



(11) **EP 1 840 182 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention
of the grant of the patent:
08.06.2011 Bulletin 2011/23

(51) Int Cl.:
C09K 11/06 ^(2006.01) **H01L 51/00** ^(2006.01)
H01L 51/50 ^(2006.01)

(21) Application number: **07006146.0**

(22) Date of filing: **26.03.2007**

(54) **Compound for organic electroluminescence and organic electroluminescent device**

Verbindung für organische Elektrolumineszenz und organische Elektrolumineszenzvorrichtung

Composé pour dispositif électroluminescent organique, et dispositif électroluminescent organique

(84) Designated Contracting States:
DE GB

(30) Priority: **27.03.2006 JP 2006084406**

(43) Date of publication of application:
03.10.2007 Bulletin 2007/40

(73) Proprietor: **Seiko Epson Corporation**
Shinjuku-ku,
Tokyo 163-0811 (JP)

(72) Inventor: **Fujita, Tetsuji**
Suwa-shi,
Nagano-ken 392-8502 (JP)

(74) Representative: **HOFFMANN EITLE**
Patent- und Rechtsanwälte
Arabellastraße 4
81925 München (DE)

(56) References cited:
WO-A-02/077060 US-A1- 2005 249 972

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Description1. Technical Field

[0001] The present invention relates to an organic EL device applied to displays or display light sources, and more particularly, to a compound for organic EL desirably applied to a coat-type organic EL device and to an organic EL device using the same.

2. Related Art

[0002] Recently, the development of organic electroluminescent devices (organic EL devices) using an organic electroluminescent element (organic EL element) which serves as a self-emission display for replacing a liquid crystal display has accelerated. With respect to such an organic EL device and a method of producing the organic EL device, JP-A-2000-323276 and JP-T-2002-536492 are examples of the related art.

[0003] A process where a host material and a light emitting dopant are used as a material of a light emitting layer is applied to a known organic EL device (organic EL apparatus) so as to assure high efficiency of light emission, a change in the color of emitted light, and a long life span. The process is frequently applied to organic EL devices including an organic material provided using deposition, but not to polymer-coat-type organic EL devices which include a layer formed using an inkjet process (liquid droplet jet process) or a spin coating process.

[0004] Within the present description, the term 'host material' refers to a material which is capable of providing both holes and electrons.

[0005] Previously, the following problems have been encountered when applying a host material and a light emitting dopant to a polymer-coat-type organic EL device :

[0006] (1) When a solution containing the host and the light emitting dopant is applied, bleeding of the light emitting dopant may occur. The reason is that, if the solution of materials having a low molecular weight is applied to the polymer and dried, the materials having a low molecular weight flow out from the surface layer during the drying.

[0007] (2) The light emitting dopant material has poor hole or electron trapping ability. When the host material is a conjugated polymer, the trapping ability is very poor. In such a conjugated polymer, it is believed that since the holes and the electrons preferentially flow through the host polymer molecule, it is difficult for the light emitting dopant to trap the holes and the electrons.

[0008] (3) The development of the light emitting dopant material is time-consuming. The reason is that the system including the host and light emitting dopant is inefficient in the polymer-coat-type organic EL device field in comparison with the deposition type of EL (small-molecular- EL).

SUMMARY

[0009] The present invention provides an organic EL device using a compound for organic EL that contains a host material and a light emitting dopant to constitute a light emitting layer, thereby assuring high efficiency of light emission and a long life span.

[0010] The inventor has conducted studies to solve the above problems, and the results are as follows.

[0011] With respect to the above problem (1), the following solution may be provided.

[0012] The light emitting dopant may be polymerized to prevent bleeding of the light emitting dopant during the coating/drying. It is preferable that the dopant have π conjugation (typical n conjugation and conjugation having N atoms). However, in the coat type of organic EL, it is necessary to dissolve the dopant in a predetermined solvent. Thus, the polymerization may be performed using a non-conjugation connection group having a predetermined molecular weight according to the type of design.

[0013] With respect to the above problem (2), the following solution may be provided.

[0014] In the molecule design, a functional group that is preferentially capable of trapping holes or electrons is added to the molecule of the light emitting dopant during the polymerization disclosed in the problem (1) to improve the ability of the dopant. Particularly, the functional group having the hole trapping ability is added to the molecule to improve the ability of the dopant.

