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(71) Applicant (for all designated States except US): **FUJI PHOTO FILM CO., LTD.** [JP/JP]; 210, Nakanuma, Minami-ashigara-shi, Kanagawa, 2500193 (JP).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **TAKAMOTO, Tet-sufumi** [JP/JP]; c/o FUJI PHOTO FILM CO., LTD., 210, Nakanuma, Minami-ashigara-shi, Kanagawa, 2500193 (JP). **OBAYASHI, Tatsuhiko** [JP/JP]; c/o FUJI PHOTO FILM CO., LTD., 210, Nakanuma, Minami-ashigara-shi, Kanagawa, 2500193 (JP).

(74) Agent: **SIKS & Co.**; 8th Floor, Kyobashi-Nisshoku Bldg., 8-7, Kyobashi 1-chome, Chuo-ku, Tokyo 104-0031 (JP).

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(54) Title: FILM, METHOD FOR PRODUCING FILM, AND IMAGE DISPLAY DEVICE

(57) Abstract: A film having a glass transition temperature (T_g) of not lower than 250°C, a linear thermal expansion coefficient of from -20 to 40 ppm/°C within a temperature range of from 25°C to 250°C, and a light transmittance at 420 nm of at least 70% is disclosed. The film has good heat resistance, good optical properties, good mechanical properties and a small linear thermal expansion coefficient.



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DESCRIPTION
FILM, METHOD FOR PRODUCING FILM,
AND IMAGE DISPLAY DEVICE

5 TECHNICAL FIELD

The present invention relates to a novel film having good heat resistance, good optical properties and good mechanical properties, to a method for producing it, and to an image display device that comprises the film.

10

BACKGROUND ART

As having good transparency and good heat resistance and having small optical anisotropy, an inorganic glass material is widely used as a transparent material. However, since
15 inorganic glass has a large specific gravity and is brittle, shaped glass articles are defective in that they are heavy and are readily broken. Owing to such defects, development of plastic materials substitutable for inorganic glass materials is in full flood these days.

20 As plastic materials substitutable for organic glass materials, for example, there are known polymethyl methacrylate, polycarbonate, polyethylene terephthalate. Since these plastic materials are lightweight and have good mechanical properties and good workability, they are recently used in
25 various applications such as lenses and films.

Also in the field of flat panel displays for liquid-crystal devices and organic EL display devices, there is increasing a great need for improving the fracture resistance of panels and for reducing the weight and the thickness thereof.
30 In that situation, replacing glass substrates with plastic film substrates is under investigation. Since plastic film substrates are flexible, they can be utilized as substrates in display devices for mobile information communication instruments of, for example, mobile information terminals such

as mobile telephones, pocket-size personal computers and laptop personal computers, and there is a great need for them.

For heat-resistant plastics usable for the above-mentioned object, heretofore known are heat-resistant amorphous polymers, for example, modified polycarbonate (modified PC, for example, see JP-A 2000-227603, claim 7, [0009] to [0019]), polyether sulfone (PES, for example, see JP-A 2000-284717, [0010], [0021] to [0027]), cyclo-olefin copolymer (e.g., see JP-A 2001-150584, [0027] to [0039]).

However, there is still a problem in that even using such heat-resistant plastics could not give plastic film substrates of satisfactory heat resistance. Specifically, when a conductive layer is formed on such a heat-resistant plastic substrate and then it is exposed to a high temperature not lower than 150°C for imparting an alignment film thereto, then there occurs a problem in that the conductivity and the gas-barrier property of the layer may greatly lower and worsen. When TFT is disposed on the substrate in fabricating active matrix-type image display devices, then the substrate is required to have further better heat resistance. In that situation, there is still a great need for providing plastic substrates having much better heat resistance.

As a heat-resistant optical film, heretofore proposed is a polyarylate film having a fluorene structure in the backbone chain of the polymer (e.g., see JP-A 3-28222). However, since the in-plane linear thermal expansion coefficient (CTE) thereof is large, the film is problematic in that, in the process of disposing TFT thereon, the inorganic layer formed on the film may be cracked or TFT may be significantly misregistered and therefore the resulting structure could not have good TFT properties.

On the other hand, for lowering the linear thermal expansion coefficient of a transparent resin, there is known a press-stretching method (e.g., see the 53rd annual meeting

preprint of the Polymer Society of Japan, p. 779). However, the press-stretching method is applied to polymer of low heat resistance, such as PMMA and PC, and is not to polymer of high heat resistance. In addition, a roll-stretching method and a
5 tenter-stretching method generally employed in the art are not also applied to polymer of high heat resistance.

Given the situation as above, it is strongly desired to develop a plastic film having high heat resistance, capable of sufficiently satisfying the requirements of good mechanical
10 properties and optical properties, and having a small linear thermal expansion coefficient.

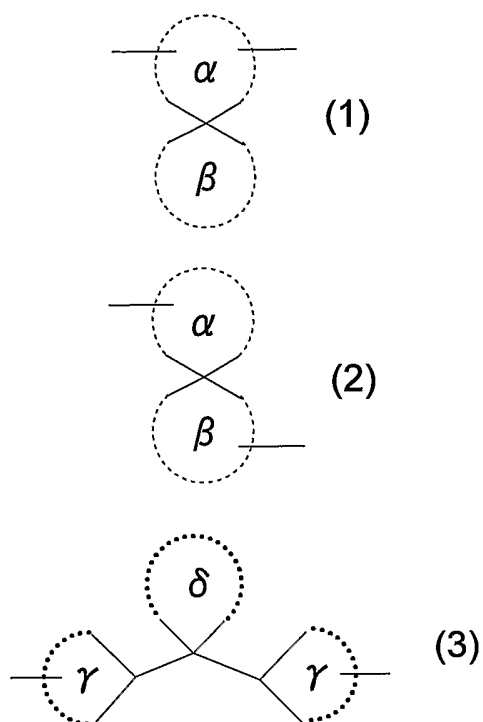
DISCLOSURE OF THE INVENTION

The present invention has been made to solve the problems
15 with conventional plastic materials, and one object of the invention is to provide a plastic film having good heat resistance, good optical properties and good mechanical properties and having a small linear thermal expansion coefficient, and to provide a method for producing it. Another
20 object of the invention is to provide an image display device of good image display quality that comprises the film.

We, the present inventors have assiduously studied, and, as a result, have found that the invention having the constitution mentioned below can solve the problems.

25 [1] A film having a glass transition temperature (T_g) of not lower than 250°C, a linear thermal expansion coefficient of from -20 to 40 ppm/°C within a temperature range of from 25°C to 250°C, and a light transmittance at 420 nm of at least 70%.

[2] The film of [1], which comprises a polymer containing
30 a structure of the following formula (1), (2) or (3):



5 wherein in formulae (1) and (2), the ring α and the ring β each independently represent a monocyclic or polycyclic ring, and they bond to each other via one quaternary carbon atom; in formula (1), the linking groups bond to any two carbon atoms of the ring α ; in formula (2), the linking groups bond to any one carbon atom of the ring α and to any one carbon atoms of the ring β ; in formula (3), the two rings γ and the ring δ each independently represent a monocyclic or polycyclic ring, and they bond together at one quaternary carbon atom of the ring δ , the linking groups bond to any carbon atoms of the ring γ .

15 [3] The film of [1] or [2], of which the in-plane mean refractive index N_{xy} is larger by at least 0.02 than the refractive index N_z in the thickness direction thereof.

[4] A method for producing a film of any of [1] to [3], which comprises stretching a film of a resin having a glass transition temperature (T_g) of not lower than 250°C.

20

[5] The method of [4], wherein the film is stretched according to a press-stretching process.

[6] The method of [4], wherein the film is stretched according to a biaxially-stretching process.

[7] The method of any of [4] to [6], wherein the film is stretched while it contains a solvent.

5 [8] A film produced by the method of any of [4] to [7].

[9] A film having a gas-barrier layer, fabricated by forming the gas-barrier layer on a film of any of [1] to [3] or [8].

10 [10] A film having a transparent conductive layer, fabricated by forming the transparent conductive layer on a film of any of [1] to [3], [8] or [9].

[11] A film having a TFT, fabricated by forming the TFT on a film of any of [1] to [3] and [8] to [10].

15 [12] An image display device comprising, as the substrate thereof, a film of any of [1] to [3] and [8] to [11].

[13] The image display device of [12], which is a liquid-crystal display device or an organic electroluminescent display device.

20 The film of the invention is characterized in that it has good heat resistance, good optical properties and good mechanical properties and has a small linear thermal expansion coefficient. The image display device of the invention has good image display quality. In particular, it is useful as a liquid-crystal display device and an organic EL display device.

25

BEST MODE FOR CARRYING OUT THE INVENTION

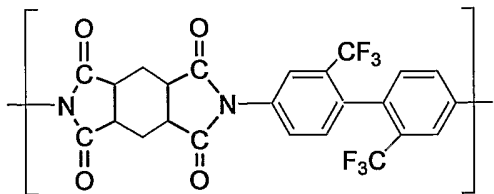
30 The film and the image display device of the invention are described in detail hereinunder. The description of the constitutive elements of the invention given hereinunder is for some typical embodiments of the invention, to which, however, the invention should not be limited. In this description, the numerical range expressed by the wording "a number to another number" means the range that falls between the former number indicating the lowermost limit of the range and the latter

number indicating the uppermost limit thereof.

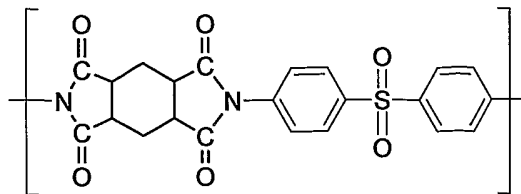
For the film of the invention, used is a resin having a glass transition temperature (Tg) of not lower than 250°C. Not specifically defined in point of its detail, the resin may be
5 any one having a glass transition temperature (Tg) of not lower than 250°C. For example, it includes polyester, polyarylate, polyamide, polyimide, polybenzoxazole, polyether, polysulfone, polyesteramide, polyesterimide, polyamidimide, polyether sulfone, polyether ketone.

10 Examples of the resin usable in the invention are mentioned below, to which, however, the resin for use in the invention should not be limited.

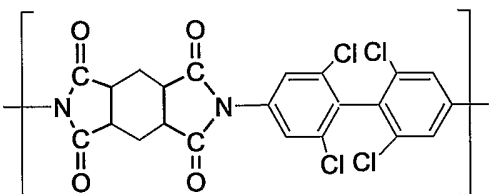
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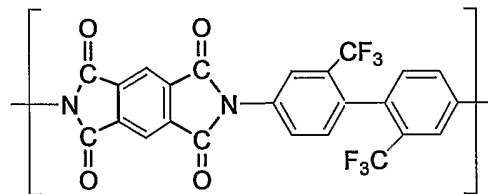
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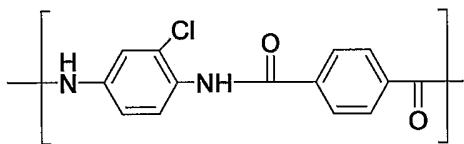
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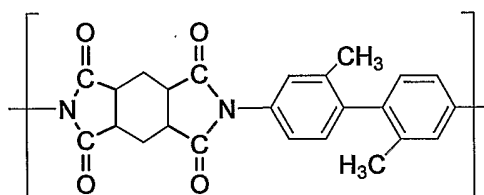
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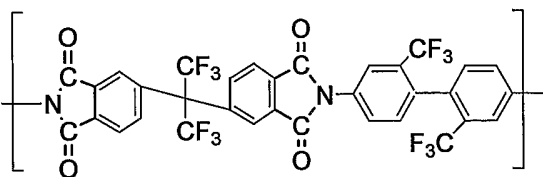
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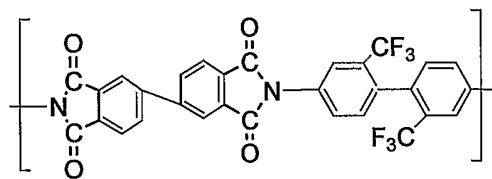
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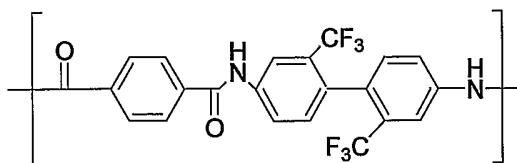
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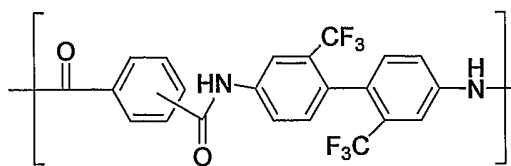
J-8



J-9



J-10



Preferably, the resin for use in the invention has a structure of formulae (1) to (3) in the backbone chain thereof.

