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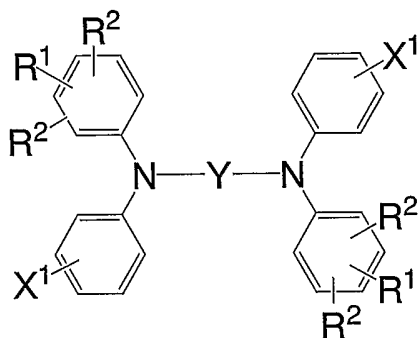
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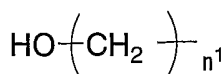
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ning of each regular issue of the PCT Gazette.(54) Title: CONDUCTIVE MATERIAL, COMPOSITION FOR THE CONDUCTIVE MATERIAL, CONDUCTIVE LAYER,
ELECTRONIC DEVICE, AND ELECTRONIC EQUIPMENT

(A1)



(A2)

(57) Abstract: The object of the present invention is to provide a
conductive material having a high carrier transport ability, a com-
position for the conductive material from which a conductive layer
having a high carrier transport ability can be made, a conductive
material formed of the composition and having a high carrier trans-
port ability, a conductive layer formed using the conductive ma-
terial as a main material, an electronic device provided with the
conductive layer and having high reliability, and electronic equip-
ment provided with the electronic device. The conductive material
of the present invention is obtained by polycondensation reaction
of substituents X¹ of compounds each represented by the follow-
ing general formula (A1) through phosgene and/or its derivative to
link the compounds: wherein two R¹'s may be the same or differ-
ent and each independently represents a straight-chain alkyl group
having 2 to 8 carbon atoms, four R²'s may be the same or differ-
ent and each independently represents a hydrogen atom, a methyl
group or an ethyl group, Y represents a group containing at least
one substituted or unsubstituted aromatic hydrocarbon ring or sub-
stituted or unsubstituted heterocycle, and two X¹'s may be the same
or different and each independently represents a substituent repre-sented by the following general formula (A2): wherein n¹ is an integer of 2 to 8.

DESCRIPTION

CONDUCTIVE MATERIAL, COMPOSITION FOR THE CONDUCTIVE MATERIAL, CONDUCTIVE LAYER, ELECTRONIC DEVICE, AND ELECTRONIC EQUIPMENT

CROSS-REFERENCE

The entire disclosures of Japanese Patent Application No. 2004-359544 filed on December 13, 2004 and Japanese Patent Application No. 2005-107149 filed on April 4, 2005 are expressly incorporated by reference herein.

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a conductive material, a composition for the conductive material, a conductive layer, an electronic device, and electronic equipment, and more specifically to a conductive material, a composition for the conductive material from which a conductive layer having a high carrier transport ability can be made, a conductive layer formed using the conductive material as a main material, an electronic device provided with the conductive layer and having high reliability, and electronic equipment provided with the electronic device.

Description of the Prior Art

Electroluminescent devices using organic materials (hereinafter, simply referred to as an "organic EL device") have been extensively developed in expectation of their use as solid-state luminescent devices or emitting devices for use in inexpensive large full-color displays.

In general, such an organic EL device has a structure in which a light emitting layer is provided between a cathode and an anode. When an electric field is applied between the cathode and the anode, electrons are injected into the light emitting layer from the cathode side, and holes are injected into the light emitting layer from the anode side.

The injected electrons and holes are recombined in the light emitting layer, which then causes their energy level to return from the conduction band to the valence band. At this time, excitation energy is released as light energy so that the light emitting layer emits light.

In such organic EL devices, it has been known that a layered device structure, in which organic layers formed of organic materials having different carrier transport properties for electrons or holes are provided between a light emitting layer and a cathode and/or an anode, is effective in obtaining a high-efficiency organic EL device with high luminance.

For this purpose, it is necessary to laminate a light emitting layer and organic layers having different carrier transport properties from each other (hereinafter, these layers are collectively referred to as "organic layers") on the electrode. However, in the conventional manufacturing method using an application method, when such organic layers are laminated, mutual dissolution occurs between the adjacent organic layers, thereby causing the problem of deterioration in the light emitting efficiency of a resultant organic EL

device, the color purity of emitted light, and/or the pattern precision.

For this reason, in the case where organic layers are laminated, these organic layers have to be formed using organic materials having different solubilities.

In order to solve such a problem, a method for improving the durability of a lower organic layer, that is, the solvent resistance of the lower organic layer has been disclosed (see, for example, JP-A No. 09-255774). In this method, organic materials constituting the lower organic layer are polymerized to improve the solvent resistance of the lower organic layer.

Another method for improving the solvent resistance of a lower organic layer is found in JP-A No. 2000-208254. This publication discloses a method in which a curing resin is added to an organic material constituting the lower organic layer to cure the organic material together with the curing resin.

However, even in the case where such a method is employed in manufacturing an organic EL device, the characteristics of the resultant organic EL device are not so improved as to meet expectations in actuality.

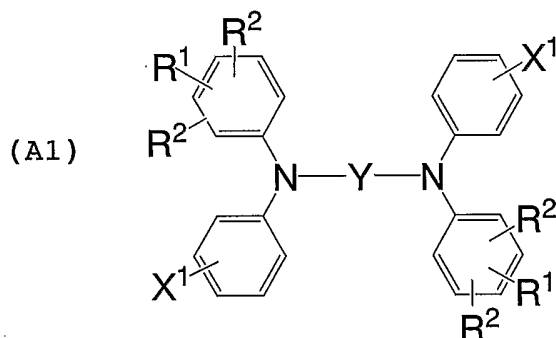
The problem described above has also been raised in thin film transistors using organic materials.

SUMMARY OF THE INVENTION

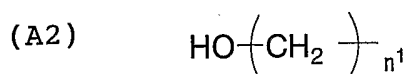
It is therefore the object of the present invention to

provide a conductive material having a high carrier transport ability, a composition for the conductive material from which a conductive layer having a high carrier transport ability can be made, a conductive layer having a high carrier transport ability, a high-reliability electronic device provided with the conductive layer, and electronic equipment provided with the electronic device.

In order to achieve the above object, the present invention is directed to a conductive material which is obtained by polycondensation reaction of substituents X^1 of compounds each represented by the following general formula (A1) through phosgene and/or its derivative to link the compounds:



wherein two R^1 's may be the same or different and each independently represents a straight-chain alkyl group having 2 to 8 carbon atoms, four R^2 's may be the same or different and each independently represents a hydrogen atom, a methyl group or an ethyl group, Y represents a group containing at least one substituted or unsubstituted aromatic hydrocarbon ring or substituted or unsubstituted heterocycle, and two X^1 's may be the same or different and each independently represents a substituent represented by the following general formula (A2):



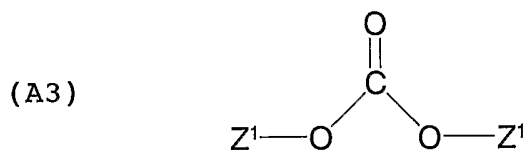
wherein n^1 is an integer of 2 to 8.

According to the present invention described above, it is possible to provide a conductive material having a high carrier transport ability.

In the conductive material according to the present invention, it is preferred that the group Y contains at least one substituted or unsubstituted aromatic hydrocarbon ring.

This allows the conductive material to exhibit a hole transport ability.

Further, in the conductive material according to the present invention, it is also preferred that the phosgene derivative is a compound represented by the following general formula (A3):



wherein two Z^1 s may be the same or different and each independently represents an alkyl group, a phenyl group or a benzyl group each having 1 to 6 carbon atoms.

When the polycondensation reaction is made using this compound, it is possible to eliminate a by-product from a

conductive layer formed of the conductive material. As a result, it is possible to prevent the hole transport ability of the conductive layer from being decreased.

Further, in the conductive material according to the present invention, it is also preferred that the two substituents X^1 are identical with each other.

This makes it possible to prevent appropriately interaction between main skeletons of the compounds each represented by the above-mentioned general formula (A1) from occurring in the conductive material, thereby enabling to improve the hole transport ability of the conductive layer. Here, the main skeletons mean portions of the compounds other than their substituents X^1 .

Further, in the conductive material according to the present invention, it is also preferred that each substituent X^1 is bonded to the 3-, 4- or 5-position of the benzene ring.

This makes it possible for the main skeletons to exist at a suitable interval in the conductive material more reliably.

Furthermore, in the conductive material according to the present invention, it is also preferred that the two substituents R^1 are identical with each other.

This makes it possible for adjacent polymers (the conductive material) to exist at a substantially certain interval in a resultant conductive layer formed of the

conductive material. As a result, it becomes possible to decrease the interaction between the adjacent main skeletons of different polymers reliably, thereby enabling the conductive layer formed of the conductive material to have a high hole transport ability.

Moreover, in the conductive material according to the present invention, it is also preferred that each substituent R^1 is bonded to the 4-position of the benzene ring.

This makes it possible to prevent the adjacent polymers from closely approaching to each other in the resultant conductive layer which is mainly formed of the conductive material.

Moreover, in the conductive material according to the present invention, it is also preferred that the group Y consists of carbon atoms and hydrogen atoms.

This makes it possible for the conductive material to have a high hole transport ability, and therefore the resultant conductive layer to be formed of the conductive material can also have a high hole transport ability.

Moreover, in the conductive material according to the present invention, it is also preferred that the group Y contains 6 to 30 carbon atoms in total.

This also makes it possible for the conductive material to have a higher hole transport ability, and therefore the

resultant conductive layer to be formed of the conductive material can also have a higher hole transport ability.

Moreover, in the conductive material according to the present invention, it is also preferred that the group Y contains 1 to 5 aromatic hydrocarbon rings.

This also makes it possible for the conductive material to have a higher hole transport ability, and therefore the resultant conductive layer to be formed of the conductive material can also have a higher hole transport ability.

Moreover, in the conductive material according to the present invention, it is also preferred that the group Y is a biphenylene group or a derivative thereof.

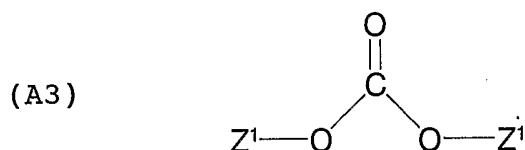
This also makes it possible for the conductive material to have a higher hole transport ability, and therefore the resultant conductive layer to be formed of the conductive material can also have a higher hole transport ability.

Moreover, in the conductive material according to the present invention, it is also preferred that the group Y contains at least one substituted or unsubstituted heterocycle.

This makes it possible to adjust characteristics of the carrier transport ability more easily.

Moreover, in the conductive material according to the present invention, it is also preferred the phosgene derivative

is a compound represented by the following general formula (A3):



wherein two Z¹s may be the same or different and each independently represents an alkyl group, a phenyl group or a benzyl group each having 1 to 6 carbon atoms.

When the polycondensation reaction is made using such a compound, it is possible to eliminate a by-product from the conductive layer formed of the conductive material. As a result, it is possible to prevent the carrier transport ability of the conductive layer from being decreased.

Further, in the conductive material described above, it is preferred that the two substituents X¹ are identical with each other.

This makes it possible to prevent interaction between the main skeletons from occurring in the conductive material, thereby enabling a carrier transport ability of the conductive material to be improved.

Further, in the composition described above, it is also preferred that each substituent X¹ is bonded to the 3-, 4- or 5-position of the benzene ring.

This makes it possible for adjacent main skeletons to exist at a suitable interval in the conductive material more

reliably.

Further, in the conductive material described above, it is also preferred that the two substituents R^1 are identical with each other.

This makes it possible for the adjacent polymers to exist at a substantially certain interval in a conductive layer to be formed of the conductive material. As a result, it becomes possible to decrease the interaction between the adjacent main skeletons of different polymers reliably, thereby enabling the conductive layer to have a higher carrier transport ability.

Further, in the conductive material described above, it is also preferred that each substituent R^1 is bonded to the 4-position of the benzene ring.

This makes it possible for adjacent polymers (the conductive material) to exist at a substantially certain interval in a resultant conductive layer formed of the conductive material. As a result, it becomes possible to decrease the interaction between the adjacent main skeletons of different polymers reliably, thereby enabling the conductive layer formed of the conductive material to have a high carrier transport ability.

Further, in the conductive material described above, it is also preferred that the heterocycle contains at least one heteroatom selected from the group comprising nitrogen, oxygen, sulfur, selenium and tellurium.

By selecting such a heterocyclic ring which contains such a kind of heteroatom, the energy level of the valence and conduction bands or the size of the band gap of the conductive material easily changes, so that it is possible to change the characteristics of the carrier transport ability of the conductive material reliably.

Further, in the conductive material described above, the heterocycle may be either of an aromatic heterocycle or a nonaromatic heterocycle, but the aromatic heterocycle is more preferable.

By using such an aromatic heterocycle, it is possible to prevent appropriately the electron density of the main skeleton having a conjugated chemical structure from being biased, that is, it is possible to prevent the localization of π electrons appropriately. As a result, the carrier transport ability of the conductive material is prevented from being impaired.

Further, in the conductive material described above, it is preferred that the group Y contains 1 to 5 heterocycles.

By allowing the group Y to have such a number of heterocyclic rings, it is possible to change the energy level of the valence and conduction bands or the size of the band gap of the conductive material sufficiently.

Further, in the conductive material described above, it is preferred that the group Y contains at least one substituted

or unsubstituted aromatic hydrocarbon ring in addition to the heterocycle.

By selecting such a group containing the heterocycle and such an aromatic hydrocarbon ring as the group Y, it is possible to impart a desired carrier transport ability to the conductive material more reliably.

Further, in the conductive material described above, it is preferred that the group Y contains two aromatic hydrocarbon rings respectively bonded to each N in the general formula (A1) directly and at least one heterocycle existing between these aromatic hydrocarbon rings.

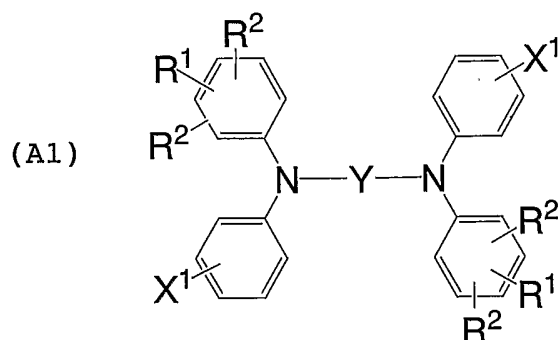
This makes it possible to prevent reliably the electron density in the conductive material from being biased, and thereby enabling the conductive material to have an even carrier transport ability.

Furthermore, in the conductive material described above, it is preferred that the group Y contains 2 to 75 carbon atoms in total.

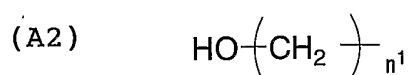
According to such a conductive material, since the planarity of the main skeleton is maintained, it is possible to prevent reliably the carrier transport ability of the conductive material from being decreased.

Another aspect of the present invention is directed to a composition for the conductive material which contains a

compound represented by the following general formula (A1) and a phosgene derivative:



wherein two R^1 's may be the same or different and each independently represents a straight-chain alkyl group having 2 to 8 carbon atoms, four R^2 's may be the same or different and each independently represents a hydrogen atom, a methyl group or an ethyl group, Y represents a group containing at least one substituted or unsubstituted aromatic hydrocarbon ring or substituted or unsubstituted heterocycle, and two X^1 's may be the same or different and each independently represents a substituent represented by the following general formula (A2):



wherein n^1 is an integer of 2 to 8.

According to the composition for the conductive material described above, it is possible to produce a conductive layer (polymer) having a high carrier transport ability.

Other aspect of the present invention is directed to a conductive layer mainly formed of the conductive material described above. Such a conductive layer can have a high hole

transport ability.

In this case, it is preferred that the conductive layer is used for a hole transport layer. Such a hole transport layer can also have a high hole transport ability.

In this case, it is preferred that the average thickness of the hole transport layer is in the range of 10 to 150 nm. When such a hole transport layer is used in an organic EL device, it is possible to increase the reliability of the organic EL device.

Further, the conductive layer of the present invention described above may be used for an electron transport layer. Such an electron transport layer can also have a high electron transport ability.

In this case, it is preferred that the average thickness of the electron transport layer is in the range of 10 to 100 nm. When such an electron transport layer is used in an organic EL device, it is possible to increase the reliability of the organic EL device.

Furthermore, the conductive layer of the present invention described above may be used for an organic semiconductor layer. Such an organic semiconductor layer can exhibit excellent semiconductor characteristics.

In this case, it is preferred that the average thickness of the organic semiconductor layer is in the range of 0.1 to

1,000 nm. When such an organic semiconductor layer is used in an organic thin film transistor, it is possible to increase the reliability of the organic thin film transistor.

The other aspect of the present invention is directed to an electronic device comprising a laminated body which includes the conductive layer as described above. Such an electronic device can have high reliability.

Examples of the electronic device may include a light emitting device and a photoelectric transducer. These light emitting device and photoelectric transducer can also have high reliability.

In this case, it is preferred that the light emitting device includes an organic EL device. Such an organic EL device can also have high reliability.

In the present invention, examples of the electronic device may also include a switching element. Such a switching element can also have high reliability.

In this case, it is preferred that the switching element includes an organic thin film transistor. Such an organic thin film transistor can also have high reliability.

Yet other aspect of the present invention is directed to electronic equipment comprising the electronic device described above. Such electronic equipment can also have high reliability.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view which shows an example of an organic EL device;

FIG. 2(a) is a cross-sectional view of an organic TFT, and FIG. 2(b) is a plan view of the organic TFT;

FIG. 3(a) to FIG. 3(d) are illustrations which explain the manufacturing method of the organic TFT shown in FIG. 2;

FIG. 4(a) to FIG. 4(d) are illustrations which explain the manufacturing method of the organic TFT shown in FIG. 2;

FIG. 5 is a perspective view which shows the structure of a personal mobile computer (or a personal notebook computer) to which the electronic equipment according to the present invention is applied;

FIG. 6 is a perspective view which shows the structure of a mobile phone (including the personal handyphone system (PHS)) to which the electronic equipment according to the present invention is applied; and

FIG. 7 is a perspective view which shows the structure of a digital still camera to which the electronic equipment according to the present invention is applied.

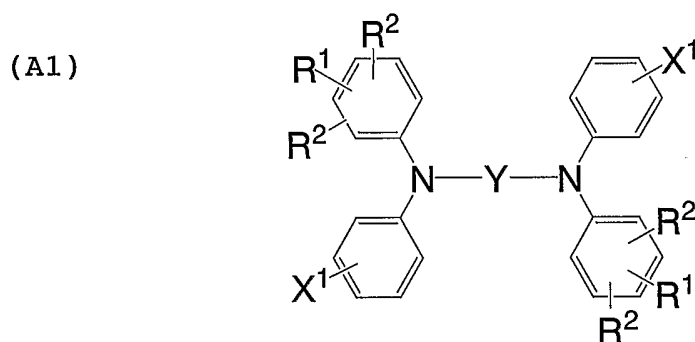
BEST MODE FOR CARRYING OUT THE INVENTION

Hereinbelow, a conductive material, a composition for the conductive material, a conductive layer, an electronic device, and electronic equipment according to the present invention will be described in detail with reference to preferred embodiments shown in the accompanying drawings.

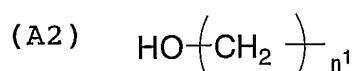
(Conductive Layer)

First, a conductive layer obtained by using a conductive material according to the present invention as its main material (that is, a conductive layer according to the present invention) will be described.

A conductive material according to the present invention contains as its main ingredient a polymer obtained by polycondensation reaction of substituents X^1 of compounds (which are an arylamine derivative) each represented by the following general formula (A1) through phosgene or its derivative to link or bond the compounds.

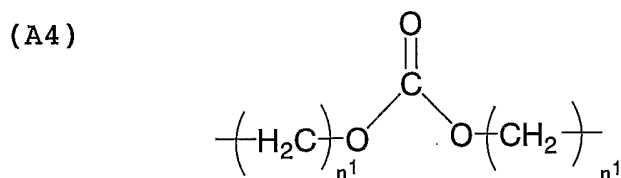


wherein two R^1 s may be the same or different and each independently represents a straight-chain alkyl group having 2 to 8 carbon atoms; four R^2 s may be the same or different and each independently represents a hydrogen atom, a methyl group, or an ethyl group; two X^1 s may be the same or different and each independently represents a substituent represented by the following general formula (A2); and Y represents a group containing at least one substituted or unsubstituted aromatic ring hydrocarbon or a group containing at least one substituted or unsubstituted heterocycle.



wherein n^1 is an integer of 2 to 8.

In more details, the conductive material according to the present invention contains as its main gradient a polymer obtained by linking main skeletons (arylamine skeletons) of the compounds each represented by the above-mentioned general formula (A1) via a chemical structure produced by polycondensation reaction of their substituents X^1 and phosgene represented by the chemical formula COCl_2 and/or its derivative. Here, the main skeleton is a portion of each compound other than its substituents X^1 , and the chemical structure is represented by the following chemical formula (A4) (hereinafter, this chemical structure will be simply referred to as "link structure" on occasions).



wherein two n^1 's may be the same or different and each independently represents an integer of 2 to 8.

Such a polymer has a structure in which the main skeletons are repeatedly linked via the link structure represented by the general formula (A4), that is, a chemical structure in which two straight-chain carbon-carbon bonds (alkylene group) are bonded by a carbonate bond. Due to the chemical structure, the main skeletons repeatedly exist at a predetermined interval. Therefore, the interaction between the adjacent main skeletons

can be decreased.

Each main skeleton has a conjugated chemical structure, and a unique spread of the electron cloud thereof contributes to smooth transportation of carriers (holes or electrons) in the polymer.

For this reason, the polymer exhibits a high carrier transport ability. Therefore, a conductive layer formed of such a polymer as its main material also has a high carrier transport ability.

In such a polymer, if the interval between the main skeletons is too small, interaction between the adjacent main skeletons tends to be strong. On the other hand, if the interval between the main skeletons is too large, it becomes difficult to transfer carriers between the main skeletons, causing the carrier transport ability of the polymer to be impaired.

In view of the facts mentioned above, it is preferred that the chemical structure is determined as follows.

Namely, as the structure of the substituent X^1 (that is, the substituent X^1 represented by the general formula (A2)) and phosgene and its derivative, those such as follows are preferably selected.

Specifically, it is preferred that the substituent X^1 has a straight-chain carbon-carbon link (i.e., an alkylene group) in which n^1 is 2 to 8, in particular 3 to 6. This makes it

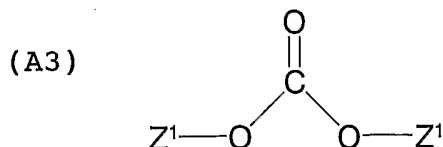
possible for the main skeletons to exist at a suitable interval, thereby decreasing the interaction between the adjacent main skeletons in a resultant polymer reliably. This also makes it possible to transfer carriers between the main skeletons more reliably so that the resultant polymer has a high carrier transport ability.

Preferably, each of the two substituents X^1 contains substantially the same number of carbon atoms, more preferably the same number of carbon atoms. This makes it possible for the adjacent main skeletons to exist at an interval of a certain distance. As a result, it is possible to prevent the electron density in the polymer from being biased. This makes it possible to improve the carrier transport ability of the polymer.