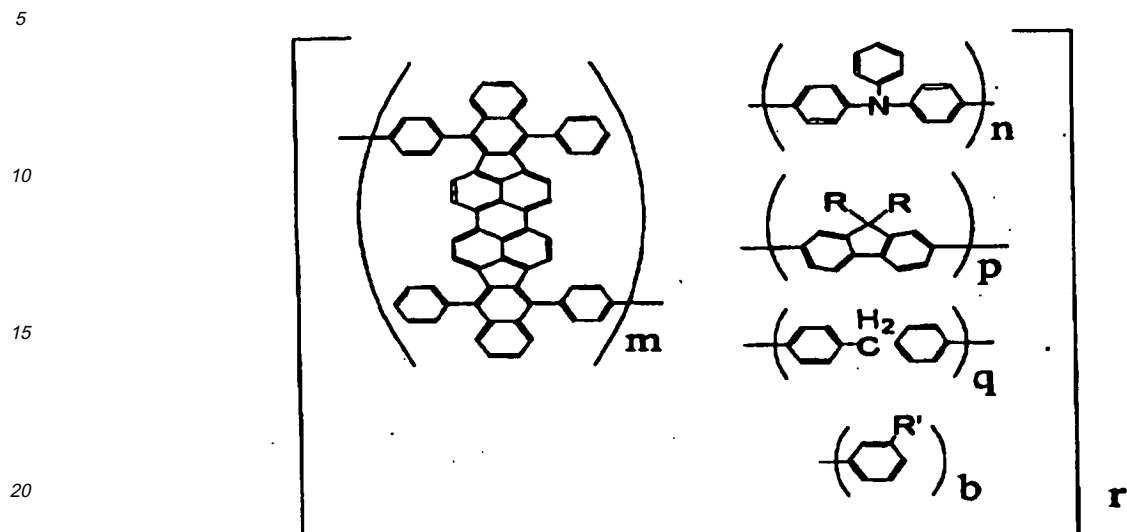
[0015] Preferably, the luminous center and the functional group having the hole trapping ability of the light emitting dopant are connected through then π conjugation system. Through the n conjugation, the direct hole trapping of the luminous center is assured.

[0016] The IP (ionization potential) of the host material is the criterion for hole trapping ability improvement. In connection with this, it is required that ease of oxidation is better with respect to the host material.

[0017] Based on the above description, the inventor accomplished the invention.

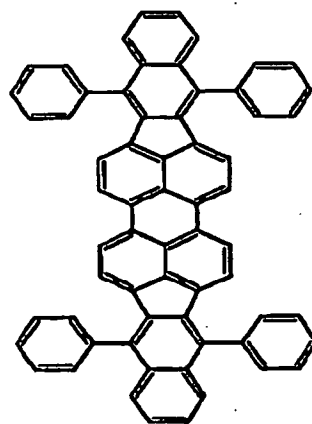
[0018] According to the invention, an organic electroluminescent device is provided, wherein a compound for organic

electroluminescence comprising a polymer molecule which is represented by the following Formula 6, is applied to a light emitting layer:

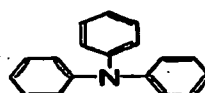


[0019] The polymer of formula 6 has constituents units derived from the molecules represented by the following Formulae 1 to 5

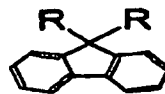
Formula 1



Formula 2

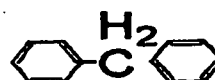


Formula 3

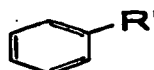


where R is an alkyl groups, an aryl group, or an alkylaryl group,

Formula 4



Formula 5



where R¹ is hydrogen, an alkyl group, or an alkylaryl group.

[0020] In the polymer molecule, the molecule of Formula 1 acts as a molecular unit that emits red light, the molecule of Formula 2 acts as a hole trapping unit, and the molecules of Formulae 3 and 4 act as connection units for polymerization in the organic EL device. The molecule of Formula 3 also acts as an electron trapping unit and slightly controls the amount of electrons flowing through the light emitting layer. The molecule of Formula 5 is a functional group that is used to prevent a halogen element from being provided to an end of the molecule.

[0021] Since the polymer molecule is capable of trapping the holes, the polymer molecule is applied to the light emitting layer of the organic EL device to trap the holes flowing through the light emitting layer, thereby generating cations. The cations trap the electrons flowing through the light emitting layer, causing recombination in the polymer molecule. Accordingly, the molecular unit of Formula 1 that is the light emitting unit creates electroluminescence.