In formulae (1) and (2), the ring α and the ring β each independently represent a monocyclic or polycyclic ring, and they bond to each other via one quaternary carbon atom. In formula (1), the linking groups bond to any two carbon atoms of the ring α . In formula (2), the linking groups bond to any one carbon atom of the ring α and to any one carbon atoms of the ring β . In formula (3), the two rings γ and the ring δ each independently represent a monocyclic or polycyclic ring, and they bond together at one quaternary carbon atom of the ring δ , and the linking groups bond to any carbon atoms of the ring γ .

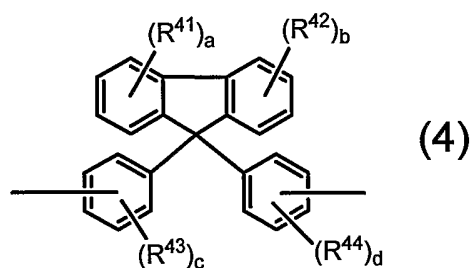
In formulae (1) and (2), the ring α and the ring β indicate a polycyclic structure, but preferably, they are independently a bicyclic to pentacyclic ring, more preferably a bicyclic or tricyclic ring. The rings α and β may have the same or different structures. The rings constituting the polycyclic structure may be any of alicyclic, aromatic or heterocyclic rings. The structure of the ring to which the linking group bonds may be any of alicyclic, aromatic or heterocyclic rings, but is preferably an aromatic ring.

The rings α and β may have a substituent. Preferred examples of the substituent are an alkyl group (preferably having from 1 to 10 carbon atoms, such as a methyl group, an ethyl group, an isopropyl group, a tert-butyl group), a halogen atom (e.g., a chlorine atom, a bromine atom, an iodine atom), an aryl group (preferably having from 6 to 20 carbon atoms, such as a phenyl group, a biphenyl group, a naphthyl group), an alkoxy group (preferably having from 1 to 10 carbon atoms, such as a methoxy group, an ethoxy group, an isopropoxy group), an acyl group (preferably having from 2 to 10 carbon atoms, such as an acetyl group, a propionyl group, a butyryl group), an acylamino group (preferably having from 1 to 10 carbon atoms, such as a

formylamino group, an acetylamino group), a nitro group, a cyano group. More preferably, they are an alkyl group, a halogen atom, an aryl group, an alkoxy group and a nitro group, still more preferably, an alkyl group and a halogen atom.

5 In formula (3), the ring δ represents a monocyclic or polycyclic structure, but is preferably a monocyclic to pentacyclic structure, more preferably a monocyclic to tetracyclic structure, still more preferably a bicyclic to tetracyclic structure. When the ring δ is a polycyclic
10 structure, then at least one ring constituting it is preferably an aromatic ring. The ring γ represents a monocyclic or polycyclic structure, but is preferably a monocyclic structure. The ring γ and the δ may be the substituent such as that mentioned hereinabove for formulae (1) and (2).

15 One preferred example having the structure of formula (3) is a resin containing a structure of the following formula (4) in the backbone chain thereof:



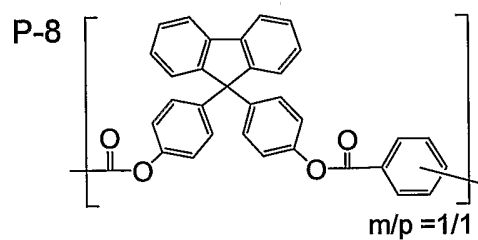
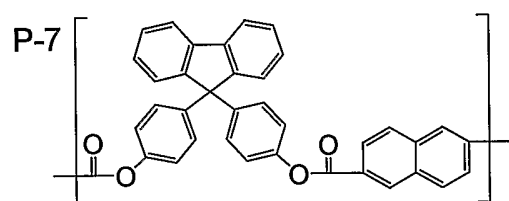
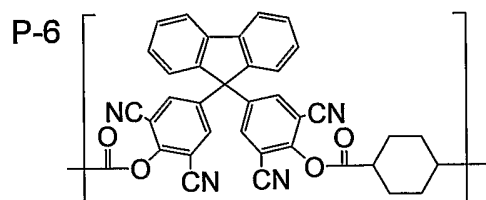
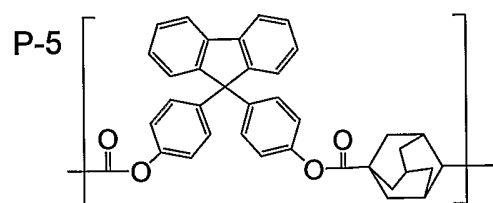
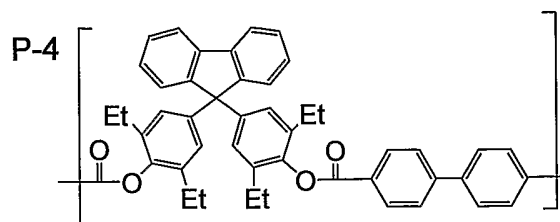
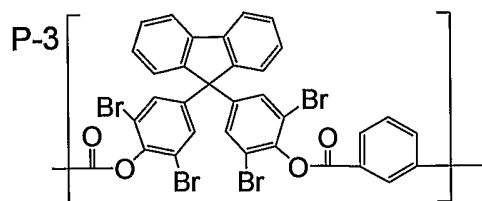
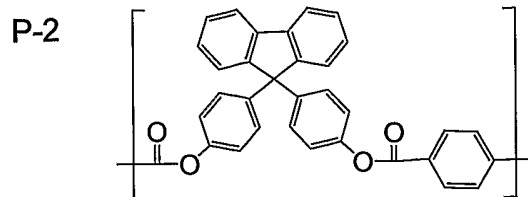
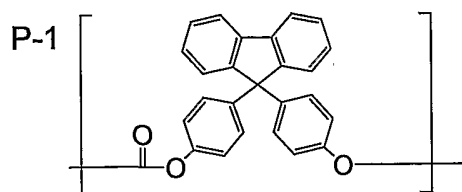
In formula (4), R^{41} to R^{44} each independently represent
20 a substituent, including, for example, those mentioned hereinabove for formulae (1) and (2). More preferably, the substituent is an alkyl group, an aryl group or a halogen atom. a and b each independently indicate an integer of from 0 to 4, preferably from 0 to 3, more preferably from 0 to 2. c and d
25 each independently indicate an integer of from 0 to 3, preferably from 0 to 2. The position at which the linking group bonds to the skeleton may be any position of the aromatic ring, but is preferably a meta- or para-position to the quaternary carbon atom, more preferably a para-position thereto.

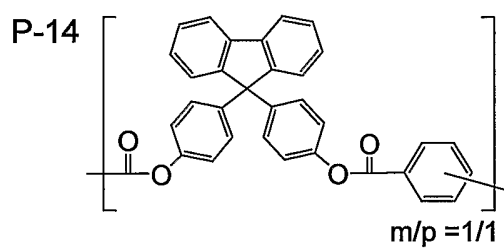
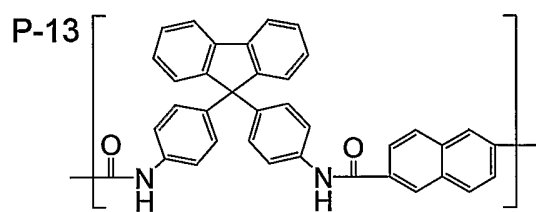
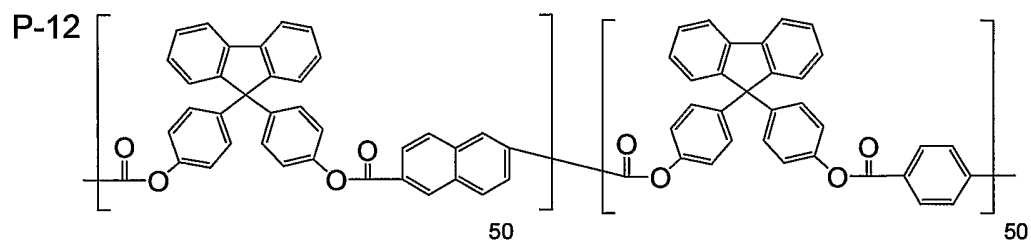
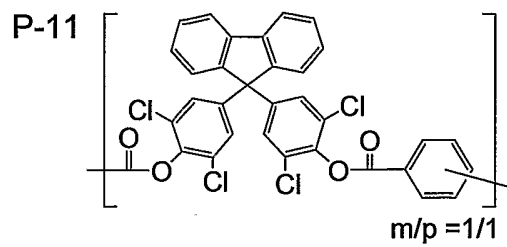
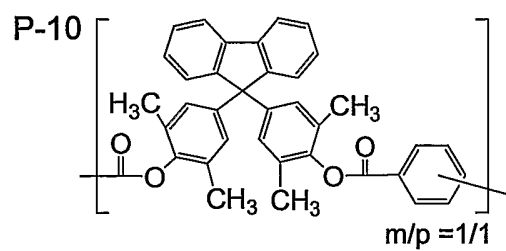
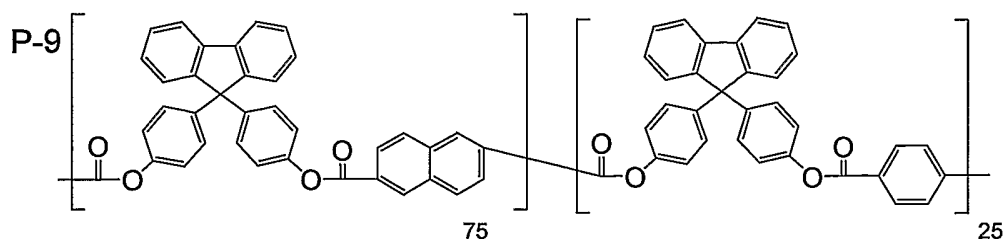
The polymer for use in the invention may contain a plurality of repetitive units of formulae (1) to (4), and may contain any other repetitive unit than the units of formulae (1) to (4), not detracting from the effect of the invention.

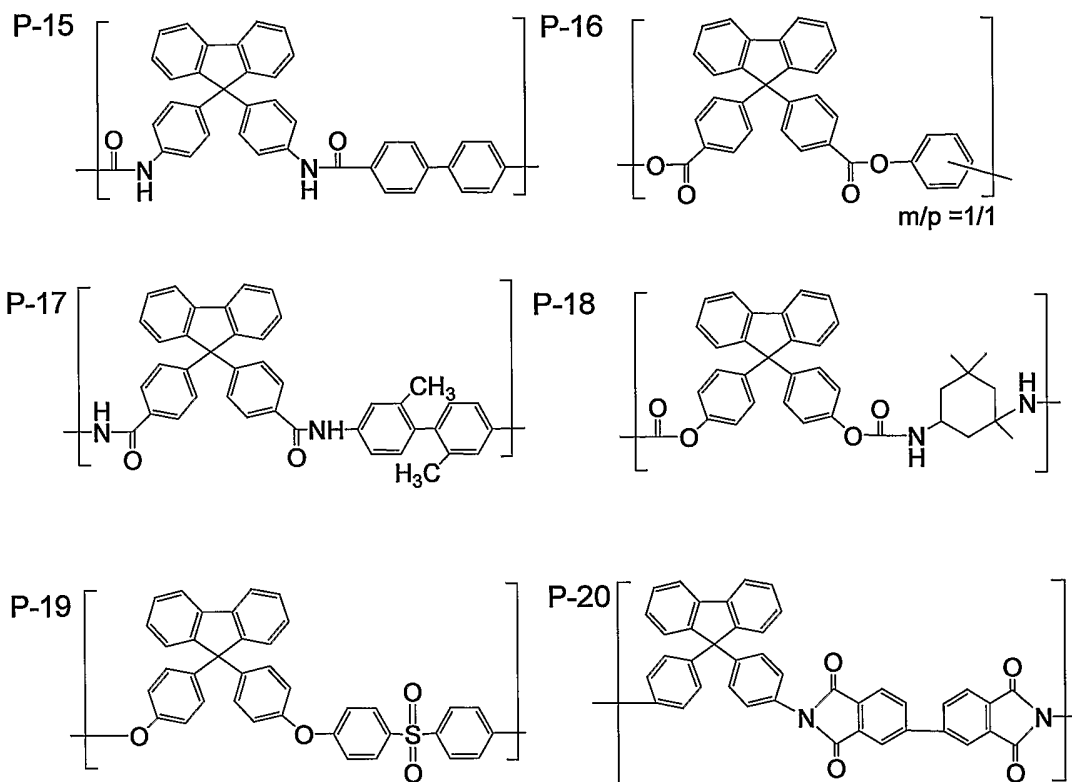
5 The amount of the repetitive units of formulae (1) to (4) in the polymer for use in the invention is generally at least 10 mol%, but preferably at least 20 mol%, more preferably at least 30 mol%.

