present invention.

FIG. 5 shows the spectrum change of an adhesive film prepared in Comparative Example 1 after a high temperature durability test.

FIG. 6 shows the spectrum change of the adhesive film prepared in Comparative Example 1 after a high temperature/high humidity test.

FIG. 7 shows the spectrum change of the adhesive film prepared in Comparative Example 2.

FIG. 8 shows the structure of the plasma display filter of Example 7 comprising the multifunctional adhesive according to the present invention.

FIG. 9 shows the structure of the plasma display filter of Example 8 comprising the multifunctional adhesive according to the present invention.

FIG. 10 shows the structure of the plasma display filter of Comparative Example 3.

**DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

Hereunder is given a detailed description of the present invention.

The present invention provides a multifunctional adhesive film for a plasma display panel having good durability and adhesivity, which comprises a pressure-sensitive acryl-based adhesive having superior adhesivity and durability and being capable of replacing the conventional adhesive (PSA) as a binder resin, a color compensation dye, and a near infrared ray dye.

The film of the present invention comprises a neon-cut dye capable of blocking neon light around 590 nm and a near infrared ray dye capable of blocking near infrared rays around 850 nm and 950 nm in order to satisfy typical optical
characteristics required for a plasma display filter.

The multifunctional adhesive film of the present invention effectively reduces the neon peak around 570-600 nm, which is generated from the PDP module, and blocks light in the NIR region of 800-1100 nm to 10 % or below. When tested at high temperature and humidity, more specifically at 80 °C for 500 hours and at 60 °C and 90% RH for 500 hours, the concentration of the dye in the visible and NIR region changes by 10 % or less. Because a sheet of film can have the color compensation or both the color compensation and the near infrared ray blocking performances, the number of films can be reduced to simplify the structure.

Hereunder is given a more detailed description of the adhesive film of the present invention.

A PDP has a film (filter) exerting several functions in front of the panel in order to block electromagnetic radiation, neon radiation, near infrared rays, etc. generated during operation. An adhesive (PSA) is used to form the film. This adhesive should have not only superior adhesivity but also excellent transmittance in the visible region (380-780 nm).

Accordingly, the film of the present invention comprises an acryl-based adhesive and a near infrared ray blocking dye. Also, the film of the present invention may comprise an acryl-based adhesive and a neon-cut dye, and further comprises a near infrared ray blocking dye.

Preferably, the adhesive used as a binder resin in the present invention is an acryl-based adhesive having a glass transition temperature (Tg) of 0 °C or below. The acryl-based adhesive may be obtained from copolymerization of 75-99.89 wt% of
a (meth)acrylate ester monomer having a C\textsubscript{1-12} alkyl group, 0.1-20 wt% of an α,β-unsaturated carboxylate monomer, which is a functional monomer, and 0.01-5 wt% of a polymeric monomer having a hydroxyl group. The copolymerization may be performed by one skilled in the art.

More preferably, the acryl-based adhesive is a butyl acrylate (BA)/hydroxyethyl methacrylate (HEMA) copolymer or a butyl acrylate/acrylic acid (AA) copolymer, because these have superior absorption ability compared with an acryl adhesive in the prior art at the visible region and a near infrared ray region.

The near infrared ray blocking dye may be one that is commonly used, for example a diimmonium dye. If required, it may be used along with a metal-complex dye or a phthalocyanine dye. The diimmonium dye absorbs near infrared rays in the broad region of 900-1200 nm.

The near infrared ray blocking dye may be at least one selected from the group consisting of a diimmonium dye represented by Chemical Formula 4 below, a phthalocyanine dye represented by Chemical Formula 5 below, a naphthalocyanine dye represented by Chemical Formula 6 below, and a metal-complex dye represented by Chemical Formula 7 and Chemical Formula 8 below.
In Chemical Formula 4, each of $R_1 - R_{12}$ is, independently, a hydrogen atom, a halogen atom, a substituted or unsubstituted alkyl group with $C_1 - C_{16}$, or a substituted or unsubstituted aryl group with $C_1 - C_{16}$; and $X$ is a monovalent or divalent organic anion, a monovalent anion, or a divalent inorganic anion.
In Chemical Formulas 5 and 6, each of R is, independently, a hydrogen atom, a halogen atom, a substituted or unsubstituted alkyl group with C$_{1}$-C$_{16}$, a substituted or unsubstituted phenyl group, a substituted or unsubstituted alkoxy group having C$_{1}$-C$_{5}$, a substituted or unsubstituted allyloxy group, a fluorine-substituted alkoxy group, or a pentagonal ring having at least one substituted or unsubstituted nitrogen atom; and M is at least one selected from the group consisting of the two hydrogen atoms, a divalent metal atom, a trivalent or tetravalent substituted metal atom, and an oxy-metal atom, and is preferably Ni, Pt, Pd, or Cu.