Furthermore, it is to be noted that each substituent X^1 may be bonded to the 2-, 3-, 4-, 5- or 6-position of the benzene ring, but preferably bonded to the 3-, 4- or 5-position. This makes it possible to exhibit the effect obtained by linking the adjacent main skeletons via the link structure conspicuously. Namely, it is possible for the adjacent main skeletons to exist at a suitable interval more reliably.

Phosgene and/or its derivative is not limited to a specific one so long as it is possible to form the chemical structure represented by the general formula (A4) by the polycondensation reaction with the substituents X^1 (hydrated alkyl group), but it is preferred to use one containing as its main ingredient phosgene and/or a compound represented by the

following general formula (A3) (hereinafter, simply referred to as "compound (A3)" on occasions).



wherein , two Z^1 s may be the same or different and each independently represents an alkyl group, a phenyl group or a benzyl group each having 1 to 6 carbon atoms.

When the substituents X^1 are allowed to make polycondensation reaction with phosgene and/or its derivative, a by-product material is produced. By using phosgene and/or the above-mentioned compound (A3) in such polycondensation reaction, it is possible to eliminate such by-product material from a conductive layer (hole transport layer 41) relatively easily as will be described with reference to the process (A2) of the manufacturing method of the organic EL device. In this way, it is possible to prevent carriers from being captured by the by-product material in the conductive layer. As a result, it is possible to prevent appropriately a carrier transport ability of the conductive layer from being decreased.

In the chemical structure represented by the general formula (A4), there exist two double bonds (π bonds) constituting a carbonate bond. Therefore, even in the case where the interval between the main skeletons becomes relatively long, it is possible to perform transfer of carriers between the main skeletons through the π bonds reliably.

Further, an alkylene group exists between the carbonate bond and each main skeleton. This makes it possible to prevent electron density in the main skeleton from being biased toward the link structure. Therefore, even in the case where the interval between the main skeletons becomes relatively short, it is possible to prevent or suppress the interaction between the main skeletons from being increased appropriately.

In this connection, it is to be noted that if the link structure represented by the general formula (A4) has a structure having many conjugated π bonds such as a benzene ring, interaction occurs between the adjacent main skeletons through such a structure, which cancels the effect obtained by allowing the adjacent main skeletons to exist at a suitable interval.

Next, a description will be made with regard to the main skeletons which contribute to carrier transportation in a polymer.

As described above, each substituent R^1 has a straight-chain alkyl group having 2 to 8 carbon atoms, preferably a straight-chain alkyl group having 3 to 6 carbon atoms. This makes it possible for adjacent polymers to exist at a suitable interval by preventing the adjacent polymers from closely approaching to each other by steric hindrance of the substituent R^1 . As a result, it becomes possible to decrease the interaction between the adjacent main skeletons of different polymers reliably in a conductive layer to be formed, thereby enabling the conductive layer to have a high carrier transport ability.

Preferably, the two substituents R^1 contain substantially the same number of carbon atoms, more preferably the same number of carbon atoms. This makes it possible for the adjacent polymers to exist at an interval of a certain distance in the conductive layer. As a result, the density of the polymers in the conductive layer becomes uniform.

Further, each substituent R^1 may be bonded to any of the 2- to 6-position of a benzene ring, but preferably it is bonded to the 4-position. This makes it possible to exhibit the effect of introduction of the substituents R^1 more conspicuously. Namely, it is possible to prevent reliably the adjacent polymers from closely approaching to each other.

Furthermore, as described above, the substituent R^2 is a hydrogen atom, a methyl group, or an ethyl group, and the substituent R^2 is selected in accordance with the number of carbon in the substituent R^1 . Specifically, when the number of carbon in the substituent R^1 is large, a hydrogen atom is selected as the substituent R^2 , while when the number of carbon in the substituent R^1 is small, a methyl group or an ethyl group is selected as the substituent R^2 .

In the compound represented by the above-mentioned general formula (A1) (hereinafter, simply referred to as "compound (A1)"), it is possible to change the carrier transport ability of the polymer by appropriately setting the chemical structure of a group (or a linking group) Y. The reason for this can be considered as follows. In the polymer, the energy

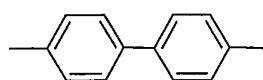
level of the valence and conduction bands or the size of the band gap is changed according to changes in the spread of the electron cloud (i.e., distribution of electrons) in the main skeleton which contributes to carrier transportation.

In the compound (A1), the group Y contains at least one substituted or unsubstituted aromatic hydrocarbon ring or at least one substituted or unsubstituted heterocyclic ring. By selecting kinds of the aromatic hydrocarbon ring and/or heterocyclic ring appropriately, it is possible to adjust carrier transport properties in a resultant polymer relatively easily.

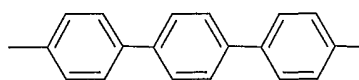
For example, by selecting a structure constituted from substituted or unsubstituted aromatic hydrocarbon ring as the group Y, it is possible to obtain a polymer which can exhibit a hole transport ability.

In more details, as for the structure constituted from the unsubstituted aromatic hydrocarbon ring, those represented by the following chemical formulas (C1) to (C16) can be mentioned.

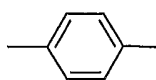
(C1) to (C16)



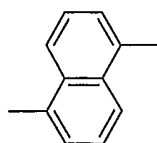
(C1)



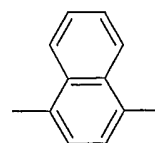
(C2)



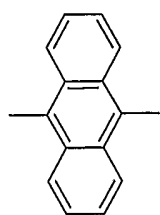
(C3)



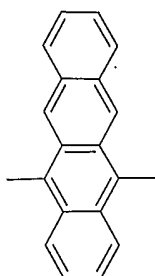
(C4)



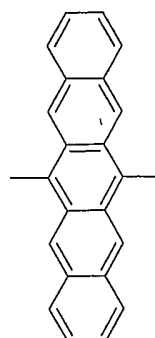
(C5)



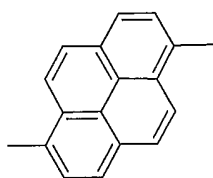
(C6)



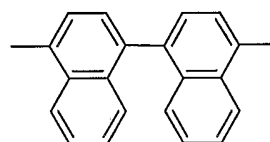
(C7)



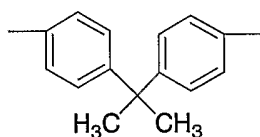
(C8)



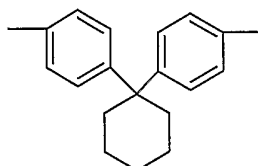
(C9)



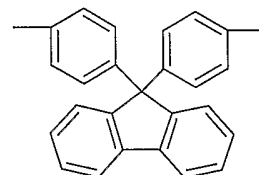
(C10)



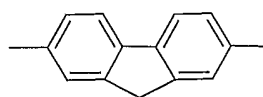
(C11)



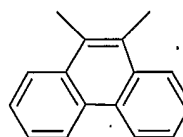
(C12)



(C13)

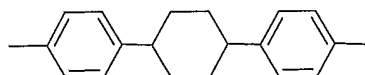


(C14)

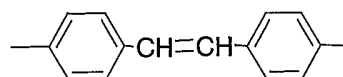


(C15)

(C16)



(C17)



In this case, it is preferred that the group Y has 6 to 30 carbon atoms, more preferably 10 to 25 carbon atoms, and even more preferably 10 to 20 carbon atoms, in total.

Further, in the group Y, it is preferred that the number of aromatic hydrocarbon ring is 1 to 5, more preferably 2 to 5, and even more preferably 2 to 3.

Taking the above-mentioned factors into account, in the compound (A1) a biphenylene group represented by the chemical formula (C1) or its derivative is considered to be a particularly preferable structure as the group Y.

By selecting such a group, the hole transport ability of the resultant polymer becomes excellent, and thus the resultant conductive layer can also have an excellent hole transport ability.

Next, by selecting a structure which contains at least one substituted or unsubstituted heterocyclic ring as the group Y, it is possible to control a carrier transport ability of the resultant polymer more easily.

In this connection, it is preferred that such a heterocyclic ring contains at least one heteroatom selected from among nitrogen, oxygen, sulfur, selenium, and tellurium. By selecting such a heterocyclic ring that contains such a kind of heteroatom, it becomes easy to change the energy level of the valence and conduction bands or the size of the band gap of the polymer.

The heterocyclic ring may be either an aromatic heterocycle or a nonaromatic heterocycle, but an aromatic

heterocycle is preferably used. By using an aromatic heterocycle, it is possible to prevent appropriately the electron density of the main skeleton with a conjugated chemical structure from being biased, that is, it is possible to prevent localization of π electrons appropriately. As a result, the carrier transport ability of the polymer is prevented from being impaired.

Preferably, the group Y contains 1 to 5 heterocyclic rings, more preferably 1 to 3 heterocyclic rings. By allowing the group Y to have such a number of heterocyclic rings, it is possible to change the energy level of the valence and conduction bands or the size of the band gap of the polymer sufficiently.

In the case where the group Y contains at least one substituted or unsubstituted heterocyclic ring, the group Y may further contain at least one aromatic hydrocarbon ring in addition to the at least one heterocyclic ring. By selecting a group containing the heterocycle and such an aromatic hydrocarbon ring as the group Y, it is possible to impart a desired carrier transport property to the polymer more reliably.

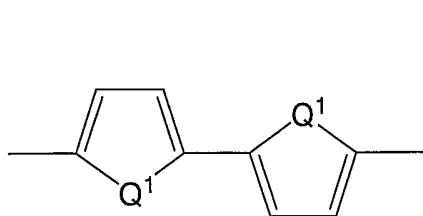
More preferably, the group Y contains two aromatic hydrocarbon rings each bonded to each N in the general formula (A1) directly and at least one heterocyclic ring which exists between these aromatic hydrocarbon rings. By using such a group Y, it is possible to prevent the electron density of the polymer from being biased reliably. As a result, the polymer can have

an even (uniform) carrier transport ability.

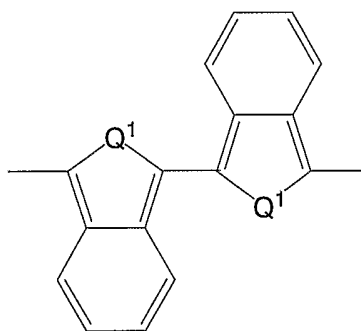
Further, preferably, the group Y has 2 to 75 carbon atoms, more preferably 2 to 50 carbon atoms, in total. If the group Y has too many carbon atoms in total, the solubility of the compound represented by the general formula (A1) in a solvent tends to be lowered depending on the kind of its substituent X^1 , creating a possibility that the range of the choices of solvents to be used in preparing the composition for conductive materials according to the present invention becomes narrow.

On the other hand, by setting a total number of carbon atoms contained in the group Y to a value within the above range, it is possible to maintain the planarity of the main skeleton. As a result, it is possible to prevent reliably the carrier transport ability of the polymer from being impaired.

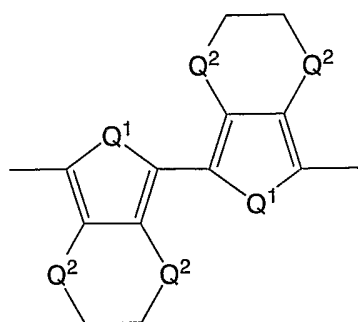
Taking these factors into account, as a structure constituted from the unsubstituted heterocyclic rings, such structures as represented by any one of the following chemical formulas (D1) to (D20) are considered to be preferable structures.



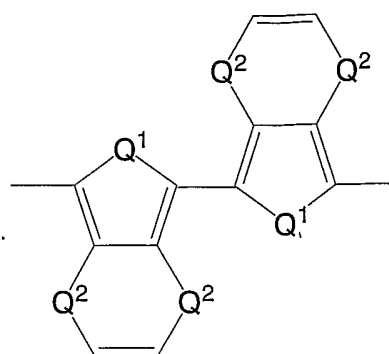
(D1)



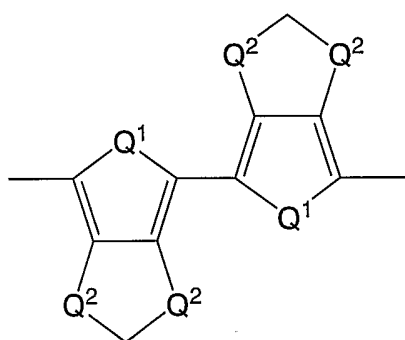
(D2)



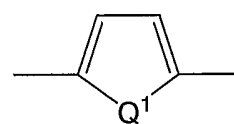
(D3)



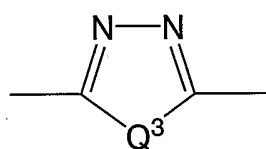
(D4)



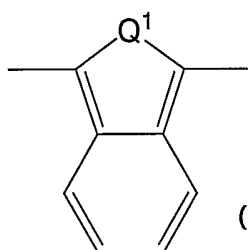
(D5)



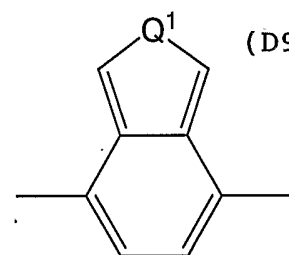
(D6)



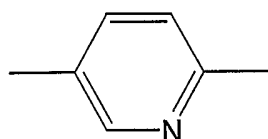
(D7)



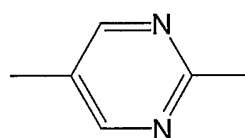
(D8)



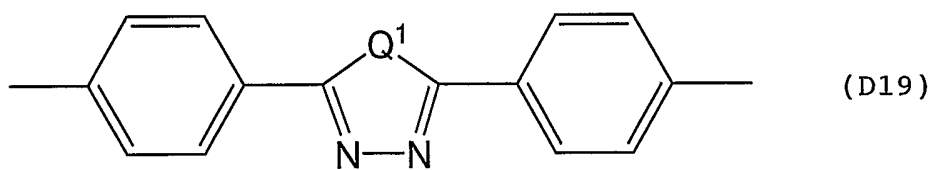
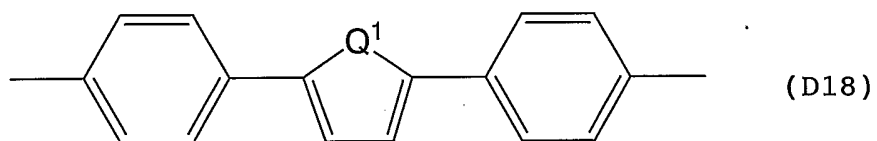
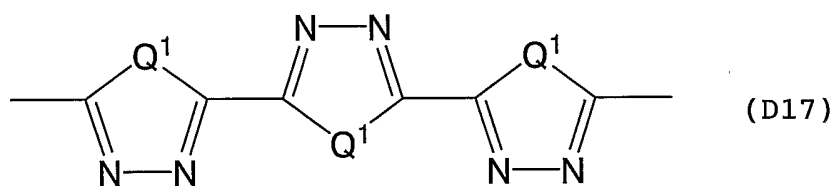
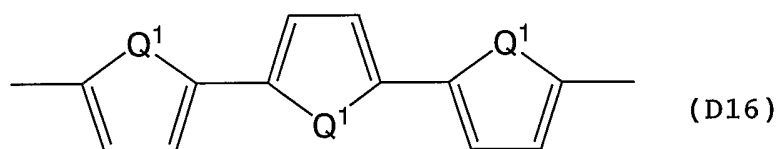
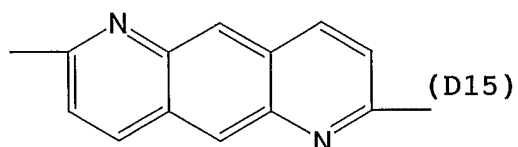
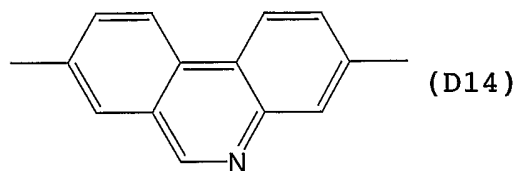
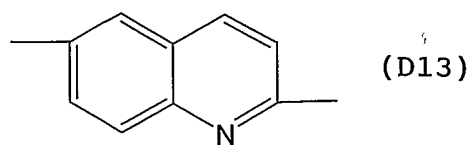
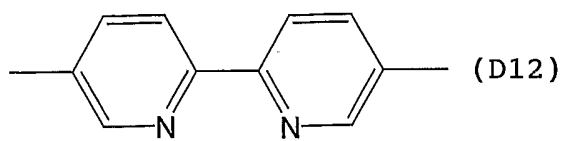
(D9)

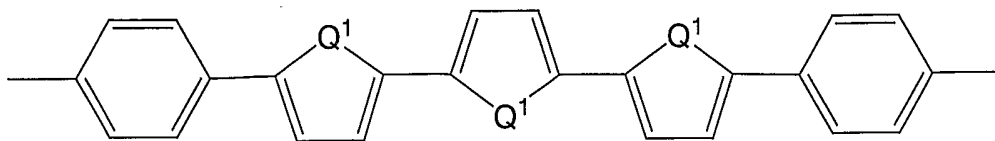


(D10)



(D11)





(D20)

Note that in these chemical formulas each Q^1 may be the same or different and each independently represent N- T^1 , S, O, Se, or Te (where T^1 represents H, CH_3 , or Ph), each Q^2 may be the same or different and each independently represent S or O, and each Q^3 may be the same or different and each independently represent N- T^3 , S, O, Se, or Te (where T^3 represents H, CH_3 , C_2H_5 or Ph).

As described above, by determining the chemical structure of the group Y appropriately, it is possible to control a carrier transport ability of the resultant polymer. For example, a polymer obtained by selecting any one of the chemical formulas (D2), (D16), (D18) and (D20) as the group Y can exhibit a high hole transport ability as compared to a polymer obtained by selecting the chemical formula (D17) and can exhibit an especially high hole transport ability as compared to a polymer obtained by selecting the chemical formula (D8) or (D19).

On the contrary, a polymer obtained by selecting any one of the chemical formulas (D8), (D17) and (D19) as the group Y can exhibit a high electron transport ability as compared to a polymer obtained by the chemical formula (D2) or (D16). Further, the polymer obtained by selecting any one of the chemical formulas (D8), (D17) and (D19) as the group Y can also

exhibit an especially high electron transport ability as compared to a polymer obtained by selecting the chemical formula (D18) or (D20).

Further, the unsubstituted heterocyclic ring and/or the unsubstituted aromatic hydrocarbon ring contained in the group Y may introduce a substituent so long as the planarity of the main skeleton is not greatly affected. Examples of such a substituent include an alkyl group having a relatively small number of carbon atoms such as a methyl group or an ethyl group or and a halogen group and the like.

Furthermore, since such a conductive material is mainly formed of a polymer obtained by the polycondensation reaction, the conductive layer also has excellent solvent resistance. As a result, in the case where an upper layer is formed onto the conductive layer in contact therewith, it is possible to prevent assuredly the conductive layer from being swelled up or dissolved by the solvent or dispersant contained in a material for forming the upper layer.

In addition to the above, in the case where electronic devices (which will be described later in details) are manufactured using a laminated body having such a conductive layer, it is possible to prevent reliably the constituent material of the conductive layer and the constituent material of the contacting layer which is in contact with the conductive layer from being mutually dissolved with the elapse of time at the boundary between the conductive layer and the contacting layer since the conductive layer is mainly formed of the polymer

described above. As a result, it is possible to prevent the characteristics of the electronic devices from being deteriorated with the elapse of time.

(Organic Electroluminescent Device)

Next, an embodiment of the electronic device according to the present invention will be described. In this embodiment, the electronic device of the present invention is embodied as an organic electroluminescent device (hereinafter, simply referred to as an "organic EL device") that is a light emitting device.

FIG. 1 is a cross-sectional view which shows an example of the organic EL device.

The organic EL device 1 shown in FIG. 1 includes a transparent substrate 2, an anode 3 provided on the substrate 2, an organic EL layer 4 provided on the anode 3, a cathode 5 provided on the organic EL layer 4 and a protection layer 6 provided so as to cover these layers 3, 4 and 5.

The substrate 2 serves as a support for the organic EL device 1, and the layers described above are formed on the substrate 2.

As a constituent material of the substrate 2, a material having a light-transmitting property and a good optical property can be used.

Examples of such a material include various resins such

as polyethylene terephthalate, polyethylene naphthalate, polypropylene, cycloolefin polymer, polyamide, polyethersulfone, polymethylmethacrylate, polycarbonate, and polyarylate, and various glass materials, and the like. At least one of these materials can be used as a constituent material of the substrate 2.

The thickness of the substrate 2 is not particularly limited, but is preferably in the range of about 0.1 to 30 mm, more preferably in the range of about 0.1 to 10 mm.

The anode 3 is an electrode which injects holes into the organic EL layer 4 (that is, into a hole transport layer 41 described later). This anode 3 is made substantially transparent (which includes transparent and colorless, colored and transparent, or translucent) so that light emission from the organic EL layer 4 (that is, from a light emitting layer 42 described later) can be visually identified.

From such a viewpoint, a material having a high work function, excellent conductivity, and a light transmitting property is preferably used as the constituent material of the anode 3 (hereinafter, referred to as "anode material").

Examples of such an anode material include oxides such as ITO (Indium Tin Oxide), SnO_2 , Sb-containing SnO_2 , and Al-containing ZnO , Au, Pt, Ag, Cu, and alloys containing two or more of them. At least one of these materials can be used as an anode material.

The thickness of the anode 3 is not limited to any specific value, but is preferably in the range of about 10 to 200 nm, more preferably in the range of about 50 to 150 nm. If the thickness of the anode 3 is too thin, there is a case that a function of the anode 3 will not be sufficiently exhibited. On the other hand, if the anode 3 is too thick, there is a case that the light transmittance will be significantly lowered depending on, for example, the kind of anode material used, thus resulting in an organic EL device that is not suitable for practical use.

It is to be noted that conductive resins such as polythiophene, polypyrrole, and the like can also be used as the anode material.

On the other hand, the cathode 5 is an electrode which injects electrons into the organic EL layer 4 (that is, into an electron transport layer 43 described later).

As a constituent material of the cathode 5 (hereinafter, referred to as "cathode material"), a material having a low work function is preferably used.

Examples of such a cathode material include Li, Mg, Ca, Sr, La, Ce, Er, Eu, Sc, Y, Yb, Ag, Cu, Al, Cs, Rb, and alloys containing two or more of them. At least one of these materials can be used as a cathode material.

Particularly, in the case where an alloy is used as a cathode material, an alloy containing a stable metallic element

such as Ag, Al, or Cu, specifically an alloy such as MgAg, AlLi, or CuLi is preferably used. The use of such an alloy as a cathode material makes it possible to improve the electron injection efficiency and stability of the cathode 5.

The thickness of the cathode 5 is preferably in the range of about 1 nm to 1 μ m, more preferably in the range of about 100 to 400 nm. If the thickness of the cathode 5 is too thin, there is a case that a function of the cathode 5 will not be sufficiently exhibited. On the other hand, if the cathode 5 is too thick, there is a case that the light emitting efficiency of the organic EL device 1 will be lowered.

