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(54) Title: FILM FOR DISPLAY PANEL, OPTICAL FILTER, MANUFACTURING METHOD THEREOF AND PLASMA DISPLAY PANEL

(57) Abstract: A film for a display panel comprising: a transparent plastic substrate; a first adhesive layer; and a mesh-like metal foil layer, in this order, wherein a top of the first adhesive layer is in contact with the mesh-like metal foil layer and air, and wherein the mesh-like metal foil layer has a mesh portion having a haze of 10 % or less, and the film for a display panel has an electromagnetic wave shielding property and a light transmissive property.



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## DESCRIPTION

FILM FOR DISPLAY PANEL, OPTICAL FILTER, MANUFACTURING  
METHOD THEREOF AND PLASMA DISPLAY PANEL

## Technical Field

The present invention relates to a light transmissive electromagnetic wave shielding film which shields against an electromagnetic wave generated from the display front of a CRT (cathode-ray tube), a PDP (plasma display panel), a liquid crystal, EL (electroluminescence), a FED (field emission display), or the like, a microwave oven, electronic equipment, a printed wiring board, or the like, and has a light transmissive property, and a manufacturing method thereof, and a light transmissive electromagnetic wave shielding film for a plasma display, and an optical filter for a plasma display having the same, and a plasma display panel.

## Background Art

In recent years, electro-magnetic interference: EMI has been sharply increasing with an increase in use of various electrical facilities and electronic applied facilities. It has been pointed out that the EMI not

only causes the malfunctions and the failures of electronic or electrical devices, but also imposes health disorder to the operators of these devices. For this reason, the electronic and electrical devices are required to be suppressed in electromagnetic wave emission intensity within the standard or the regulation.

For the countermeasure of the EMI, an electromagnetic wave is required to be shielded. Obviously, for this, it is only essential that the property of a metal not to allow an electromagnetic wave to pass therethrough is utilized. For example, there are adopted a method in which the case is made of a metal body or a high electrically conductive body, a method in which a metal plate is inserted between a circuit substrate and a circuit substrate, and a method in which the cable is covered with a metal foil. However, for a CRT, a PDP, or the like, the operator is required to recognize the characters and the like displayed on the screen. Therefore, the transparency in the display is required. Thus, with any of the methods, the display front often becomes opaque, and hence the methods are improper as the electromagnetic wave shielding methods.

Particularly, a PDP produces a larger amount of electromagnetic waves as compared with a CRT and the like, and hence it is required to have a stronger

electromagnetic wave shielding ability. The electromagnetic wave shielding ability can be expressed by the surface resistance value with simplicity. For example, a light transmissive electromagnetic wave shielding material for a CRT is required to have a surface resistance value of about 300  $\Omega/\text{sq}$  or less. In contrast, a light transmissive electromagnetic wave shielding material for a PDP is required to have a surface resistance value of about 2.5  $\Omega/\text{sq}$  or less. For a consumer plasma television using a PDP, 1.5  $\Omega/\text{sq}$  or less is highly required, and more desirably, a very high electrical conductivity of 0.1  $\Omega/\text{sq}$  or less is required.

Whereas, as the required level on the transparency, about 70 % or more is required as for a CRT, and 80 % or more as for a PDP, and further, more higher transparency has been desired.

In order to solve the problem, as shown below, various materials / methods for achieving both the electromagnetic wave shielding property and the light transmissive property using a metal mesh having apertures have been proposed heretofore. The typical examples thereof may include an etched mesh utilizing a photolithography method.

<Etched mesh utilizing photolithography method> As such a method, there is proposed a method in which copper

foil is etched utilizing a photolithography method to form a copper mesh on a transparent substrate (see, e.g., JP-A-2003-152385 and Japanese Patent No. 3570420).

This method will be described in more details. First, an adhesive layer is stacked on a transparent plastic substrate, and metal foil is bonded thereon. At this step, the metal foil used is rough to a certain degree, and is not smooth, and has been surface-roughened for ensuring the adhesion between the metal foil and the adhesive layer. Then, by a chemical etching process utilizing a photoresist, the metal foil is etched into a desirable pattern. Thus, a metal mesh made of fine wires and having a large aperture area can be formed on the transparent plastic film. In this case, however, at the portion from which the metal foil has been removed, the adhesive layer is exposed. Onto the adhesion layer, the rough surface form of the surface-roughened metal foil side has been transferred. Therefore, the film in this state has a property of scattering light. JP-A-2003-152385 and Japanese Patent No. 3570420 disclose a method in which a metal mesh and an adhesion layer are covered with a resin having a refractive index close to that of the adhesion layer, which can reduce the light scattering.

However, the further decrease in scattering light

and the further inhibition of haze are still required. In response to such needs, JP-A-2000-286594 and JP-A-2005-268688 are disclosed (referred to following paragraphs).

A conventional etched mesh utilizing a photolithography method can be microprocessed, and hence, it can make a mesh with a high aperture ratio (high transmissivity), and has an advantage of capable of also shielding against a strong electromagnetic wave emission. On the other hand, it also has the following problem.

The adhesion layer which has ensured the adhesion between the metal foil and the transparent plastic base material has a rough surface also after etching, and causes light scattering. When it is mounted on a display as it is, the image of the display becomes blur like the image through frosted glass. For this reason, unfavorably, it cannot be utilized as a film for a display panel having an electromagnetic wave shielding property. In JP-A-2003-152385 and Japanese Patent No. 3570420 above, this problem is solved by covering the rough surface with a resin, and smoothing the rough surface form. However, the process includes the formation of an adhesive, coating of the adhesive on the metal mesh, drying of the solvent, and heating and curing. Thus, the process unfavorably requires

complicated steps. Further, the process has another problem that bubbles are formed in a part of the metal mesh side upon covering the surface with a resin. This problem also matters for bonding a sheet-like adhesive sheet onto the metal mesh side not with a coating process of an adhesive. In order to remove the bubbles, a step of pressure bonding it to the transparent substrate unfavorably becomes necessary. The step for eliminating light scattering is required to be the coating and long-time pressurization as described above, causing the reduction of the productivity, and a large increase in cost. Thus, the improvement has been desired.

Whereas, in JP-A-2000-286594 above, there is proposed a metal mesh which has a surface roughness Ra of the surface of the metal pattern layer set at 0.10 to 1.00  $\mu\text{m}$ , and thereby does not reduce the visibility of the screen due to the haze caused by the formation of unevenness. However, also in JP-A-2000-286594 above, in the optical filter using the metal mesh, the metal mesh layer is covered with an adhesive layer, and the uneven form causing the haze is filled with the adhesive layer. Then, the metal mesh is the outermost layer. Thus, a configuration of an optical filter not covered with the adhesive layer is not disclosed. Therefore, heretofore, an etched mesh which has a sufficiently low haze, and

does not blur the image without covering the metal mesh with a resin, and embedding it in the resin, and an optical filter using the same are not known, and the improvement has been desired.