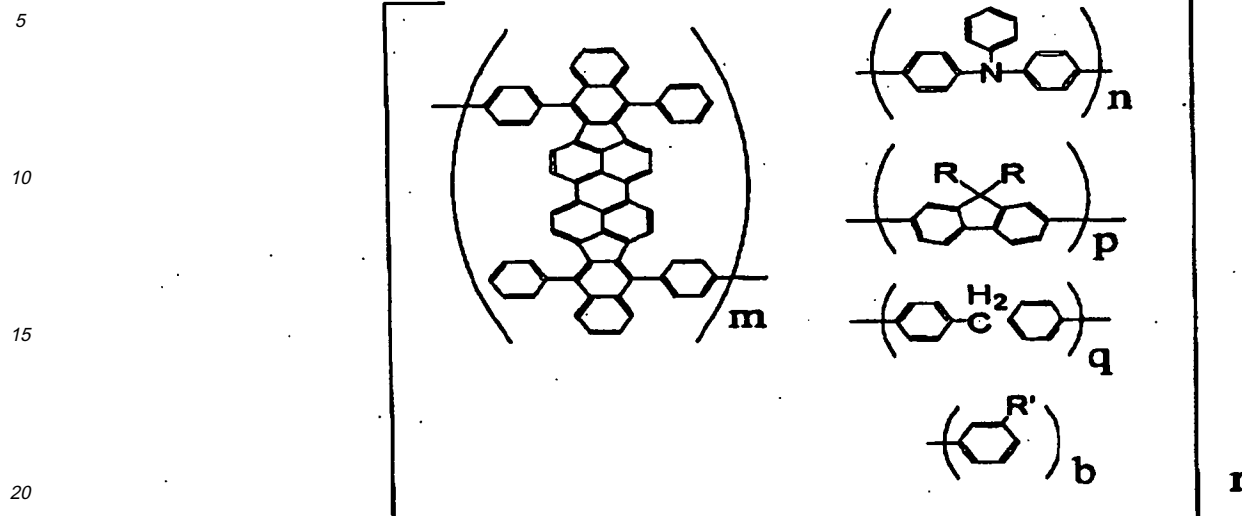
[0022] The term 'recombination' means that the molecule of the luminous center is in the excitation state due to the holes and the electrons trapped by the polymer molecule.

[0023] That is, energy that is generated in the course of converting 'the excitation state' into 'the ground state' is observed in an electroluminescent form.

[0024] Therefore, the polymer molecule is applied to the organic EL device to very efficiently emit red light for a long time.

[0025] In the organic EL device according to the invention, the compound for organic EL comprises a polymer molecule which is represented by the following Formula 6

Formula 6



[0026] In Formula 6, R is an alkyl group, an aryl group, or an alkylaryl group, R' is hydrogen, an alkyl group, or an alkylaryl group, m, n, and p each are an integer of 1 or more, q and b each are an integer of 0 or more, and r is an integer of 1 or more.

[0027] As described above, the polymer molecule is applied to the organic EL device to very efficiently emit red light for a long time.

[0028] In Formula 6, r is an integer denoting the degree of polymerization of the oligomer unit constituting the polymer molecule (the smallest unit including the molecules of Formulae 1 to 5).

[0029] Additionally, it is preferable that q in Formula 6 is 0. In another preferred embodiment, q is an integer of 1 to 4, since solubility is reduced according to the type of solvent of the ink for coating or according to q and r.

[0030] In the organic EL compound according to the above-mentioned aspect, m that is the integer denoting the number of light emitting units of Formula 1 is preferably 1 or 2 in an oligomer unit of Formula 6.

[0031] The oligomer preferably has r of 1 in Formula 6. Accordingly, it is possible to assure desirable EL luminance in the design of the oligomer molecule.

[0032] In the organic EL compound according to the above-mentioned aspect, n that is the integer denoting the number of units having a hole trapping ability of Formula 2 is preferably 2 or more in the oligomer unit of Formula 6.

[0033] This makes it possible to assure desirable EL luminance in molecular design of the oligomer unit.

[0034] In the organic EL compound according to the above-mentioned aspect, p that is the integer denoting the number of connection units for polymerization having an electron trapping ability of Formula 3 is preferably 1 to 4 in the oligomer unit of Formula 6.

[0035] This makes it possible to improve the solubility to the solvent in molecular design of the oligomer unit. Additionally, this preferred embodiment allows for controlling the flow of the electrons and for optimizing light emission efficiency.

[0036] In the organic EL compound according to the above-mentioned aspect, it is preferable that the unit of Formula 1 and the unit of Formula 2 be directly connected to each other at one point or more in the oligomer unit of Formula 6.

[0037] This makes it possible to improve the hole trapping ability, light emission efficiency, and a half-life of luminance in molecular design of the oligomer unit.

[0038] According to the invention, the organic EL device includes the compound for organic EL applied to a light emitting layer.

[0039] The compound for organic EL is applied to the light emitting layer to provide desirable characteristics of the material. Thus, it is possible to produce the device including desirable light emission efficiency and half-life of luminance.

[0040] Preferably the compound for organic EL is used as a light emitting dopant material for the light emitting layer of the organic EL device according to the invention.

[0041] The light emitting layer creates electroluminescence when voltage is applied to the organic EL device and an electric current flows. In the coat type of organic EL device, the number of materials constituting the light emitting layer is typically 1. The light emitting layer has three abilities of injection and transportation of the electrons and the holes and creation of electroluminescence.