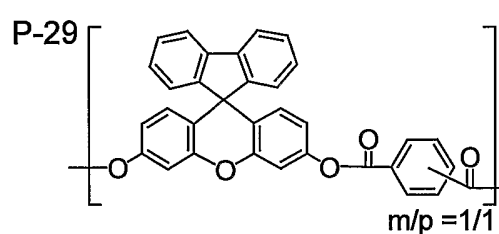
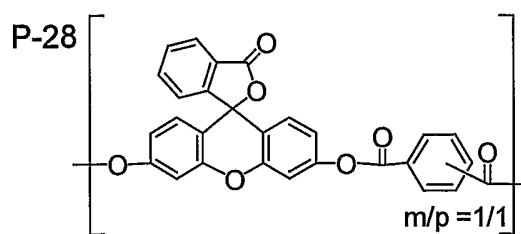
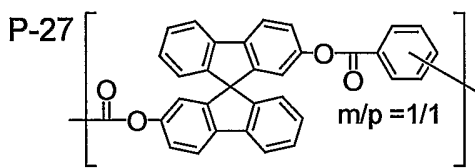
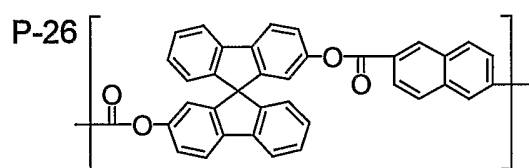
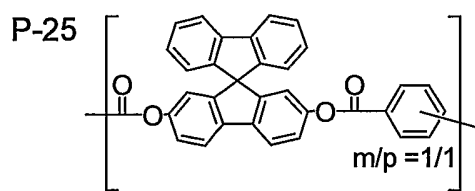
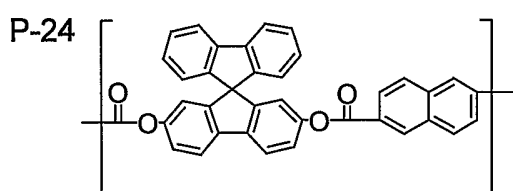
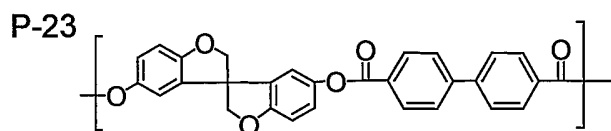
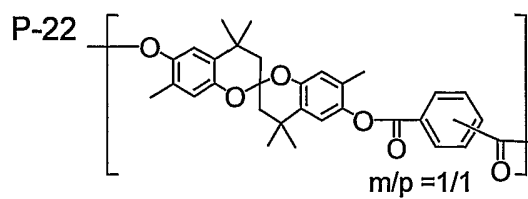
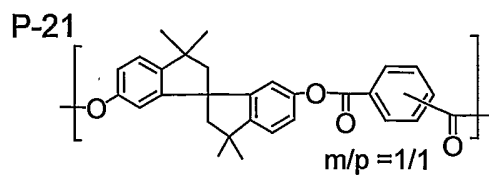
10 The linking group in the polymer that contains the repetitive units of formulae (1) to (4) includes a single bond, an ester bond, a carbonate bond, an amido bond, an imido bond, a ketone bond, an ether bond, a sulfone bond, an urethane bond, an urea bond, a benzazole bond. Of those, preferred are an ester bond, a carbonate bond, an amido bond, an imido bond and an ether
15 bond; more preferred are an ester bond, an amido bond and an imido bond. Of such various bonding modes, the linking group in the polymer may be one type alone, or may be a combination of different types.

20 Examples of the polymer that contains the structure of formulae (1) to (4) are mentioned below, to which, however, the polymer for use in the invention should not be limited.

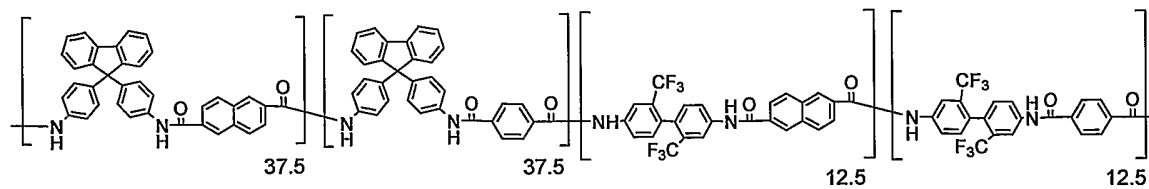




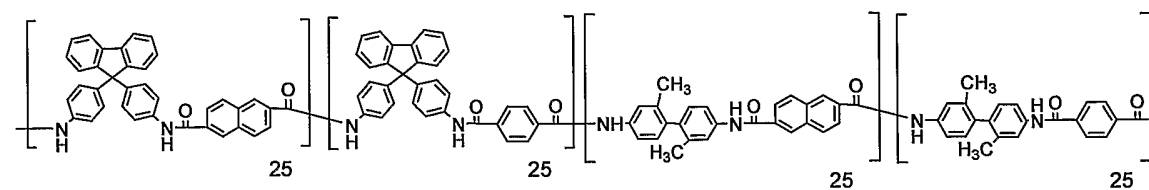




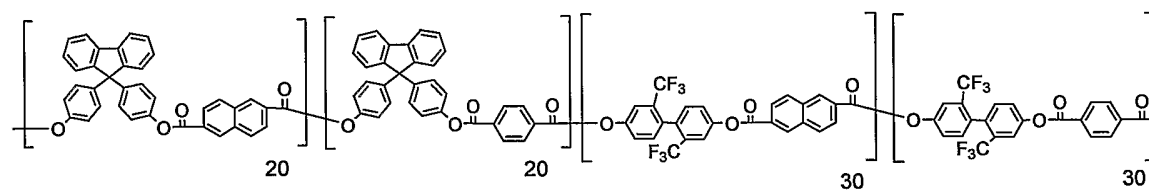
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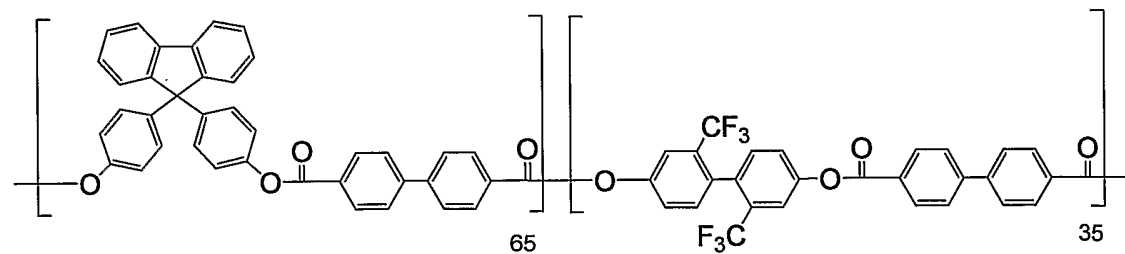
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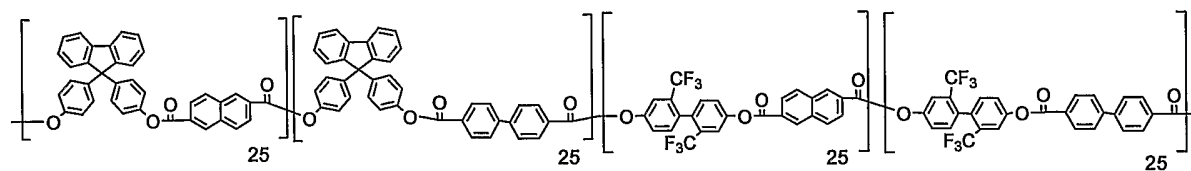
P-32



P-33



P-34



For producing the film of the invention, herein employable are known methods, but preferred are a solution casting method and an extrusion forming method (melt forming method).

5 The casting and drying mode in a solution casting method is described in, for example, USP 2,336,310, 2,367,603, 2,492,078, 2,492,977, 2,492,978, 2,607,704, 2,739,069, 2,739,070; British Patents 640,731, 736,892; JP-B 45-4554, 49-5614; JP-A 60-176834, 60-203430, 62-115035.

10 Examples of the production apparatus for producing the film of the invention according to a solution casting method are those described in JP-A 2002-189126, paragraphs [0061] to [0068] and in Figs. 1 and 2, to which, however, the production apparatus for use in the invention should not be limited.

15 In a solution casting method, a resin composition is dissolved in a solvent. Not specifically defined, the solvent to be used may be any one capable of dissolving the resin composition but is preferably one capable of dissolving it in an amount of at least 10% by mass in terms of the solid
20 concentration at 25°C. Also preferably, the solvent has a boiling point of not higher than 250°C, more preferably not higher than 205°C. When the solvent has a boiling point of not higher than 205°C, then it is favorable since the solvent may be sufficiently evaporated away by drying, not remaining in the
25 film formed.

 The solvent of the type includes, for example, methylene chloride, chloroform, tetrahydrofuran, benzene, cyclohexane, toluene, xylene, 1,2-dichloroethane, ethyl acetate, methyl acetate, acetone, methyl ethyl ketone, methyl isobutyl ketone,
30 chlorobenzene, dimethylformamide, dimethylacetamide, N-methylpyrrolidone, methanol, ethanol, cyclohexanone, anisole, to which, however, the solvent for use in the invention should not be limited.

 Two or more of the solvents as above may be mixed for use

herein. Examples of the mixed solvent are those prepared by mixing methylene chloride with one or more different types of alcohols having from 1 to 5 carbon atoms. In these, the alcohol content is preferably from 5 to 20% by mass of the mixed solvent.

5 Other preferred examples are those prepared by mixing ethers, ketones and esters having from 3 to 12 carbon atoms in any desired ratio, to which, if desired, one or more different types of alcohols having from 1 to 5 carbon atoms may be added. The organic solvents described in Hatsumei Kyokai's Disclosure
10 Bulletin 2001-1745, paragraph 6 are also preferred examples for use herein.

The concentration of the resin composition to be in the solution for use in the solution casting method is suitably from 5 to 60% by mass, but preferably from 10 to 40% by mass, more
15 preferably from 10 to 30% by mass. When the concentration of the resin composition is from 5 to 60% by mass, then the solution may have a suitable viscosity, and the thickness of the film to be formed is easy to control and, in addition, the solution enjoys good film formability.

20 The solution casting method is not specifically defined, in which, for example, the resin solution may be cast on a flat plate or a roll by the use of a bar coater, a T-die, a bar-combined T-die, a doctor blade, a roll coater or a die coater.

The temperature at which the solvent is evaporated away
25 varies depending on the boiling point of the solvent used. Preferably, the coating film is dried in two stages. In the first stage, the coating film is dried at 10 to 100°C until the solvent concentration is reduced to at most 50% by mass, preferably at most 40% by mass. Next, in the second stage, the
30 film is peeled from a flat plate or a roll, and further dried at a temperature falling between 60°C and T_g of the resin.

When the film is peeled from a flat plate or a roll, it may be peeled immediately after the finish of the first-stage drying or may be peeled after it is once cooled.

Preferably, the film of the invention is stretched. For stretching it, any known method is employable. For example, the film may be stretched according to a roll-monoaxial stretching method, a tenter-monoaxial stretching method, a simultaneous biaxial stretching method, a successive biaxial stretching method, an inflation method or a rolling method, as in JP-A 62-115035, 4-152125, 4-284211, 4-298310, 11-48271. One example of stretching the film by the use of a tenter is described in detail hereinunder.