In Chemical Formulas 7 and 8, each of R and R$_{1}$-R$_{4}$ is, independently, a hydrogen atom, an alkyl group having C$_{1}$-C$_{16}$, an aryl group, an alkoxy group, a phenoxy group, a hydroxy group, an alkylamino group having C$_{1}$-C$_{16}$, an arylamino group, a trifluoromethyl group, an alkylthio group having C$_{1}$-C$_{16}$, an arylthio group, a nitro group, a cyano group, a halogen atom, a phenyl group, or a naphthyl group.

In Chemical Formula 4, the monovalent organic anion may be an organic carboxylate ion, an organic sulfonate ion, an organic borate ion, etc. The organic carboxylate ion may be acetate, lactate, trifluoroacetate, propionate, benzoate, oxalate, succinate, or stearate. The organic sulfonate ion may be a metal sulfonate, toluenesulfonate, naphthalenemonosulfonate, chlorobenzenesulfonate, nitrobenzenesulfonate, dodecylbenzenesulfonate, benzonesulfonate, ethanesulfonate, or trifluoromethanesulfonate. Preferably, the organic borate ion is tetraphenylborate or butyltriphenylborate.

In Chemical Formula 4, the monovalent inorganic anion is preferably a halogenate anion, such as fluoride, chloride, bromide, iodide, thiocyanate,
hexafluoroantimonate, perchlorate, periodate, nitrate, tetrafluoroborate, hexafluorophosphate, molybdate, tungstate, titanate, vanadate, phosphate, and borate. Preferably, the divalent inorganic anion is naphthalene-1,5-disulfonate, naphthalene-1,6-disulfonate, a naphthalene disulfonate derivative, etc.

The neon-cut dye has a maximum absorption wavelength of 570-600 nm and a half bandwidth of 50 nm or below. Preferably, it has the structure of an intramolecular or intermolecular metal-complex.

For example, the neon-cut dye may be at least one selected from the group consisting of a porphyrin dye having an intramolecular metal-complex, as represented by Chemical Formula 1 below, and a cyanine dye having an intermolecular metal-complex structure, as represented by Chemical Formulas 2 and 3 below. Preferably, the neon-cut dye may be porphyrin dye.
In Chemical Formula 1, each of $R_1$-$R_6$ is, independently, a hydrogen atom, a halogen atom, a substituted or unsubstituted alkyl group having C$_1$-C$_{16}$ or an alkoxy group having C$_1$-C$_{16}$, a substituted or unsubstituted phenyl group, a substituted or unsubstituted allyloxy group, a fluorine-substituted alkoxy group, or a pentagonal ring having at least one substituted or unsubstituted nitrogen atom; and M is a hydrogen atom, an oxygen atom, a halogen atom, or a coordinated divalent to tetravalent metal atom.

In Chemical Formulas 2 and 3, each of $R$ is, independently, a hydrogen atom, a substituted or unsubstituted aliphatic hydrocarbon having 1-30 carbon atoms, an alkoxy group having 1-8 carbon atoms, or an aryl group having 6-30 carbon atoms; each of $X$ and $Y$ is, independently, a halogen atom, a nitro group, a carboxyl group, an alkoxy group having 2-8 carbon atoms, a phenoxycarbonyl group, a carboxylate group, an alkyl group having 1-8 carbon atoms, an alkoxy group having 1-8 carbon atoms, or an aryl group having 6-30 carbon atoms.