Further, in JP-A-2005-268688 above, as a method for obtaining a low haze electromagnetic wave shielding film having a low metal mesh, there is proposed a method in which a metal film is formed on a transparent substrate without using an adhesive layer, and then, a mesh pattern is formed by etching. However, with this method, the metal layer is formed by a vapor phase growth method. For this reason, this method has a manufacturing problem that enormous amounts of time and costs are required for obtaining the metal layer thickness necessary for electromagnetic wave shielding.

#### Disclosure of the Invention

The present invention has been completed in view of such circumstances. It is an object of the invention to provide a method for manufacturing an electromagnetic wave shielding film which has a high electromagnetic wave shielding property, scatters less light, and has a high light transmittance, and further a method for manufacturing a transmissive electromagnetic wave shielding film, capable of mass production at a low cost.

Further, it is another object of the invention to provide a light transmissive electromagnetic wave shielding film obtainable from the manufacturing method. Still further, it is a still other object of the invention to provide a light transmissive electromagnetic wave shielding film for a plasma display panel including the light transmissive electromagnetic wave shielding film, and a plasma display panel.

The present inventors conducted a close study from the viewpoint of achieving less light scattering, and acquiring a high electromagnetic wave shielding property and a high transparency at the same time. As a result, they found that the foregoing objects can be effectively attained by a light transmissive electromagnetic wave shielding film for a display panel and a manufacturing method thereof. Thus, they have completed the invention.

Namely, the objects of the invention are attained by the following manufacturing methods.

- (1) A film for a display panel comprising:  
a transparent plastic substrate;  
a first adhesive layer; and  
a mesh-like metal foil layer, in this order,  
wherein a top of the first adhesive layer is in contact with the mesh-like metal foil layer and air, and  
wherein the mesh-like metal foil layer has a mesh

portion having a haze of 10 % or less, and the film for a display panel has an electromagnetic wave shielding property and a light transmissive property.

Incidentally, herein, the term "the haze of the mesh portion" denotes the haze measured for a film formed of a transparent plastic base material, and an adhesive layer, and a mesh made of metal foil formed thereon in one piece. More preferably, the haze of the mesh portion is 5% or less.

(2) The film for a display panel as described in (1) above,

wherein the mesh-like metal foil layer has a line width of 20  $\mu\text{m}$  or less, a line interval of 100  $\mu\text{m}$  or more and a line thickness of 20  $\mu\text{m}$  or less.

More preferably, the top of the first adhesive layer is in contact with the roughened surface (mat surface) of the metal foil layer and air. Incidentally, herein, the term "line thickness" denotes a thickness of the metal thin wire portion constituting the mesh.

(3) The film for a display panel as described in (1) or (2) above, which has a surface resistivity of less than 0.1  $\Omega/\square$ .

(4) The film for a display panel as described in any of (1) to (3) above,

wherein the mesh-like metal foil layer has a line

thickness of from 6  $\mu\text{m}$  to 12  $\mu\text{m}$ .

(5) The film for a display panel as described in any of (1) to (4) above,

wherein the mesh-like metal foil layer comprises a copper foil at least a surface of which has been subjected to a blackening treatment.

(6) The film for a display panel as described in any of (1) to (5) above, which further comprises a second adhesive layer on an opposite side of the transparent plastic substrate from the mesh-like metal foil layer.

(7) The film for a display panel as described in any of (1) to (6) above, which further comprises a third adhesive layer on the mesh-like metal foil layer.

(8) The film for a display panel as described in any of (1) to (7) above, which further comprises a peelable protective film.

(9) The film for a display panel as described in any of (1) to (8) above, which further comprises a functional transparent layer having at least one function selected from an infrared ray shielding property, a hard coating property, an antireflection property, an anti-glare property, an anti-electrostatic property, an anti-staining property, an ultraviolet ray cutting property, a gas barrier property and a display panel breakage preventing property.

(10) An optical filter for a display panel comprising a film for a display panel as described in any of (1) to (9) above.

(11) The optical filter for a display panel as described in (10) above, which has the mesh-like metal foil layer at the outermost layer.

(12) A plasma display panel comprising an optical filter for a display panel as described in (10) or (11) above.

(13) A plasma display panel comprising a film for a display panel as described in any of (1) to (9) above.

(14) A method for manufacturing a film for a display panel, the method comprising:

stacking a metal foil on a transparent plastic substrate with an adhesive layer interposed therebetween; and

subjecting the metal foil to a chemical etching process, so as to form a mesh-like metal foil layer having a line width of 20  $\mu\text{m}$  or less, a line interval of 100  $\mu\text{m}$  or more and a line thickness of 20  $\mu\text{m}$  or less,

wherein a top of the adhesive layer is in contact with the mesh-like metal foil layer and air, and

wherein the mesh-like metal foil layer has a mesh portion having a haze of 10 % or less, and the film for a display panel has an electromagnetic wave shielding

property and a light transmissive property.

(15) The method for manufacturing a film for a display panel as described in (14) above,

wherein the mesh-like metal foil layer has a line thickness of from 6  $\mu\text{m}$  to 12  $\mu\text{m}$ .

(16) The method for manufacturing a film for a display panel as described in (14) or (15) above,

wherein the metal foil is stacked on the transparent plastic substrate with an adhesive selected from an adhesive dissolving or swelling in an organic solvent, an adhesive dissolving or swelling in an acidic aqueous solution or an alkaline aqueous solution and an adhesive flowing upon heating.

(17) The method for manufacturing a film for a display panel as described in (16) above, which further comprises subjecting a stack of the transparent plastic substrate and the mesh-like metal foil layer to at least one of: a washing treatment with at least one of an organic solvent, an acidic aqueous solution and an alkaline aqueous solution; and a heating treatment.

#### Best Mode For Carrying Out the Invention

Below, a method for manufacturing a film for a display panel having an electromagnetic wave shielding property and a light transmissive property, and a film

for a display panel of the invention will be described in details.

Incidentally, "to" in this specification is used as having the meaning of including the numerical values described before and after it as the lower limit value and the upper limit value, respectively.

[Transparent plastic substrate]

Examples of the transparent plastic substrate for use in the manufacturing method of the invention may include: polyesters such as polyethylene terephthalate (PET) and polyethylene naphthalate; polyolefins such as polyethylene (PE), polypropylene (PP), polystyrene, and EVA; vinyl type resins such as polyvinyl chloride and polyvinylidene chloride; other than these, polyether ether ketone (PEEK), polysulfone (PSF), polyether sulfone (PES), polycarbonate (PC), polyamide, polyimide, acrylic resin, and triacetyl cellulose (TAC).