Stretching the film may be attained at room temperature or under heat. The film may be stretched while it is dried, and this is especially effective when a solvent remains in the film. The film may be stretched monoaxially or biaxially, but preferably biaxially. For example, when the film-peeling speed is set higher than the film-winding up speed by controlling the speed of the film conveyor rollers in the system, then the film is stretched. When the film is conveyed while its width is held by a tenter and while the tenter width is gradually broadened, then the film may be stretched. After dried, the film may be stretched by the use of a stretcher (preferably monoaxially stretched by the use of a long stretcher). Preferably, the draw ratio of the film (the ratio of the increment by stretching to the original length of the film) is from 0.5 to 300%, more preferably from 1 to 200%, still more preferably from 1 to 100%.

Preferably, the pulling rate in stretching is from 5%/min to 1000%/min, more preferably from 10%/min to 500%/min. Based on the glass transition temperature (T_g) of the film, the temperature at which the film is stretched is preferably from T_g to $(T_g + 50^\circ\text{C})$, more preferably from T_g to $(T_g + 40^\circ\text{C})$, still more preferably from T_g to $(T_g + 30^\circ\text{C})$. Preferably, the film is stretched by the use of a heat rolls, a radiation heat source (IR heater) and/or hot air. For enhancing the temperature uniformity in stretching, a constant temperature zone may be

employed.

Preferably, the film is preheated before stretched. If desired, the film may be heated after stretched. Preferably, the heat treatment is effected within a temperature range of
5 from a temperature lower by 20°C than the glass transition temperature of the film to a temperature higher by 10°C than it; and the heat treatment time is preferably from 1 second to 3 hours. Regarding the heating mode, the film may be heated in any mode of zone heating or partial heating with an IR heater.
10 During or after the process, both sides of the film may be trimmed away. Preferably, the trimmed waste is collected and recycled for film formation. Regarding the tenter for drying a web by holding the width of the web with it, the speed in the solution casting method may be increased or the surface smoothness
15 quality reduction in broadening the web width may be prevented by controlling the drying gas jetting mode, the gas jetting angle, the aeration speed distribution, the aeration speed, the aeration amount, the temperature difference, the aeration amount difference, the upper and lower jetting aeration ratio
20 and the use of high-specific-heat drying gas, as in JP-A 11-077718.

For preventing stretching unevenness, the stretched thermoplastic resin film may be subjected to heat treatment for thermal relaxation with applying thereto a temperature profile
25 in the width direction of the film, as in JP-A 11-077822.

Further, for also preventing stretching unevenness, the solvent concentration in the film to be stretched may be controlled to fall between 2 and 10% of the solid content of the film, as in JP-A 4-204503.

30 For preventing the film from curling by defining the clipping-in width of the film, the tenter clipping-in width D of the film to be stretched may be defined to $D \leq (33 / (\log (\text{draw ratio}) \times \log (\text{volatile content})))$, as in JP-A 2002-248680. In that condition, the film may be stretched whereby the stretched

film may be prevented from curling and its conveyance may be easier.

In addition, for satisfying both high-speed soft film conveyance and stretching, the tenter conveyance may be changed
5 to pin conveyance in the former stage and to clip conveyance in the latter stage, as in JP-A 2002-337224.

For producing an optical film with small Re and small Re distribution, the peeled web may be processed according to a process that comprises conveying a peeled web to a first tenter
10 unit, and holding both side edges in the lateral direction of the web to thereby keep the web width constant or stretch the web in the lateral direction, drying the web into a film, and conveying the film to a second tenter unit, and holding both side edges in the lateral direction of the film to thereby keep
15 the film width constant or stretch the film in the lateral direction, as in JP-A 2002-311245.

For stretching the film, also employable is the method of using a lateral-stretching tenter (lateral stretcher) described in JP-A 2003-014933, which comprises fixing both
20 sides of a web with clips or pins and stretching the web by broadening the distance between the clips or the pins in the lateral direction. For stretching or shrinking the film in the machine direction, a simultaneous biaxial stretcher may be used to broaden or narrow the distance between the clips or the pins
25 in the conveyance direction (machine direction). When the clip units are driven according to a linear driving system, then the film may be smoothly stretched and it is favorable since the risk of film fracture may be reduced. For stretching in the machine direction, plural rolls are driven at different
30 peripheral speeds and the film may be led through the rolls so as to be stretched in the machine direction owing to the difference in the peripheral roll speeds. These stretching methods may be combined in any desired manner in stretching the film of the invention, and the stretching process may be

effected in two or more stages of machine-direction stretching, lateral stretching, machine-direction or lateral stretching, and machine-direction stretching.

For preventing the web from foaming in tenter drying, for
5 improving the releasability of the web and for preventing the web from generating dust, employable is a drying apparatus specifically so designed that the width of the drier therein is shorter than that of the web being dried therein so as to prevent the hot air from the drier from directly shooting the
10 sides of the web, as in JP-A 2003-004374.

Also preventing the web from foaming in tenter drying, for improving the releasability of the web and for preventing the web from generating dust, employable is a technique of disposing a windshield plate inside the side edges of the web
15 being dried in a tenter drier so as to prevent the dry air from directly shooting the web-holding part of the tenter therein, as in JP-A 2003-019757.

For stable conveyance and drying thereof, the film to be dried may be so controlled as to satisfy (1) $T \leq 60$, and $40 \leq X \leq 200$; (2) $60 < T \leq 120$, and $40 + (T - 60) \times 0.2 \leq X \leq 300$; or (3) $120 < T$, and $52 + (T - 120) \times 0.2 \leq X \leq 400$, in which
20 X (μm) indicates the thickness of both side edges of the dried film held by a pin tenter, and T (μm) indicates the mean thickness of the dried film product, as in JP-A 2003-053749.

25 So as to prevent the film from being wrinkled in a multi-stage tenter, a heating chamber and a cooling chamber may be provided in the multi-stage tenter in a tenter system and the right and left clip chains fitted to the film may be separately cooled therein, as in JP-A 2-182654.

30 So as to prevent the web from being broken, wrinkled and erroneously conveyed, the pin density on the inner side may be larger than that on the outer side in the pin tenter, as in JP-A 9-077315.

. So as to prevent the web from foaming inside the tenter

and to prevent the web from adhering to the holding member in the tenter, the tenter drier may be specifically so designed that the pins to hold both side edges of the web to be dried are cooled to a temperature lower than the web foaming temperature by an air jet cooler, and the pins just before the site at which the web is caught are cooled to a temperature not higher than the dope-gelling temperature + 15°C by the use of a duct cooler, as in JP-A 9-085846.

So as to prevent a pin tenter from being out of place and to prevent the web being dried with it from being contaminated with impurities, there may be employed a solution casting method in which the plug structure of the pin tenter is cooled so that the surface temperature of the web that is in contact with the plug structure is not higher than the gelling temperature of the web, as in JP-A 2003-103542.

For preventing the quality of film such as the surface smoothness thereof from being lowered in increasing the line speed in a solution casting method and in broadening the web width by the use of a tenter, the web drying in a tenter may be so controlled that the drying gas speed could fall between 0.5 and 20 (40) m/sec, the lateral-direction temperature profile could be at most 10%, the upper and lower aeration ratio around the web could fall between 0.2 and 1 and the drying gas ratio could fall between 30 and 250 J/Kmol, as in JP-A 11-077718. JP-A 11-077718 describes preferred drying conditions in tenter drying that depend on the amount of the solvent remaining in the web to be dried. Concretely, it discloses the following: (1) After a web is peeled from a support and before the amount of the solvent remaining in the web reaches 4% by weight, the angle at which the drying air is jetted out from an air jet outlet is controlled fall between 30° and 150° to the flat surface of the film, and, based on the uppermost limit of the gas speed on the surface of the film positioned in the prolonged direction in which the drying gas jet stream travels, the drying air speed

distribution on the film surface is co controlled that the difference between the uppermost limit and the lowermost limit of the gas speed could be within 20% of the uppermost limit thereof, and in that condition, the drying gas is jetted out and the web is dried with it; (2) when the amount of the solvent remaining in the web is from 70 to 130% by weight, then the drying gas speed on the web surface from a gas-jetting type drier is controlled to fall between 0.5 m/sec and 20 m/sec; (3) when the amount of the solvent remaining in the web is from 4% by weight to less than 70% by weight, then the web is dried with a drying gas jet at a speed of from 0.5 m/sec to 40 m/sec, and, based on the uppermost limit of the temperature of the drying gas applied to the web, the temperature distribution of the drying gas in the lateral direction of the web being dried with it is so controlled that the difference between the uppermost limit and the lowermost limit of the drying gas temperature could be within 10% of the uppermost limit thereof; (4) when the amount of the solvent remaining in the web is from 4% by weight to 200% by weight, then the aeration ratio, q , of the drying gas to be jetted onto the web from the outlet of the jet gas drier positioned above and below the traveling web could be $0.2 \leq q \leq 1$; more preferably, (5) at least one type of vapor is used as the drying gas, and the mean specific heat of the gas is from 31.0 J/K·mol to 250 J/K·mol; and (6) the web may be dried with a drying gas under a saturated vapor pressure thereof, in which the concentration of the organic compound that is liquid at room temperature is at most 50%.

For improving the surface smoothness of the dried film, for preventing the quality of the film from being worsened owing to the film tearing in a tenter and for increasing the producibility, the ratio in the tenter, $L_r = L_{tt}/L_t$ may be controlled to $1.0 \leq L_r \leq 1.99$ in which L_t (m) indicates a non-specific web traveling length in the tenter and L_{tt} (m) indicates the sum total of the length in the web traveling

direction of the parts having the same length as Lt and held by tenter clips, as in JP-A 11-090943. In this condition, it is desirable that the web-holding parts are disposed with no space therebetween in the lateral direction of the web.

5 For preventing the surface smoothness of the web being introduced into a tenter from being worsened owing to the web loosening, and for improving the web stability into the tenter, a unit for preventing the web from being loosened in the lateral direction of the web may be disposed before the tenter mouth
10 in a plastic film production apparatus, as in JP-A 11-090944. In this system, the loosening preventing unit is preferably a rotary roller capable of rotating within an angle range that expands from 2 to 60 degrees in the lateral direction of the web. Also preferably, a suction unit is disposed above the web
15 being dried, and a fan for aeration may be disposed below the web.

 For producing a film having stable physical properties, the peeled web having a solvent content of from 12 to 50% by mass may be conveyed under tension given thereto in the lateral
20 direction of the web, as in JP-A 2000-289903. Specifically, in the system, the width of the web is detected by a web width detector, a web holder and a web conveyor having at least two variable folding points disposed therein, and the web width is computed from the detected signal and the position of the
25 folding points may be thereby changed.

 For preventing the clippability of the web being dried, for preventing the web from being broken for a long period of time and for obtaining a film of good quality, a drying apparatus may be employed which is specifically so designed that a web
30 edge curling preventing guide plate is disposed on at least the lower side of the upper and the lower sides of both edges of the web at both right and left sides in the area near to the tenter mouth, and the web-facing face of the guide plate comprises of a web contact resin part and a web contact metal

part both arranged in the web traveling direction, as in JP-A 2003-033933. Preferred embodiments of the apparatus are as follows: (1) The web contact resin part of the web-facing surface of the guide plate is disposed on the upstream side of the web-traveling direction and the web contact metal part is on the downstream side thereof; (2) the step difference (including inclination) between the web contact resin part and the web contact metal part of the guide plate is at most 500 μm ; (3) the distance between the web contact resin part and the web contact metal part of the guide plate in the lateral direction thereof that is in contact with the web being processed is from 2 to 150 mm; (4) the distance between the web contact resin part and the web contact metal part of the guide plate in the web-traveling direction thereof that is in contact with the web being processed is from 5 to 120 mm; (5) the web contact resin part of the guide plate is formed by surface resin working or surface resin coating of a metal guide plate; (6) the web contact resin part of the guide plate is formed of a single resin; (7) the distance between the web-facing surfaces of the guide plates disposed above and below the web at both side edges thereof is from 3 to 30 mm; (8) the distance between the web-facing surfaces of the guide plates disposed above and below the web at both side edges thereof is broadened in a ratio of at least 2 mm per 100 mm of the width of the web in the lateral direction of the web and toward the center thereof; (9) the upper and lower guide plates of the web at the right and left side edges thereof each have a length of from 10 to 300 mm, and they are shifted back and forth in the web-traveling direction, and the distance between the thus-shifted upper and lower guide plates is from -200 to +200 mm; (10) the web-facing surface of the upper guide plate is formed of a resin or a metal alone; (11) the web contact resin part of the guide plate is formed of Teflon®, and the web contact metal part thereof is formed of stainless steel; (12) the surface roughness of the web-facing

surface of the guide plate or that of the web contact resin part and/or the web contact metal part is at most 3 μm . The position at which the web edge curling preventing upper and lower guide plates are disposed is preferably between the peeling side edge of the support and the tenter introduction part, more preferably nearer to the tenter mouth.