The organic EL layer 4 is provided between the anode 3 and the cathode 5. The organic EL layer 4 includes the hole transport layer 41, the light emitting layer 42, and the electron transport layer 43. These layers 41, 42 and 43 are formed on the anode 3 in this order.

The hole transport layer 41 has the function of transporting holes, which are injected from the anode 3, to the light emitting layer 42. The electron transport layer 43 has the function of transporting electrons, which are injected from the cathode 5, to the light emitting layer 42.

As a constituent material for one of the hole transport layer 41 and the electron transport layer 43 or for both the layers 41, 43, the conductive material according to the present invention can be used.

For example, in the case where the conductive material of the present invention is used as the constituent material of the hole transport layer 41, a compound having a chemical structure of the group Y which is constituted from a substituted or unsubstituted aromatic hydrocarbon ring can be used.

In more detail, compounds having chemical structures of the group Y represented by any one of the above-mentioned chemical formulas (C1) to (C16) can be used.

In this regard, it is to be noted that the constituent material of the electron transport layer 43 are not limited to specific materials, and various materials can be used for the electron transport layer 43.

Examples of such materials that can be used for the electron transport layer 43 include: benzene-based compounds (starburst-based compounds) such as 1,3,5-tris[(3-phenyl-6-tri-fluoromethyl)quinoxaline-2-yl]benzene (TPQ1), and 1,3,5-tris[{3-(4-t-butylphenyl)-6-trisfluoromethyl}quinoxaline-2-yl]benzene (TPQ2); naphthalene-based compounds such as naphthalene; phenanthrene-based compounds such as phenanthrene; chrysene-based compounds such as chrysene; perylene-based compounds such as perylene; anthracene-based compounds such as anthracene; pyrene-based compounds such as pyrene; acridine-based compounds such as acridine; stilbene-based compounds such as stilbene; thiophene-based compounds such as BBO; butadiene-based compounds such as butadiene; coumarin-based compounds such as coumarin;

quinoline-based compounds such as quinoline; bistyryl-based compounds such as bistyryl; pyrazine-based compounds such as pyrazine and distyrylpyrazine; quinoxaline-based compounds such as quinoxaline; benzoquinone-based compounds such as benzoquinone, and 2,5-diphenyl-para-benzoquinone; naphthoquinone-based compounds such as naphthoquinone; anthraquinone-based compounds such as anthraquinone; oxadiazole-based compounds such as oxadiazole, 2-(4-biphenylyl)-5-(4-t-butylphenyl)-1,3,4-oxadiazole (PBD), BMD, BND, BDD, and BAPD; triazole-based compounds such as triazole, and 3,4,5-triphenyl-1,2,4-triazole; oxazole-based compounds; anthrone-based compounds such as anthrone; fluorenone-based compounds such as fluorenone, and 1,3,8-trinitro-fluorenone (TNF); diphenoquinone-based compounds such as diphenoquinone, and MBDQ; stilbenequinone-based compounds such as stilbenequinone, and MBSQ; anthraquinodimethane-based compounds; thiopyran dioxide-based compounds; fluorenylidene-methane-based compounds; diphenyldicyanoethylene-based compounds; florene-based compounds such as florene; metallic or non-metallic phthalocyanine-based compounds such as phthalocyanine, copper phthalocyanine, and iron phthalocyanine; and various metal complexes such as 8-hydroxyquinoline aluminum (Alq_3), and complexes having benzoxazole or benzothiazole as a ligand. These compounds may be used singly or in combination of two or more of them.

In the case where both of the hole transport layer 41 and the electron transport layer 43 are formed using the conductive material according to the present invention as a main material,

a constituent material of the hole transport layer 41 and a constituent material of the electron transport layer 43 are selected in consideration of their hole transport ability and electron transport ability.

Specifically, these constituent materials are selected so that the hole transport ability of the hole transport layer 41 becomes relatively higher than that of the electron transport layer 43 and the electron transport ability of the hole transport layer 41 becomes relatively lower than that of the electron transport layer 43. In other words, these constituent materials are selected so that the electron transport ability of the electron transport layer 43 becomes relatively higher than that of the hole transport layer 41 and the hole transport ability of the electron transport layer 43 becomes relatively lower than that of the hole transport layer 41.

For example, in the case where a polymer of a compound represented by the general formula (A1) in which the group Y has a chemical structure represented by the chemical formula (D18) or (D20) is used as a conductive material for forming a hole transport layer 41, a conductive material for forming an electron transport layer 43 is preferably a polymer of a compound represented by the general formula (1) in which the group Y has a chemical structure represented by the chemical formula (D7) or (D19). In this case, a polymer of a compound represented by the general formula (1) in which the group Y has a chemical structure represented by the chemical formula (D17) may also be used as a conductive material for forming the electron transport layer 43. In the case where a polymer of

a compound represented by the general formula (1) in which the group Y has a chemical structure represented by the chemical formula (D7), (D19), or (D17) is used as a conductive material for forming an electron transport layer 43, the conductive material for forming the hole transport layer 41 may also be a polymer of a compound represented by the general formula (1) in which the group Y has a chemical structure represented by the chemical formula (D2) or (D16).

Further, the volume resistivity of the hole transport layer 41 is preferably $10\ \Omega\cdot\text{cm}$ or larger, more preferably $10^2\ \Omega\cdot\text{cm}$ or larger. This makes it possible to provide an organic EL device 1 having a higher light emitting efficiency.

The thickness of the hole transport layer 41 is not limited to any specific value, but is preferably in the range of about 10 to 150 nm, more preferably in the range of about 50 to 100 nm. If the thickness of the hole transport layer 41 is too thin, there is a case that a pin hole may be produced. On the other hand, if the thickness of the hole transport layer 41 is too thick, there is a case that the transmittance of the hole transport layer 41 may be lowered so that the chromaticity (hue) of luminescent color of the organic EL device 1 is changed.

The thickness of the electron transport layer 43 is not limited to any specific value, but is preferably in the range of about 1 to 100 nm, more preferably in the range of about 20 to 50 nm. If the thickness of the electron transport layer 43 is too thin, there is a case that a pin hole may be produced, thereby causing a short-circuit. On the other hand, if the

electron transport layer 43 is too thick, there is a case that the value of resistance may become high.

Further, the conductive material according to the present invention is particularly useful for forming a relatively thin hole transport layer 41 or electron transport layer 43.

When a current flows between the anode 3 and the cathode 5 (that is, a voltage is applied across the anode 3 and the cathode 5), holes are moved in the hole transport layer 41 and electrons are moved in the electron transport layer 43, and the holes and the electrons are then recombined in the light emitting layer 42. Then, in the light emitting layer 42, excitons are produced by energy released upon the recombination, and the excitons release energy (in the form of fluorescence or phosphorescence) or emit light when returning to the ground state.

Any material can be used as a constituent material of the light emitting layer 42 (hereinafter, referred to as "light emitting material") so long as it can provide a field where holes can be injected from the anode 3 and electrons can be injected from the cathode 5 during the application of a voltage to allow the holes and the electrons to be recombined.

Such light emitting materials include various low-molecular light emitting materials and various high-molecular light emitting materials (which will be mentioned below). At least one of these materials can be used as a light emitting material.

In this regard, it is to be noted that the use of a low-molecular light emitting material makes it possible to obtain a dense light emitting layer 42, thereby improving the light emitting efficiency of the light emitting layer 42. Further, since a high-molecular light emitting material is relatively easily dissolved in a solvent, the use of such a high-molecular light emitting material makes it easy to form a light emitting layer 42 by means of various application methods such as an ink-jet method and the like. Furthermore, if the low-molecular light emitting material and the high-molecular light emitting material are used together, it is possible to obtain the synergistic effect resulting from the effect of the low-molecular light emitting material and the effect of the high-molecular light emitting material. That is, it is possible to obtain the effect that a dense light emitting layer 42 having excellent light emitting efficiency can be easily formed by means of various application methods such as the ink-jet method and the like.

Examples of such a low-molecular light emitting material include: benzene-based compounds such as distyrylbenzene (DSB), and diaminodistyrylbenzene (DADSB); naphthalene-based compounds such as naphthalene and Nile red; phenanthrene-based compounds such as phenanthrene; chrysene-based compounds such as chrysene and 6-nitrochrysene; perylene-based compounds such as perylene and N,N'-bis(2,5-di-t-butylphenyl)-3,4,9,10-perylene-di-carboxy imide (BPPC); coronene-based compounds such as coronene; anthracene-based compounds such as anthracene and

bisstyrylanthracene; pyrene-based compounds such as pyrene;
 pyran-based compounds such as
 4-(di-cyanomethylene)-2-methyl-6-(para-dimethylaminostyryl)
 -4H-pyran (DCM); acridine-based compounds such as acridine;
 stilbene-based compounds such as stilbene; thiophene-based
 compounds such as 2,5-dibenzooxazolethiophene;
 benzooxazole-based compounds such as benzooxazole;
 benzoimidazole-based compounds such as benzoimidazole;
 benzothiazole-based compounds such as
 2,2'-(para-phenylenedivinylene)-bisbenzothiazole;
 butadiene-based compounds such as
 bistyryl(1,4-diphenyl-1,3-butadiene) and
 tetraphenylbutadiene; naphthalimide-based compounds such as
 naphthalimide; coumarin-based compounds such as coumarin;
 perynone-based compounds such as perynone; oxadiazole-based
 compounds such as oxadiazole; aldazine-based compounds;
 cyclopentadiene-based compounds such as
 1,2,3,4,5-pentaphenyl-1,3-cyclopentadiene (PPCP);
 quinacridone-based compounds such as quinacridone and
 quinacridone red; pyridine-based compounds such as
 pyrrolopyridine and thiadiazolopyridine; spiro compounds such
 as 2,2',7,7'-tetraphenyl-9,9'-spirobifluorene; metallic or
 non-metallic phthalocyanine-based compounds such as
 phthalocyanine (H₂Pc) and copper phthalocyanine; florene-based
 compounds such as florene; and various metallic complexes such
 as 8-hydroxyquinoline aluminum (Alq₃),
 tris(4-methyl-8-quinolinolate) aluminum(III) (Almq₃),
 (8-hydroxyquinoline) zinc (Znq₂),
 (1,10-phenanthroline)-tris-(4,4,4-trifluoro-1-(2-thienyl)-b
 utane-1,3-dionate) europium(III) (Eu(TTA)₃(phen)),

fac-tris(2-phenylpyridine) iridium (Ir(ppy)_3), and
 (2,3,7,8,12,13,17,18-octaethyl-21H, 23H-porphin)
 platinum(II).

Examples of a high-molecular light emitting material include polyacetylene-based compounds such as trans-type polyacetylene, cis-type polyacetylene, poly(di-phenylacetylene) (PDPA), and poly(alkyl, phenylacetylene) (PAPA); polyparaphenylenevinylene-based compounds such as poly(para-phenylenevinylene) (PPV), poly(2,5-dialkoxy-para-phenylenevinylene) (RO-PPV), cyano-substituted-poly(para-phenylenevinylene) (CN-PPV), poly(2-dimethyloctylsilyl-para-phenylenevinylene) (DMOS-PPV), and poly(2-methoxy-5-(2'-ethylhexoxy)-para-phenylenevinylene) (MEH-PPV); polythiophene-based compounds such as poly(3-alkylthiophene) (PAT), and poly(oxypropylene)triol (POPT); polyfluorene-based compounds such as poly(9,9-dialkylfluorene) (PDAF), α,ω -bis[N,N'-di(methylphenyl)aminophenyl]-poly[9,9-bis(2-ethylhexyl)fluorene-2,7-diyl] (PF2/6am4), poly(9,9-dioctyl-2,7-divinylene-fluorenyl)-alt-co(anthracene-9,10-diyl); polyparaphenylene-based compounds such as poly(para-phenylene) (PPP), and poly(1,5-dialkoxy-para-phenylene) (RO-PPP); polycarbazole-based compounds such as poly(N-vinylcarbazole) (PVK); and polysilane-based compounds such as poly(methylphenylsilane) (PMPS), poly(naphthylphenylsilane) (PNPS), and poly(biphenylphenylsilane) (PBPS).

Further, the conductive material according to the present invention can also be used as the light emitting material depending on the combination of constituent materials used for forming a hole transport layer 41 and an electron transport layer 43.

For example, in the case where poly(thiophene/styrenesulfonic acid) such as poly(3,4-ethylenedioxythiophene/styrenesulfonic acid) or an arylamine compound such as N,N'-bis(1-naphthyl)-N,N'-diphenyl-benzidine(α -NPD) is used as a constituent material of the hole transport layer 41 and a triazole-based compound such as 3,4,5-triphenyl-1,2,4-triazole or an oxadiazole compound such as 2-(4-t-butylphenyl)-5-(biphenyl-4-yl)-1,3,5-oxadiazole (PBD) is used as a constituent material of the electron transport layer 43, a polymer of the compound represented by the general formula (1) in which the group Y has a chemical structure represented by the chemical formula (D12) or (D14) can be used as a conductive material for forming a light emitting layer 42.

The thickness of the light emitting layer 42 is not limited to any specific value, but is preferably in the range of about 10 to 150 nm, more preferably in the range of about 50 to 100 nm. By setting the thickness of the light emitting layer to a value within the above range, recombination of holes and electrons efficiently occurs, thereby enabling the light emitting efficiency of the light emitting layer 42 to be further improved.

It is to be noted here that any one of the electron transport layer 41, the light emitting layer 42, and the electron transport layer 43 in the organic EL device 1 may be formed using the conductive material according to the present invention or all the layers 41, 42, and 43 may be formed using the conductive material according to the present invention.

Although, in the present embodiment, each of the light emitting layer 42, the hole transport layer 41, and the electron transport layer 43 is separately provided, they may be formed into a hole-transportable light emitting layer which combines the hole transport layer 41 with the light emitting layer 42 or an electron-transportable light emitting layer which combines the electron transport layer 43 with the light emitting layer 42. In this case, an area in the vicinity of the boundary between the hole-transportable light emitting layer and the electron transport layer 43 or an area in the vicinity of the boundary between the electron-transportable light emitting layer and the hole transport layer 41 functions as the light emitting layer 42.

Further, in the case where the hole-transportable light emitting layer is used, holes injected from an anode into the hole-transportable light emitting layer are trapped by the electron transport layer, and in the case where the electron-transportable light emitting layer is used, electrons injected from a cathode into the electron-transportable light emitting layer are trapped in the electron-transportable light emitting layer. In both cases, there is an advantage in that

the recombination efficiency of holes and electrons can be improved.

In this regard, it is to be noted that between the adjacent layers in the layers 3, 4 and 5, any additional layer may be provided according to its purpose. For example, a hole injecting layer for improving the injection efficiency of holes from the anode 3 may be provided between the hole transport layer 41 and the anode 3, or an electron injecting layer for improving the injection efficiency of electrons from the cathode 5 may be provided between the electron transport layer 43 and the cathode 5. In such a case where the organic EL device 1 includes a hole injecting layer and/or an electron injecting layer, the conductive material according to the present invention can be used as a constituent material of the hole injecting layer and/or the electron injecting layer.

As a constituent material of a hole injecting layer other than the conductive material according to the present invention, for example, copper phthalocyanine, 4,4',4''-tris(N,N-phenyl-3-methylphenylamino)triphenylamine (M-MTDATA), or the like can be used.

As described above, the protection layer 6 is provided so as to cover the layers 3, 4 and 5 constituting the organic EL device 1. This protection layer 6 has the function of hermetically sealing the layers 3, 4 and 5 constituting the organic EL device 1 to shut off oxygen and moisture. By providing such a protection layer 6, it is possible to obtain the effect of improving the reliability of the organic EL device

1 and the effect of preventing the alteration and deterioration of the organic EL device 1.

Examples of a constituent material of the protection layer 6 include Al, Au, Cr, Nb, Ta and Ti, alloys containing them, silicon oxide, various resin materials, and the like. In this regard, it is to be noted that in the case where a conductive material is used as a constituent material of the protection layer 6, it is preferred that an insulating film is provided between the protection layer 6 and each of the layers 3, 4 and 5 to prevent a short circuit therebetween, if necessary.

The organic EL device 1 can be used for a display, for example, but it can also be used for various optical purposes such as a light source and the like.

In the case where the organic EL device 1 is used for a display, the drive system thereof is not particularly limited, and either of an active matrix system or a passive matrix system may be employed.

The organic EL device 1 as described above can be manufactured in the following manner, for example.

[A1] Step of forming anode

First, a substrate 2 is prepared, and then an anode 3 is formed on the substrate 2.

The anode 3 can be formed by, for example, chemical vapor deposition (CVD) such as plasma CVD, thermal CVD, and laser CVD,

vacuum deposition, sputtering, dry plating such as ion plating, wet plating such as electrolytic plating, immersion plating, and electroless plating, thermal spraying, a sol-gel method, a MOD method, bonding of a metallic foil, or the like.

[A2] Step of forming hole transport layer

Next, the substrate 2 on which the anode 3 is formed is placed in a chamber, and a hole transport layer (that is, a conductive layer of the present invention) 41 mainly constituted of the conductive material according to the present invention is formed on the anode 3.

As for the method for forming the hole transport layer 41, various methods can be employed if the methods allow the substituents X^1 of the compounds each represented by the above-mentioned general formula (A1) (hereinafter, simply referred to as "the compound (A1)" on occasions) to make polycondensation reaction with phosgene and/or its derivative. However, it is preferred to employ: (A2-I) a method in which the substituents X^1 are allowed to make polycondensation reaction with phosgene (hereinafter, referred to as "phosgene method") or (A2-II) a method in which the substituents X^1 are allowed to make ester exchange reaction with a phosgene derivative (hereinafter, referred to as "ester exchange method"). According to these methods, by setting various process conditions appropriately, it is possible to control the degree of the polycondensation reaction relatively easily, and therefore it is also possible to control a chain length of a resultant polymer (that is, conductive material) easily and reliably.

Hereinbelow, a detailed description will be made with regard to these methods.

(A2-I) Phosgene method

(A2-Ia) First, a hole transport material obtained by dissolving the compound (A1) and a base in an organic solvent is applied (or supplied) onto the anode 3.

In the application of the hole transport material, various application methods such as a spin coating method, a casting method, a micro gravure coating method, a gravure coating method, a bar coating method, a roll coating method, a wire-bar coating method, a dip coating method, a spray coating method, a screen printing method, a flexographic printing method, an offset printing method, an ink-jet method, and the like can be employed. By employing such application methods, it is possible to supply the hole transport material onto the anode 3 relatively easily.

Examples of the organic solvent include halogen compound-based solvents such as dichloromethane (methylene chloride), trichloromethane, carbon tetrachloride, 1,1-dichloroethane, 1,2-dichloroethane, 1,1,1-trichloroethane, and pentachloroethane; aromatic hydrocarbon-based solvents such as toluene, xylene, and benzene; ether-based solvents such as diethyl ether, diisopropyl ether, 1,2-dimethoxyethane (DME), 1,4-dioxane, tetrahydrofuran (THF), tetrahydropyran (THP), anisole, diethylen glycol dimethyl ether, and diethylen glycol ethyl

ether. These solvents can be used singly or in combination with two or more of them.

Further, the base is used for stabilizing a carbonyl group supplied from phosgene. Examples of the base include basic organic solvents such as pyridine, triethylamine, tributylamine, dimethyl aniline, formyldimethylamine, and triphenylamine; alkali metal hydroxide such as potassium hydroxide, lithium hydroxide, and cesium hydroxide. Among these substances, one containing the basic organic solvent as its major component is preferably used. The basic organic solvent can be eliminated or removed from the obtained hole transport layer 41 relatively easily. Therefore, it is possible to prevent reliably the basic organic solvent from remaining in the hole transport layer 41 as impurities.

Furthermore, in the basic organic solvents mentioned above, pyridine, triethylamine, tributylamine, and dimethyl aniline are preferably used because they function as a catalyst for promoting the polycondensation reaction between the substituents X^1 and phosgene in the next step (A2-Ib). This makes it possible to promote the polycondensation reaction more effectively.

In this regard, it is to be noted that examples of the catalyst further include in addition to the above substances quaternary ammonium salts such as trimethyl benzyl ammonium chloride, triethyl benzyl ammonium chloride, and tributyl benzyl ammonium chloride, and they may be contained in the hole transport material.

The mixing ratio of the organic solvent and the base is preferably in the range of 10:1 to 2:1 in volume ratio, and more preferably in the range of 5:1 to 3:1.

(A2-Ib) Next, phosgene is supplied onto the hole transport material applied on the anode 3. In this way, the substituents X^1 are allowed to make polycondensation reaction with phosgene to produce a polymer (conductive material of the present invention) in which the compounds (A1) are linked together via the link structure, so that the hole transport layer 41 is formed on the anode 3.

In this regard, the temperature of the mixture upon promoting the polycondensation reaction is preferably in the range of -20 to 20°C, and more preferably in the range of -20 to 0°C. By setting the temperature within the above range, it is possible to control relatively easily the progress of the polycondensation reaction in the mixture supplied onto the anode 3.

Further, the reaction time is preferably in the range of 1 minute to 4 hours, and more preferably in the range of 15 minutes to 2 hours, though this is slightly changed depending on the temperature of the mixture.

Furthermore, the thus obtained hole transport layer 41 may be subjected to a heat treatment, as needed, in an atmosphere or an inert atmosphere or under reduced pressure (in a vacuum). In this way, it is possible to dry (eliminate the solvent or

dispersion medium) or solidify the hole transport layer 41, for example. In this regard, it is to be noted that the hole transport layer 41 may be dried without such a heat treatment.

As stated above, in the phosgene method, phosgene is preferably used for the reaction with the compound (A1), but triphosgene, bromphosgene, bis(2,4,6-trichlorophenyl) carbonate, bis(2,4-dichlorophenyl) carbonate, bis(2-cyanophenyl) carbonate, chloroformate trichloromethyl, and the like may be used other than phosgene. They can be used singly or in combination with two or more of them.

[A2-II] Ester exchange method

(A2-Iia) First, a composition for the conductive material according to the present invention (a hole transport material) containing the compound (A1) and the phosgene derivative described above is applied (or supplied) onto the anode 3.

In the application of the hole transport material, the same methods described above with reference to the step (A2-Iia) can be employed.

As for a solvent or a dispersion medium used for preparation of the conductive material, the organic solvents described above with reference to the step {A2-Ia} can be used. Further, examples of solvents that can be used in this ester exchange method other than the above-mentioned organic solvents include: inorganic solvents such as nitric acid, sulfuric acid, ammonia, hydrogen peroxide, water, carbon disulfide, carbon tetrachloride, and ethylene carbonate; and various organic

solvents such as ketone-based solvents e.g. methyl ethyl ketone (MEK), acetone, diethyl ketone, methyl isobutyl ketone (MIBK), methyl isopropyl ketone (MIPK), and cyclohexanone; alcohol-based solvents e.g. methanol, ethanol, isopropanol, ethylene glycol, diethylene glycol (DEG), and glycerin; cellosolve-based solvents e.g. methyl cellosolve, ethyl cellosolve, and phenyl cellosolve; aliphatic hydrocarbon-based solvents e.g. hexane, pentane, heptane, and cyclohexane; aromatic heterocyclic compound-based solvents e.g. pyridine, pyrazine, furan, pyrrole, thiophene, and methyl pyrrolidone; amide-based solvents e.g. N,N-dimethylformamide (DMF) and N,N-dimethylacetamide (DMA); ester-based solvents e.g. ethyl acetate, methyl acetate, and ethyl formate; sulfur compound-based solvents e.g. dimethyl sulfoxide (DMSO) and sulfolane; nitrile-based solvents e.g. acetonitrile, propionitrile, and acrylonitrile; organic acid-based solvents e.g. formic acid, acetic acid, trichloroacetic acid, and trifluoroacetic acid; and mixed solvents containing them.