In the invention, the plastic film is preferably a polyethylene terephthalate film from the viewpoints of the transparency, the heat resistance, and the ease of handling.

When the thickness of the transparent plastic substrate is small, the handling property is bad. When the thickness is large, the transmittance is reduced. Therefore, the thickness is preferably 5 to 200  $\mu\text{m}$ ,

further preferably 10 to 130  $\mu\text{m}$ , and more preferably 40 to 80  $\mu\text{m}$ .

The electromagnetic wave shielding material for a display is required to have transparency. Therefore, the transparency of the support is desirably high. The total visible light transmittance of the plastic film or the plastic sheet in this case is preferably 70 to 100 %, further preferably 85 to 100 %, and in particular preferably 90 to 100 %. Whereas, in the invention, as the plastic film and the plastic palte, the ones colored in such a degree as not to impair the objects of the invention can also be used.

The plastic films in the invention can be used in the form of a single layer, or they can be also used in the form of a multilayered film made of a combination of two layers or more thereof.

When the film of the invention is bonded onto a transparent substrate, and used as an optical filter, a glass plate can be used. The type thereof has no particular restriction. However, when it is employed for use as an electromagnetic wave shielding film for a display, tempered glass including a tempered layer provided on the surface is preferably used. The tempered glass has a higher possibility of preventing breakage as compared with glass not subjected to a tempering

treatment. Further, the tempered glass obtained by an air cooling method is preferred from the viewpoint of the safety for the following reason. Even in case of breakage, the broken pieces thereof are small, and the end faces thereof do not become sharp.

[Electrically conductive metal portion]

Then, the metal foil portion, particularly the metal thin wire portion constituting the metal foil portion in the invention will be described.

As the metal foil materials, mention may be made of metals such as copper, aluminum, nickel, iron, gold, cobalt, tin, stainless steel, tungsten, chromium, titanium, palladium, platinum, manganese, zinc, and rhodium, or alloys of combinations thereof. The metal is preferably copper, aluminum, or nickel from the viewpoints of the electrical conductivity, the price, and the like. Further, when a magnetic field shielding property is imparted thereto, paramagnetic metal particles are preferably used as the electrically conductive metal particles.

The manufacturing method of the metal foil portion is not especially limited. For example, the metal foil portion can be manufactured by a photolithography process (resist film bonding - light exposure - development - chemical etching - resist film peeling).

For the metal portion, from the viewpoints of raising the contrast, and preventing the electrically conductive metal portion from being oxidized and discolored with time, the metal portion is preferably copper, and further preferably, the one of which at least the surface has been subjected to a blackening treatment. The blackening treatment can be carried out using a method performed in the printed wiring board field. For example, the blackening treatment can be carried out by a treatment in an aqueous solution of sodium chlorite (31 g/l), sodium hydroxide (15 g/l), and trisodium phosphate (12 g/l) at 95 °C for 2 hours. Whereas, blackening is also preferably achieved by providing a black or gray metal layer with electroplating. For example, blackening can be achieved by electroplating nickel, tin, zinc, cobalt, and an alloy thereof.

The surface resistance value of the light transmissive electromagnetic wave shielding film (electrically conductive metal portion) of the invention is preferably 10  $\Omega$ /sq or less, more preferably 2.5  $\Omega$ /sq or less, further preferably 1.50  $\Omega$ /sq or less, and most preferably 0.1  $\Omega$ /sq or less.

When the metal portion in the invention is for use as a light transmissive electromagnetic wave shielding material, it is preferably in the form of a geometric

figure of a combination of a triangle such as a regular triangle, an isosceles triangle, or a right-angled triangle, a tetragon such as a square, a rectangle, a rhombus, a parallelogram, or a trapezoid, an (equilateral) hexagon, an (equilateral) heptagon, or the like. It is further preferably in the form of a mesh made of these geometric figures. In the invention, it is most preferably in the form of a lattice-like mesh made of squares.

For use of the light transmissive electromagnetic wave shielding material, the line width of the electrically conductive metal portion is preferably 20  $\mu\text{m}$  or less, and the line interval is preferably 100  $\mu\text{m}$  or more. Whereas, the electrically conductive metal portion may have a part with a line width of more than 20  $\mu\text{m}$  for the purpose of ground connection, or the like. Whereas, from the viewpoint of making an image inconspicuous, the line width of the electrically conductive metal portion is further preferably less than 15  $\mu\text{m}$ .

As for the thickness of the metal portion, i.e. line thickness, for use as an electromagnetic wave shielding material of a display, a thinner metal portion provides a wider viewing angle, and hence it is preferred. The thickness is preferably 1  $\mu\text{m}$  or more and 20  $\mu\text{m}$  or less, more preferably 1  $\mu\text{m}$  or more and 13  $\mu\text{m}$  or less, further

preferably 2 to 10  $\mu\text{m}$ , and most preferably 3 to 7  $\mu\text{m}$ . Further, the metal silver portion is preferably in a pattern. The metal portion may be configured in one layer, or in the structure of a lamination of two or more layers.

The electrically conductive metal portion in the invention has an aperture ratio of preferably 85 % or more, further preferably 90 % or more, and most preferably 95 % or more from the viewpoint of the visible light transmittance. Whereas, the term "aperture ratio" is the ratio of portions not having fine lines forming the mesh with respect to the total area. For example, the aperture ratio of a square lattice-like mesh with a line width of 10  $\mu\text{m}$  and a pitch of 200  $\mu\text{m}$  is 90 %. Incidentally, the aperture ratio of the metal silver portion in the invention has no particular restriction on the upper limit. However, the aperture ratio is preferably 98 % or less from the relationship between the surface resistance value and the line width value.

[Adhesive]

A description will be given to the adhesive for bonding the transparent plastic substrate with the metal foil, for use in the invention. Whereas, the following description applies to an adhesive to be used on the mesh-like metal foil layer, and also another adhesive to

be used for the side opposite from the mesh-like metal foil layer. These adhesives may be the same or different. The adhesive is an adhesive which dissolves or swells in an organic solvent, an adhesive which dissolves or swells in an acidic aqueous solution or an alkaline aqueous solution, or an adhesive which flows upon heating.