For preventing the web being dried in a tenter from being cut or from being unevenly dried therein, the web may be, after peeled from a support, laterally stretched and dried by the use of a lateral stretcher while the solvent content of the web is from 12 to 50% by mass, or a pressure of from 0.2 to 10 kPa may be applied to both surfaces of the web when the solvent content of the web has reached 10% by mass or less, as in JP-A 11-048271. In this process, the tension application to the web is finished when the solvent content of the web has reached 4% by weight or less. When a pressure is applied to both surfaces of the web (film) by the use of nip rolls, then it is desirable that from 1 to 8 pairs of nip rolls are used, and the temperature in pressing is preferably from 100 to 200°C.

For obtaining a film that is thin and has good optical isotropy and good surface smoothness, the film formation may be carried out under a condition of $0.3 X \leq Y \leq 0.9 X$ in which X indicates the percentage of the solvent remaining in the film being peeled, and Y indicates the percentage of the solvent remaining in the film being led into a tenter, as in JP-A 2000-239403.

For stretching the film formed in a casting process, there may be employed a method of stretching it under heat, and a method of stretching it while the film still contains a solvent therein, as in JP-A 2002-286933. In the former method of stretching the film under heat, it is desirable that the film is stretched at a temperature not higher than a temperature around the glass transition point of the resin that constitutes the film. On the other hand, when the cast film is stretched while it still

contains a solvent, then it may be once dried and then again contacted with a solvent, and the resulting solvent-containing film may be stretched.

Preferably, the film of the invention is stretched with pressing. The "press-stretching method" as referred to herein is meant to indicate a stretching method in which a film is isotropically stretched under pressure applied thereto from its top and bottom.

The press-stretching method is described, for example, in JP-B 63-24806, 1-32054, 1-32055, 3-67845, 4-74167; Shaping Work, Vol. 9, No. 4, pp. 306-312; Shaping Work, Vol. 9, No. 5, pp. 356-362; Shaping Work, Vol. 9, No. 9, pp. 713-718. In particular, the air-gap process, the 2-station process and the constant mold temperature process described in Shaping Work, Vol. 9, No. 4, pp. 306-312; Shaping Work, Vol. 9, No. 5, pp. 356-362; and Shaping Work, Vol. 9, No. 9, pp. 713-718 are favorably utilized herein. The pressure in pressing the film is preferably from 10 MPa to 500 MPa, more preferably from 20 MPa to 500 MPa, still more preferably from 35 MPa to 500 MPa. The mold temperature in pressing is preferably from T_g to $(T_g + 100)^\circ\text{C}$, more preferably from T_g to $(T_g + 75)^\circ\text{C}$, still more preferably from T_g to $(T_g + 50)^\circ\text{C}$. The draw ratio in press-stretching is preferably from 1.2 to 10 times, more preferably from 1.5 to 10 times, still more preferably from 2.0 to 10 times. The thickness of the stretched film is preferably from 10 to 500 μm , more preferably from 20 to 500 μm , still more preferably from 25 to 500 μm . The draw ratio refers to the areal ratio based on the area before the stretching.

In press-stretching, a lubricant film or a lubricant agent may be used. For the lubricant resin film, usable are polytetrafluoroethylene, polypropylene and polyethylene. The lubricant agent may be polydimethylsiloxane. For lowering T_g of the film in press-stretching it, a solvent or a plasticizer may be added to the resin for the film. One sheet of preform

may be press-stretched; or plural sheets of preform may be laminated and press-stretched. In the latter case of laminating plural preform sheets, it is desirable that a lubricant film and/or a lubricant agent is used between the preform sheets. The preform as referred to herein means a tabular resin before stretched. The preform for use in the invention may be prepared in a melt-forming process, or may be prepared in a solution-forming process. The preform as referred to herein also means a film and/or a sheet before press-stretched.

When the film of the invention is stretched, it may be stretched while it contains a solvent therein for the purpose of lowering the apparent Tg of the film. A film having a high Tg may be thermally decomposed while stretched under heat. However, when the film of the type is stretched while it still contains a solvent therein, it may be stretched at a temperature lower than its thermal decomposition temperature.

Preferably, the solvent content of the film being stretched is from 1 to 50% by mass, more preferably from 1 to 45% by mass, still more preferably from 1 to 40% by mass. The solvent content of the film may vary while the film is stretched. The temperature at which the solvent-containing film is stretched is preferably from 0 to 250°C, more preferably from 0 to 230°C, still more preferably from 10 to 220°C. For making the film contain a solvent therein, herein employable are a method of utilizing a wet film being dried and a method of adding a solvent to a dried film. In the invention, the former is preferred. The solvent to remain in the film may be any one, but is preferably a solvent of the same type as that used in doping.

Regarding the condition under which the solvent-containing film is stretched, any known stretching methods are employable herein. For example, herein employable are a roll-monoaxial stretching method, a tenter-monoaxial

stretching method, a simultaneous biaxial stretching method, a successive biaxial stretching method, an inflation method and a rolling method, as in JP-A 62-115035, 4-152125, 4-284211, 4-298310, 11-48271. In addition, the above-mentioned
5 press-stretching method is also usable.

Regarding the condition under which the solvent-containing film is stretched, the others than the stretching temperature may be the same as those mentioned hereinabove for the condition under which the solvent-free film
10 is stretched.

When the solvent-containing film is stretched, the draw ratio (areal ratio) is preferably from 1.2 to 10 times, more preferably from 1.5 to 10 times, still more preferably from 2.1 to 10 times.

15 After stretched, the film of the invention may be subjected to heat treatment for removing the residual stress. The heat treatment is preferably conducted at a temperature of from 250°C to (T_g + 20°C), more preferably 260°C to (T_g + 20°C), still more preferably 270°C to (T_g + 20°C).

20 Preferably, the film of the invention satisfies $N_{xy} - N_z \geq 0.02$ in which N_{xy} indicates the in-plane mean refractive index of the film and N_z indicates the refractive index in the thickness direction of the film, more preferably $N_{xy} - N_z \geq 0.025$, still more preferably $N_{xy} - N_z \geq 0.03$. Also preferably, the
25 difference between the in-plane refractive index N_x and N_y of the film of the invention is at most 0.02, more preferably at most 0.018, still more preferably at most 0.015. N_x is meant to indicate the refractive index of the film in the direction in which the in-plane refractive index of the film is the
30 largest; and N_y is meant to indicate the in-plane refractive index of the film in the direction perpendicular to the N_x direction. As calculated, N_{xy} is $(N_x + N_y)/2$.

Preferably, the weight-average molecular weight of the resin for use in the invention is from 10,000 to 5,000,000, more

preferably from 15,000 to 5,000,000, still more preferably from 20,000 to 5,000,000.

The glass transition temperature (T_g) of the resin for use in the invention is preferably from 250 to 450°C, more
5 preferably from 250 to 400°C, still more preferably from 250 to 380°C.

An inorganic material may be mixed in the resin for use in the invention. The amount of the inorganic material that may be mixed in the resin is preferably from 1 to 30% by mass,
10 more preferably from 1 to 25% by mass, still more preferably from 1 to 20% by mass. The inorganic material includes metal oxides and/or metal composite oxides, metal oxides formed through sol-gel reaction, inorganic layered compounds, and organized inorganic layer compounds.

15 Preferably, the linear thermal expansion coefficient of the film of the invention is from -20 to 40 ppm/°C within a temperature range of from 25°C to 250°C, more preferably from -15 to 25 ppm/°C, still more preferably from -10 to 15 ppm/°C. The film of the invention having a linear thermal expansion
20 coefficient of from -20 to 40 ppm/°C within a temperature range of from 25°C to 250°C has the advantages in that, when an inorganic material for a gas-barrier layer or a transparent electrode is laminated thereon, then the inorganic layer may be prevented from being cracked owing to the thermal expansion
25 difference between the film and the inorganic layer and the inorganic layer may be prevented from being dislocated.

Preferably, the light transmittance at 420 nm of the film of the invention having a thickness of 50 μm is from 70% to 100%, more preferably from 75% to 100%, still more preferably from
30 80% to 100%. Also preferably, the whole light transmittance in 400 nm to 700 nm of the film is from 70 to 100%, more preferably from 80 to 100%, still more preferably from 85 to 100%.

Preferably, the haze of the film of the invention is at most 3%, more preferably at most 2%, still more preferably at

most 1%.

Depending on its use, the film of the invention may be coated with any other layer, or may be subjected to surface treatment of saponification, corona treatment, flame treatment, glow discharge treatment or the like for the purpose of increasing its adhesiveness to other parts. In addition, an anchor layer may be disposed on the film surface.

A transparent conductive layer may be laminated on at least one surface of the film of the invention. The transparent conductive layer may be any known metal film or metal oxide film. Above all, a metal oxide film is preferred for the transparent conductive layer in view of its transparency, conductivity and mechanical properties. For it, for example, employable are metal oxide films of indium oxide, cadmium oxide or tin oxide with an impurity of tin, tellurium, cadmium, molybdenum, tungsten, fluorine, zinc and germanium added thereto; and metal oxide films of zinc oxide or titanium oxide with an impurity of aluminium added thereto. Above all, preferred is a thin film of indium oxide comprising essentially tin oxide and containing from 2 to 15% by mass of zinc oxide, as it has good transparency and good conductivity.

For forming the transparent conductive layer, any method is employable so far as it may give the intended thin film. For example, however, suitable for the film formation is a vapor-phase deposition method of depositing a material in a vapor phase, for example, a sputtering method, a vacuum vapor deposition method, an ion-plating method, a plasma CVD method or a Cat-CVD method. The film may be formed, for example, according to the methods described in Japanese Patent No. 3,400,324, or JP-A 2002-322561 or 2002-361774. Above all, especially preferred is a sputtering method as the film formed may have especially excellent conductivity and transparency.

In the sputtering method, the vacuum vapor deposition method, the ion-plating method and the plasma CVD method, the

vacuum degree is preferably from 0.133 mPa to 6.65 Pa, more preferably from 0.665 mPa to 1.33 Pa. Before forming the transparent conductive layer thereon, it is desirable that the film substrate is subjected to surface treatment such as plasma treatment (back-sputtering) or corona treatment. During the formation of the transparent conductive layer thereon, the film may be heated at 50 to 200°C.

The thickness of the transparent conductive layer is preferably from 20 to 500 nm, more preferably from 50 to 300 nm.

The surface resistivity of the transparent conductive layer, as measured at 25°C and at a relative humidity of 60%, is preferably from 0.1 to 200 Ω /square, more preferably from 0.1 to 100 Ω /square, still more preferably from 0.5 to 60 Ω /square. Also preferably, the light transmittance at 420 nm of the transparent conductive layer is at least 80%, more preferably at least 83%, still more preferably at least 85%.

A gas-barrier layer may be formed on at least one surface of the film of the invention for retarding the gas penetration through the film. For the gas-barrier layer, for example, preferably mentioned are metal oxides comprising, as the essential ingredient thereof, one or more metals selected from a group consisting of silicon, aluminium, magnesium, zinc, zirconium, titanium, yttrium and tantalum; metal nitrides with silicon, aluminium or boron; and their mixtures. Of those, more preferred is a film formed of a metal oxide comprising, as the essential ingredient thereof, a silicon oxide having a ratio of the number of oxygen atoms to that of silicon atoms of from 1.5 to 2.0, in view of its gas-barrier property, transparency, surface smoothness, flexibility, film stress and cost. The gas-barrier layer formed of such an inorganic compound may be formed, for example, according to a vapor-phase deposition method of depositing a material in a vapor phase, for example, a sputtering method, a vacuum vapor deposition method, an

ion-plating method, a plasma CVD method or a Cat-CVD method. Above all, especially preferred are a sputtering method and a Cat-CVD method as the layer formed may have an especially excellent gas-barrier property. During the formation of the gas-barrier layer thereon, the film may be heated at 50 to 250°C.