In M of Chemical Formula 1, the divalent metal atom may be Cu, Zn, Fe, Co, Ni, Ru, Rd, Pd, Mn, Sn, Mg, Ti, etc; the trivalent metal atom may be substituted by a halogen atom, a hydroxy group, or an alkoxy group such as Al-Cl, Ga-Cl, In-Cl, Fe-Cl, Ru-Cl, etc; and the quadrivalent atom may be substituted by two substituents
selected from a halogen atom, a hydroxy group, and an alkoxy group such as SiCl₂,
GaCl₂, TiCl₂, SnCl₂, Si(OH)₂, Ge(OH)₂, Mn(OH)₂, Sn(OH)₂, etc. Also, M may be an
oxymetal binding with oxygen such as VO, MnO₂, TiO₂, etc.

The proportion of the acryl-based adhesive to the near infrared ray blocking
dye by weight is 10:1 to 10,000:1. The weight proportion varies with the weight
portion of solvent in the adhesive solution, viscosity of the adhesive solution, molar
extinction coefficient of the near infrared ray blocking dye, and wanted transmittance
value.

For a film comprising a neon-cut dye, the weight proportion of the acryl
adhesive to the neon-cut dye is 10:1-10,000:1. The weight proportion also varies
with the weight portion of solvent in the adhesive solution, viscosity of the adhesive
solution, molar extinction coefficient of the neon-cut dye, and desired transmittance
value.

The multifunctional adhesive film of the present invention may further
comprise a solvent. The solvent may be a commonly used organic solvent,
preferably methyl ethyl ketone (MEK), tetrahydrofuran (THF), ethyl acetate, toluene,
etc. The content of the solvent is not particularly limited.

The adhesive film of the present invention may further comprise a
crosslinking agent and a coupler.

The crosslinking agent may be a polyfunctional compound such as an
isocyanate crosslinking agent, an epoxy crosslinking agent, an aziridine crosslinking
agent, and a metal chelate crosslinking agent. More preferably, it is an isocyanate
crosslinking agent, such as tolylene diisocyanate, xylene diisocyanate,
diphenylmethane diisocyanate, hexamethylene diisocyanate, etc., although it is not limited to them. The crosslinking agent may be used at 0.01-2 parts by weight per 100 parts by weight of the acryl copolymer.

Preferably, the coupler is a silane coupler. The silane coupler improves adhesion reliability especially when left alone for a long time at high temperature and humidity. The silane coupler may be vinylsilane, epoxysilane, methacrylsilane, etc. For example, vinyltrimethoxysilane, vinyltriethoxysilane, γ-glycidoxypropyltrimethoxysilane, γ-methacyrloxypropyltrimethoxysilane, etc. may be used alone or in combination. The silane coupler may be used at 0.01-2 parts by weight per 100 parts by weight of the acryl copolymer.

The method of preparing the adhesive film is not particularly limited. For example, it may be prepared by mixing a dye and a binder, adding a predetermined amount of crosslinking agent and coupler thereto to obtain a coating solution, coating it on a film, and then curing it. Preferably, the resultant coating has a thickness of at least 10 μm. The coating may be performed by spray coating, roll coating, bar coating, spin coating, and so on.

The present invention also provides a plasma display panel filter comprising the multifunctional adhesive film for a plasma display panel. The plasma display panel filter may be prepared by stacking a substrate film, an anti-reflection film (AR film), the near infrared ray film of the present invention, the multifunctional adhesive film functionalizing color compensation or both color compensation and near infrared ray blocking, an electromagnetic interference film (EMI film), a black screen processing film, etc.
The plasma display panel filter may be prepared by adequately stacking the above-mentioned films on a transparent substrate made of glass or polyethylene terephthalate (PET). The filter of the present invention may comprise at least one near infrared ray film, a color compensation film, and a film functionalizing both color compensation and near infrared ray blocking. Each film may be located either above or below the substrate. When at least one of the multifunctional films is directly stacked on the substrate, no adhesive is used. When a layer not including the multifunctional film is formed, a commonly used pressure-sensitive adhesive (PSA) may be used. That is to say, the electromagnetic interference film and the black screen processing film may be stacked by using a conventional adhesive.

The present invention further provides a plasma display panel comprising the plasma display panel filter. The plasma display panel may be prepared by a method well known in the art, which will not be described in detail.

When a filter comprising the adhesive film of the present invention is used in a panel assembly, a plasma display panel having superior durability at high temperature and humidity with little transmittance change, superior thermal stability, and good transmittance in the visible region can be obtained.