As the polymers each to be the main component of the adhesive which dissolves or swells in an organic solvent, mention may be made of the following thermoplastic resins as typical ones. For example, there are usable (di)enes such as natural rubber, polyisoprene, poly-1,2-butadiene, polyisobutene, polybutene, poly-2-heptyl-1,3-butadiene, poly-2-t-butyl-1,3-butadiene, and poly-1,3-butadiene, polyethers such as polyoxyethylene, polyoxypropylene, polyvinyl ethyl ether, polyvinyl hexyl ether, and polyvinyl butyl ether, polyesters such as polyvinyl acetate and polyvinyl propionate, and poly(meth)acrylic acid esters of polyurethane, ethyl cellulose, polyvinyl chloride, polyacrylonitrile, polymethacrylonitrile, polysulfone, polysulfide, polyethyl acrylate, polybutyl acrylate, poly-2-ethylhexyl acrylate, poly-t-butyl acrylate, poly-3-ethoxypropyl acrylate, polyoxycarbonyl tetramethacrylate, polymethyl acrylate, polyisopropyl methacrylate, polydodecyl methacrylate, polytetradecyl

methacrylate, poly-n-propyl methacrylate, poly-3,3,5-trimethylcyclohexyl methacrylate, polyethyl methacrylate, poly-2-nitro-2-methylpropyl methacrylate, poly-1,1-diethylpropyl methacrylate, polymethyl methacrylate, and the like. If required, these acrylic polymers may be copolymerized in combination of two or more thereof, or may be used in a blend of two or more thereof.

Further, as copolymer resins of acrylic resins and other resins than acrylic, epoxy acrylate, urethane acrylate, polyether acrylate, polyester acrylate, and the like can also be used. Particularly, urethane acrylate, epoxy acrylate, and polyether acrylate are excellent in terms of the adhesion. As epoxy acrylates, mention may be made of (meth)acrylic acid adducts of 1,6-hexanediol diglycidyl ether, neopentyl glycol diglycidyl ether, allyl alcohol diglycidyl ether, resorcinol diglycidyl ether, adipic acid diglycidyl ester, phthalic acid diglycidyl ester, polyethylene glycol diglycidyl ether, trimethylolpropane triglycidyl ether, glycerin triglycidyl ether, pentaerythritol tetraglycidyl ether, sorbitol tetraglycidyl ether, and the like. Such polymers having hydroxyl groups within the molecules as epoxy acrylate are effective for the improvement of the adhesion. These copolymer resins can be used, if required, in combination of two or more thereof. To the

resin composition for use in the invention, if required, additives such as a diluent, a plasticizer, an antioxidant, a filler, and a tackifier may be added.

Typical one of a polymer to be the main component of the adhesive which dissolves or swells in an acidic aqueous solution or an alkaline aqueous solution is an acrylic polymer. As the monomers forming it, mention may be made of, other than (meth)acrylic acid esters such as methyl (meth)acrylate, ethyl (meth)acrylate, butyl (meth)acrylate, and 2-ethylhexyl (meth)acrylate, hydrophilic functional group-containing monomers such as acrylic acid, itaconic acid, hydroxyethyl (meth)acrylate, ethoxyethyl acrylate, (meth)acrylamide, diacetacrylamide, N-methylol (meth)acrylamide, dimethylaminoethyl (meth)acrylate, and N-vinylpyrrolidone. The weight average molecular weight of an acrylic acid ester polymer obtained by copolymerizing these monomers can be adjusted by adjustment of the concentration of the initiator, or the concentration of a chain transfer agent such as a mercapto compound, and a weight average molecular weight of 500 or more is selected. Hardening of these polymers using a hardener is achieved by introducing a functional group having active hydrogen at the end or at the side chain of the molecule. An isocyanate compound having at least two or more isocyanic acid ester groups in one

molecule is effective. Aromatic isocyanates such as tolylene diisocyanate and trimethylolpropane tris-(tolylene diisocyanate), and aliphatic isocyanates such as hexamethylene diisocyanate and trimethylhexamethylene diisocyanate can be used. To the resin composition for use in the invention, if required, additives such as a tackifier, a diluent, a plasticizer, an antioxidant, a filler, and a swelling agent may be added.

As the organic solvents to be used for the purpose of dissolving or swelling the adhesive layer in the invention, mention may be made of the following ones: alcohols such as methanol, ethanol, 1-propanol, 2-propanol, 1-butanol, 2-butanol, isobutyl alcohol, tert-butyl alcohol, 1-pentanol, 2-pentanol, 3-pentanol, 2-methyl-1-butanol, isopentyl alcohol, tert-pentyl alcohol, 3-methyl-2-butanol, neopentyl alcohol, 1-hexanol, 2-methyl-1-pentanol, 4-methyl-2-pentanol, 2-ethyl-1-butanol, 1-heptanol, 2-heptanol, 3-heptanol, 1-octanol, 2-octanol, 2-ethyl-1-hexanol, 1-nonanol, 3,5,5-trimethyl-1-hexanol, and 1-decanol, hydrocarbons such as hexane, heptane, octane, nonane, decane, benzene, ethylbenzene, butylbenzene, o-, m-, or p-xylene, styrene, toluene, and cyclohexane, ethers such as diethyl ether, dipropyl ether, diisopropyl ether, dibutyl ether, butylphenyl ether, methoxytoluene, benzylethyl ether diphenyl ether,

dibenzyl ether, propylene oxide, dioxane, 2-methylfuran, tetrahydrofuran, tetrahydropiran, 1,2-dimethoxyethane, 1,2-diethoxysilane, 1,2-dibutoxysilane, diethylene glycol dimethyl ether, diethylene glycol diethyl ether, glycerin ether, crown ether, and acetal, esters such as methyl acetate, ethyl acetate, and propyl acetate, ketones such as acetone, methyl ethyl ketone, 2-pentanone, 3-pentanone, 2-hexanone, methyl isobutyl ketone, 2-heptanone, 4-heptanone, diisobutyl ketone, acetonitrile acetone, phorone, isophorone, cyclohexanone, and acetophenone, and phenols such as phenol, and o-, m-, or p-cresol.

Whereas, as the acidic aqueous solutions or the alkaline aqueous solutions, mention may be made of acidic aqueous solutions of hydrochloric acid, sulfuric acid, nitric acid, hydrogen fluoride, and polyphosphorus acid, or the alkaline aqueous solutions of sodium hydroxide, potassium hydroxide, ammonium, and the like. Out of these, organic solvents are most excellent in handling property. Out of these, alcohols are most suitable in terms of the ease of balancing the adhesion characteristics and the peeling characteristics.