Preferably, the thickness of the gas-barrier layer is from 10 to 300 nm, more preferably from 30 to 200 nm.

The gas-barrier layer may be formed on the same side as or on the opposite side to the transparent conductive layer.

Regarding the gas-barrier property of the film of the invention, the water vapor permeability through the film, as measured at 40°C and at a relative humidity of 90%, is preferably from 0 to 5 g/m²·day, more preferably from 0 to 3 g/m²·day, still more preferably from 0 to 2 g/m²·day. The oxygen permeability through the film, as measured at 40°C and at a relative humidity of 90%, is preferably from 0 to 1 ml/m²·day·atm, more preferably from 0 to 0.7 ml/m²·day·atm, still more preferably from 0 to 0.5 ml/m²·day·atm. The film of which the gas-barrier property falls within the range as above is good, because, for example, when it is used in organic EL display devices or liquid-crystal display devices, the EL devices and others are substantially prevented from being deteriorated by water vapor or oxygen.

For further improving the barrier property thereof, the film of the invention preferably has a defect compensation layer formed adjacent to the gas-barrier layer thereof. The defect compensation layer may be formed according to (1) a method of utilizing an inorganic oxide layer formed through sol-gel reaction as in USP 6,171,663 or JP-A 2003-94572; or (2) a method of utilizing an organic substance layer as in USP 6,413,645. The defect compensation layer may be formed according to a method of vapor deposition in vacuum followed by curing with UV rays or electron rays, or a method of coating followed by heating and curing through exposure to electron rays or UV rays. In the latter case of forming the layer in a coating mode,

employable are various known coating methods of, for example, spraying, spin coating or bar coating.

An inorganic barrier layer, an organic barrier layer or an inorganic-organic hybrid barrier layer may be formed on the film of the invention for the purpose of imparting chemical resistance to the film.

[Image Display Device]

The film of the invention described hereinabove may be used in image display devices. The type of the image display devices to which the invention is applicable is not specifically defined, and the invention is applicable to any known ones. When the film of the invention is used as a substrate, then flat panel displays of good image quality can be fabricated. The flat panel displays include liquid-crystal displays, plasma displays, organic electroluminescent (EL) displays, inorganic electroluminescent displays, fluorescent character display tubes, light-emitting diodes, field emission displays. In addition to these, the film of the invention is also usable in other display devices heretofore having a glass substrate, as a substrate substitutive for the glass substrate in those conventional display systems. Further, the film of the invention is usable in other applications of solar cells and touch panels, in addition to flat panel displays. Regarding the touch panels, the invention is applicable to those described in JP-A 5-127822 and 2002-48913.

The film of the invention is favorably used as a substrate for thin-film transistor (TFT) display devices. For fabricating TFT arrays, for example, referred to is the method described in JP-T 10-512104 (the term "JP-T" as referred to herein means a published Japanese translation of a PCT patent application). The substrate may have a color filter for color image display. The color filter may be fabricated in any method, but is preferably fabricated through photolithography.

When the film of the invention is used as a substrate in

liquid-crystal displays, it is desirable that the resin composition constituting the film is an amorphous polymer in order to attain the optical uniformity of the film. In addition, for the purpose of controlling the retardation (Re) of the film and the wavelength-dependent dispersion thereof, resins that differ in point of the positivity or the negativity of their intrinsic birefringence may be combined, or resins having a large (or small) wavelength-dependent retardation dispersion may be combined.

It is desirable that different types of resin compositions are combined and laminated to construct the film of the invention for the purpose of controlling the retardation (Re) of the film or for bettering the gas-barrier property and the mechanical property of the film. Preferred combinations of different resin compositions for use herein are not specifically defined, for which, therefore, usable are any resin compositions mentioned hereinabove.

A reflection-type liquid-crystal display device generally comprises a lower substrate, a reflective electrode, a lower alignment film, a liquid-crystal layer, an upper alignment film, a transparent electrode, an upper substrate, a $\lambda/4$ plate and a polarizing film laminated in that order from the bottom. In this, the film of the invention may be used as the transparent electrode and/or the upper substrate. For color image display, it is desirable that a color filter layer is disposed between the reflective electrode and the lower alignment film, or between the upper alignment film and the transparent electrode.

A transmission-type liquid-crystal display device generally comprises a backlight, a polarizer, a $\lambda/4$ plate, a lower transparent electrode, a lower alignment film, a liquid-crystal layer, an upper alignment film, an upper transparent electrode, an upper substrate, a $\lambda/4$ plate and a polarizing film disposed in that order from the bottom. In this,

the film of the invention may be used as the upper transparent electrode and/or the upper substrate. For color image display, it is desirable that a color filter layer is disposed between the lower transparent electrode and the lower alignment film, or between the upper alignment film and the transparent electrode.

Not specifically defined in point of the type of the liquid-crystal layer (liquid-crystal cell) therein, various display modes are proposed for liquid-crystal display devices, including, for example, TN (twisted nematic), IPS (in-plane switching), FLC (ferroelectric liquid crystal), AFLC (antiferroelectric liquid crystal), OCB (optically compensated bent), STN (super twisted nematic), VA (vertically aligned) and HAN (hybrid aligned nematic) modes. In addition, a modified display mode is also proposed, in which any of the above-mentioned display modes are aligned and divided. The film of the invention is effective in liquid-crystal display devices of any display modes as above. In addition, the film is also effective in liquid-crystal display devices of any types of transmission, reflection or semitransmission.

These liquid-crystal cells and liquid-crystal display devices are described in JP-A 2-176625; JP-B 7-69536; MVA (SID97, Digest of Tech. Papers (preprint) 28 (1997) 854); SID99, Digest of Tech. Papers (preprint) 30 (1999) 206; JP-A 11-258605; Survival (Monthly Display, Vol. 6, No. 3 (1994) 14); PVA (Asia Display 98, Proc. of the-18th-Inter. Display Res. Conf. (preprint) (1998) 383); Para-A (LCD/PDP International '99); DDVA (SID98, Digest of Tech. Papers (preprint) 29 (1998) 838); EOC (SID98, Digest of Tech. Papers (preprint) 29 (1998) 319); PSHA (SID98, Digest of Tech. Papers (preprint) 29 (1998) 1081); RFFMH (Asia Display 98, Proc. of the-18th-Inter. Display Res. Conf. (preprint) (1998) 375); HMD (SID98, Digest of Tech. Papers (preprint) 29 (1998) 702); JP-A 10-123478; International Laid-Open WO98/48320; Japanese Patent No. 3,022,477; and

International Laid-Open W000/65384.

The film of the invention may also be used in organic EL display devices. Examples of the layer constitution of an organic EL device are anode/light-emitting layer/transparent cathode; anode/light-emitting layer/electron-transporting layer/transparent cathode; anode/hole-transporting layer/light-emitting layer/electron-transporting layer/transparent cathode; anode/hole-transporting layer/light-emitting layer/transparent cathode; anode/light-emitting layer/electron-transporting layer/electron-injection layer/transparent cathode; anode/hole-injection layer/hole-transporting layer/light-emitting layer/electron-transporting layer/electron-injection layer/transparent cathode.

The organic EL display device in which the film of the invention can be used may attain light emission when a direct current (optionally including an alternating current component) voltage (generally from 2 V to 40 V) or a direct current is applied thereto. For driving the light-emitting devices mentioned above, for example, referred to are the methods described in JP-A 2-148687, 6-301355, 5-29080, 7-134558, 8-234685, 8-241047; USP 5,828,429, 6,023,308; and Japanese Patent No. 2,784,615.

The full-color display mode of the organic EL display device may be any of a color filter mode, a three color independent emission mode, or a color conversion mode.

The driving system of the liquid-crystal display device and the organic EL display device may be any of a passive matrix driving mode or an active matrix driving mode.

The film of the invention is usable as an optical film, a phase retardation film, a polarizer-protective film, a transparent conductive film, a substrate for display devices, a substrate for flexible displays, a substrate for flat panel displays, a substrate for solar cells, a substrate for touch

panels, a substrate for flexible circuits, an optical disc-protective film, etc.

The invention is described in more detail with reference to the following Examples, in which the material used, its amount and the ratio, the details of the treatment and the treatment process may be suitably modified or changed not overstepping the spirit and the scope of the invention. Accordingly, the invention should not be limitatively interpreted by the Examples mentioned below.

(Production Example 1) Production of Compound P-30:

15.67 g of 4,4'-(9-fluorenylidene)dianiline, 4.80 g of 2,2'-bistrifluoromethyl-4,4'-diaminobiphenyl, 6.49 g of 2,6-naphthalenedicarboxylic acid, 4.98 g of terephthalic acid, 37.23 g of triphenyl phosphite, 6.0 g of lithium chloride, 30 ml of dewatered pyridine and 200 ml of dewatered N-methylpyrrolidone were put into a 1-liter three-neck flask equipped with a stirrer and a reflux condenser, and stirred in a nitrogen atmosphere at 100°C for 3 hours. The reaction solution was diluted with 300 ml of dimethylacetamide, and the put into 2 liters of methanol to give a white powder. The resulting powder was taken out through filtration, dispersed in 500 ml of methanol, and washed by refluxing it therein under heat for 1 hour. The white powder was taken out through filtration and dried to obtain 25.0 g of Compound P-30. Through GPC (in a solvent of DMF based on polystyrene standard, Tosoh's HLC-8120GPC), the weight-average molecular weight of the polymer product was 90,000. The polymer was dissolved in N-methylpyrrolidone, cast onto a glass plate and dried thereon. The resulting film having a thickness of 100 μm was analyzed with TMA8310 (Rigaku Denki's Thermo Plus Series), and its glass transition temperature was 360°C.

(Production Example 2) Production of Compound P-32:

1) Production of
2,2'-bistrifluoromethyl-4,4'-dihydroxybiphenyl:

20 g of 2,2'-bistrifluoromethyl-4,4'-diaminobiphenyl,
130 ml of aqueous 36.5% hydrochloric acid and 592 ml of distilled
5 water were put into a 2-liter three-neck flask equipped with
a stirrer, a reflux condenser and a dropping funnel, and
dissolved with stirring under heat. The resulting solution was
cooled to -5°C, and a solution prepared by dissolving 8.62 g
of sodium nitrite in 55.1 ml of water was gradually and dropwise
10 added thereto with keeping its inner temperature at 0 to 5°C.
After the addition, this was stirred for 20 minutes still at
that temperature (diazo solution A).

110 ml of phosphoric acid and 1500 ml of distilled water
were added to a 5-liter three-neck flask equipped with a stirrer,
15 a reflux condenser and a dropping funnel, and with stirring at
100°C, the diazo solution A was gradually and dropwise added
to it. After the addition, this was refluxed under heat for
20 minutes, and then the reaction solution was cooled, and ethyl
acetate was added to it to extract the resulting organic layer.
20 Further, magnesium sulfate was added to the organic layer to
dry it, and then this was concentrated and purified through
silica gel column chromatography (development solvent,
hexane/ethyl acetate = 3/1; R_f = 0.3) to obtain 12 g of
2,2'-bistrifluoromethyl-4,4'-dihydroxybiphenyl. The
25 product was identified through 400 MHz ¹H-NMR.

¹H-NMR (d₆-DMSO), δ (ppm): 7.10 (d, 2H), 7.19 (d, 2H), 7.20 (s,
2H), 10.30 (s, 2H).