As described above, the adhesive film for a plasma display panel, which comprises an acryl-based adhesive having superior adhesivity and durability as a binder resin and a color compensation dye or a color compensation dye and a near infrared ray blocking dye, has superior durability at high temperature and humidity with little transmittance change, superior thermal stability, good transmittance in the visible region, and superior near infrared ray blocking performance. In particular, the
film is adhesive in itself, so it is unnecessary to use additional adhesive in manufacturing a plasma display panel filter which simplifies the manufacturing process and reduces thickness of the filter.

The present invention is described in further detail with reference to the preferred examples. However, the following examples are only for the understanding of the present invention and they do not limit the present invention.

<Examples>

The multifunctional adhesive films according to the present invention were prepared and tested as follows.

<Film preparation>

1. Preparation of coating solution: A coating solution for preparing a multifunctional adhesive film was prepared alone or by mixing with a butyl acrylate(BA)/hydroxyethyl methacrylate (HEMA) copolymer or a butyl acrylate (BA)/acrylic acid (AA) copolymer as an adhesive resin, and a neon-cut dye, a first near infrared ray blocking dye, and a second near infrared ray blocking dye.

2. Coating: The coating solution was coated on a film to a thickness of 15 μm. After drying at 120 °C for 3 minutes, the coating surface was laminated with a film.

3. Aging: Aging was performed at room temperature for 3 days.

<Durability test>

High temperature condition: Transmittance was compared before and after keeping the film in a chamber at 80 °C for 500 hours.

(Example 1)

The film preparation including the near infrared ray blocking dye
100 parts by weight (15.5 wt%) of a butyl acrylate (BA)/hydroxyethyl methacrylate (HEMA) copolymer solution dissolved in 84.5 ml of ethyl acetate, 0.05 parts by weight of a diimmonium dye represented by Chemical Formula 4 as a near infrared ray blocking dye (CIR1081, Japan Carlit Co.), 0.05 parts by weight of T-39M as an isocyanate crosslinking agent, and 0.07 parts by weight of T-789J as a silane coupler were added to 45 parts by weight of methyl ethyl ketone (MEK) and mixed to obtain a coating solution. The coating solution was coated on a substrate film to a thickness of 23 \( \mu \text{m} \) to obtain a multifunctional adhesive film.

Durability was tested as described above. The results are given in Table 1 below.

<table>
<thead>
<tr>
<th></th>
<th>Transmittance in the visible region (%)</th>
<th>Transmittance in the NIR region (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>438nm</td>
<td>450nm</td>
</tr>
<tr>
<td>Initial</td>
<td>70.4</td>
<td>68.0</td>
</tr>
<tr>
<td>500 hours later</td>
<td>70.3</td>
<td>67.7</td>
</tr>
</tbody>
</table>

As seen in Table 1, the adhesive film shows superior transmittance maintenance in the visible region and the near infrared ray (NIR) region after the high temperature test.

(Example 2)

An adhesive film was prepared in the same manner of Example 1, except for using a phthalocyanine dye (IP12, Japan catalyst Co.) represented by Chemical Formula 5 as a near infrared ray blocking dye.

(Example 3)
An adhesive film was prepared in the same manner of Example 1, except for using a butyl acrylate/acrylic acid copolymer solution instead of the butyl acrylate (BA)/hydroxyethyl methacrylate (HEMA) copolymer solution as an acryl-based adhesive.

(Example 4)

100 parts by weight (15.5 wt%) of a butyl acrylate (BA)/hydroxyethyl methacrylate (HEMA) copolymer solution dissolved in 84.5 ml of ethyl acetate, 0.05 parts by weight of a porphyrin dye represented by Chemical Formula 1, 0.05 parts by weight of T-39M as an isocyanate crosslinking agent, and 0.07 parts by weight of T-789J as a silane coupler were added to 45 parts by weight of methyl ethyl ketone (MEK) and mixed to obtain a coating solution. The coating solution was coated on a substrate film to a thickness of 23 microns to obtain a multifunctional adhesive film.

Durability was tested as described above. The results are given in Table 2 below. Spectrum change of the adhesive film is shown in FIG. 2.