The polymers each to be the main component of the adhesive which flows upon heating are the ones described above. However, in the invention, the wording "which

flows upon heating" denotes "which has a softening temperature ( $T_g$ ) of the polymer of 200 °C or less", and more preferably 150 °C or less. For use as an electromagnetic wave shielding adhesive film, the use environment is generally at 60 °C or less, and hence the softening temperature of the adhesive is further preferably 60 to 120 °C or less. On the other hand, the weight average molecular weight of the polymer is preferably 500 or more and 1,000,000 or less for use. When the molecular weight is less than 300, the cohesive force of the adhesive composition is too low, resulting in a reduction of adhesion to the adherend. When the molecular weight exceeds 1,000,000, peeling or swelling in an organic solvent or the like becomes difficult. The adhesion layer having a refractive index in the range of 1.45 to 1.70 is preferably used in the invention. The selection of this refractive index is due to the following reason. When the plastic film for use in the invention differs in refractive index from the adhesion layer, the visible light transmittance is reduced. Further, when the refractive index is preferably 1.45 to 1.60, the visible light transmittance is less reduced, and favorable. The refractive indices of the foregoing polymers fall within this range. The coating thickness of the adhesion layer has no particular restriction.

However, it is preferably 0.05  $\mu\text{m}$  to 50  $\mu\text{m}$ , more preferably 0.1  $\mu\text{m}$  to 30  $\mu\text{m}$ , and furthermore preferably 0.5  $\mu\text{m}$  to 10  $\mu\text{m}$ .

Whereas, the adhesive for use in the invention may be in the form of a water dispersion of the polymer. This is a dispersion of a synthetic resin dispersed in a disperse medium containing water as a main component. The content of water contained in the disperse medium is preferably 30 % to 100 %, and more preferably 50 % to 100 %. As other solvents than water, solvents soluble in water, including, alcohols such as methanol, ethanol, and isopropyl alcohol, ketones such acetone and methyl ethyl ketone, and the like are selected.

[Other functional film than electromagnetic wave shielding film]

In the invention, if required, additionally, as a functional layer having a functionality, a functional layer having a function other than an electromagnetic wave shielding function may be further provided. This functional layer can be specified variously according to each intended use. For example, for use as an electromagnetic wave shielding material for a display, an antireflection layer which has been adjusted in refractive index and film thickness, and imparted with an antireflection function; a non-glare layer or an anti-

glare layer (both having a glare preventing function); a near-infrared absorption layer including a compound or a metal absorbing a near-infrared ray; a layer having a color tone adjusting function, absorbing a visible light within a specific wavelength range; a stain-proof layer having a function of easily removing stains such as fingerprints; a scratch-proof hard coat layer; a layer having an impact absorption function; a layer having a glass scattering preventing function upon glass breakage; and other layers may be provided. These functional layers may be provided on the side opposite from the emulsion layer forming the electromagnetic wave shielding layer of the invention with the support interposed therebetween.

These composite functional films may be directly bonded to a PDP, or may be bonded to a transparent substrate such as a glass plate or an acrylic resin plate separately from the plasma display panel main body. These functional films are each referred to as an optical filter (or simply as a filter).

As the methods for forming the antireflection layer imparted with an antireflection function, in order to suppress the reflection of external light and suppress the reduction of contrast, there are a method in which an inorganic substance such as a metal oxide, fluoride,

silicide, boride, carbide, nitride, or a sulfide is stacked on the functional layer in a single layer or in a multilayer by a vacuum deposition method, a sputtering method, an ion plating method, an ion beam assisting method, or the like, a method in which resins with different refractive indices such as an acrylic resin and a fluoro-resin are stacked in a single layer or in a multilayer, or other methods.

Alternatively, a film subjected to an antireflection treatment can be bonded onto the filter. Further, if required, a non-glare layer or an anti-glare layer can also be provided. As the methods for forming the non-glare layer or the anti-glare layer, there can be used a method in which a fine powder of silica, melamine, acrylic resin, or the like is made into an ink, and coated on the surface, and other methods. At this step, for the curing of the ink, heat curing, light curing, or the like can be used. Further, a film subjected to a non-glare treatment or an anti-glare treatment can be bonded onto the filter. Further, if required, a hard coat layer can be provided.

The near-infrared absorption layer is, specifically, a layer containing a near-infrared absorption coloring matter such as a metal complex compound, a silver-sputtered layer, or the like. Herein the silver-

sputtered layer is configured such that dielectric layers and metal layers are stacked alternately on a substrate by sputtering or the like, and thereby it can cut 1000-nm or more light of from a near-infrared ray, a far-infrared ray, to an electromagnetic wave. The dielectric layer contains a transparent metal oxide such as indium oxide or zinc oxide, or the like as a dielectric. The metal contained in the metal layer is generally silver, or a silver-palladium alloy. The silver-sputtered layer generally has a structure in which about 3 layers, 5 layers, or 11 layers are stacked starting from the dielectric layer.

In a PDP, the phosphor emitting blue light has a characteristic of emitting red light, although in a slight amount, other than blue light. Therefore, unfavorably, the portion which should be displayed in blue is displayed in purplish color. The layer having a color tone adjusting function, absorbing a visible light within the specific wavelength range is, as a countermeasure thereagainst, a layer for carrying out correction of the emitted light, and contains a coloring matter absorbing light in the vicinity of 595 nm.

(Protective film)

The peelable protective films are not necessarily required to be provided on the opposite sides of the

electromagnetic wave shielding sheet (light transmissive electromagnetic wave shielding film). As shown in FIG. 2A of JP-A-2003-188576, the following configuration is acceptable: a protective film is only provided on the mesh-like metal foil disposed on a laminated body, and it is not provided on the transparent base material film (corresponding to the "transparent support" in this specification) side. Whereas, as shown in FIG. 2B of the foregoing publication, the following configuration is acceptable: a protective film is only provided on the transparent base material film side of the laminated body, and no protective film is provided on the metal foil.

On the electromagnetic wave shielding film, a sheet having effects of imparting the antireflection property, imparting anti-staining property, near-infrared absorption, and the like is further stacked for use. Therefore, for stacking, the protective film is required to be peeled off. For this reason, desirably, stacking of the protective film on the metal foil side is carried out, peelably, in common expression.

The peel strength of the protective film when the film is stacked on the metal foil is preferably 5 mN/25 mm width to 5 N/25 mm width, and more preferably 10 mN/25 mm width to 100 mN/25 mm width. When it is less than the

lower limit, unfavorably, peeling is too easy, and the protective film may be peeled during handling or by careless contact. Whereas, when the peel strength exceeds the upper limit, a large force is required for peeling, and further, likewise unfavorably, in peeling, the mesh-like metal foil may be peeled from the transparent base material film (or from the adhesive layer).