The mixing ratio of the compound (A1) and the phosgene derivative in the composition for the conductive material is preferably in the range of 1:1 to 1:12 in a molar ratio, and more preferably in the range of 1:2 to 1:6. This makes it possible to promote the polycondensation reaction between the substituents X¹ and the phosgene derivative effectively, and to thereby prevent effectively the compound (A1) from remaining unreacted in the obtained hole transport layer 41. Further, by containing the phosgene derivative of which amount is larger than the compound (A1) as the mixing ratio mentioned above, it is possible for the phosgene derivative to exhibit a function

of a reaction solvent.

In this connection, it is to be noted that a catalyst for promoting the ester exchange reaction may be added to the composition for the conductive material. As for the catalyst, catalysts same as those mentioned above with reference to the step (A2-Ia) may be used.

(A2-IIb) Next, the composition for the conductive material applied onto the anode 3 is heated.

By doing so, the ester exchange reaction (polycondensation reaction) between the substituents X^1 and the phosgene derivative is progressed, and therefore it is possible to obtain a polymer (that is, the conductive material of the present invention) which is linked by the link structure. Further, it is also possible to eliminate the by-product and the unreacted phosgene derivative from the hole transport layer 41 reliably. As a result, the hole transport layer 41 which is mainly formed of the conductive material of the present invention is formed on the anode 3.

The temperature for heating the composition for the conductive material is preferably in the range of 120 to 200°C, and more preferably in the range of 150 to 180°C. If the heating temperature is lower than the above-mentioned lower limit value, there is a case that formation of polymer does not progress adequately depending on the kind of the phosgene derivative used. On the other hand, if the heating temperature is higher than the above-mentioned upper limit value, there is a possibility

that a resultant polymer will be degraded or deteriorated, which is undesirable. However, by setting the heating temperature within the above-mentioned range, it is possible to eliminate the by-product and the unreacted phosgene derivative from the obtained hole transport layer 41 assuredly.

Further, the reaction time is preferably in the range of 1 minute to 4 hours, and more preferably in the range of 15 minutes to 2 hours, though this is slightly changed depending on the temperature of the mixture.

Furthermore, it is preferred that the heating of the composition for the conductive material is carried out under reduced pressure.

As described above, when the polycondensation reaction occurs between the substituents X1 and the phosgene derivative, a by-product is produced. When the compound represented by the general formula (A3) is used as the phosgene derivative, a by-product represented by the chemical formula $Z^1\text{-OH}$ is produced. Such a by-product (impurities) and the unreacted phosgene derivative can be eliminated from the hole transport layer 41 to be formed by heating the composition for the conductive material. In this case, if the heating is carried out under reduced pressure, it is possible to eliminate the by-product and the unreacted phosgene derivative more reliably. This makes it possible to prevent holes from being captured by the by-product or the unreacted phosgene derivative in the hole transport layer 41 reliably. As a result, it is possible to prevent the hole transport ability of the hole transport layer

41 from being decreased.

In this regard, it is to be noted that examples of the by-product represented by the chemical formula $Z^1\text{-OH}$ include methyl alcohol, ethyl alcohol, n-propyl alcohol, isopropyl alcohol, n-butyl alcohol, isobutyl alcohol, sec-butyl alcohol, tert-butyl alcohol, n-amyl alcohol, isoamyl alcohol, sec-amyl alcohol, tert-amyl alcohol, sec-isoamyl alcohol, diethyl carbinol, tert-butyl carbinol, 1-hexanol, 2-hexanol, 3-hexanol, 2-methyl-2-pentanol, 2-methyl-3-pentanol, 3-methyl-1-pentanol, 3-methyl-2-pentanol, 3-methyl-3-pentanol, 4-methyl-2-pentanol, 2,3-dimethyl-1-butanol, 2,3-dimethyl-2-butanol, 3,3-dimethyl-2-butanol, phenol, and benzyl alcohol, and the like.

Furthermore, the degree of the reduced pressure (degree of vacuum) is preferably 10^5 Pa or less, and more preferably 10^3 Pa or less. This makes it possible to eliminate the by-product and the unreacted phosgene derivative from the hole transport layer 41 reliably.

In this regard, it is to be noted that there is no particular limitation on the atmosphere in which the heating is carried out, but it is preferred that the heating is carried out in an inert gas atmosphere such as nitrogen gas and rare gas e.g. argon gas, helium gas, xenon gas, or the like. This makes it possible to prevent the ester exchange reaction between the substituents X^1 and the phosgene derivative from being inhibited due to the presence of the gas in the atmosphere. As

a result, it is possible to progress the ester exchange reaction reliably.

By forming the hole transport layer 41 using the conductive material according to the present invention as its main material by means of the method described above, it is possible to prevent the hole transport layer 41 from being swelled up or dissolved by a solvent or a dispersion medium contained in a light emitting layer material when the light emitting layer material is supplied in the next step [3A]. With this result, it is possible to prevent mutual dissolution from occurring between the hole transport layer 41 and the light emitting layer 42 reliably.

Further, by forming the hole transport layer 41 using the conductive material (polymer) according to the present invention as its main material, it is possible to prevent reliably the constituent materials of the hole transport layer 41 and the light emitting layer 42 from being mixed to each other with the elapse of time at the boundary of these layers 41, 42 in the obtained organic EL device.

The weight average molecular weight of the polymer is not particularly limited to any specific value, but it is preferably in the range of 2,000 to 1,000,000, and more preferably in the range of 5,000 to 300,000. This makes it possible to prevent reliably swelling-up and mutual dissolution of the polymer from occurring.

In this connection, it is to be noted that the hole

transport layer 41 may contain the compound (A1) and the phosgene derivative to such an extent that occurrence of the mutual dissolution of the hole transport layer 41 and the light emitting layer 42 is prevented.

[A3] Step of forming light emitting layer

Next, a light emitting layer 42 is formed on the hole transport layer 41.

The light emitting layer 42 can be formed by, for example, applying onto the hole transport layer 41, a light emitting layer material (that is, a material for forming a light emitting layer) obtained by dissolving the light emitting material as described above in a solvent or dispersing the light emitting material in a dispersion medium.

As solvents or dispersion media in which the light emitting material is to be dissolved or dispersed, the same solvents or dispersion media that have been mentioned with reference to the step of forming the hole transport layer [A2] can be used.

Further, as methods for applying the light emitting layer material onto the hole transport layer 41, the same application methods that have been mentioned with reference to the step of forming the hole transport layer [A2] can be employed.

[A4] Step of forming electron transport layer

Next, an electron transport layer 43 is formed on the light emitting layer 42.

In the case where a constituent material of the electron transport layer 43 is formed of the conductive material according to the present invention, the electron transport layer 43 can be formed using the composition for conductive materials according to the present invention in the same manner that has been described with reference to the step of forming the hole transport layer [A2].

On the other hand, in the case where a constituent material of the electron transport layer 43 is not formed of the conductive material according to the present invention, the electron transport layer 43 can be formed using the known electron transport materials described above in the same manner that has been described with reference to the step of forming the light emitting layer [A3].

In this regard, it is to be noted that in the case where the light emitting layer 42 is not formed using a polymer such as the conductive material according to the present invention, a solvent or dispersion medium in which the composition for conductive materials for use in forming the electron transport layer 43 is to be dissolved or dispersed is selected from among those which do not cause swelling and dissolution of the light emitting layer 42. By using such a solvent or a dispersion medium, it is possible to prevent mutual dissolution between the light emitting layer 42 and the electron transport layer 43 reliably.

[A5] Step of forming cathode

Next, a cathode 5 is formed on the electron transport layer 43.

The cathode 5 can be formed by, for example, vacuum deposition, sputtering, bonding of a metallic foil, or the like.

[A6] Step of forming protection layer

Next, a protection layer 6 is formed so as to cover the anode 3, the organic EL layer 4, and the cathode 5.

The protection layer 6 can be formed or provided by, for example, bonding a box-like protection cover made of the material as mentioned above by the use of various curable resins (adhesives).

As for such curable resins, all of thermosetting resins, photocurable resins, reactive curable resins, and anaerobic curable resins can be used.

The organic EL device 1 is manufactured through these steps as described above.

(Organic Thin Film Transistor)

Next, another embodiment of the electronic device according to the present invention will be described. In this embodiment, the electronic device of the present invention is embodied as an organic thin film transistor that is a switching element (hereinafter, simply referred to as an "organic TFT").

FIG. 2(a) is a cross-sectional view of an organic TFT 10,

and FIG. 2(b) is a plan view of the organic TFT 10. It is to be noted that in the following description, the upper side and the lower side in FIG. 2(a) will be referred to as "upper side" and "lower side", respectively.

The organic TFT 10 shown in FIG. 2 is provided on a substrate 20. On the substrate 20, a source electrode 30, a drain electrode 40, an organic semiconductor layer (that is, a conductive layer according to the present invention) 50, a gate insulating layer 60, and a gate electrode 70 are laminated in this order from the side of the substrate 20.

Specifically, in the organic TFT 10, the source electrode 30 and the drain electrode 40 are separately provided on the substrate 20, and the organic semiconductor layer 50 is provided so as to cover these electrodes 30 and 40. On the organic semiconductor layer 50, the gate insulating layer 60 is provided. On the gate insulating layer 60, the gate electrode 70 is provided so as to overlap with at least a region between the source electrode 30 and the drain electrode 40.

In the organic TFT 10, the region in the organic semiconductor layer 50 which is existed between the source electrode 30 and the drain electrode 40 functions as a channel region 510 where carriers are moved. Hereinafter, the length of the channel region 510 in a direction that carriers are moved, that is, the distance between the source electrode 30 and the drain electrode 40 is referred to as "channel length L", and the length of the channel region 510 in a direction orthogonal to the direction of the channel length L is referred to as

"channel width W".

The organic TFT 10 is an organic TFT having a structure in which the source electrode 30 and the drain electrode 40 are provided so as to be closer to the substrate 20 than the gate electrode 70 provided through the gate insulating layer 60. That is, the organic TFT 10 is an organic TFT having a top gate structure.

Hereinbelow, components of the organic TFT 10 will be described one by one.

The substrate 20 supports the layers (or the components) constituting the organic TFT 10. As such a substrate 20, for example, the same substrate that has been described with reference to the substrate 2 of the organic EL device 1 can be used. Alternatively, a silicon substrate or a gallium arsenide substrate may be used as the substrate 20.

On the substrate 20, the source electrode 30 and the drain electrode 40 are provided side by side at a predetermined distance in the direction of the channel length L.

The constituent material of the source electrode 30 and the drain electrode 40 is not particularly limited so long as it has conductivity. Examples of such a constituent material include metallic materials such as Pd, Pt, Au, W, Ta, Mo, Al, Cr, Ti, Cu, and alloys containing two or more of them, conductive oxide materials such as ITO, FTO, ATO, and SnO₂, carbon materials such as carbon black, carbon nanotube, and fullerene, and

conductive polymeric materials such as polyacetylene, polypyrrole, polythiophene e.g., PEDOT (poly-ethylenedioxythiophene), polyaniline, poly(p-phenylene), poly(p-phenylenevinylene), polyfluorene, polycarbazole, polysilane, and derivatives thereof. Among them, the conductive polymeric materials are usually doped with iron chloride, iodine, strong acid, organic acid, or a polymer such as polystyrenesulfonic acid so as to have conductivity when used. These conductive materials can be used singly or in combination of two or more of them.

The thickness of each of the source electrode 30 and the drain electrode 40 is not particularly limited, but is preferably in the range of about 30 to 300 nm, more preferably in the range of about 50 to 200 nm.

The distance between the source electrode 30 and the drain electrode 40, that is, the channel length L is preferably in the range of about 2 to 30 μm , more preferably in the range of about 2 to 20 μm .

The channel width W is preferably in the range of about 0.1 to 5 mm, more preferably in the range of about 0.3 to 3 mm.

As described above, the organic semiconductor layer 50 is provided on the substrate 20 so as to cover the source electrode 30 and the drain electrode 40. As a constituent material of the organic semiconductor layer 50, the conductive material according to the present invention can be used.

As described above, by appropriately setting the chemical structure of the group Y of the compound represented by the general formula (A1), it is possible to impart a desired carrier transport property to a resultant polymer (that is, to a conductive material according to the present invention).

Therefore, the conductive material according to the present invention is useful for forming an organic semiconductor layer 50 because it is possible to impart good semiconductivity to the polymer by appropriately setting the chemical structure of the group Y.

As a conductive material constituting such an organic semiconductor layer 50, for example, a polymer of the compound represented by the general formula (A1) in which the group Y has a chemical structure represented by any one of the chemical formulas (D2), (D3), (D16), (D17) and (D20) is preferably selected.

The thickness of the organic semiconductor layer 50 is preferably in the range of about 0.1 to 1,000 nm, more preferably in the range of about 1 to 500 nm, and even more preferably in the range of about 10 to 100 nm. By setting the thickness of the organic semiconductor layer 50 to a value within the above range, it is possible to prevent an increase in size of the organic TFT 10 (especially, an increase in thickness of the organic TFT 10) while maintaining a high carrier transport ability of the organic TFT 10.

By using the organic semiconductor layer 50 which is

obtained by using a polymer such as the conductive material according to the present invention as its main material, it is possible to obtain an organic TFT 10 having reduced size and weight. In addition, it is also possible for the organic TFT 10 to have excellent flexibility. Such an organic TFT 10 is suitably used for a switching element of a flexible display provided with the organic EL devices described above.

The organic semiconductor layer 50 is not limited to one provided so as to cover the source electrode 30 and the drain electrode 40. The organic semiconductor layer 50 should be provided in at least the region between the source electrode 30 and the drain electrode 40 (that is, in at least the channel region 510).

As described above, the gate insulating layer 60 is provided on the organic semiconductor layer 50.

The gate insulating layer 60 is provided to insulate the gate electrode 70 from the source electrode 30 and the drain electrode 40.

The gate insulating layer 60 is preferably formed using an organic material (especially, an organic polymeric material) as its main material. By using an organic polymeric material as a main material of the gate insulating layer 60, it is possible to form the gate insulating layer 60 easily as well as to bring the gate insulating layer 60 into closer contact with the organic semiconductor layer 50.

Examples of such an organic polymeric material include polystyrene, polyimide, polyamideimide, polyvinylphenylene, polycarbonate (PC), acrylic resins such as polymethylmethacrylate (PMMA), fluorinated resins such as polytetrafluoroethylene (PTFE), phenolic resins such as polyvinyl phenol and novolac resins, and olefin-based resins such as polyethylene, polypropylene, polyisobutylene, and polybutene. These organic polymeric materials may be used singly or in combination of two or more of them.

The thickness of the gate insulating layer 60 is not particularly limited, but is preferably in the range of about 10 to 5,000 nm, more preferably in the range of about 100 to 1,000 nm. By setting the thickness of the gate insulating layer 60 to a value within the above range, it is possible to prevent the size of the organic TFT 10 from being increased (especially, an increase in thickness of the organic TFT 10) while reliably insulating the gate electrode 70 from the source electrode 3 and the drain electrode 40.

It is to be noted that the gate insulating layer 60 is not limited to one comprised of a single layer and may have two or more layers.

As described above, the gate electrode 70 is provided on the gate insulating layer 60.

As constituent materials of the gate electrode 70, the same constituent materials that have been mentioned with reference to the source electrode 30 and the drain electrode

40 can be used.

The thickness of the gate electrode 70 is not particularly limited, but is preferably in the range of about 0.1 to 5,000 nm, more preferably in the range of about 1 to 5,000 nm, even more preferably in the range of about 10 to 5,000 nm.

In the organic TFT 10 as described above, the amount of current flowing between the source electrode 30 and the drain electrode 40 is controlled by changing voltage applied to the gate electrode 70.

Namely, in the OFF-state where voltage is not applied to the gate electrode 70, only a little current flows even by applying voltage across the source electrode 30 and the drain electrode 40 because carriers hardly exist in the organic semiconductor layer 50. On the other hand, in the ON-state where voltage is applied to the gate electrode 70, an electric charge is induced in the surface of the organic semiconductor layer 50 that is in contact with the gate insulating layer 60 so that a channel for carriers is formed in the channel region 510. In such a state, by applying voltage across the source electrode 30 and the drain electrode 40, it is possible to allow carriers (holes or electrons) to pass through the channel region 510.

Such an organic TFT 10 as described above can be manufactured in the following manner, for example.

FIGs. 3 and 4 are drawings (cross-sectional views) to be

used for explaining a manufacturing method of the organic TFT 10 shown in FIG. 2. It is to be noted that, in the following description, the upper side and lower side in FIGs. 3 and 4 will be referred to as the "upper side" and the "lower side", respectively.

[B1] Step of forming source electrode and drain electrode

[B1-1]

First, a substrate 20 as shown in FIG. 3 (a) is prepared. The substrate 20 is washed with, for example, water (e.g., pure water) and/or organic solvents. Water and organic solvents may be used singly or in combination of two or more of them.

Next, a photoresist is supplied onto the substrate 20 to form a film 80' (see FIG. 3 (b)).

As a photoresist to be supplied onto the substrate 20, either a negative-type photoresist or a positive-type photoresist may be used. When the negative-type photoresist is used, an area irradiated with light (that is, an area exposed to light) is cured and then an area other than the area exposed to light is dissolved by development to be removed. When the positive-type photoresist is used, an area exposed to light is dissolved by development to be removed.

Examples of such a negative-type photoresist include water-soluble photoresists such as rosin-dichromate, polyvinyl alcohol (PVA)-dichromate, shellac-dichromate,

casein-dichromate, PVA-diazo, and acrylic photoresists and oil-soluble photoresists such as polyvinyl cinnamate, cyclized rubber-azide, polyvinyl cinnamylidene acetate, and polycinnamic acid β -vinylloxyethyl ester.

Examples of a positive-type photoresist include oil-soluble photoresists such as o-naphthoquinonediazide.

Any method can be used for supplying a photoresist onto the substrate 20, but various application methods are preferably employed.

As such application methods, the same methods that have been mentioned with reference to the step of forming the hole transport layer [A2] in the manufacturing method of the organic EL device 1 can be employed.

Next, the film 80' is exposed to light through a photomask and is then developed to form a resist layer 80 having openings 820 where a source electrode 30 and a drain electrode 40 are to be formed (see FIG. 3(C)).

[B1-2]

Next, as shown in FIG. 3 (d), a predetermined amount of a liquid material 90 containing a constituent material of a source electrode 30 and a drain electrode 40 to be formed or a precursor thereof is supplied to the openings 820 provided on the substrate 20.

As solvents or dispersion media in which a constituent

material of a source electrode 30 and a drain electrode 40 or a precursor thereof is dissolved or dispersed for preparing a liquid material 90, the same solvents or dispersion media that have been mentioned with reference to the step of forming hole transport layer [A2] can be used.

As methods for supplying the liquid material 90 to the openings 820, the same application methods that have been mentioned above can be employed. Among these application methods, an inkjet method (that is, a liquid droplet ejecting method) is preferably employed. By employing the inkjet method, it is possible to eject the liquid material 90 in the form of liquid droplets from a nozzle of a liquid droplet ejecting head, thereby enabling the liquid material 90 to be reliably supplied to the openings 820. As a result, adhesion of the liquid material 90 to the resist layer 80 is reliably prevented.

[B1-3]

Next, the solvent or dispersion medium contained in the liquid material 90 supplied to the openings 820 is removed to form a source electrode 30 and a drain electrode 40.

The temperature at which the solvent or dispersion medium is removed is not particularly limited, and slightly varies depending on the kind of solvent or dispersion medium used. However, the temperature at which the solvent or dispersion medium is removed is preferably in the range of about 20 to 200°C, more preferably in the range of about 50 to 100°C. By removing the solvent or dispersion medium at a temperature within the above range, it is possible to reliably remove the solvent or

dispersion medium from the liquid material 90.

In this connection, it is to be noted that the solvent or dispersion medium contained in the liquid material 90 may be removed by heating under reduced pressure. By doing so, it is possible to more reliably remove the solvent or dispersion medium from the liquid material 90.

[B1-4]

Next, the resist layer 80 provided on the substrate 20 is removed to obtain the substrate 20 on which the source electrode 30 and the drain electrode 40 are formed (see FIG. 4(a)).

A method for removing the resist layer 80 is appropriately selected depending on the kind of resist layer 80. For example, ashing such as plasma treatment or ozone treatment, irradiation with ultraviolet rays, or irradiation with a laser such as a Ne-He laser, an Ar laser, a CO₂ laser, a ruby laser, a semiconductor laser, a YAG laser, a glass laser, a YVO₄ laser, or an excimer laser may be carried out. Alternatively, the resist layer 80 may be removed by being brought into contact with a solvent capable of dissolving or decomposing the resist layer 80 by, for example, immersing the resist layer 80 in such a solvent.

[B2] Step of forming organic semiconductor layer

Next, as shown in FIG. 4(b), an organic semiconductor layer 50 is formed on the substrate 20 so as to cover the source electrode 30 and the drain electrode 40 provided on the

substrate 20.

At this time, a channel region 510 is formed between the source electrode 30 and the drain electrode 40 (that is, in an area corresponding to an area where a gate electrode 70 is to be formed).

The organic semiconductor layer 50 can be formed by the same methods as those described with reference to the step of forming the hole transport layer [A2] in the manufacturing method of the organic EL device 1.

The organic semiconductor layer 50 is formed using the conductive material (that is, the polymer) according to the present invention as its main material. Therefore, when a gate insulating layer material is supplied onto the organic semiconductor layer 50 in the next step [B3], swelling and dissolution of the polymer due to a solvent or dispersion medium contained in the gate insulating layer material is properly inhibited or prevented. As a result, mutual dissolution between the organic semiconductor layer 50 and a gate insulating layer 60 is reliably prevented.

By forming an organic semiconductor layer 50 using a polymer such as the conductive material according to the present invention as its main material, it is possible to reliably prevent the mixing of the constituent materials of the organic semiconductor layer 50 and the gate insulating layer 60 from occurring near the boundary between these layers 50 and 60 with the lapse of time.

[B3] Step of forming gate insulating layer

Next, as shown in FIG. 4(c), a gate insulating layer 60 is formed on the organic semiconductor layer 50 by an application method.

Specifically, the gate insulating layer 60 can be formed by applying or supplying a solution containing an insulating material or a precursor thereof onto the organic semiconductor layer 50 by the application method described above. When necessary, the thus obtained layer is subjected to aftertreatment such as heating, irradiation with infrared rays, or exposure to ultrasound.