Table 2

<table>
<thead>
<tr>
<th></th>
<th>Transmittance in the visible region (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>400 nm</td>
</tr>
<tr>
<td>Initial</td>
<td>68.8</td>
</tr>
<tr>
<td>500 hours later</td>
<td>68.7</td>
</tr>
</tbody>
</table>

As seen in Table 1 and FIG. 2, the adhesive film comprising the color compensation dye of Example 4 shows superior transmittance maintenance in the visible region.
(Example 5)

100 parts by weight (14.5 wt%) of a butyl acrylate/acrylic acid copolymer solution dissolved in 84.5 ml of ethyl acetate, 0.05 parts by weight of a porphyrin dye represented by Chemical Formula 1, 0.23 parts by weight of T-39M as an isocyanate crosslinking agent, and 0.03 parts by weight of T-789J as a coupler were added to 45 parts by weight of methyl ethyl ketone (MEK) and mixed to obtain a coating solution. The coating solution was coated on a substrate film to obtain a multifunctional adhesive film.

Durability was tested as described above. The results are given in Table 3 below. Spectrum change of the adhesive film is shown in FIG. 3.

Table 3

<table>
<thead>
<tr>
<th></th>
<th>Transmittance in the visible region (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>400 nm</td>
</tr>
<tr>
<td>Initial</td>
<td>67.9</td>
</tr>
<tr>
<td>500 hours later</td>
<td>67.0</td>
</tr>
</tbody>
</table>

As seen in Table 3 and FIG. 3, the adhesive film comprising the color compensation dye of Example 5 shows superior transmittance maintenance in the visible region.

(Example 6)

An adhesive film was prepared in the same manner of Example 4, except for further using 0.3 parts by weight of a porphyrin dye, 0.3 parts by weight of diimmonium dye (first near infrared ray blocking dye) (CIR1081, Japan Carlit Co.), and 0.1 parts by weight of a phthalocyanine dye (second near infrared ray blocking
dye) (IP12, Japan Catalyst Co.).

The coating solution was coated on a substrate film to obtain a multifunctional adhesive film.

Durability was tested as described above. The results are given in Table 4 below. Spectrum change of the adhesive film is shown in FIG. 4.

Table 4

<table>
<thead>
<tr>
<th>Transmittance in the visible region (%)</th>
<th>Transmittance in the NIR region (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>400 nm</td>
<td>450 nm</td>
</tr>
<tr>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>Initial</td>
<td>23.4</td>
</tr>
<tr>
<td>500 hours later</td>
<td>23.6</td>
</tr>
</tbody>
</table>

As seen in Table 4 and FIG. 4, the adhesive film comprising the color compensation dye of Example 6 shows superior transmittance maintenance not only in the visible region but also in the NIR region.

(Comparative Example 1)

An adhesive film was prepared by changing the composition of the coating solution to the following composition.

Composition: cyanine dye as the neon-cut dye (0.0214g, TY102: Asahi denka), 14BB (100g, acryl-based having –OH group), a curing agent (0.03g, T-39M), and a coupling agent (0.07g, T-789J).

Coating on the substrate: Bar coating, drying thickness 25μm.

Thereafter, the durability was tested as described above. The results are given in Table 5 below, and the spectrum change of the adhesive film is shown in FIG.
Table 5

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>Transmittance in the NIR region (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>450</td>
</tr>
<tr>
<td>Pre-durability test</td>
<td>57.6</td>
</tr>
<tr>
<td>Durability 10 min. later at 100 °C</td>
<td>43.6</td>
</tr>
<tr>
<td>Durability 500 hours later at high temperature (80 °C)</td>
<td>43.0</td>
</tr>
</tbody>
</table>

Also, the test results of high temperature and high humidity are given in Table 6, and the spectrum change of the adhesive film is shown in FIG. 6.

Table 6

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>Transmittance in the NIR region (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>450</td>
</tr>
<tr>
<td>Pre-durability test</td>
<td>56.6</td>
</tr>
<tr>
<td>Durability 10 min. later at 100 °C</td>
<td>56.3</td>
</tr>
<tr>
<td>Durability 500 hours later at high temperature and high humidity (80 °C, RH 90%)</td>
<td>53.2</td>
</tr>
</tbody>
</table>

As seen in the results, the adhesive film comprising the color compensation dye of Comparative Example 1 shows inferior transmittance maintenance in the visible region, compared with Examples of the present invention.

(Comparative Example 2)

An adhesive film was prepared by changing the composition of the coating solution to the following composition.