In order to satisfy the foregoing respective points, as the film forming the protective film, a resin film of a polyolefin type resin such as a polyethylene resin or a polypropylene resin, a polyester resin such as a polyethylene terephthalate resin, a polycarbonate resin, an acrylic resin, or the like is preferably used. Whereas, from the foregoing viewpoint, on the surface on the side of the protective film to be the outermost surface when the film is applied to a laminated body, preferably, at least, a corona discharge treatment is performed, or an easy adhesion layer is stacked.

Whereas, as a self-adhesive forming the protective film, the one of an acrylic acid ester type, a rubber type, or a silicone type can be used.

The material for a film for the protective film, and the material for the self-adhesive can be applied as they are also to the protective film applied to the metal foil

side. Therefore, for both the protective films, different ones can be used. However, the same matter can be used for both the protective films.

(Static protective property)

In order to prevent the electrostatic discharge caused by adhesion of dust due to electrostatic charging, or contact with the human body, it is preferable that the antistatic property (static protective property) is imparted to the transmissive electromagnetic wave shielding film.

As a functional film having an antistatic property, a film with a high electrical conductivity can be used. For example, it is essential only that the electrical conductivity is about  $10^{11} \Omega/\square$  or less in terms of the surface resistance.

The film with a high electrical conductivity can be formed by providing an antistatic layer on a transparent base material. As the antistatic agents for use in the antistatic layer, specifically, mention may be made of trade name PELESTAT (manufactured by Sanyo Chemical Industries Ltd.), trade name ELECTROSTRIPPER (manufactured by Kao Corporation), and the like. Other than these, the antistatic layer may be formed of a known transparent electrically conductive film of ITO or the like, or an electrically conductive film including

electrically conductive ultrafine particles including ITO, ultrafine particles and tin oxide ultrafine particles dispersed therein. Alternatively, the antistatic property may be imparted by allowing the foregoing hard coat layer, antireflection layer, anti-glare layer, and the like to contain electrically conductive ultrafine particles, or the like.

(Ultraviolet ray cutting property)

To the light transmissive electromagnetic wave shielding film, preferably, the ultraviolet ray cutting property is imparted for the purpose of preventing degradation of a coloring matter described later, and a transparent base material, and the like. The functional film having an ultraviolet ray cutting property can be formed by a method in which the transparent base material itself is allowed to contain an ultraviolet absorber, or by providing an ultraviolet absorption layer on a transparent base material.

As the ultraviolet ray cutting ability required for protecting the coloring matter, the transmittance in the ultraviolet region shorter than 380 nm wavelength is 20 % or less, preferably 10 % or less, and further preferably 5 % or less. The functional film having an ultraviolet ray cutting property can be obtained by forming a layer containing an ultraviolet absorber or an inorganic

compound which reflects or absorbs an ultraviolet ray on a transparent base material. The usable ultraviolet absorbers are conventionally known ones such as benzotriazole type and benzophenone type ones. The type / concentration thereof are determined by the dispersibility / solubility in a medium in which the ultraviolet absorbers are dispersed or dissolved, the absorption wavelength / absorption coefficient, the thickness of the medium, and the like, and have no particular restriction.

Incidentally, the functional film having an ultraviolet ray cutting property is preferable in the following points: it less absorbs light in the visible light region, and is not considerably reduced in visible light transmittance, and does not show a color of yellow or the like.

Whereas, when the film containing a coloring matter described later is formed on the functional film, a layer having an ultraviolet ray cutting property is desirably present outside the layer.

(Gas barrier property)

When a light transmissive electromagnetic wave shielding film is used under an environment of higher temperature / humidity than ordinary temperatures and ordinary humidities, a coloring matter described layer

may be deteriorated by the moisture, the moisture may aggregate in the adhesive for use in bonding, or at the bonding interface, thereby to cause fog, or the adhesive may undergo phase separation under the influence of the moisture, thereby to cause fog. Therefore, the light transmissive electromagnetic wave shielding film preferably has a gas barrier property.

In order to prevent such coloring matter degradation or fog, it is essential to prevent the moisture from entering a layer containing a coloring matter or an adhesive layer. The water vapor transmittance of the functional film is  $10 \text{ g/m}^2\cdot\text{day}$  or less, and preferably  $5 \text{ g/m}^2\cdot\text{day}$  or less.

The light transmissive electromagnetic wave shielding film obtained by the manufacturing method of the invention has favorable electromagnetic wave shielding property and light transmissive property. Therefore, it can be used as a light transmissive electromagnetic wave shielding material. Particularly, the light transmissive electromagnetic wave shielding film of the invention can be preferably used as the light transmissive electromagnetic wave shielding film for use in the display front of a CRT (cathode-ray tube), a PDP (plasma display panel), a liquid crystal, EL (electroluminescence), or the like, a microwave oven,

electronic equipment, a printed wiring board, or the like, and particularly, in a plasma display panel.

As described above, the light transmissive electromagnetic wave shielding film of the invention can be preferably used as a light transmissive electromagnetic wave shielding film for a plasma display panel. For this reason, the plasma display panel formed by using the light transmissive electromagnetic wave shielding film for a plasma display panel including the light transmissive electromagnetic wave shielding film of the invention has a high electromagnetic wave shielding ability, a high contrast, and a high transparency, and can be manufactured at a low cost.

#### Examples

Below, the invention will be described more specifically by way of examples of the invention. Incidentally, the materials, the amount thereof used, the ratio, the treatment contents, the procedures, and the like shown in the following examples can be appropriately changed unless they depart from the gist of the invention. Therefore, the following specific examples should not be construed as limiting the scope of the invention.

[Example 1]

A transparent PET film with a thickness of 50  $\mu\text{m}$  was used as a transparent plastic substrate. Thereon, electrolyzed copper foil with a thickness of 18  $\mu\text{m}$  which is an electrically conductive material was laminated and bonded so that the roughened surface thereof was on the adhesion side, with the following adhesive 1 interposed therebetween. The resulting PET film with the copper foil thereon was subjected to a photolithography process (resist film bonding - light exposure - development - chemical etching - resist film peeling), to obtain a lattice-like mesh of copper with a line width of 15  $\mu\text{m}$  and a line interval of 300  $\mu\text{m}$ . Then, the PET film with the copper mesh thereon was heated to 120  $^{\circ}\text{C}$ , to obtain a sample of the invention (treatment time 30 minutes). The adhesive 1 which had bonded the PET and the copper foil was softened by this treatment. Therefore, it was possible to reduce the haze, resulting in a sample of the invention.

(Adhesive 1)

VYLON UR-1400 (trade name, manufactured by TOYOBO Ltd., saturated polyester resin,  $\text{Mn} = 40,000$ )

100 parts by weight

MEK 286 parts by weight

Cyclohexanone 5 parts by weight

The refractive index and the softening point after

drying the solvent of the composition of the adhesive 1 were 1.55 and 83 °C, respectively.