2) Production of Compound P-32:

2.66 g of 4,4'-(9-fluorenylidene)diphenol, 3.86 g of
30 2,2'-bistrifluoromethyl-4,4'-dihydroxybiphenyl, 60 mg of
sodium hydrosulfite, 278 mg of tetra-n-butylammonium chloride,
65 ml of methylene chloride, and 75 ml of distilled water were
put into a 300-ml three-neck flask equipped with a stirrer, and
dissolved with stirring in a nitrogen atmosphere. To the

resulting solution, added was a solution prepared by dissolving 2.54 g of 2,6-naphthalenedicarboxylic acid chloride and 2.03 g of terephthalic acid chloride in 30 ml of methylene chloride. Further, a mixture of 21 ml of aqueous 2 mol/liter sodium chloride solution, 120.2 ml of 4-t-butylphenol and 9 ml of water was dropwise added to it at 20 to 23°C, taking 1 hour. After the addition, this was stirred for 3 hours, and the reaction solution was transferred into a one-liter three-neck flask, and 350 μ l of acetic acid and 300 ml of ethyl acetate were gradually added to it. The resulting polymer powder was taken out through filtration, and washed with 300 ml of ethyl acetate, 300 ml of water and 300 ml of methanol in that order, and dried to obtain 8.13 g of Compound P-32. Through GPC (in a solvent of THF based on polystyrene standard, Tosoh's HLC-8120GPC), the weight-average molecular weight of the polymer product was 80,000. The polymer was dissolved in methylene chloride, cast onto a glass plate and dried thereon. The resulting film having a thickness of 100 μ m was analyzed with TMA8310 (Rigaku Denki's Thermo Plus Series), and its glass transition temperature was 305°C.

A method of forming a film in a mode of press-stretching is described below. In all Examples, the size of the preform was 100 mm $\times$ 100 mm $\times$ 0.5 mm, and the preform was preheated at a predetermined temperature under a pressure of 1 MPa for 30 minutes. The press-stretching was carried out according to an air-gap process. A Teflon® film (75 μ m thick) was used as a lubricant film.

(Example 1)

P-8 was produced according to the method described in JP-A 3-28222. Its weight-average molecular weight was 100,000 and its glass transition temperature was 310°C.

A preform of the resin P-8 was preheated by the use of a mold at 320°C under a pressure of 1 MPa for 30 minutes. The

preform was press-stretched according to an air-gap process in which the die plate temperature was 320°C, the cooling die temperature was 100°C, the pressure was 30 MPa, and the draw ratio was 3 times (areal ratio), and a film F-1 was thus produced.

5

(Examples 2 to 4)

Films F-2 to F-4 were produced under the same condition as in Example 1, for which, however, the pressure in press-stretching was changed to 40, 50 and 100 MPa, respectively.

10

(Examples 5 to 7)

Films F-5 to F-7 were produced under the same press-stretching pressure (100 MPa) as in Example 4, for which, however, the draw ratio (areal ratio) was changed to 2 times, 4 times and 5 times, respectively.

15

(Comparative Example 1)

A film H-1 was produced by dissolving P-8 in methylene chloride and casting the resulting solution onto a glass plate and drying it thereon.

20

(Comparative Example 2)

Simultaneously biaxial stretching the same preform as in Example 1 was tried by pulling it at a surface resin temperature of 320°C, but it was broken at the draw ratio of 2 times (areal ratio).

25

The following Examples 8 to 16 are to demonstrate a method for forming a stretched film by stretching a solvent-containing film.

30

(Example 8)

A resin P-8 was dissolved in methylene chloride to prepare a 15 mas.% dope. Using a doctor blade, this was cast onto a

glass plate, and dried thereon at 40°C. Before completely dried, this was peeled from the glass plate, and cut into a piece having a size of 120 mm × 120 mm. This was stretched by the use of a simultaneous biaxial stretcher. The stretching condition was as follows: The resin temperature was 200°C, the pulling rate was 100 mm/min (both in the machine direction and in the lateral direction), the chuck-to-chuck distance was 100 mm, and the draw ratio was 2.0 times (areal ratio). After thus stretched, this was dried in vacuum at 100°C for 2 hours. The resultant was fixed in a mold and subjected to a heat treatment in a nitrogen atmosphere at 300°C for 1 hour to obtain a film F-8.

Before stretched, after stretched and after dried, the weight of the film was measured. From the data, the residual solvent amount before and after stretched was computed.

(Examples 9, 10)

In the same manner as in Example 8 using the resin P-8, films F-9 and F-10 were produced, for which, however, the stretching condition was varied.

(Examples 11 to 14)

The same manner as in Example 8 was conducted using the resin P-32 and the resulting films still containing a solvent were stretched to produce films F-11 to F-14. For the solvent, used were methylene chloride and DMAc. The heat treatment in a nitrogen atmosphere was conducted at 300°C for 5 minutes.

(Examples 15 and 16)

A resin P-30 was used, and the resulting films still containing a solvent were stretched to produce films F-15 and F-16. For the solvent, used was DMAc. The heat treatment in a nitrogen atmosphere was conducted at 300°C for 1 hour.

(Comparative Examples 3 and 4)

Using a resin P-32, a dope was prepared, cast, and completely dried to produce films H-3 and H-4. Stretching the film H-4 was tried by the use of a simultaneous biaxial stretcher at a resin temperature of 315°C, but it was broken at the draw ratio of 2 times (areal ratio).

(Comparative Examples 5 and 6)

Using a resin P-30, a dope was prepared, cast, and completely dried to produce films H-5 and H-6. Stretching the film H-6 was tried by the use of a simultaneous biaxial stretcher at a resin temperature of 370°C, but it was broken at the draw ratio of 2 times (areal ratio).

(Test and Evaluation)

The weight-average molecular weight and the glass transition temperature (T_g) of the polymers used in Examples 1 to 16 and Comparative Examples 1 to 6, as well as the thickness, the linear thermal expansion coefficient, the light transmittance at 420 nm and the elastic modulus in tension of the produced films F-1 to F-16 and H-1 to H-6 were measured according to the methods mentioned below.

<Weight-Average Molecular Weight>

Using Tosoh's HLC-8120 GPC and according to polystyrene-based GPC with tetrahydrofuran or DMF serving as a solvent, the molecular weight of each sample is determined as a value relative to that of a molecular weight-standardized polystyrene.

<Glass Transition Temperature (T_g)>

Using a differential scanning calorimeter (Seiko's DSC6200), T_g of each film sample is measured in nitrogen at a heating rate of 10°C/min.

<Thickness of Film>

Using a dial-type thickness gauge, Anritsu's K402B, the

thickness of a film substrate is measured.

<Linear Thermal Expansion Coefficient>

A film sample (19 mm × 5 mm piece) is prepared, and this is analyzed with TMA (Rigaku Denki's TMA8310). The test
5 condition is as follows: The heating rate is 3°C/min; the temperature range is from 25°C to 250°C. Three samples are tried in one test, and their data are averaged.

<Light Transmittance>

Using a spectrophotometer (Shimadzu's spectrophotometer,
10 UV-3100PC), the light transmittance of a film substrate is measured at a wavelength of 420 nm.

<Refractive Index Difference>

Using an Abbe's refractometer DR-M2 (by Atago), the in-plane refractive index (N_x and N_y) and the thickness
15 direction refractive index (N_z) of a film sample are measured at 25°C and at a wavelength of 589 nm. The in-plane refractive index N_{xy} is calculated as the average of N_x and N_y , $((N_x + N_y)/2)$. The refractive index difference is calculated as $N_{xy} - N_z$.

<Elastic Modulus in tension>

20 A film sample (1.0 cm × 5.0 cm piece) is prepared, and its elastic modulus in tension is measured using a tensilon (Toyo Baldwin's Tensilon RTM-25) at a pulling rate of 3 mm/min. Three samples are tried in one test, and their data are averaged. (The sample is left at 25°C and at a relative humidity of 60%
25 overnight, and then used in the test. The chuck-to-chuck distance is 3 cm.)

Table 1

	Film	Condition in Stretching		Physical Properties of Polymer		Physical Properties of Film				
		stretching method (pressure MPa parenthesized)	draw ratio (areal ratio)	weight-average molecular weight	glass transition temperature (°C)	thickness (μm)	linear thermal expansion coefficient (ppm/°C)	light transmittance (%)	refractive index difference N _{xy} - N _z	elastic modulus in tension (GPa)
Example 1	F-1	press (30)	3	100,000	310	166	39	89	0.056	2.2
Example 2	F-2	press (40)	3	100,000	310	168	35	88	0.079	2.3
Example 3	F-3	press (50)	3	100,000	310	167	31	89	0.085	2.5
Example 4	F-4	press (100)	3	100,000	310	169	25	89	0.135	3.0
Example 5	F-5	press (100)	2	100,000	310	290	30	88	0.098	2.3
Example 6	F-6	press (100)	4	100,000	310	126	23	90	0.158	3.1
Example 7	F-7	press (100)	5	100,000	310	102	22	89	0.177	3.2
Comparative Example 1	H-1	-	-	100,000	310	105	78	89	0.009	2.0
Comparative Example 2	H-2	simultaneous biaxial stretching	2	100,000	310	broken during stretching				

The linear thermal expansion coefficient of the films produced according to a press-stretching method was smaller than that of the cast films. In a simultaneous biaxially-stretching method, most films were broken and failed
5 to be stretched by 2 times (areal ratio). The present inventors have succeeded in producing films that have a small linear thermal expansion coefficient according to a press-stretching method.

10

Table 2

	Film	Resin	Condition in Stretching			Physical Properties of Polymer			Residual Solvent Amount		Physical Properties of Film				
			stretching temperature (°C)	draw ratio (areal ratio)	type of solvent	weight-average molecular weight	glass transition temperature (°C)	before stretched	after stretched	thickness (μm)	linear thermal expansion coefficient (ppm/°C)	light transmittance (%)	refractive index difference Nxy - Nz	elastic modulus in tension (GPa)	
Example 8	F-8	P-8	200	2	methylene chloride	100000	310	7.8	5.2	112	40	89	0.062	2.2	
Example 9	F-9	P-8	200	2.5	methylene chloride	100000	310	8.0	5.3	91	35	88	0.081	2.3	
Example 10	F-10	P-8	200	3	methylene chloride	100000	310	7.9	5.0	75	31	89	0.091	2.5	
Example 11	F-11	P-32	200	2	methylene chloride	80000	305	12.3	9.5	110	37	89	0.072	2.2	
Example 12	F-12	P-32	200	2.5	methylene chloride	80000	305	12.5	9.4	90	32	88	0.095	2.3	
Example 13	F-13	P-32	200	2	DMAc	80000	305	8.2	6.5	108	38	88	0.069	2.1	
Example 14	F-14	P-32	200	2.5	DMAc	80000	305	8.0	6.2	89	34	87	0.085	2.2	
Example 15	F-15	P-30	200	2	DMAc	90000	360	11.5	9.2	109	34	90	0.087	2.1	
Example 16	F-16	P-30	200	2.5	DMAc	90000	360	11.2	9.0	90	25	89	0.132	2.2	
Comparative Example 1	H-1	P-8	-	-	-	100000	310	-	-	105	78	89	0.009	2.0	
Comparative Example 2	H-2	P-8	320	2	no	100000	310	-	-	broken during stretching					
Comparative Example 3	H-3	P-32	-	-	-	100000	305	-	-	110	75	89	0.008	2.1	
Comparative Example 4	H-4	P-32	315	2	no	80000	305	-	-	broken during stretching					
Comparative Example 5	H-5	P-30	-	-	-	80000	360	-	-	107	72	89	0.008	2.2	
Comparative Example 6	H-6	P-30	370	2	no	90000	360	-	-	broken during stretching					

The linear thermal expansion coefficient of the stretched films produced by simultaneously biaxially stretching films that contain a solvent therein at a temperature not higher than T_g of the films was smaller than that of the cast films. In a simultaneous biaxially-stretching method, most films with no solvent therein were broken and failed to be stretched by 2 times (areal ratio). The present inventors have succeeded in producing films that have a small linear thermal expansion coefficient according to a method of stretching films with a solvent therein.

(Example 17) Construction and Evaluation of Flat Panel Display (TN-mode liquid-crystal display device):

1. Formation of Gas-Barrier Layer

A target of SiO_2 was sputtered onto both surfaces of the films F-1 to F-16 and H-1, H-3 and H-5 fabricated in the above, according to a DC magnetron sputtering process under a vacuum of 500 Pa in an Ar atmosphere at an output power of 5 kW. Thus formed, the gas-barrier layer had a thickness of 60 nm. The water vapor permeation through the film samples with a gas-barrier layer formed on both surfaces thereof was at most 0.1 $\text{g/m}^2\cdot\text{day}$, measured at 40°C and at a relative humidity of 90%; and the oxygen permeation through them was at most 0.1 $\text{ml/m}^2\cdot\text{day}$, measured at 40°C and at a relative humidity of 90%.