Composition: a cyanine NIR absorbing dye (0.01g, TY102: Asahi denka), 14BB (100g, acryl-based having –OH group), a curing agent (0.006g, T-39M), and a
coupling agent (0.014g, T-789J).

Coating on the substrate: Bar coating, drying thickness 20μm.

Curing condition: 3 days at room temperature.

Thereafter, the durability was tested as described above. The results are given in Table 7 below, and the spectrum change of the adhesive film is shown in FIG. 7.

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>450</th>
<th>550</th>
<th>586</th>
<th>628</th>
<th>854</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength (nm)</td>
<td>450</td>
<td>550</td>
<td>586</td>
<td>628</td>
<td>854</td>
</tr>
<tr>
<td>Pre-durability test</td>
<td>80.9</td>
<td>84.8</td>
<td>84.3</td>
<td>80.7</td>
<td>34.2</td>
</tr>
<tr>
<td>Durability 500 hours later at high temperature (80 °C)</td>
<td>81.2</td>
<td>85.1</td>
<td>84.7</td>
<td>82.5</td>
<td>35.4</td>
</tr>
</tbody>
</table>

As seen in the results, the adhesive film of Comparative Example 2 also shows inferior transmittance maintenance in the visible region, compared with Examples of the present invention.

(Example 7)

**Preparation of plasma display panel filter**

A plasma display panel filter as shown in FIG. 8 (five-layer structure) was prepared by stacking an anti-reflection film (AR film) 30, an adhesive film 28 prepared in Example 1, toughened glass 26, a pressure-sensitive adhesive layer (PSA) 24, and an electromagnetic interference film (EMI film) 22 on a glass substrate.

(Example 8)

**Preparation of plasma display panel filter**
A plasma display panel filter as shown in FIG. 9 (seven-layer structure) was prepared by stacking an anti-reflection film (AR film) 30, an adhesive film 28 prepared in Example 4, an NIR film 29, toughened glass 26, a PSA 24, and an electromagnetic interference film (EMI film) 22 on a glass substrate.

(Comparative Example 3)

A plasma display panel filter was prepared by stacking an anti-reflection film 30, an adhesive layer 24, a color compensation film of Comparative Example 1 25, an adhesive layer 24, a conventional near infrared ray film of Comparative Example 2 29, an adhesive layer 24, toughened glass 26, an adhesive layer 24, and an electromagnetic interference film 22. All the films were laminated using a rubber adhesive (PSA). Its structure is shown in FIG. 10. The filter of Comparative Example 3 has a nine-layer structure.

As is apparent from the above description, the multifunctional adhesive film of the present invention has improved durability because an acryl-based adhesive is used as a binder resin and it functionalizes color compensation and near infrared ray blocking performances using a color compensation dye and a near infrared ray blocking dye. In addition, it has superior near infrared ray transmittance, and in particularly it requires no additional adhesive because the film itself has superior adhesivity. Thus, it can simplify the structure of the plasma display panel filter and can be utilized in manufacturing of a plasma display panel filter and a plasma display panel. While the present invention has been described in detail with reference to the preferred embodiments, those skilled in the art will appreciate that various
modifications and substitutions can be made thereto without departing from the spirit and scope of the present invention as set forth in the appended claims.
WHAT IS CLAIMED IS:

1. A multifunctional adhesive film for a plasma display panel comprising an acryl-based adhesive and a near infrared ray blocking dye.

2. The multifunctional adhesive film of claim 1, wherein the acryl-based adhesive is a butyl acrylate/hydroxyethyl methacrylate copolymer or a butyl acrylate/acrylic acid copolymer.

3. The multifunctional adhesive film of claim 1, wherein the near infrared ray blocking dye is comprised at 0.01-10 parts by weight per 100 parts by weight of the acryl-based adhesive.