(Comparative Example 1)

A transparent PET film with a thickness of 50  $\mu\text{m}$  was used as a transparent plastic substrate. Thereon, copper foil with a thickness of 18  $\mu\text{m}$  which is an electrically conductive material was heat laminated and bonded so that the roughened surface thereof was on the adhesion side, with the following adhesive 3 interposed therebetween. The resulting PET film with the copper foil thereon was subjected to a photolithography process (resist film bonding - light exposure - development - chemical etching - resist film peeling), to obtain a lattice-like mesh of copper with a line width of 15  $\mu\text{m}$  and a line interval of 300  $\mu\text{m}$ . A film with the copper mesh formed thereon was taken as Comparative Example 1.

(Comparative Example 2)

The PET film with the copper mesh of Comparative Example 1 was heated to 120 °C in the same manner as with Example 1, thereby to obtain a sample of Comparative Example 2 (treatment time 30 times).

(Comparative Example 3)

The sample of Comparative Example 1 was coated with a resin, and thermally pressure bonded to an acrylic plate (0.5 MPa, 60 °C, 120 minutes, autoclave treatment)

according to the method of Example 1 described in Japanese Patent No. 3570420, resulting in a sample of Comparative Example 2. The applied resin used was that of the composition of the adhesive 3 of the patent example.

(Adhesive 3)

Polyacrylic acid ester (MAA / BA / HEA = 85 / 10 / 5, Mw = 550,000) 100 parts by weight

Colonate L (trifunctional isocyanate, trade name, manufactured by NIPPON POLYURETHANE INDUSTRY Co., Ltd.)

3.5 parts by weight

Toluene 450 parts by weight

Ethyl acetate 10 parts by weight

The softening point after drying the solvent of the composition was 200 °C or more.

[Example 2]

A sample was formed in the same manner as in Example 1, except that an adhesive 2 was used in place of the adhesive 1.

(Adhesive 2)

Polybutadiene elastomer (Poly bd R-45HT: trade name, manufactured by Idemitsu Kosan Co., Ltd.)

100 parts by weight

Toluene 450 parts by weight

Ethyl acetate 10 parts by weight

The refractive index and the softening point after drying the solvent of the composition of the adhesive layer 1 were 1.50 and 61 °C, respectively.

<Evaluation method>

(Aperture ratio) The line width of the mesh was measured. Then, the aperture ratio was determined from  $(\text{pitch} - \text{line width}) \times (\text{pitch} - \text{line width}) / (\text{pitch} \times \text{pitch})$ .

(Surface resistance) The surface resistivity was measured by means of a resistivity meter Loresta manufactured by Mitsubishi Chemical Corporation.

(Haze) The haze of the copper mesh sample provided on the PET substrate was measured by means of a haze meter manufactured by NIPPON DENSHOKU Industries Ltd.

[Example 3]

A sample was formed in the same manner as in Example 1, except for using an adhesive 4 in place of the adhesive 1.

(Adhesive 4)

An adhesive composition was prepared in the following manner.

|                                                                                |                     |
|--------------------------------------------------------------------------------|---------------------|
| JURYMER ET-410 (trade name, manufactured by NIHON JUNYAKU Co., Ltd.: Tg 44 °C) | 100 parts by weight |
| Water                                                                          | 10 parts by weight  |

A transparent PET film with a thickness of 97 μm was

used as a transparent plastic base material. Thereon, electrolyzed copper foil with a thickness of 12  $\mu\text{m}$  which is an electrically conductive material was heat laminated and bonded so that the roughened surface thereof was on the adhesion side, with the adhesive 4 interposed therebetween. The resulting PET film with the copper foil thereon was subjected to a photolithography process (resist film bonding - light exposure - development - chemical etching - resist film peeling), to obtain a lattice-like mesh of copper with a line width of 15  $\mu\text{m}$  and a line interval of 300  $\mu\text{m}$ . Then, the PET film with the copper foil thereon was immersed in a water bath, and then heated to 140 °C, resulting in a sample of the invention.

Table 1

| Test sample | Aperture ratio | Surface resistance     | Haze | Bubble Defect | Remark    | Flowability of adhesive between PET /copper foil | Presence or absence of resin (adhesive) layer on copper mesh |
|-------------|----------------|------------------------|------|---------------|-----------|--------------------------------------------------|--------------------------------------------------------------|
| Ex. 1       | 90 %           | <0.1. $\Omega/\square$ | 7 %  | None          | Invention | Flowing                                          | None                                                         |
| Ex. 2       | 90 %           | <0.1. $\Omega/\square$ | 4 %  | None          | Invention | Flowing                                          | None                                                         |
| Ex. 3       | 90 %           | <0.1. $\Omega/\square$ | 3 %  | None          | Invention | Flowing                                          | None                                                         |
| Comp. Ex. 1 | 90 %           | <0.1. $\Omega/\square$ | 14 % | None          | Comp. Ex. | Not flowing                                      | None                                                         |
| Comp. Ex. 2 | 90 %           | <0.1. $\Omega/\square$ | 13 % | None          | Comp. Ex. | Not flowing                                      | None                                                         |
| Comp. Ex. 3 | 90 %           | <0.1. $\Omega/\square$ | 5 %  | Present       | Comp. Ex. | Not flowing                                      | Present                                                      |

As indicated from the table, it is shown that each sample of the invention is a copper mesh film having a small haze, which can be obtained with ease without carrying out operations of coating with a resin and drying of the solvent, and an operation of bonding with an adhesive sheet for thermal pressure bonding.

Thus, in order to obtain a low haze copper mesh, a step of filling the metal mesh with a resin and smoothing the unevenness is essentially necessary with the conventional methods shown in Comparative Examples.

Further, the sample of the invention does not require further provision of a resin layer, which has been essential conventionally for sufficiently reducing the haze, on the metal mesh provided on the transparent base material. Therefore, for the first time, it became possible to totally eliminate the defect of mixing of bubbles generated in the step of providing the resin layer.

[Example 4]

On the surface on the opposite side of the light transmissive electromagnetic wave shielding film obtained in Example 3 from the mesh-like metal layer, a glass plate was bonded with a 25  $\mu\text{m}$ -thick acrylic type light transmissive self-adhesive interposed therebetween. The acrylic type light transmissive self-adhesive layer was

allowed to contain therein a toning dye (PS - Red - G, PS - Violet - RC, manufactured by Mitsui Chemicals, Inc.) for adjusting the transmission characteristics of the optical filter. Further, on the main surface on the opposite side of the glass plate, an antireflection film having a self-adhesive layer and a near-infrared ray cutting ability (trade name ReaLook, N785UV-013, manufactured by NOF Corporation) was bonded, thereby to manufacture an optical filter.