[B4] Step of forming gate electrode

Next, as shown in FIG. 4(d), a gate electrode 70 is formed on the gate insulating layer 60 by an application method.

Specifically, the gate electrode 70 can be formed by applying or supplying a solution containing an electrode material or a precursor thereof onto the gate insulating layer 60 by the application method. When necessary, the thus obtained layer is subjected to aftertreatment such as heating, irradiation with infrared rays, or exposure to ultrasound.

As application methods to be used, the same methods that have been mentioned above can be employed. Particularly, an inkjet method is preferably employed. By employing the inkjet method, it is possible to eject a solution containing an electrode material or a precursor thereof in the form of liquid

droplets from a nozzle of a liquid droplet ejecting head to carry out patterning. As a result, a gate electrode 70 having a predetermined shape is easily and reliably formed on the gate insulating layer 60.

The organic TFT 10 is manufactured through the steps described above.

(Electronic equipment)

The electronic devices according to the present invention such as the organic EL device (which is a light emitting device) 1 and the organic TFT (which is a switching element) 10 as described above can be used for various electronic equipment.

FIG. 5 is a perspective view which shows the structure of a personal mobile computer (or a personal notebook computer) to which the electronic equipment according to the present invention is applied.

In FIG. 5, a personal computer 1100 is comprised of a main body 1104 provided with a keyboard 1102 and a display unit 1106 provided with a display. The display unit 1106 is rotatably supported by the main body 1104 via a hinge structure.

In the personal computer 1100, for example, the display unit 1106 includes the organic EL device (which is a light emitting device) 1 and the organic TFT (which is a switching element) 10 described above.

FIG. 6 is a perspective view which shows the structure

of a mobile phone (including the personal handyphone system (PHS)) to which the electronic equipment according to the present invention is applied.

The mobile phone 1200 shown in FIG. 6 includes a plurality of operation buttons 1202, an earpiece 1204, a mouthpiece 1206, and a display.

In this mobile phone 1200, for example, the display includes the organic EL device (which is a light emitting device) 1 and the organic TFT (which is a switching element) 10 described above.

FIG. 7 is a perspective view which shows the structure of a digital still camera to which the electronic equipment according to the present invention is applied. In this drawing, interfacing to external devices is simply illustrated.

In a conventional camera, a silver salt film is exposed to the optical image of an object. On the other hand, in the digital still camera 1300, an image pickup device such as a CCD (Charge Coupled Device) generates an image pickup signal (or an image signal) by photoelectric conversion of the optical image of an object.

In the rear surface of a case (or a body) 1302 of the digital still camera 1300, there is provided a display which provides an image based on the image pickup signal generated by the CCD. That is, the display functions as a finder which displays the object as an electronic image.

In this digital still camera 1300, for example, the display includes the organic EL device (which is a light emitting device) 1 and the organic TFT (which is a switching element) 10 described above.

In the inside of the case, there is provided a circuit board 1308. The circuit board 1308 has a memory capable of storing an image pickup signal.

In the front surface of the case 1302 (in FIG. 7, the front surface of the case 1302 is on the back side), there is provided a light receiving unit 1304 including an optical lens (an image pickup optical system) and a CCD.

When a photographer presses a shutter button 1306 after checking an object image on the display, an image pickup signal generated by the CCD at that time is transferred to the memory in the circuit board 1308 and then stored therein.

Further, in the side surface of the case 1302 of the digital still camera 1300, there are provided a video signal output terminal 1312 and an input-output terminal for data communication 1314. As shown in FIG. 7, when necessary, a television monitor 1430 and a personal computer 1440 are connected to the video signal output terminal 1312 and the input-output terminal for data communication 1314, respectively. In this case, an image pickup signal stored in the memory of the circuit board 1308 is outputted to the television monitor 1430 or the personal computer 1440 by

carrying out predetermined operation.

The electronic equipment according to the present invention can be applied not only to the personal computer (which is a personal mobile computer) shown in FIG. 5, the mobile phone shown in FIG. 6, and the digital still camera shown in FIG. 7 but also to a television set, a video camera, a view-finder or monitor type of video tape recorder, a laptop-type personal computer, a car navigation device, a pager, an electronic notepad (which may have communication facility), an electronic dictionary, an electronic calculator, a computerized game machine, a word processor, a workstation, a videophone, a security television monitor, an electronic binocular, a POS terminal, an apparatus provided with a touch panel (e.g., a cash dispenser located on a financial institute, a ticket vending machine), medical equipment (e.g., an electronic thermometer, a sphygmomanometer, a blood glucose meter, an electrocardiograph monitor, ultrasonic diagnostic equipment, an endoscope monitor), a fish detector, various measuring instruments, gages (e.g., gages for vehicles, aircraft, and boats and ships), a flight simulator, various monitors, and a projection display such as a projector.

The conductive material, the composition for the conductive material, the conductive layer, the electronic device, and the electronic equipment according to the present invention have been described based on the embodiments shown in the drawings, but the present invention is not limited thereto.

For example, in the case where the electronic device according to the present invention has a hole transport layer as a conductive layer, such an electronic device can be used for, for example, a solar cell that is an example of light receiving devices (or photoelectric transducers) as well as the organic EL device as described above that is an example of display devices (or light emitting devices).

Further, in the case where the electronic device according to the present invention has an organic semiconductor layer as a conductive layer, such an electronic device can be used for, for example, a semiconductor device as well as the organic TFT as described above that is an example of switching elements.

Furthermore, the conductive layer according to the present invention can be used as, for example, wiring or an electrode as well as the hole transport layer as described above. In this case, a resultant electronic device according to the present invention can be used for a wiring board and the like.

Examples

Next, the present invention will be described with reference to Examples.

1. Synthesis of compound

First, compounds (AI) to (SII) described below were prepared.

<Compound (AI)>

6-(p-aminophenyl)hexanol was treated with 4-methoxybenzylbromide and sodium hydride in anhydrous dimethylformamide to transform hydroxyl group into benzyl ether group and then it was protected.

Next, 1 mol of the obtained compound was dissolved in 150 mL of acetic acid, and acetic anhydride was dropped therein at room temperature and then they were stirred. After the completion of the reaction, solid matter precipitated was filtered and then dried after washing with water.

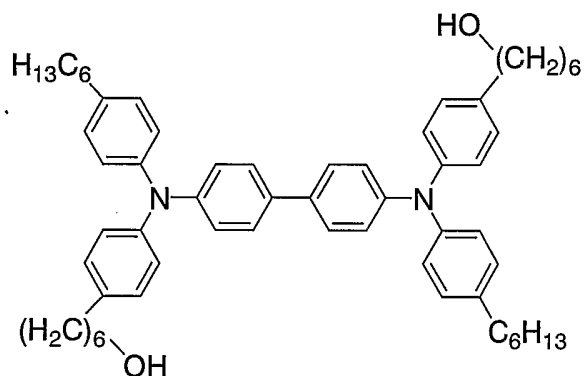
Next, 0.37 mol of the thus obtained substance, 0.66 mol of 1-bromo-4-hexylbenzene, 1.1 mol of potassium carbonate, copper powder, and iodine were mixed and heated at 200°C. After the mixture was allowed to cool, 130 mL of isoamyl alcohol, 50 mL of pure water, and 0.73 mol of potassium hydroxide were added to the mixture, and then they were stirred and dried.

Further, 130 mmol of the thus obtained compound, 62 mmol of 4,4'-diiodobiphenyl, 1.3 mmol of palladium acetate, 5.2 mmol of t-butylphosphine, 260 mmol of sodium t-butoxide, and 700 mL of xylene were mixed, and then they were stirred at 120°C. Thereafter, the mixture was allowed to cool for crystallization.

The thus obtained compound was then reduced by hydrogen gas under Pd-C catalyst so that transformation was made from the benzyl ether group to the hydroxyl group to carry out deprotection, and then it was allowed to cool for crystallization to obtain a compound.

Then, the thus obtained compound was confirmed to be the following compound (AI) by means of a mass spectrum (MS) method, a ^1H -nuclear magnetic resonance (^1H -NMR) spectrum method, a ^{13}C -nuclear magnetic resonance (^{13}C -NMR) spectrum method, and a Fourier transform infrared absorption (FT-IR) spectrum method.

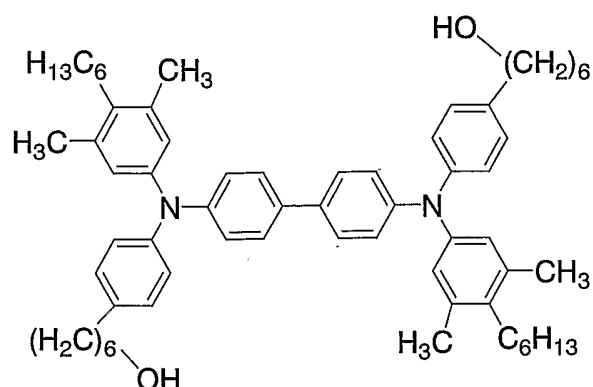
(AI)



<Compound (BI)>

A compound (BI) was obtained in the same manner as the compound (AI) except that 1-bromo-4-hexylbenzene was changed to 1-bromo-3,5-dimethyl-4-hexylbenzene.

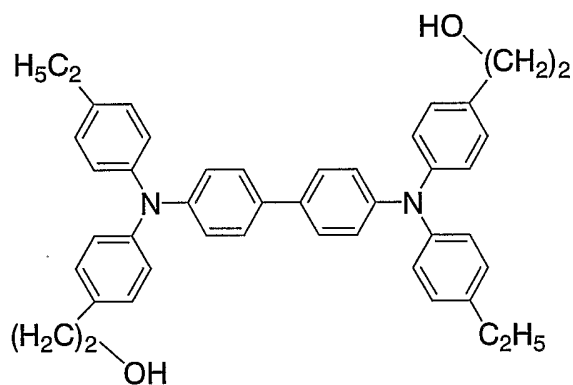
(BI)



<Compound (CI)>

A compound (CI) was obtained in the same manner as the compound (AI) except that 6-(p-aminophenyl)hexanol was changed to 2-(p-aminophenyl)ethanol and 1-bromo-4-hexylbenzene was changed to 1-bromo-4-ethylbenzene, respectively.

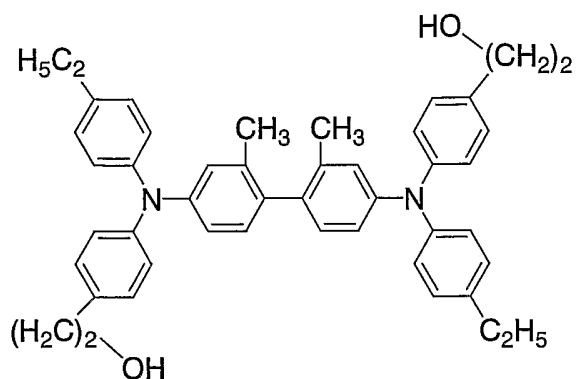
(CI)



<Compound (DI)>

A compound (DI) was obtained in the same manner as the compound (CI) except that 4,4'-diiodobiphenyl was changed to 4,4'-diiodo-2,2'-dimethylbiphenyl.

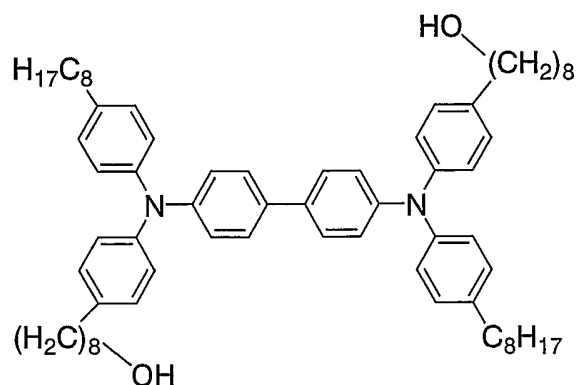
(DI)



<Compound (EI)>

A compound (EI) was obtained in the same manner as the compound (AI) except that 6-(p-aminophenyl)hexanol was changed to 8-(p-aminophenyl)octanol and 1-bromo-4-hexylbenzene was changed to 1-bromo-4-octylbenzene, respectively.

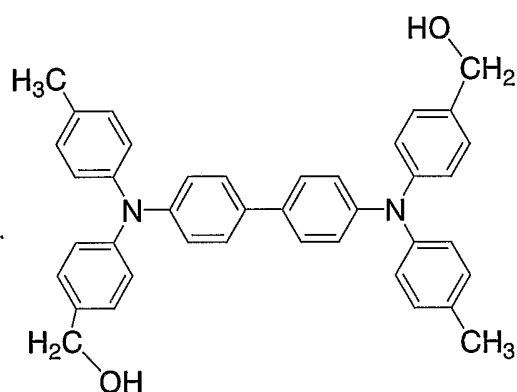
(EI)



<Compound (FI)>

A compound (FI) was obtained in the same manner as the compound (AI) except that 6-(p-aminophenyl)hexanol was changed to 1-(p-aminophenyl)methanol and 1-bromo-4-hexylbenzene was changed to 4-bromotoluene, respectively.

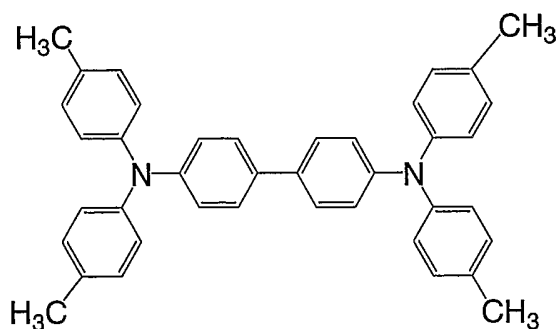
(FI)



<Compound (GI)>

As for the following compound (GI), N,N,N',N'-tetrakis(4-methylphenyl)-benzidine ("OSA 6140" provided by TOSCO CO., LTD.) was prepared.

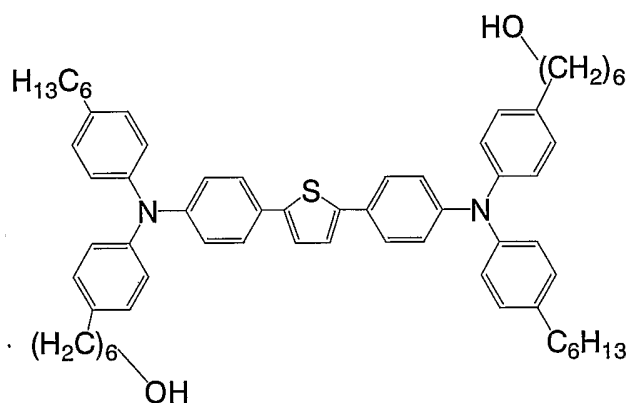
(GI)



<Compound (AII)>

A compound (AII) was obtained in the same manner as the compound (AI) except that 4,4'-diiodobiphenyl was changed to 2,5-bis(4-iodophenyl)-thiophene.

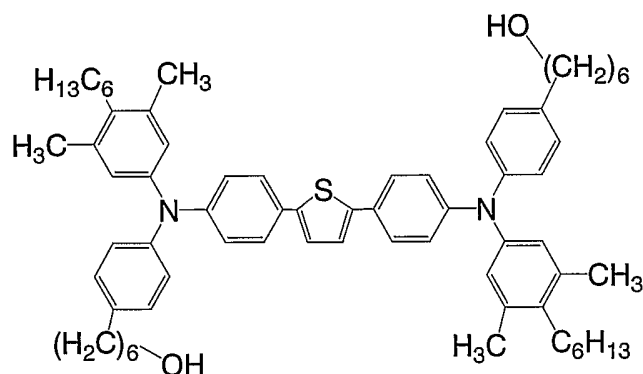
(AII)



<Compound (BII)>

A compound (BII) was obtained in the same manner as the compound (AII) except that 1-bromo-4-hexylbenzene was changed to 1-bromo-3,5-dimethyl-4-hexylbenzene.

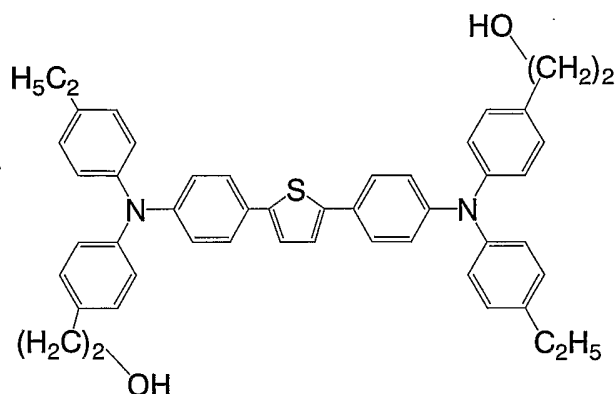
(BII)



<Compound (CII)>

A compound (CII) was obtained in the same manner as the compound (AII) except that 6-(p-aminophenyl)hexanol was changed to 2-(p-aminophenyl)ethanol and 1-bromo-4-hexylbenzene was changed to 1-bromo-4-ethylbenzene, respectively.

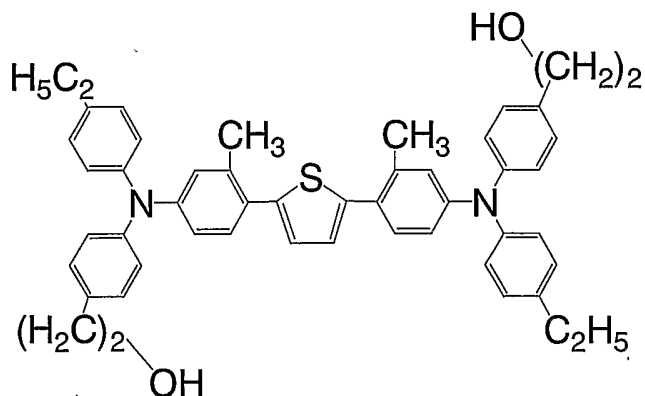
(CII)



<Compound (DII)>

A compound (DII) was obtained in the same manner as the compound (CII) except that 2,5-bis(4-iodophenyl)-thiophene was changed to 2,5-bis(2-methyl-4-iodophenyl)-thiophene.

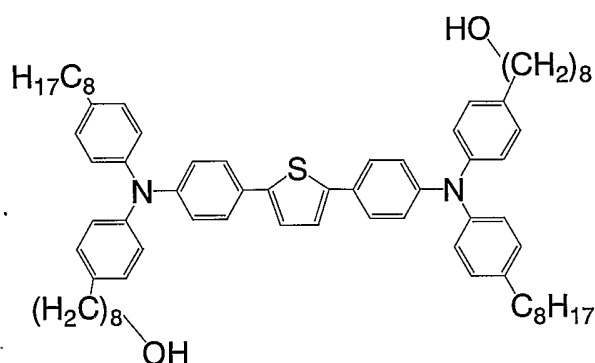
(DII)



<Compound (EII)>

A compound (EII) was obtained in the same manner as the compound (AII) except that 6-(p-aminophenyl)hexanol was changed to 8-(p-aminophenyl)octanol and 1-bromo-4-hexylbenzene was changed to 1-bromo-4-octylbenzene, respectively.

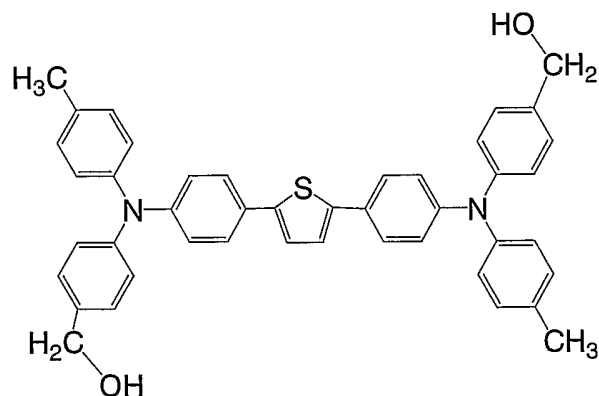
(EII)



<Compound (FII)>

A compound (FII) was obtained in the same manner as the compound (AII) except that 6-(p-aminophenyl)hexanol was changed to 1-(p-aminophenyl)methanol and 1-bromo-4-hexylbenzene was changed to 4-bromotoluene, respectively.

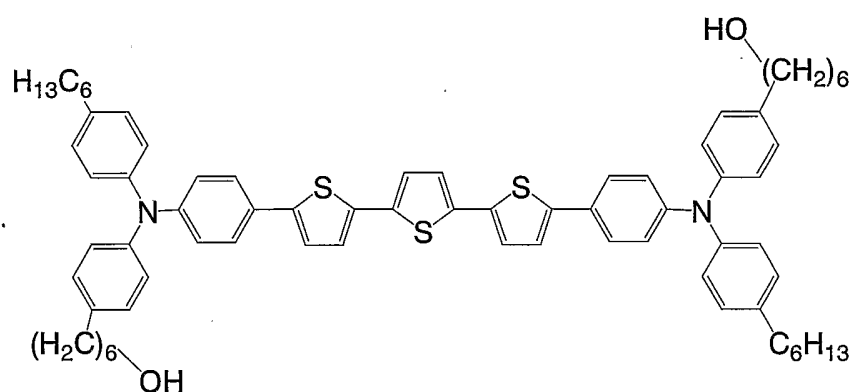
(FII)



<Compound (GII)>

A compound (GII) was obtained in the same manner as the compound (AII) except that 2,5-bis(4-iodophenyl)-thiophene was changed to 5,5''-bis(4-iodophenyl)-2,2':5',2''-ter-thiophene.

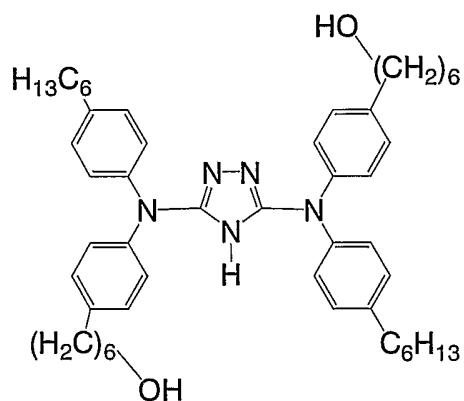
(GII)



<Compound (HII)>

A compound (HII) was obtained in the same manner as the compound (AII) except that 2,5-bis(4-iodophenyl)-thiophene was changed to 3,5-diiodo-1,2,4-triazole.

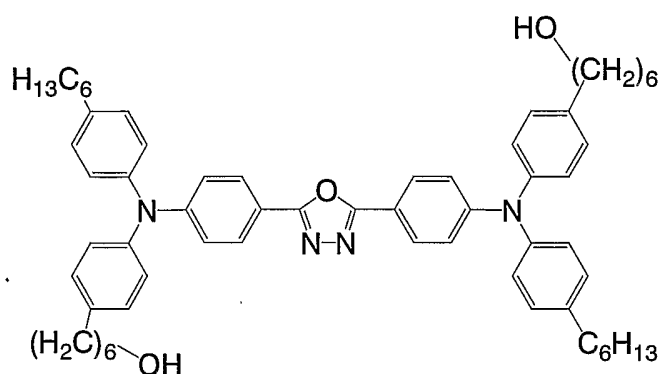
(HII)



<Compound (III)>

A compound (III) was obtained in the same manner as the compound (AII) except that 2,5-bis(4-iodophenyl)-thiophene was changed to 2,5-(4-iodophenyl)-1,3,4-oxadiazole.