4. The multifunctional adhesive film of claim 1, wherein the near infrared ray blocking dye is at least one selected from the group consisting of a dlimmonium dye represented by Chemical Formula 4 below, a phthalocyanine dye represented by Chemical Formula 5 below, a naphthalocyanine dye represented by Chemical Formula 6 below and a metal-complex dye represented by Chemical Formula 7 or Chemical Formula 8 below:
where

in Chemical Formula 4, each of R₁-R₁₂ is, independently, a hydrogen atom, a halogen atom, a substituted or unsubstituted alkyl group with C₁-C₁₆, a substituted or unsubstituted aryl group with C₁-C₁₆, and X is a monovalent or divalent organic anion or a monovalent or divalent inorganic anion,

in Chemical Formulas 5 and 6, each of R is, independently, a hydrogen atom,
a halogen atom, a substituted or unsubstituted alkyl group with C₁-C₁₆, a substituted or unsubstituted phenyl group, a substituted or unsubstituted alkoxy group having C₁-C₅, a substituted or unsubstituted allyloxy group, a fluorine-substituted alkoxy group, or a pentagonal ring having at least one substituted or unsubstituted nitrogen atom, and M is at least one selected from the group consisting of two hydrogen atoms, a divalent metal atom, a trivalent or tetravalent substituted metal atom, and an oxy-metal atom, and is preferably Ni, Pt, Pd, or Cu; and,

in Chemical Formulas 7 and 8, each of R and R₁-R₄ is, independently, a hydrogen atom, an alkyl group having C₁-C₁₆, an aryl group, an alkoxy group, a phenoxy group, a hydroxy group, an akylamino group having C₁-C₁₆, an arylamino group, a trifluoromethyl group, an alkythio group having C₁-C₁₆, an arylthio group, a nitro group, a cyano group, a halogen atom, a phenyl group, or a naphthyl group.

5. The multifunctional adhesive film of claim 1, which further comprises at least one additive selected from the group consisting of 0.01-2 parts by weight of a crosslinking agent and 0.01-2 parts by weight of a coupler per 100 parts by weight of the pressure-sensitive acryl-based adhesive.

6. A plasma display panel filter comprising any multifunctional adhesive film of claims 1 to 5 on at least one side of a substrate.

7. The multifunctional adhesive film of claim 6, which further comprises an anti-reflection film (AR film), an electromagnetic interference film (EMI film), and a
black screen processing film.

8. A plasma display panel comprising the filter of claim 6.


10. The multifunctional adhesive film of claim 9, wherein the acryl-based adhesive is a butyl acrylate/hydroxyethyl methacrylate copolymer or a butyl acrylate/acrylic acid copolymer.

11. The multifunctional adhesive film of claim 9, wherein the neon-cut dye is comprised at 0.01-10 parts by weight per 100 parts by weight of the acryl-based adhesive.

12. The multifunctional adhesive film of claim 9, wherein the neon-cut dye is at least one selected from the group consisting of a porphyrin compound having an intramolecular metal-complex structure, as represented by Chemical Formula 1 below, and a cyanine compound having an intermolecular metal-complex structure, as represented by Chemical Formula 2 and Chemical Formula 3 below:
where in Chemical Formula 1,

each of R₁-R₆ is, independently, a hydrogen atom, a halogen atom, a substituted or unsubstituted alkyl group having C₁-C₁₆, or an alkoxy group having C₁-C₁₆, a substituted or unsubstituted phenyl group, a substituted or unsubstituted
allyloxy group, a fluorine-substituted alkoxy group, or a pentagonal ring having at least one substituted or unsubstituted nitrogen atom, and M is a hydrogen atom, an oxygen atom, a halogen atom, or a coordinated divalent to tetravalent metal atom; and,

in Chemical Formulas 2 and 3,

each of R is, independently, a hydrogen atom, a substituted or unsubstituted aliphatic hydrocarbon having 1-30 carbon atoms, an alkoxy group having 1-8 carbon atoms, or an aryl group having 6-30 carbon atoms, and each of X and Y is, independently, a halogen atom, a nitro group, a carboxyl group, an alkoxy group having 2-8 carbon atoms, a phenoxy carbonyl group, a carboxylate group, an alkyl group having 1-8 carbon atoms, an alkoxy group having 1-8 carbon atoms, or an aryl group having 6-30 carbon atoms.

13. The multifunctional adhesive film of claim 9, which further comprises 0.01-10 parts by weight of a near infrared ray blocking dye per 100 parts by weight of the acryl-based adhesive.