2. Formation of Transparent Conductive Layer

While the gas-barrier layer-coated films F-1 to F-16 and H-1, H-3 and H-5 were heated at 100°C, a target of ITO (In_2O_3 , 95 mas.%; SnO_2 , 5 mas.%) was sputtered onto them according to a DC magnetron sputtering process under a vacuum of 0.665 Pa in an Ar atmosphere at an output power of 5 kW to thereby form a transparent conductive layer of an ITO film having a thickness of 140 nm on one surface of each sample. The surface resistivity of the transparent conductive layer-coated film samples was 30 Ω/square at 25°C and at a relative humidity of 60%.

3. Heat Treatment

Assuming a process of disposing TFT thereon, the films F-1 to F-16 and H-1, H-3 and H-5 with a transparent conductive layer formed thereon at a room temperature were heated to 300°C. After cooled to room temperature, the SiO₂ layer and the ITO layer of the samples were checked for cracks. No crack was found in F-1 to F-16; but some cracks were found in H-1, H-3 and H-5.

The in-plane linear thermal expansion coefficient of the films stretched according to a press-stretching method and that of the films stretched while they still contain a solvent therein are much lower than that of the unstretched films, and therefore, the inorganic layers formed on the former are not cracked.

4. Fabrication of Circularly-Polarizing Film

On the side opposite to the transparent conductive layer-formed side of the film substrates produced by the use of a film of the invention F-4 and comparative films F-8 and F-9, laminated was a $\lambda/4$ plate as described in JP-A 2000-826705 and 2002-131549, and a polarizer as described in JP-A 2002-86554 was further laminated thereon to fabricate a circularly-polarizing film. The angle between the transmission axis of the polarizer and the slow axis of the $\lambda/4$ plate was 45°.

5. Construction of TN-mode Liquid-Crystal Display Device

On the transparent conductive layer (ITO)-formed side of a film of the invention F-4, comparative films F-8 and F-9 and a glass substrate with a micropatterned aluminium reflection electrode disposed thereon, formed was a polyimide alignment film (SE-7992, by Nissan Chemical), and heated at 200°C for 30 minutes. Neither increase in the resistance value nor increase in the vapor permeation was seen at all in the sample that comprises the film of the invention F-4. As opposed to this, however, both the resistance value and the vapor permeation of the samples comprising the comparative film F-8 or F-9 increased

by 2 times or more.

After rubbed, the two substrates (glass substrate and plastic substrate) were placed one upon another via a 1.7 μm -thick spacer put therebetween in such a manner that the alignment films of the two could face each other. The situations of the two substrates were so controlled that the rubbing directions of the alignment films of the two could cross at an angle of 110° . A liquid crystal (MLC-6252, by Merck) was injected into the space between the two substrates to form a liquid-crystal layer therebetween. The process gave a TN-mode liquid-crystal cell having a twist angle of 70° and a value of Δn of 269 nm.

Further, on the side opposite to the ITO side of the film substrate, laminated were the above-mentioned $\lambda/4$ plate and polarizer to construct a reflection-type liquid-crystal display device.

The device comprising the film of the invention F-4 produced good images. However, the images produced in the device that comprises the comparative film F-8 or F-9 had black peppers (fine black spots were formed in the image area and these interfered with image formation) caused by the reduction in the barrier property of the film and had color misregistration caused by the cracking of the conductive layer of the film.

25 (Example 18) Construction and Evaluation of Organic EL Device:

Using a film of the invention F-4, and comparative films F-8 and F-9, constructed were organic EL device samples A, B and C.

An aluminium lead wire was fitted to the transparent electrode layer of the substrate film having a transparent conductive layer formed thereon and having been subjected to heat treatment, and it was worked into a laminate structure. An aqueous dispersion of polyethylenedioxythiophene/polystyrenesulfonic acid (Bayer's

Baytron P, having a solid content of 1.3% by mass) was applied onto the surface of the transparent electrode in a mode of spin coating and then dried in vacuum at 150°C for 2 hours to thereby form a hole-transporting organic thin layer having a thickness
 5 of 100 nm. This is a substrate X.

On the other hand, on one surface of a temporary support of polyether sulfone (Sumitomo Bakelite's Sumilite FS-1300) having a thickness of 188 μm , a light-emitting organic thin film layer-forming coating solution having a composition mentioned
 10 below was applied by the use of a spin coater, and dried at room temperature to thereby form a light-emitting organic thin film layer having a thickness of 13 nm on the temporary support. This is a transfer material Y.

Polyvinyl carbazole (Mw = 63000, by Aldrich):

15 40 mas.pts.

Tris(2-phenylpyridine)/indium complex

(orthometalated complex): 1 mas.pt.

Dichloroethane: 3200 mas.pts.

The substrate X and the transfer material Y were placed
 20 one upon another in such a manner that the organic thin film layer of the former could be in contact with the light-emitting organic thin film layer of the latter, heated and pressed by the use of a pair of hot rollers at 160°C under 0.3 MPa and at 0.05 m/min. Then, the temporary support was peeled off, and
 25 the light-emitting organic thin film layer was formed on the top of the substrate X. This is a substrate XY.

On the other hand, on one surface of a 50 μm -thick polyimide film (Ube Kosan's Upilex-50S) cut in a size of 25 mm square, a patterned mask was set for vapor deposition (the mask
 30 restricts the light-emitting area to 5 mm $\times$ 5 mm), and Al was deposited onto the film in a mode of vapor deposition under a reduced atmosphere of about 0.1 mPa to thereby form an Al electrode having a film thickness of 0.3 μm . Using a target thereof, Al_2O_3 was deposited on the Al layer in the same pattern

as that of the Al layer in a mode of vapor deposition according to a DC magnetron sputtering process. Thus formed, the Al₂O₃ layer had a thickness of 3 nm. An aluminium lead wire was fitted to the Al electrode, and a laminate structure was thus constructed. An electron-transporting organic thin film layer-forming coating solution having a composition mentioned below was applied onto the laminate structure by the use of a spin coater, and dried in vacuum at 80°C for 2 hours to thereby form thereon an electron-transporting organic thin film layer having a thickness of 15 nm. This is a substrate Z.

Polyvinyl butyral 2000 L (Mw = 2000, by Denki Kagaku Kogyo):

10 mas.pts.

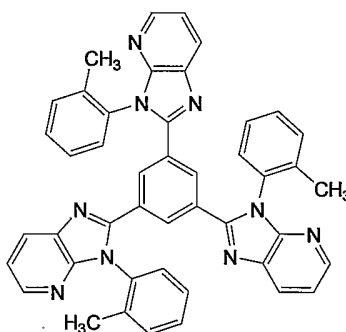
1-Butanol:

3500 mas.pts.

Electron-transporting compound having the following

15 structure:

20 mas.pts.



The substrate XY and the substrate Z were placed one upon another in such a manner that the electrodes of the two could face each other via the light-emitting organic thin film layer sandwiched therebetween, and laminated under heat and pressure by the use of a pair of hot rollers at 160°C under 0.3 MPa and at 0.05 m/min. The process gave organic EL device samples A, B, C.

Using a source measure unit Model 2400 (by Toyo Technica), a direct current voltage was applied to the organic EL device samples A, B and C. The sample A of the invention emitted light.

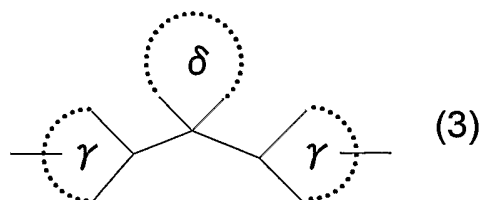
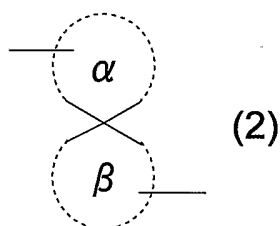
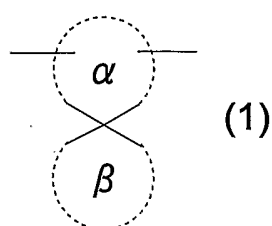
On the other hand, the comparative samples B and C emitted only in a moment, but soon did not emit.

Optionally after coated with various functional layers formed thereon, the film of the invention may be used in image display devices such as flat panel display devices including liquid-crystal displays, plasma displays, organic electroluminescent (EL) displays, inorganic electroluminescent devices, fluorescent character display tubes, light-emitting diodes and field emission devices. In addition, the film of the invention is usable in solar cells and touch panels.

CLAIMS

1. A film having a glass transition temperature (T_g) of not lower than 250°C, a linear thermal expansion coefficient of from -20 to 40 ppm/°C within a temperature range of from 25°C to 250°C, and a light transmittance at 420 nm of at least 70%.

2. The film as claimed in claim 1, which comprises a polymer containing a structure of the following formula (1), (2) or (3):



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wherein in formulae (1) and (2), the ring α and the ring β each independently represent a monocyclic or polycyclic ring, and they bond to each other via one quaternary carbon atom; in formula (1), the linking groups bond to any two carbon atoms of the ring α ; in formula (2), the linking groups bond to any one carbon atom of the ring α and to any one carbon atoms of the ring β ; in formula (3), the two rings γ and the ring δ each independently represent a monocyclic or polycyclic ring, and they bond together at one quaternary carbon atom of the ring δ , the linking groups bond to any carbon atoms of the ring γ .

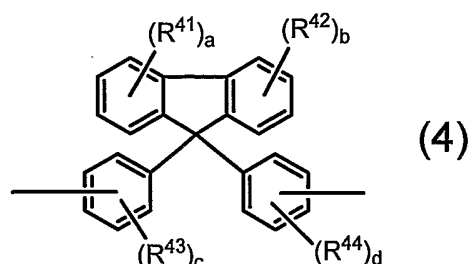
3. The film as claimed in claim 2, wherein the polymer

contains the structure of formula (1).

4. The film as claimed in claim 2, wherein the polymer contains the structure of formula (2).

5. The film as claimed in claim 2, wherein the polymer
5 contains the structure of formula (3).

6. The film as claimed in claim 5, wherein the polymer contains a structure of the following formula (4):



wherein R^{41} to R^{44} each independently represent a substituent;
10 a and b each independently indicate an integer of from 0 to 4;
and c and d each independently indicate an integer of from 0
to 3.

7. The film as claimed in any one of claims 1 to 6, of
which the in-plane mean refractive index N_{xy} is larger by at
15 least 0.02 than the refractive index N_z in the thickness
direction thereof.

8. The film as claimed in any one of claims 2 to 7, wherein
the weight-average molecular weight of the polymer is from
10,000 to 5,000,000.

20 9. A method for producing a film having a glass
transition temperature (T_g) of not lower than 250°C, a linear
thermal expansion coefficient of from -20 to 40 ppm/°C within
a temperature range of from 25°C to 250°C, and a light
transmittance at 420 nm of at least 70%, which comprises
25 stretching a film of a resin having a glass transition
temperature (T_g) of not lower than 250°C.

10. The method as claimed in claim 9, wherein the film
is stretched according to a press-stretching process.

11. The method as claimed in claim 9, wherein the film

is stretched according to a biaxially-stretching process.

12. The method as claimed in any one of claims 9 to 11, wherein the film is stretched while it contains a solvent.

13. The method as claimed in claim 12, wherein the
5 solvent content of the film being stretched is from 1 to 50% by mass.

14. A film produced by the method of any one of claims 9 to 13.

15. A film having a gas-barrier layer, which is
10 fabricated by forming the gas-barrier layer on a film of any one of claims 1 to 8 or 14.

16. A film having a transparent conductive layer, which is fabricated by forming the transparent conductive layer on a film of any one of claims 1 to 8, 14 or 15.

17. A film having a TFT, fabricated by forming the TFT
15 on a film of any one of claims 1 to 8, or 14 to 16.

18. An image display device comprising, as the substrate thereof, a film of any one of claims 1 to 8, or 14 to 17.

19. The image display device as claimed in claim 18,
20 which is a liquid-crystal display device.

20. The image display device as claimed in claim 18, which is an organic electroluminescent display device.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/JP2005/018053

A. CLASSIFICATION OF SUBJECT MATTER

B29C55/00 B29D7/01 B32B27/00 C08J5/18 C08L101/12
G02F1/1333 H01L29/786

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)

B29C B32B C08J B29D H01L C08L G02F H05K H01B G02B H01G

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)

EPO-Internal, WPI Data, CHEM ABS Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

14 December 2005

Date of mailing of the international search report

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Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Meiners, C

INTERNATIONAL SEARCH REPORT

International Application No

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

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