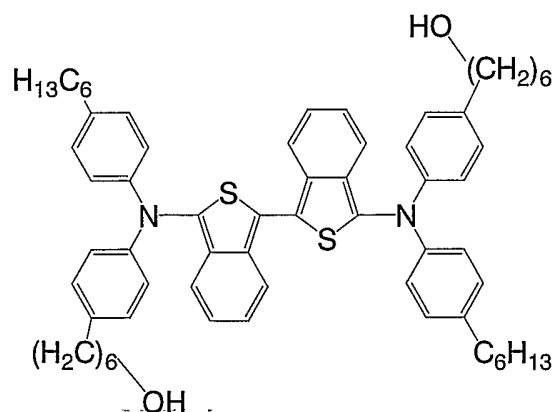
(III)



<Compound (JII)>

A compound (JII) was obtained in the same manner as the compound (AII) except that 2,5-bis(4-iodophenyl)-thiophene was changed to 3,3'-diiodo-1,1'-biisobenzothiophene.

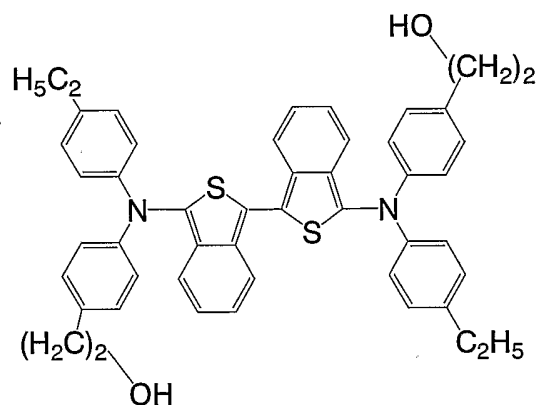
(JII)



<Compound (KII)>

A compound (KII) was obtained in the same manner as the compound (JII) except that 6-(p-aminophenyl)hexanol was changed to 2-(p-aminophenyl)ethanol and 1-bromo-4-hexylbenzene was changed to 1-bromo-4-ethylbenzene, respectively.

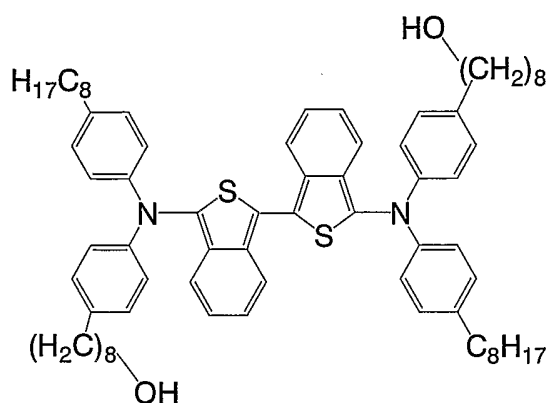
(KII)



<Compound (LII)>

A compound (LII) was obtained in the same manner as the compound (JII) except that 6-(p-aminophenyl)hexanol was changed to 8-(p-aminophenyl)octanol and 1-bromo-4-hexylbenzene was changed to 1-bromo-4-octylbenzene, respectively.

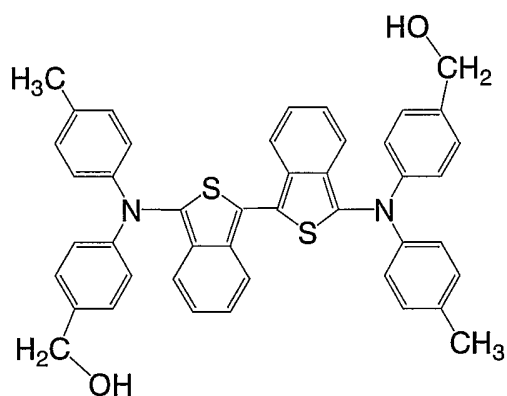
(LII)



<Compound (MII)>

A compound (MII) was obtained in the same manner as the compound (JII) except that 6-(p-aminophenyl)hexanol was changed to 1-(p-aminophenyl)methanol and 1-bromo-4-hexylbenzene was changed to 4-bromotoluene, respectively.

(MII)

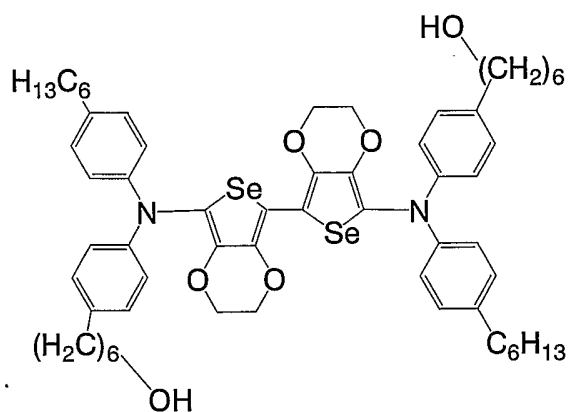


<Compound (NII)>

A compound (NII) was obtained in the same manner as the compound (AII) except that 2,5-bis(4-iodophenyl)-thiophene

was changed to
5,5'-diiodo-2,2'-bi(3,4-dioxyethyleneselenophene).

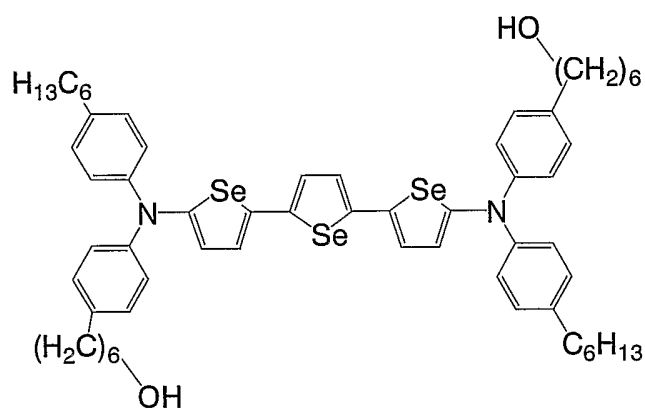
(NII)



<Compound (OII)>

A compound (OII) was obtained in the same manner as the compound (AII) except that 2,5-bis(4-iodophenyl)-thiophene was changed to 5,5''-diiodo-2,2':5',2''-ter-selenophene.

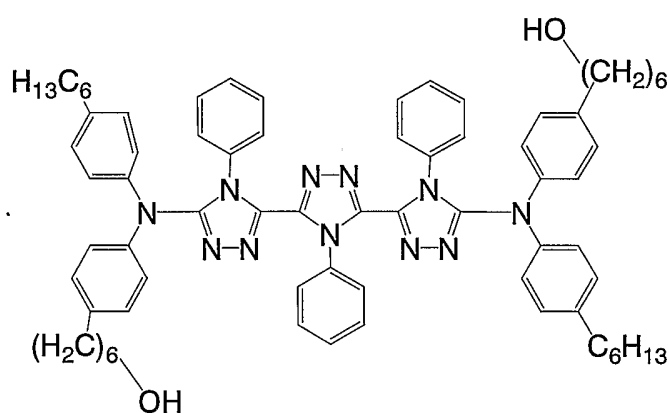
(OII)



<Compound (PII)>

A compound (PII) was obtained in the same manner as the compound (AII) except that 2,5-bis(4-iodophenyl)-thiophene was changed to 5,5''-diiodo-3,3':5',3''-ter-(4-phenyl-1,2,4-triazole).

(PII)



<Compound (QII)>

1 mol of 1-amino-4-methylbenzene was dissolved in 150 mL of acetic acid, and acetic anhydride was dropped therein at room temperature, and then they were stirred. After the completion of the reaction, solid matter precipitated was filtered, and was then dried after washing with water.

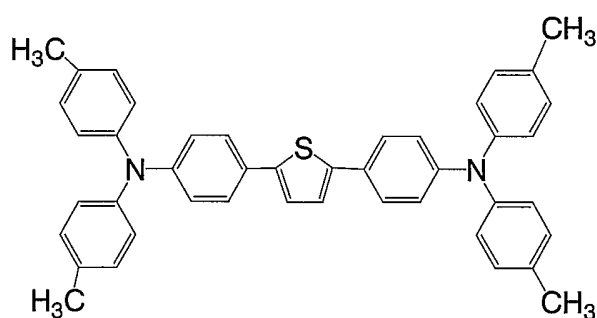
Next, 0.37 mol of the thus obtained substance, 0.66 mol of 1-bromo-4-methylbenzene, 1.1 mol of potassium carbonate, copper powder, and iodine were mixed and heated at 200°C. After the mixture was allowed to cool, 130 mL of isoamyl alcohol, 50 mL of pure water, and 0.73 mol of potassium hydroxide were added to the mixture, and then they were stirred and dried.

Further, 130 mmol of the thus obtained compound, 62 mmol of 2,5-bis(4-iodophenyl)-thiophene, 1.3 mmol of palladium acetate, 5.2 mmol of t-butylphosphine, 260 mmol of sodium t-butoxide, and 700 mL of xylene were mixed, and then they were stirred at 120°C.

Thereafter, the mixture was allowed to cool for crystallization to obtain a compound.

Then, the thus obtained compound was found to be the following compound (QII) by means of a mass spectrum (MS) method, a ^1H -nuclear magnetic resonance (^1H -NMR) spectrum method, a ^{13}C -nuclear magnetic resonance (^{13}C -NMR) spectrum method, and a Fourier transform infrared absorption (FT-IR) spectrum method.

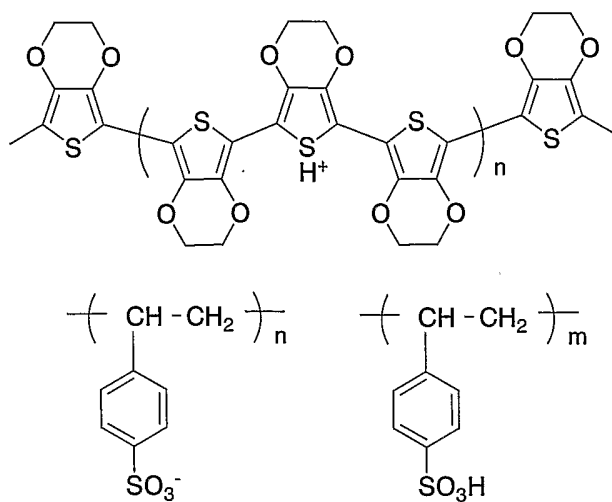
(QII)



<Compound (RII)>

Poly(3,4-ethylenedioxythiophene/styrenesulfonic acid) ("BAYTRON P CH800", Bayer) was prepared as the following compound (RII).

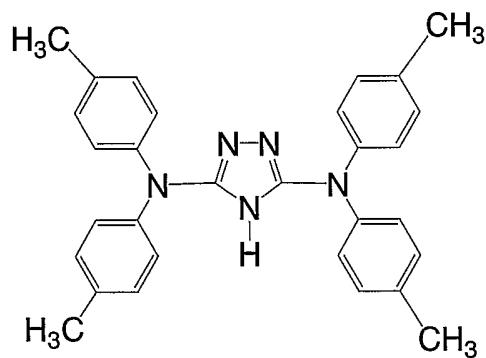
(RII)



<Compound (SII)>

A compound (SII) was obtained in the same manner as the compound (QII) except that 2,5-bis(4-iodophenyl)-thiophene was changed to 3,5-diiodo-1,2,4-triazole.

(SII)



2. Manufacture of organic EL device

Five organic EL devices were manufactured in each of the following Examples and Comparative Examples.

(Example 1A)

<Preparation of hole transport material>

The compound (AI) was used as an arylamine derivative, pyridine was used as a base, and tetrahydrofuran (THF) was used as an organic solvent, respectively, and then the compound (AI) was dissolved in a mixed solution of the pyridine solution and the THF in a volume ratio of 5:1 to prepare a hole transport material.

<Manufacture of organic EL device>

1A First, an ITO electrode (that is, an anode) was formed on a transparent glass substrate having an average thickness of 0.5 mm by vacuum evaporation so as to have an average thickness of 100 nm.

2A Next, the glass substrate on which the ITO electrode was formed was placed in a chamber, and then the hole transport material was applied onto the ITO electrode by a spin coating method.

Then, the inside of the closed chamber where the hole transport material was placed was maintained at a temperature of 0°C and phosgene was introduced thereinto so as to establish 1 atmospheric pressure (at 0°C). After such a state was being kept for one hour to allow the hydrated alkyl group of the

compound (AI) to make polycondensation reaction with phosgene, it was dried to form a hole transport layer having an average thickness of 50 nm.

3A Next, a 1.7 wt% xylene solution of poly(9,9-dioctyl-2,7-divinylene-fluorenyl-alt-co(anthracene-9,10-diyl)) (Weight average molecular weight: 200,000) was applied onto the hole transport layer by a spin coating method, and was then dried to form a light emitting layer having an average thickness of 50 nm.

4A Next, an electron transport layer having an average thickness of 20 nm was formed on the light emitting layer by vacuum evaporation of 3,4,5-triphenyl-1,2,4-triazole.

5A Next, an AlLi electrode (that is, a cathode) was formed on the electron transport layer by vacuum evaporation so as to have an average thickness of 300 nm.

6A Next, a protection cover made of polycarbonate was provided so as to cover these layers described above, and was then secured and sealed with an ultraviolet curable resin to obtain an organic EL device.

(Example 2A)

<Preparation of hole transport material>

The compound (AI) was used as an arylamine derivative, and diethyl carbonate was used as a phosgene derivative, respectively, and then the compound (AI) and the diethyl carbonate were dissolved in a solution of tetrahydrofuran (THF)

to prepare a hole transport material (a composition for the conductive material). In this case, the mixing ratio of the compound (AI) to the diethyl carbonate was 1:4 in a mole ratio.

<Manufacture of organic EL device>

Organic EL devices were manufactured in the same manner as in Example 1A except that the hole transport material applied onto the ITO electrode in the above described step 2A was subjected to a heat treatment in a nitrogen gas atmosphere with the treatment conditions at a temperature of 150°C and a pressure of 10^3 Pa for 30 minutes so that the hydrated alkyl group of the compound (AI) was allowed to make ester exchange reaction with the diethyl carbonate to thereby form a hole transport layer having an average thickness of 50 nm.

(Example 3A)

Organic EL devices were manufactured after a hole transport material was prepared in the same manner as in Example 1A except that as for the arylamine derivatives, the compound (BI) was used.

(Example 4A)

Organic EL devices were manufactured after a hole transport material was prepared in the same manner as in Example 2A except that as for the arylamine derivatives, the compound (BI) was used.

(Example 5A)

Organic EL devices were manufactured after a hole transport material was prepared in the same manner as in Example

1A except that as for the arylamine derivatives, the compound (CI) was used.

(Example 6A)

Organic EL devices were manufactured after a hole transport material was prepared in the same manner as in Example 2A except that as for the arylamine derivatives, the compound (CI) was used.

(Example 7A)

Organic EL devices were manufactured after a hole transport material was prepared in the same manner as in Example 1A except that as for the arylamine derivatives, the compound (DI) was used.

(Example 8A)

Organic EL devices were manufactured after a hole transport material was prepared in the same manner as in Example 2A except that as for the arylamine derivatives, the compound (DI) was used.

(Example 9A)

Organic EL devices were manufactured after a hole transport material was prepared in the same manner as in Example 1A except that as for the arylamine derivatives, the compound (EI) was used.

(Example 10A)

Organic EL devices were manufactured after a hole transport material was prepared in the same manner as in Example

2A except that as for the arylamine derivatives, the compound (EI) was used.

(Comparative Example 1A)

<Preparation of hole transport material>

A hole transport material was obtained by dissolving the compound (G1) with dichloroethane.

<Manufacture of organic EL device>

Organic EL devices were manufactured in the same manner as in Example 1A except that the hole transport layer was formed by drying the hole transport material applied (supplied) onto the ITO electrode in the step 2A.

(Comparative Example 2A)

<Preparation of hole transport material>

The compound (RII) was dispersed in water to prepare a 2.0 wt% water dispersion of the compound (RII) to obtain a hole transport material.

In this regard, it is to be noted that the weight ratio of 3,4-ethylenedioxythiophene to styrenesulfonic acid in the compound (RII) was 1: 20.

<Manufacture of organic EL device>

Organic EL devices were manufactured in the same manner as in Comparative Example 1A except that the hole transport material was changed to the hole transport material prepared in this Comparative Example 2A.

(Comparative Example 3A)

<Preparation of hole transport material>

The compound (AI) was used as an arylamine derivative, and the compound (AI) and a polycarbonate resin ("Panlite L 1250" produced by Teijin Chemicals LTD.) in a weight ratio of 3:7 were mixed with dichloroethane to prepare a hole transport material.

<Manufacture of organic EL device>

Organic EL devices were manufactured in the same manner as in Comparative Example 1A except that the hole transport material was changed to the hole transport material prepared in this Comparative Example 3A.

(Comparative Example 4A)

<Preparation of hole transport material>

The compound (GI) was used as an arylamine derivative, and a bisphenol A epoxy compound ("ADEKA RESIN EP" produced by ASAHI DENKA CO., LTD.) was used as a photocrosslinking agent, and then the compound (GI), the bisphenol A epoxy compound and a cationic photopolymerization initiator ("FC-508" produced by Sumitomo 3M Limited) in a weight ratio of 85:14:1 were mixed with dichloroethane to obtain a hole transport material.

<Manufacture of organic EL device>

Organic EL devices were manufactured in the same manner as in Example 1A except that the hole transport layer was formed by drying the hole transport material applied (supplied) onto the ITO electrode in the step 2A, irradiating the dried hole transport material in an atmosphere with ultraviolet rays

having a wavelength of 365 nm from a mercury lamp ("UM-452", USHIO Inc.) through a filter at an intensity of irradiation of 400 mW/cm² for 10 seconds, and then heating the hole transport material at a temperature of 110°C for 60 minutes.

(Comparative Example 5A)

Organic EL devices were manufactured after a hole transport material was prepared in the same manner as in Example 1A except that as for the arylamine derivatives, the compound (FI) was used.

(Comparative Example 6A)

Organic EL devices were manufactured after a hole transport material was prepared in the same manner as in Example 2A except that as for the arylamine derivatives, the compound (FI) was used.

(Example 1B)

<Preparation of hole transport material>

The compound (AII) was used as an arylamine derivative, pyridine was used as a base, and tetrahydrofuran (THF) was used as an organic solvent, respectively, and then the compound (AII) was dissolved in a mixed solution of the pyridine solution and the THF in a volume ratio of 5:1 to prepare a hole transport material.

<Preparation of electron transport material>

An electron transport material (that is, a composition for the conductive material) was obtained in the same manner as the hole transport material prepared in this Example except

that the compound (HII) was used as an arylamine derivative.

<Manufacture of organic EL device>

1B First, an ITO electrode (that is, an anode) was formed on a transparent glass substrate so as to have an average thickness of 100 nm in the same manner as the step 1A.

2B Next, the glass substrate on which the ITO electrode was formed was placed in a chamber, and then the prepared hole transport material was applied onto the ITO electrode by a spin coating method.

Then, the inside of the closed chamber where the hole transport material was placed was maintained at a temperature of 0°C and phosgene was introduced thereinto so as to establish a pressure of 10^5 Pa (at 0°C). After such a state was being kept for one hour to allow the hydrated alkyl group of the compound (AII) to make polycondensation reaction with phosgene, it was dried to form a hole transport layer having an average thickness of 50 nm.

3B Next, in the same manner as the above described step 3A, a light emitting layer having an average thickness of 50 nm.

4B Next, an electron transport layer having an average thickness of 20 nm was formed on the light emitting layer by polycondensation reaction of the hydrated alkyl group of the compound (HII) and phosgene in the same manner as the above described step 2B excepting that the prepared electron

transport material was used instead of the hole transport material

5B Next, an AlLi electrode (that is, a cathode) was formed on the electron transport layer so as to have an average thickness of 300 nm in the same manner as the above described step 5A.

6B Next, in the same manner as the above described step 6A, a protection cover made was provided so as to cover and seal these layers described above, thereby obtaining an organic EL device.

(Examples 2B to 13B)

In each of Examples 2B to 13B, organic EL devices were manufactured after a hole transport material and an electron transport material were prepared using the phosgene method in the same manner as in Example 1B except that as for the arylamine derivatives for use in the hole transport material and the electron transport material, the compounds shown in Table 2 were used, respectively.

(Example 14B)

<Preparation of hole transport material>

The compound (AII) was used as an arylamine derivative, and diethyl carbonate was used as a phosgene derivative, respectively, and then the compound (AII) and the diethyl carbonate were dissolved in a solution of tetrahydrofuran (THF) to prepare a hole transport material (a composition for the conductive material). In this case, the mixing ratio of the

compound (AII) to the diethyl carbonate was 1:4 in a mole ratio.

<Preparation of electron transport material>

An electron transport material (that is, a composition for the conductive material) was obtained in the same manner as the hole transport material prepared in this Example except that the compound (HII) was used as an arylamine derivative.

<Manufacture of organic EL device>

Organic EL devices were manufactured in the same manner as in Example 1B except that the hole transport material applied onto the ITO electrode in the above described step 2B was subjected to a heat treatment in a nitrogen gas atmosphere with the treatment conditions at a temperature of 150°C and a pressure of 10^3 Pa for 30 minutes so that the hydrated alkyl group of the compound (AII) was allowed to make ester exchange reaction with the diethyl carbonate to thereby form a hole transport layer having an average thickness of 50 nm, and in addition the electron transport material applied onto the light emitting layer in the above described step 4B was subjected to a heat treatment in a nitrogen gas atmosphere with the treatment conditions at a temperature of 150°C and a pressure of 10^3 Pa for 30 minutes so that the hydrated alkyl group of the compound (HII) was allowed to make ester exchange reaction with the diethyl carbonate to thereby form an electron transport layer having an average thickness of 20 nm.

(Examples 15B to 26B)

In each of Examples 15B to 26B, organic EL devices were manufactured after a hole transport material and an electron

transport material were prepared using the ester exchange method in the same manner as in Example 14B except that as for the arylamine derivatives for use in the hole transport material and the electron transport material, the compounds shown in Table 1 were used, respectively.

(Comparative Example 1B)

<Preparation of hole transport material>

The compound (QII) was dissolved with dichloroethane to obtain a hole transport material.

<Manufacture of organic EL device>

Organic EL devices were manufactured in the same manner as in Example 1B except that the hole transport layer was formed by drying the hole transport material applied (supplied) onto the ITO electrode in the above described step 2B, and the electron transport layer was formed by the vacuum evaporation of the compound (SII) in the above described step 4B.

(Comparative Example 2B)

<Preparation of hole transport material>

The compound (RII) was dispersed in water to prepare a 2.0 wt% water dispersion of the compound (RII) as a hole transport material.

In this regard, it is to be noted that the weight ratio of 3,4-ethylenedioxythiophene to styrenesulfonic acid in the compound (RII) was 1: 20.