In a conventional optical filter for a plasma display, a mesh-like metal layer is covered with a resin layer. In contrast, in this optical filter, the mesh-like metal layer is not covered with a resin layer. Therefore, the optical filter can be manufactured with ease without defects of bubbles. Further, the haze is as small as 4 %. When the optical filter is set at the front of a plasma display, and the displayed image is observed, the degradation of the image due to haze does not matter.

Incidentally, the obtained optical filter has practically trouble-free electromagnetic wave shielding ability and near-infrared ray cutting ability (the transmittance at 850 to 1100 nm is 15 % or less), and is excellent in visibility owing to the antireflection layer. Further, by allowing the optical filter to

contain a coloring matter, the toning function can be imparted thereto. Thus, the optical filter can be preferably used as an optical filter for a plasma display or the like.

#### Industrial Applicability

A film for a display panel of the present invention, configured such that a metal mesh layer is stacked on a plastic substrate with an adhesion layer interposed therebetween, and having a haze of 10 % or less, has both of a high light transmissive property and a high electrical conductivity, and can be manufactured in mass production at a low cost. An optical film using the film, a light transmissive electromagnetic wave shielding film, and a display panel also produce the same effects.

The entire disclosure of each and every foreign patent application from which the benefit of foreign priority has been claimed in the present application is incorporated herein by reference, as if fully set forth.

## CLAIMS

1. A film for a display panel comprising:  
a transparent plastic substrate;  
a first adhesive layer; and  
a mesh-like metal foil layer; in this order,  
wherein a top of the first adhesive layer is in  
contact with the mesh-like metal foil layer and air, and  
wherein the mesh-like metal foil layer has a mesh  
portion having a haze of 10 % or less, and the film for a  
display panel has an electromagnetic wave shielding  
property and a light transmissive property.

2. The film for a display panel according to claim  
1;

wherein the mesh-like metal foil layer has a line  
width of 20  $\mu\text{m}$  or less, a line interval of 100  $\mu\text{m}$  or more  
and a line thickness of 20  $\mu\text{m}$  or less.

3. The film for a display panel according to claim  
1 or 2, which has a surface resistivity of less than 0.1  
 $\Omega/\square$ .

4. The film for a display panel according to any of  
claims 1 to 3,

wherein the mesh-like metal foil layer has a line

thickness of from 6  $\mu\text{m}$  to 12  $\mu\text{m}$ .

5. The film for a display panel according to any of claim 1 to 4,

wherein the mesh-like metal foil layer comprises a copper foil at least a surface of which has been subjected to a blackening treatment.

6. The film for a display panel according to any of claims 1 to 5, which further comprises a second adhesive layer on an opposite side of the transparent plastic substrate from the mesh-like metal foil layer.

7. The film for a display panel according to any of claims 1 to 6, which further comprises a third adhesive layer on the mesh-like metal foil layer.

8. The film for a display panel according to any of claims 1 to 7, which further comprises a peelable protective film.

9. The film for a display panel according to any of claims 1 to 8, which further comprises a functional transparent layer having at least one function selected from an infrared ray shielding property, a hard coating

property, an antireflection property, an anti-glare property, an anti-electrostatic property, an anti-staining property, an ultraviolet ray cutting property, a gas barrier property and a display panel breakage preventing property.

10. An optical filter for a display panel comprising a film for a display panel according to any of claims 1 to 9.

11. The optical filter for a display panel according to claim 10, which has the mesh-like metal foil layer at the outermost layer.

12. A plasma display panel comprising an optical filter for a display panel according to claim 10 or 11.

13. A plasma display panel comprising a film for a display panel according to any of claims 1 to 9.

14. A method for manufacturing a film for a display panel, the method comprising:

stacking a metal foil on a transparent plastic substrate with an adhesive layer interposed therebetween;  
and

subjecting the metal foil to a chemical etching process, so as to form a mesh-like metal foil layer having a line width of 20  $\mu\text{m}$  or less, a line interval of 100  $\mu\text{m}$  or more and a line thickness of 20  $\mu\text{m}$  or less,

wherein a top of the adhesive layer is in contact with the mesh-like metal foil layer and air, and

wherein the mesh-like metal foil layer has a mesh portion having a haze of 10 % or less, and the film for a display panel has an electromagnetic wave shielding property and a light transmissive property.

15. The method for manufacturing a film for a display panel according to claim 14,

wherein the mesh-like metal foil layer has a line thickness of from 6  $\mu\text{m}$  to 12  $\mu\text{m}$ .

16. The method for manufacturing a film for a display panel according to claim 14 or 15,

wherein the metal foil is stacked on the transparent plastic substrate with an adhesive selected from an adhesive dissolving or swelling in an organic solvent, an adhesive dissolving or swelling in an acidic aqueous solution or an alkaline aqueous solution and an adhesive flowing upon heating.

17. The method for manufacturing a film for a display panel according to claim 16, which further comprises subjecting a stack of the transparent plastic substrate and the mesh-like metal foil layer to at least one of: a washing treatment with at least one of an organic solvent, an acidic aqueous solution and an alkaline aqueous solution; and a heating treatment.

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/311373

## A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. H05K9/00 (2006.01) i, B32B5/00 (2006.01) i, B32B15/08 (2006.01) i,  
G09F9/00 (2006.01) i

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)

Int.Cl. H05K9/00, B32B5/00, B32B15/08, G09F9/00

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

Published examined utility model applications of Japan 1922-1996  
Published unexamined utility model applications of Japan 1971-2006  
Registered utility model specifications of Japan 1996-2006  
Published registered utility model applications of Japan 1994-2006

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                       | Relevant to claim No. |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Y         | JP 2000-323891 A (HITACHI CHEMICAL CO., LTD.)<br>2000.11.24, Paragraphs 【0006】 - 【0015】 , 【0025】 ,<br>【0028】 , 【0030】 , 【0031】 (Family:none)             | 1-17                  |
| Y         | JP 2004-221565 A (FUJI PHOTO FILM CO., LTD.)<br>2004.08.05, Paragraphs 【0026】 , 【0034】 , 【0042】<br>& US 2004/0229028 A1 & EP 1434248 A2                  | 1-17                  |
| Y         | JP 11-145676 A (HITACHI CHEMICAL CO., LTD.)<br>1999.05.28, Paragraphs 【0008】 - 【0018】 & US<br>6086979 A & US 6197408 B & EP 917174 A2 & DE<br>69725448 T | 1-17                  |

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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