14. The multifunctional adhesive film of claim 9, wherein the near infrared ray blocking dye is at least one selected from the group consisting of a dlimmonium dye represented by Chemical Formula 4 below, a phthalocyanine dye represented by Chemical Formula 5 below, a naphthalocyanine dye represented by Chemical Formula 6 below, and a metal-complex dye represented by Chemical Formula 7 or Chemical Formula 8:
where

in Chemical Formula 4, each of $R_1$-$R_{12}$ is, independently, a hydrogen atom, a halogen atom, a substituted or unsubstituted alkyl group with $C_1$-$C_{16}$, or a substituted or unsubstituted aryl group with $C_1$-$C_{16}$, and $X$ is a monovalent or divalent organic anion, or a monovalent or divalent inorganic anion;

in Chemical Formulas 5 and 6, each of $R$ is, independently, a hydrogen atom, a halogen atom, a substituted or unsubstituted alkyl group with $C_1$-$C_{16}$, a substituted or unsubstituted phenyl group, a substituted or unsubstituted alkoxy group having $C_1$-$C_6$, a substituted or unsubstituted allyloxy group, a fluorine-substituted alkoxy group, or a pentagonal ring having at least one substituted or unsubstituted nitrogen atom, and $M$ is at least one selected from the group consisting of two hydrogen atoms, a divalent metal atom, a trivalent or tetravalent substituted metal atom, and an oxy-metal atom, and is preferably Ni, Pt, Pd, or Cu; and,

in Chemical Formulas 7 and 8, each of $R$ and $R_1$-$R_4$ is, independently, a hydrogen atom, an alkyl group having $C_1$-$C_{16}$, an aryl group, an alkoxy group, a phenoxy group, a hydroxy group, an alkylamino group having $C_1$-$C_{16}$, an arylamino group, a trifluoromethyl group, an alkylthio group having $C_1$-$C_{16}$, an arylthio group, a nitro group, a cyano group, a halogen atom, a phenyl group, or a naphthyl group.

15. The multifunctional adhesive film of claim 9, which further comprises at least one additive selected from the group consisting of 0.01-2 parts by weight of a crosslinking agent and 0.01-2 parts by weight of a coupler per 100 parts by weight of the pressure-sensitive acryl-based adhesive.
16. A plasma display panel filter comprising any multifunctional adhesive film of claims 9 to 15 on at least one side of a substrate.

17. The plasma display panel filter of claim 16, which further comprises an anti-reflection film (AR film), an electromagnetic interference film (EMI film), and a black screen processing film.

18. A plasma display panel comprising the filter of claim 16.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC*: C08F 22/00, G02B 5/00, C09J 133/00, G03F 7/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
IPC*: C08F, C08K, C09J, G02B, G03F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPDOC, WPI, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>EP 1111410 A2 (TOYO BOSEKI KABUSHIKI KAISHA OSAKA-SHI) 27 June 2001 (27.06.2001) claims 1, 5-7, 9, paragraph [0063].</td>
<td>1, 3, 4, 9, 11, 13, 14</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C.

See patent family annex.

Date of the actual completion of the international search 9 May 2005 (09.05.2005)

Date of mailing of the international search report 7 June 2005 (07.06.2005)

Name and mailing address of the ISA/AT
Austrian Patent Office
Dresdner Straße 87, A-1200 Vienna
Facsimile No. +43 / 1 / 534 24 / 535

Authorized officer
PUSTERER F.

Telephone No. +43 / 1 / 534 24 / 311
<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>EP 1090910 A1 (NIPPON KAYAKU KABUSHIKI KAISHA TOKYO) 11 April 2001 (11.04.2001) claims 1, 6, page 10, lines 19-24, paragraph [0041], example 9.</td>
<td>1-18</td>
</tr>
<tr>
<td>Patent document cited in search report</td>
<td>Publication date</td>
<td>Patent family member(s)</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-----------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>EP A 1090910</td>
<td></td>
<td>TW B 2245868</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN A 1306507</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE T2 699205997T</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US A1 6475590</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP A 2000229931</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP A 20000811511</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE T2 60009848T</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE D1 60009848D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN A 3300948</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US A1 2001005276</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE T2 602000225T</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US A1 200100125D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TW B 562625</td>
</tr>
<tr>
<td>JP A 20002504</td>
<td></td>
<td>none</td>
</tr>
<tr>
<td>JP A 20012011</td>
<td></td>
<td>none</td>
</tr>
<tr>
<td>US A 200200127</td>
<td></td>
<td>none</td>
</tr>
<tr>
<td>WO A 20030050</td>
<td></td>
<td>none</td>
</tr>
</tbody>
</table>