<Manufacture of organic EL device>

Organic EL devices were manufactured in the same manner as in Comparative Example 1B except that the hole transport material was changed to the hole transport material prepared in this Comparative Example.

(Comparative Example 3)

<Preparation of hole transport material>

The compound (AII) was used as an arylamine derivative, and the compound (AII) and a polycarbonate resin ("Panlite L 1250" produced by Teijin Chemicals LTD.) in a weight ratio of 3:7 were mixed with dichloroethane to prepare a hole transport material.

<Preparation of electron transport material>

An electron transport material was obtained in the same manner as the hole transport material prepared in this Comparative Example except that the compound (HII) was used as an arylamine derivative.

<Manufacture of organic EL device>

Organic EL devices were manufactured in the same manner as in Example 1B except that the hole transport layer was formed by drying the hole transport material applied (supplied) onto the ITO electrode in the above described step 2B, and the electron transport layer was formed by drying the electron transport material applied (supplied) onto the light emitting layer.

(Comparative Example 4B)

<Preparation of hole transport material>

The compound (QII) was used as an arylamine derivative, and a bisphenol A epoxy compound ("ADEKA RESIN EP" produced by ASAHI DENKA CO., LTD.) was used as a photocrosslinking agent, and then the compound (QII), the bisphenol A epoxy compound and a cationic photopolymerization initiator ("FC-508" produced by Sumitomo 3M Limited) in a weight ratio of 85:14:1 were mixed with dichloroethane to obtain a hole transport material.

<Preparation of electron transport material>

An electron transport material was obtained in the same manner as the hole transport material prepared in this Comparative Example except that the compound (SII) was used as an arylamine derivative.

<Manufacture of organic EL device>

Organic EL devices were manufactured in the same manner as in Example 1B except that the hole transport layer was formed by drying the hole transport material applied (supplied) onto the ITO electrode in the step 2B, irradiating the dried hole transport material in an atmosphere with ultraviolet rays having a wavelength of 365 nm from a mercury lamp ("UM-452", USHIO Inc.) through a filter at an intensity of irradiation of 400 mW/cm² for 10 seconds, and then heating the hole transport material at a temperature of 110°C for 60 minutes to form a hole transport layer. In addition, the electron transport layer was formed by drying the electron transport material applied onto the light emitting layer in the above described step 4B, irradiating the dried electron transport material in an atmosphere with ultraviolet rays having a wavelength of 365 nm using the same mercury lamp at an intensity of irradiation of

400 mW/cm² for 10 seconds, and then heating the electron transport material at a temperature of 110°C for 60 minutes to form an electron transport layer.

(Comparative Example 5B)

<Preparation of hole transport material>

Organic EL devices were manufactured after a hole transport material was prepared in the same manner as in Example 1B except that as for the arylamine derivatives, the compound (FII) was used.

<Manufacture of organic EL device>

Organic EL devices were manufactured in the same manner as in Example 1B except that a hole transport layer was formed using the hole transport material obtained in this Comparative Example, and the electron transport layer was formed by the vacuum evaporation of the compound (SII) in the above described step 4B.

(Comparative Example 6B)

<Preparation of hole transport material>

Organic EL devices were manufactured after a hole transport material was prepared in the same manner as in Example 14B except that as for the arylamine derivatives, the compound (FII) was used.

<Manufacture of organic EL device>

Organic EL devices were manufactured in the same manner as in Example 14B except that a hole transport layer was formed using the hole transport material obtained in this Comparative

Example, and the electron transport layer was formed by the vacuum evaporation of the compound (SII) in the above described step 4B.

3. Evaluation of organic EL device

The luminous brightness (cd/m^2), the maximum luminous efficiency (lm/W), and the time that elapsed before the luminous brightness became half of the initial value (that is, a half-life) of each of the organic EL devices obtained in the Examples and the Comparative Examples mentioned above were measured. Based on the measurement values for the five organic EL devices, an average was calculated.

In this regard, it is to be noted that the luminous brightness was measured by applying a voltage of 6V across the ITO electrode and the AlLi electrode.

The measurement values (that is, the luminous brightness, the maximum luminous efficiency, and the half-life) of each of the Examples 1A to 10A and the Comparative Examples 2A to 6A were evaluated based on the measurement values of the Comparative Example 1A according to the following four criteria, respectively.

A: The measurement value was 1.5 times or more that of Comparative Example 1A.

B: The measurement value was 1.25 times or more but less than 1.5 times that of Comparative Example 1A.

C: The measurement value was 1.00 times or more but less

than 1.25 times that of Comparative Example 1A.

D: The measurement value was 0.75 times or more but less than 1.00 times that of Comparative Example 1A.

The evaluation results are shown in the attached Table 1.

As shown in Table 1, all the organic EL devices of the Examples (that is, organic EL devices including a hole transport layer which was formed using the conductive material according to the present invention as its main material) were superior to the organic EL devices of the Comparative Examples in their luminous brightness, maximum luminous efficiency, and half-life.

From the result, it has been found that in the organic EL device according to the present invention interaction between the adjacent main skeletons was properly decreased. In addition, it has also been found that in the organic EL device according to the present invention mutual dissolution between the hole transport layer and the light emitting layer was properly prevented.

Further, it has been also found that the organic EL devices of the Examples which were formed of the conductive material having the adjacent main skeletons which were allowed to exist at a more suitable interval, the luminous brightness and the maximum luminous efficiency were further improved and the half-life was also further prolonged.

The measurement values (that is, the luminous brightness, the maximum luminous efficiency, and the half-life) of each of the Examples 1B to 26B and the Comparative Examples 2B to 6B were evaluated based on the measurement values of the Comparative Example 1B according to the following four criteria, respectively.

A: The measurement value was 1.5 times or more that of Comparative Example 1B.

B: The measurement value was 1.25 times or more but less than 1.5 times that of Comparative Example 1B.

C: The measurement value was 1.00 times or more but less than 1.25 times that of Comparative Example 1B.

D: The measurement value was 0.75 times or more but less than 1.00 times that of Comparative Example 1B.

The evaluation results are shown in the attached Table 2.

As shown in Table 2, all the organic EL devices of the Examples (that is, organic EL devices including a hole transport layer which was formed using the conductive material according to the present invention as a main material) were superior to the organic EL devices of the Comparative Examples in their luminous brightness, maximum luminous efficiency, and half-life.

From the result, it has been found that in the organic EL device according to the present invention interaction between the adjacent main skeletons was properly decreased. In

addition, it has also been found that in the organic EL device according to the present invention mutual dissolution between the hole transport layer and the light emitting layer was properly prevented.

Moreover, in the case where the evaluation results are reviewed from the view point of the substituent X^1 , there is a tendency that the conductive materials of the Examples which were formed of the compounds containing the substituents X^1 each having an appropriate n^1 value in the general formula (A2), that is the conductive materials formed of the compounds containing the substituents X^1 by which the adjacent main skeletons are allowed to exist at a suitable interval, could have more superior luminous brightness, maximum luminous efficiency, and half-life as compared to the conductive materials which do not have such a substituent X^1 .

Furthermore, the organic EL devices in the Examples each obtained by appropriately selecting conductive materials for respectively constituting the hole transport material and the electron transport material, namely, the organic EL devices in the Examples each having a preferred combination of the hole transport layer and the electron transport layer by appropriately selecting the group Y of the compound represented by the above-mentioned general formula (A1) could have superior luminous brightness, maximum luminous efficiency, and half-life.

4. Manufacture of organic TFT

Five organic TFTs were manufactured in each of the following Examples and Comparative Examples.

(Example 1C)

<Preparation of organic semiconductor material>

The compound (JII) was used as an arylamine derivative, pyridine was used as a base, and tetrahydrofuran (THF) was used as an organic solvent, respectively, and then the compound (JII) was dissolved in a mixed solution of the pyridine solution and the THF in a volume ratio of 5:1 to prepare an organic semiconductor material.

<Manufacture of organic TFT>

1C First, a glass substrate having an average thickness of 1 mm was prepared, and it was then washed with water (that is, with a cleaning fluid).

Next, a photoresist was applied onto the glass substrate by a spin coating method, and then the photoresist was prebaked to form a film.

Next, the film was irradiated with (or exposed to) ultraviolet rays through a photomask to develop it. In this way, a resist layer having openings where a source electrode and a drain electrode were to be provided was formed.

2C Next, an aqueous gold colloidal solution was supplied to the openings by an inkjet method. Then, the glass substrate to which the aqueous gold colloidal solution had been supplied was dried by heating to obtain a source electrode and

a drain electrode.

3C Next, the resist layer was removed by oxygen plasma treatment. Then, the glass substrate on which the source electrode and the drain electrode had been formed was washed with water, and was then washed with methanol.

4C Next, the glass substrate on which the source electrode and the drain electrode was placed in a chamber, and then the prepared organic semiconductor material was applied onto the glass substrate by a spin coating method.

Thereafter, phosgene was introduced into the chamber which was being kept at a temperature of 0°C and in which the organic semiconductor material was placed so that the internal pressure became 10^5 Pa (at 0°C), and then such a state was being kept for one hour so that hydrated alkyl group of the compound (JII) was allowed to make polycondensation reaction with phosgene. Thereafter, the organic semiconductor material was dried to obtain an organic semiconductor layer having an average thickness of 50 nm.

5C Next, a butyl acetate solution of polymethylmethacrylate (PMMA) was applied onto the organic semiconductor layer by a spin coating method, and was then dried to form a gate insulating layer having an average thickness of 500 nm.

6C Next, a water dispersion of polyethylenedioxythiophene was applied to an area on the gate

insulating layer corresponding to the area between the source electrode and the drain electrode by an inkjet method, and was then dried to form a gate electrode having an average thickness of 100 nm.

By way of these steps, an organic TFT was manufactured.

(Examples 2C to 7C)

In each of Examples 2C to 7C, organic TFTs were manufactured after the organic semiconductor material was prepared in the same manner as in Example 1C except that as for an arylamine derivative for use in preparing the organic semiconductor material, those shown in Table 3 were used.

(Example 8C)

<Preparation of organic semiconductor material>

Organic TFTs were manufactured after the organic semiconductor material was prepared in the same manner as in Example 14A of the hole transport material except that the compound (JII) was used as an arylamine derivative.

<Manufacture of organic TFT>

Organic TFTs were manufactured in the same manner as in Example 1C except that the organic semiconductor layer was formed by subjecting the organic semiconductor material which was applied (supplied) onto the glass substrate and prepared in this Example in the above described step 4C to a heat treatment in a nitrogen gas atmosphere with the treatment conditions at a temperature of 150°C and a pressure of 10^3 Pa for 30 minutes so that the hydrated alkyl group of the compound (JII) was

allowed to make ester exchange reaction with the diethyl carbonate to thereby form an organic semiconductor layer having an average thickness of 50 nm.

(Example 9C to Example 14C)

In each of Examples 9C to 14C, organic TFTs were manufactured in the same manner as in Example 8C using the ester exchange method except that as for the arylamine derivative for use in the organic semiconductor material, those shown in Table 3 were used.

(Comparative Example 1C)

<Preparation of organic semiconductor material>

The compound (QII) was dissolved with dichloroethane to obtain an organic semiconductor material.

<Manufacture of organic TFT>

Organic TFTs were manufactured in the same manner as in Example 1C except that by drying the organic semiconductor material prepared in this Comparative Example and applied onto the glass substrate on which the source electrode and the drain electrode were formed, an organic semiconductor layer was formed.

(Comparative Example 2C)

<Preparation of organic semiconductor material>

The compound (JII) was used as an arylamine derivative, and the compound (JII) and a polycarbonate resin ("Panlite L 1250" produced by Teijin Chemicals LTD.) in a weight ratio of 3:7 were mixed with dichloroethane to prepare an organic

semiconductor material.

<Manufacture of organic TFT>

Organic TFTs were manufactured in the same manner as in Example 1C except that as for the organic semiconductor material, the organic semiconductor material prepared in this Comparative Example was used.

(Comparative Example 3C)

<Preparation of organic semiconductor material>

The compound (QII) was used as an arylamine derivative, and a bisphenol A epoxy compound ("ADEKA RESIN EP" produced by ASAHI DENKA CO., LTD.) was used as a photocrosslinking agent, and then the compound (GI), the bisphenol A epoxy compound and a cationic photopolymerization initiator ("FC-508" produced by Sumitomo 3M Limited) in a weight ratio of 85:14:1 were mixed with dichloroethane to obtain an organic semiconductor material.

<Manufacture of organic EL device>

Organic TFTs were manufactured in the same manner as in Example 1C except that the organic semiconductor layer was formed by drying the organic semiconductor material applied (supplied) onto the ITO electrode in the step 4C, irradiating the dried organic semiconductor material in an atmosphere with ultraviolet rays having a wavelength of 365 nm from a mercury lamp ("UM-452", USHIO Inc.) through a filter at an intensity of irradiation of 400 mW/cm² for 10 seconds, and then heating the organic semiconductor material at a temperature of 110°C for 60 minutes.

(Comparative Example 4C)

Organic TFTs were manufactured after the organic semiconductor material was prepared in the same manner as in Example 1C except that as for the arylamine derivative for use in the organic semiconductor material the compound (MII) was used.

(Comparative Example 4D)

Organic TFTs were manufactured after the organic semiconductor material was prepared in the same manner as in Example 8C except that as for the arylamine derivative for use in the organic semiconductor material the compound (MII) was used.

5. Evaluation of organic TFT

The OFF-state current and the ON-state current of each of the organic TFTs manufactured in Examples and Comparative Examples were measured.

Here, the word "OFF-state current" means the value of current flowing between the source electrode and the drain electrode when a gate voltage is not applied, and the word "ON-state current" means the value of current flowing between the source electrode and the drain electrode when a gate voltage is applied.

Therefore, a larger value of ratio of the absolute value of the ON-state current to the absolute value of the OFF-state

current (hereinafter, simply referred to as a "value of ON/OFF ratio") means that an organic TFT has better characteristics.

The OFF-state current was measured at a potential difference between the source electrode and the drain electrode of 30 V, and the ON-state current was measured at a potential difference between the source electrode and the drain electrode of 30 V and an absolute value of gate voltage of 40 V.

The value of ON/OFF ratio of each of the Examples and the Comparative Examples was evaluated according to the following four criteria.

A: The value of ON/OFF ratio was 10^4 or more.

B: The value of ON/OFF ratio was 10^3 or more but less than 10^4 .

C: The value of ON/OFF ratio was 10^2 or more but less than 10^3 .

D: The value of ON/OFF ratio was less than 10^2 .

The evaluation results are shown in the following Table 3.

As shown in Table 3, the values of ON/OFF ratio of all the organic TFTs obtained in the Examples were larger than those of the organic TFTs obtained in the Comparative Examples. This means that all the organic TFTs of the Examples had better characteristics.

From the result, it has been found that interaction

between the adjacent main skeletons was properly decreased. In addition, it has been also found that in the organic EL device according to the present invention mutual dissolution between the organic semiconductor layer and the gate insulating layer was properly prevented.

Further, in the case where the evaluation results are reviewed from the view point of the substituent X^1 , there is a tendency that in the conductive materials of the Examples which were formed of the compounds containing the substituents X^1 each having an appropriate n^1 value in the general formula (A2), that is the conductive materials formed of the compounds containing the substituents X^1 by which the adjacent main skeletons were allowed to exist at a suitable interval, the value of ON/OFF ratio was more increased, that is, the characteristics of the organic TFT were further improved.

INDUSTRIAL APPLICABILITY

According to the present invention, the polymer contained in the conductive material has a structure in which main skeletons of compounds are repeatedly bonded or linked through a chemical structure which is produced by the polycondensation reaction between the substituents X^1 of the compounds and phosgene represented by the chemical formula COCl_2 or its derivative, that is, a structure in which adjacent main skeletons are allowed to exist at a suitable interval repeatedly. Therefore, it is possible to decrease the interaction between the adjacent main skeletons in the polymer. Further, by forming the constituent material of the conductive layer from such a polymer, when an upper layer is formed on the conductive layer

using a liquid material, it is possible to properly suppress or prevent the polymer from being swelled or dissolved by the solvent or dispersion medium contained in the liquid material. As a result, it is possible to prevent mutual dissolution from occurring between the conductive layer and the upper layer to be formed. For these reasons, the polymer can exhibit a high carrier transport ability, and thus a conductive material constituted from the polymer as its main material can also have a high carrier transport ability. Consequently, both an electronic device provided with such a conductive layer and electronic equipment provided such an electronic device can have high reliability. Therefore, the present invention has industrial adaptability required by PCT.

Table 1

	Hole transport material	Luminous brightness [Relative evaluation]	Maximum luminous efficiency [Relative evaluation]	Half-life [Relative evaluation]
Example 1A	Compound AI	A	A	A
Example 2A	Compound AI	A	A	A
Example 3A	Compound BI	A	A	A
Example 4A	Compound BI	A	A	A
Example 5A	Compound CI	B	B	B
Example 6A	Compound CI	B	B	B
Example 7A	Compound DI	B	B	B
Example 8A	Compound DI	B	B	B
Example 9A	Compound EI	A	A	B
Example 10A	Compound EI	A	A	B
Comp.Ex. 1A	Compound GI	1.00	1.00	1.00
Comp.Ex. 2A	Compound RII	D	C	D
Comp.Ex. 3A	Compound AI	C	D	C
Comp.Ex. 4A	Compound GI	C	C	C
Comp.Ex. 5A	Compound FI	D	C	C
Comp.Ex. 6A	Compound FI	D	C	C

Table 2

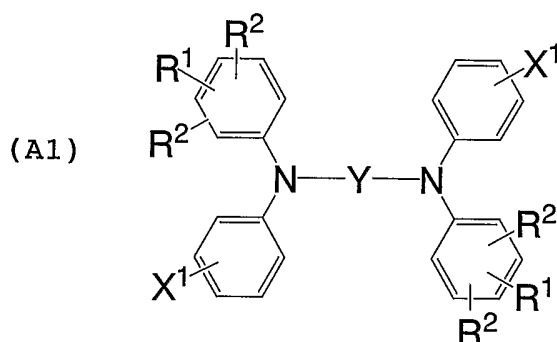
	Hole transport material	Electron transport material	Luminous brightness [Relative evaluation]	Maximum luminous efficiency [Relative evaluation]	Half-life [Relative evaluation]
Example 1B	Compound AII	Compound HII	A	A	A
Example 2B	Compound BII	Compound HII	A	A	A
Example 3B	Compound CII	Compound HII	B	B	B
Example 4B	Compound DII	Compound HII	B	B	B
Example 5B	Compound EII	Compound HII	A	A	B
Example 6B	Compound GII	Compound III	A	A	A
Example 7B	Compound AII	Compound III	A	A	A
Example 8B	Compound GII	Compound HII	A	A	A
Example 9B	Compound JII	Compound HII	A	B	A
Example 10B	Compound JII	Compound III	A	B	A
Example 11B	Compound AII	Compound PII	A	B	A
Example 12B	Compound GII	Compound PII	A	B	A
Example 13B	Compound JII	Compound PII	B	B	B
Example 14B	Compound AII	Compound HII	A	A	A
Example 15B	Compound BII	Compound HII	A	A	A
Example 16B	Compound CII	Compound HII	B	B	B
Example 17B	Compound DII	Compound HII	B	B	B
Example 18B	Compound EII	Compound HII	A	A	B
Example 19B	Compound GII	Compound III	A	A	A
Example 20B	Compound AII	Compound III	A	A	A
Example 21B	Compound GII	Compound HII	A	A	A
Example 22B	Compound JII	Compound HII	A	B	A
Example 23B	Compound JII	Compound III	A	B	A
Example 24B	Compound AII	Compound PII	A	B	A
Example 25B	Compound GII	Compound PII	A	B	A
Example 26B	Compound JII	Compound PII	B	B	B
Comp. Ex. 1B	Compound QII	Compound SII	1.00	1.00	1.00
Comp. Ex. 2B	Compound RII	Compound SII	D	C	D
Comp. Ex. 3B	Compound AII	Compound HII	C	D	C
Comp. Ex. 4B	Compound QII	Compound SII	C	C	C
Comp. Ex. 5B	Compound FII	Compound SII	D	C	C
Comp. Ex. 6B	Compound FII	Compound SII	D	C	C

Table 3

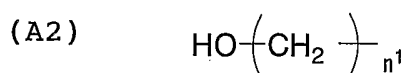
	Organic semiconductor material	ON/OFF ratio
Example 1C	Compound JII	A
Example 2C	Compound KII	B
Example 3C	Compound LII	B
Example 4C	Compound NII	A
Example 5C	Compound OII	A
Example 6C	Compound PII	A
Example 7C	Compound GII	A
Example 8C	Compound JII	A
Example 9C	Compound KII	B
Example 10C	Compound LII	B
Example 11C	Compound NII	A
Example 12C	Compound OII	A
Example 13C	Compound PII	A
Example 14C	Compound GII	A
Comp.Ex. 1C	Compound QII	D
Comp.Ex. 2C	Compound JII	C
Comp.Ex. 3C	Compound QII	C
Comp.Ex. 4C	Compound MII	C
Comp.Ex. 5C	Compound MII	C

CLAIMS

1. A conductive material which is obtained by polycondensation reaction of substituents X^1 of compounds each represented by the following general formula (A1) through phosgene and/or its derivative to link the compounds:



wherein two R^1 's may be the same or different and each independently represents a straight-chain alkyl group having 2 to 8 carbon atoms, four R^2 's may be the same or different and each independently represents a hydrogen atom, a methyl group or an ethyl group, Y represents a group containing at least one substituted or unsubstituted aromatic hydrocarbon ring or substituted or unsubstituted heterocycle, and two X^1 's may be the same or different and each independently represents a substituent represented by the following general formula (A2):

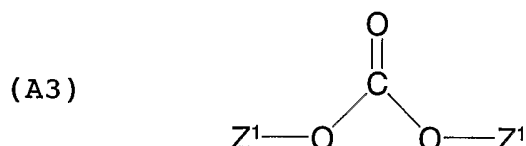


wherein n^1 is an integer of 2 to 8.

2. The conductive material as claimed in claim 1, wherein the group Y contains at least one substituted or unsubstituted

aromatic hydrocarbon ring.

3. The conductive material as claimed in claim 2, wherein the phosgene derivative is a compound represented by the following general formula (A3):



wherein two Z¹s may be the same or different and each independently represents an alkyl group, a phenyl group or a benzyl group each having 1 to 6 carbon atoms.

4. The conductive material as claimed in claim 2, wherein the two substituents X¹ are identical with each other.

5. The conductive material as claimed in claim 2, wherein each substituent X¹ is bonded to the 3-, 4- or 5-position of the benzene ring.

6. The conductive material as claimed in claim 2, wherein the two substituents R¹ are identical with each other.

7. The conductive material as claimed in claim 2, wherein each substituent R¹ is bonded to the 4-position of the benzene ring.

8. The conductive material as claimed in claim 2, wherein the group Y consists of carbon atoms and hydrogen atoms.

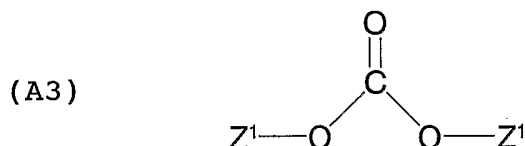
9. The conductive material as claimed in claim 2, wherein the group Y contains 6 to 30 carbon atoms in total.

10. The conductive material as claimed in claim 2, wherein the group Y contains 1 to 5 aromatic hydrocarbon rings.

11. The conductive material as claimed in claim 2, wherein the group Y is a biphenylene group or a derivative thereof.

12. The conductive material as claimed in claim 1, wherein the group Y contains at least one substituted or unsubstituted heterocycle.

13. The conductive material as claimed in claim 12, wherein the phosgene derivative is a compound represented by the following general formula (A3):



wherein two Z¹s may be the same or different and each independently represents an alkyl group, a phenyl group or a benzyl group each having 1 to 6 carbon atoms.

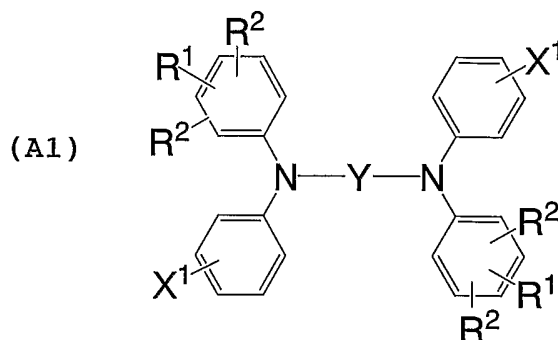
14. The conductive material as claimed in claim 12, wherein the two substituents X¹ are identical with each other.

15. The conductive material as claimed in claim 12, wherein each substituent X¹ is bonded to the 3-, 4- or 5-position of the benzene ring.

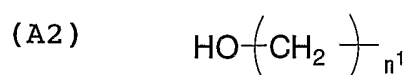
16. The conductive material as claimed in claim 12, wherein the two substituents R^1 are identical with each other.
17. The conductive material as claimed in claim 12, wherein each substituent R^1 is bonded to the 4-position of the benzene ring.
18. The conductive material as claimed in claim 12, wherein the heterocycle contains at least one heteroatom selected from the group comprising nitrogen, oxygen, sulfur, selenium and tellurium.
19. The conductive material as claimed in claim 12, wherein the heterocycle is an aromatic heterocycle.
20. The conductive material as claimed in claim 12, wherein the group Y contains 1 to 5 aromatic hydrocarbon rings.
21. The conductive material as claimed in claim 12, wherein the group Y contains at least one substituted or unsubstituted aromatic hydrocarbon ring in addition to the heterocycle.
22. The conductive material as claimed in claim 12, wherein the group Y contains two aromatic hydrocarbon rings respectively bonded to each N in the general formula (A1) directly and at least one heterocycle existing between these aromatic hydrocarbon rings.
23. The conductive material as claimed in claim 12, wherein

the group Y contains 2 to 75 carbon atoms in total.

24. A composition for a conductive material which contains a compound represented by the following general formula (A1) and a phosgene derivative:



wherein two R¹s may be the same or different and each independently represents a straight-chain alkyl group having 2 to 8 carbon atoms, four R²s may be the same or different and each independently represents a hydrogen atom, a methyl group or an ethyl group, Y represents a group containing at least one substituted or unsubstituted aromatic hydrocarbon ring or substituted or unsubstituted heterocycle, and two X¹s may be the same or different and each independently represents a substituent represented by the following general formula (A2):



wherein n¹ is an integer of 2 to 8.

25. A conductive layer mainly formed of the conductive material defined in claim 1.

26. The conductive layer as claimed in claim 25, wherein the conductive layer is a hole transport layer.

27. The conductive layer as claimed in claim 26, wherein the average thickness of the hole transport layer is in the range of 10 to 150 nm.

28. The conductive layer as claimed in claim 25, wherein the conductive layer is an electron transport layer.

29. The conductive layer as claimed in claim 28, wherein the average thickness of the electron transport layer is in the range of 1 to 100 nm.

30. The conductive layer as claimed in claim 25, wherein the conductive layer is an organic semiconductor layer.

31. The conductive layer as claimed in claim 30, wherein the average thickness of the organic semiconductor layer is in the range of 0.1 to 1,000 nm.

32. An electronic device comprising a laminated body which includes the conductive layer defined in claim 25.

33. The electronic device as claimed in claim 32, which is a light emitting device or a photoelectric transducer.

34. The electronic device as claimed in claim 33, wherein the light emitting device is an organic electroluminescent device.

35. The electronic device as claimed in claim 32, wherein the electronic device is a switching element.

36. The electronic device as claimed in claim 35, wherein the switching element is an organic thin film transistor.

37. Electronic equipment comprising the electronic device as claimed in claim 32.

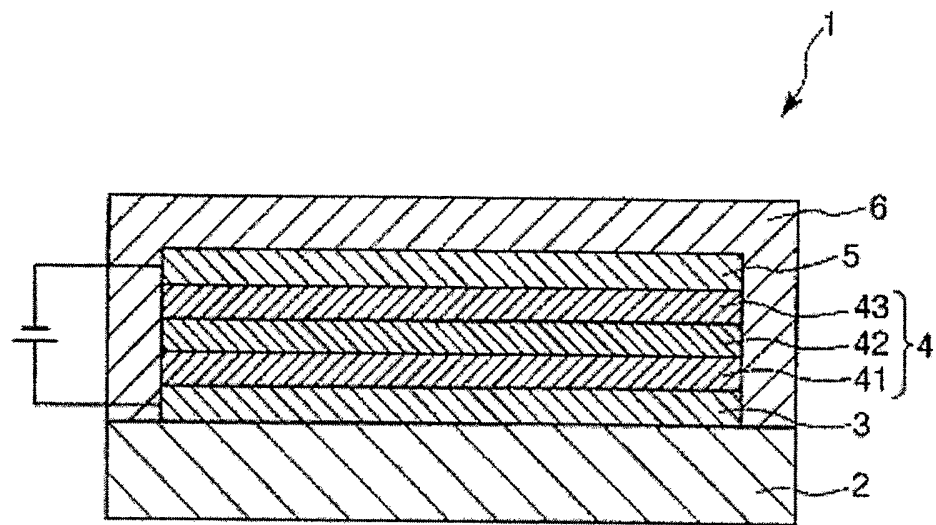


FIG. 1

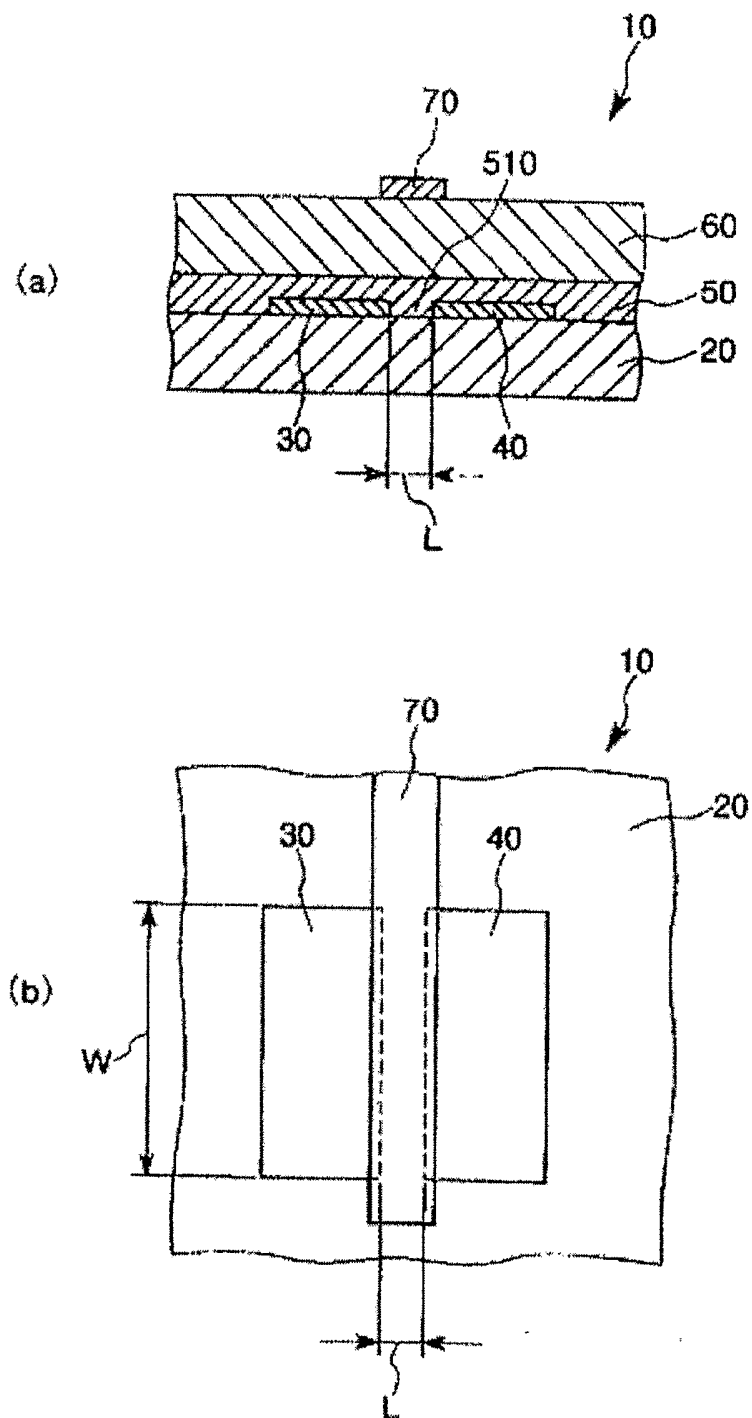


FIG. 2

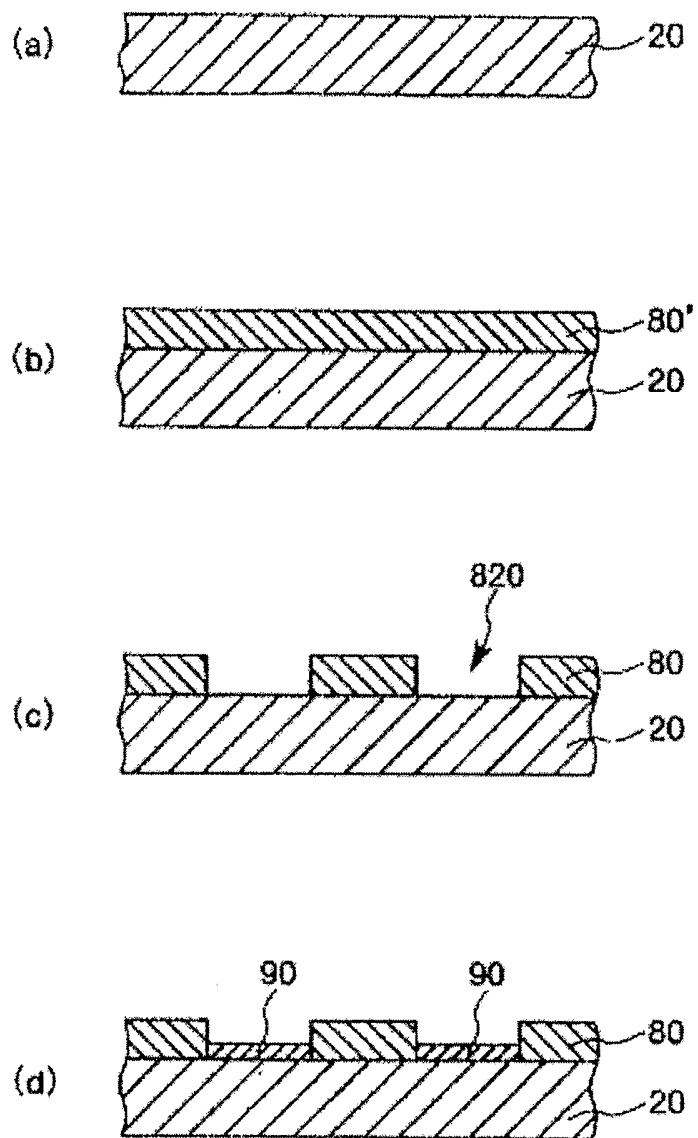


FIG. 3

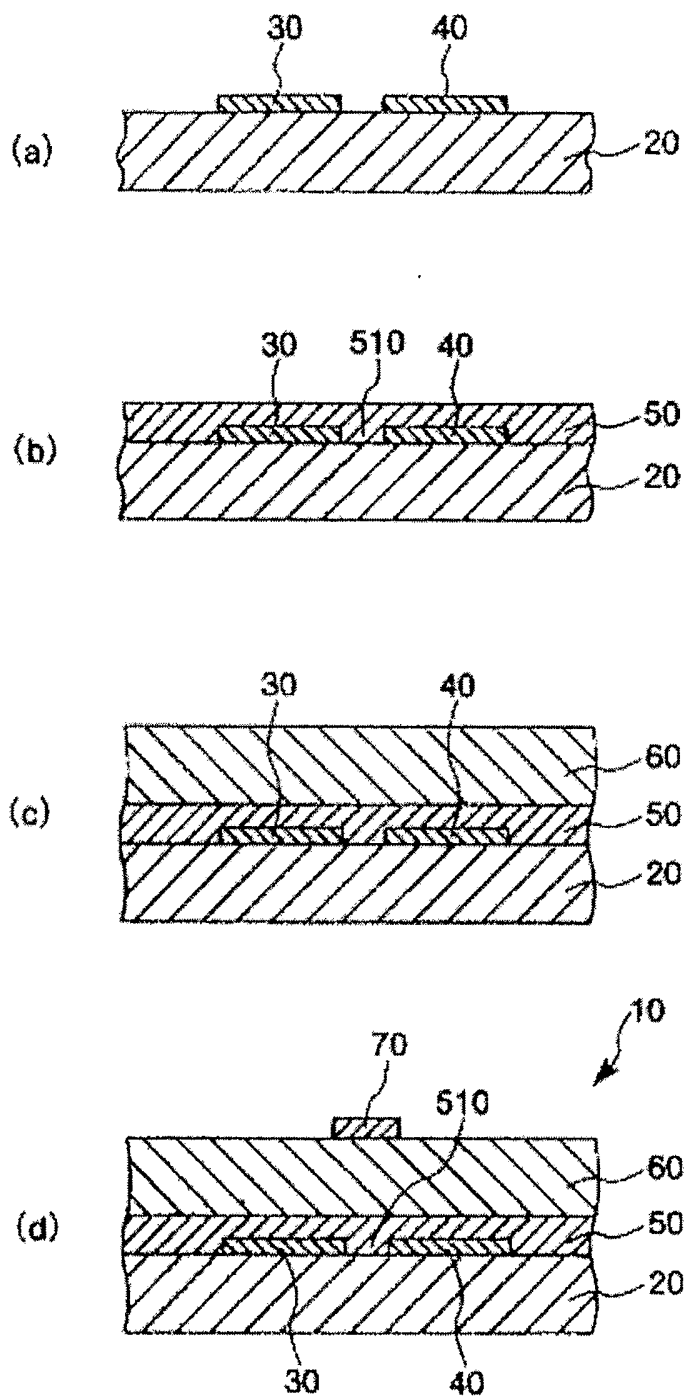


FIG. 4

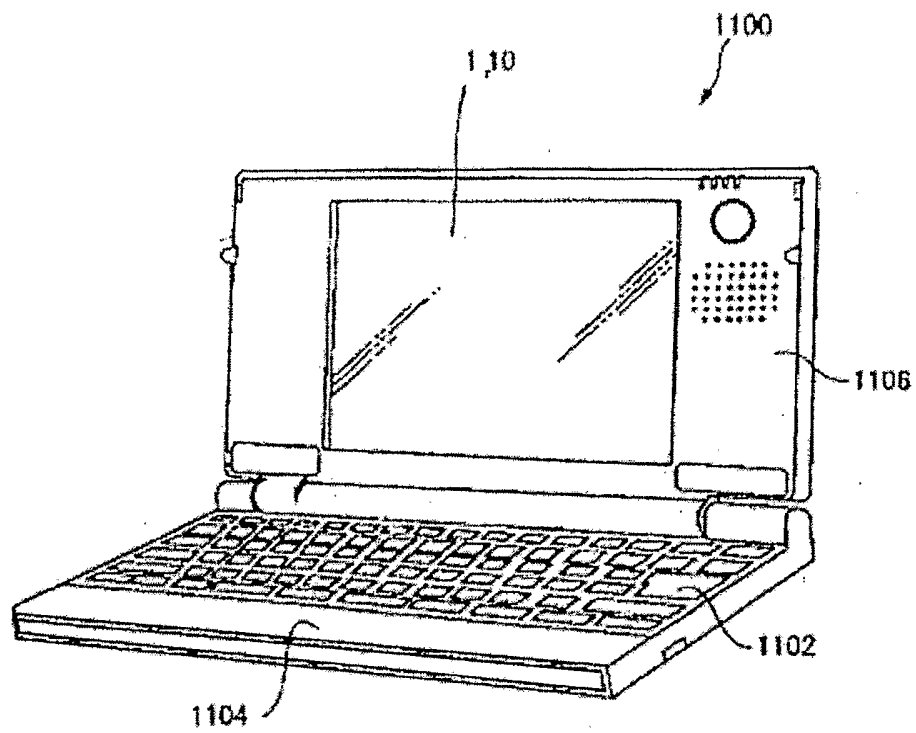


FIG. 5

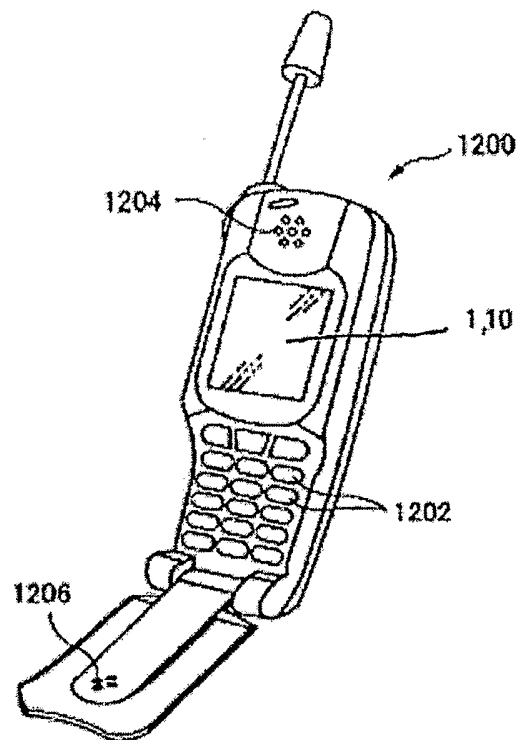


FIG. 6

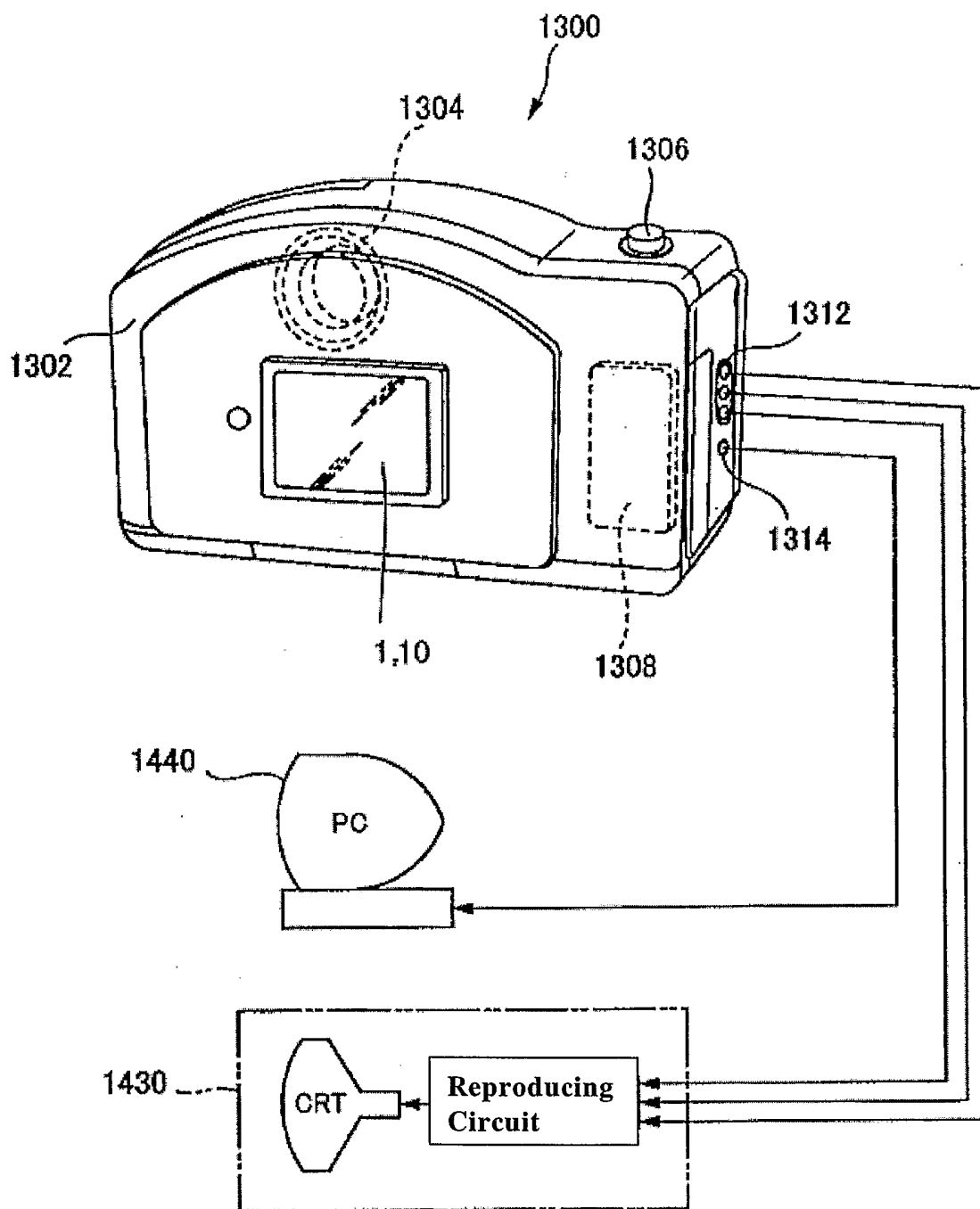


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/JP2005/023102

A. CLASSIFICATION OF SUBJECT MATTER
H01L51/30 H05B33/14 C08G64/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01L C09K H05B C08G

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 801 517 A (FRECHET ET AL) 31 January 1989 (1989-01-31) abstract column 5 - column 6 column 9 - column 10 claim 1	1-37
A	US 4 935 487 A (YANUS ET AL) 19 June 1990 (1990-06-19) column 5 - column 6 column 9 - column 10	1-37
A	US 5 698 359 A (YANUS ET AL) 16 December 1997 (1997-12-16) column 17 - column 18	1-37
A	US 5 976 418 A (FULLER ET AL) 2 November 1999 (1999-11-02) column 17 - column 18	1-37



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

20 March 2006

Date of mailing of the international search report

24/03/2006

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Heer, S

INTERNATIONAL SEARCH REPORT

International application No

PCT/JP2005/023102

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US 5976418	A	02-11-1999	NONE