[0042] The term 'light emitting dopant' is used when the dopant is applied to the light emitting layer and mainly provides the light emitting ability among the three abilities. When the dopant mainly provides the light emitting ability, the organic material that is used for the main purpose of injecting and transporting the holes and the electrons is used along with the dopant. The organic material is called a host material.

[0043] Since the compound for organic EL is used as the light emitting dopant material of the light emitting layer, desirable characteristics of the material are provided, and it is possible to produce the desirable device that has a red light emitting ability and the desirable light emission efficiency and half-life of luminance.

[0044] In the organic EL device according to the invention, preferably, the light emitting layer is formed of the light emitting dopant material and the host material. Preferably, the light emitting dopant material and the host material are included in the light emitting layer so that k shown in the following Equation 7 is 0.5 to 10.0 wt%:

Equation 7

$$k = (a / (b + c)) \times 100.$$

[0045] In Equation 7, a is the weight of the unit of Formula 1 of the light emitting dopant material, b is the weight of the light emitting dopant material, and c is the weight of the host material.

[0046] The luminous portion of the light emitting dopant (Formula 1 of the light emitting dopant material) has high intensity of fluorescence. Accordingly, if the light emitting dopant efficiently traps the electrons and the holes in the device (element), even though k is about 0.1 wt%, it is possible to create electroluminescence. However, if k is very low, the host material tends to emit light due to poor transfer of energy or undesirable trapping of the electrons and the holes. Therefore, it is preferable that the lowest limit of k is 0.5 wt%. It is difficult to determine the highest limit. In connection with this, if only the light emitting ability of the light emitting dopant is required, the highest limit may be 20 to 30 wt%. However, if the amount is very high, it may be impossible to create desirable electroluminescence due to concentration quenching. Accordingly, it is preferable that the highest limit is 10 wt% in consideration of light emission efficiency.

[0047] In the organic EL device according to the invention, preferably, the light emitting layer is formed of the light emitting dopant material and the host material. Preferably, the host material is a homopolymer or a copolymer having at least one material selected from fluorene, arylamine, or anthracene.

[0048] It is required that the host material is capable of desirably transporting the holes and the electrons. It is also required that an energy gap between the HOMO (highest occupied molecular orbital) and the LUMO (lowest unoccupied molecular orbital) in a molecular orbital is higher in comparison with the unit of Formula 1 of the polymer molecule. Additionally, it is required that a vacuum level of the LUMO (lowest unoccupied molecular orbital) is higher in comparison with the polymer of Formula 6.

[0049] When the above-mentioned requirements are satisfied, both the holes and the electrons are desirably injected from the host material to the light emitting dopant to improve light emitting efficiency and a life span.

[0050] In the organic EL device according to the invention, preferably, at least one hole injection or hole transport layer is formed between the light emitting layer and the anode.

[0051] Thereby, the injection of the holes to the light emitting layer and the light emitting efficiency are improved.

[0052] The HOMO (highest occupied molecular orbital) may be measured using photoelectrons spectroscopy equipment (AC-1) manufactured by RIKEN KEIKI Co., Ltd.

[0053] The energy gap between the HOMO (highest occupied molecular orbital) and the LUMO (lowest unoccupied molecular orbital) may be measured using thin film absorption spectrum of the host material. Typically, the energy gap is obtained using the absorption edge at the longest wavelength of the absorption spectrum. The vacuum level of the LUMO may be obtained using a simpler process in comparison with the vacuum level of the HOMO and the gap between the HOMO and the LUMO.

[0054] In the organic EL device according to invention, the light emitting layer is preferably formed through coating using a spin coating process or a liquid droplet jet process.

[0055] If the compound for organic EL is applied using the spin coating process or the liquid droplet jet process to produce the light emitting layer, the organic EL device has a desirable light emission efficiency and half-life of luminance.

[0056] Since the compound for organic EL is the oligomer or polymer molecule, the host material and the polymer have a desirable compatibility. This allows for a uniform dispersion of the host material and the light emitting dopant material in the light emitting layer.

[0057] If the compound for organic EL has a high molecular weight, the compound may be partly or entirely decomposed during the deposition in a deposition film forming process, thereby reducing the characteristics of the organic EL device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0058] The invention will be described with reference to the accompanying drawings, wherein the same numbers refer to the same elements.

[0059] Fig. 1 illustrates the synthesis of Synthesis example 1.

[0060] Fig. 2 illustrates the synthesis of Synthesis example 2.

[0061] Fig. 3 illustrates the synthesis of Synthesis example 3.

[0062] Fig. 4 illustrates the synthesis of Synthesis example 4.

[0063] Fig. 5 illustrates the synthesis of Synthesis example 5.

[0064] Fig. 6 illustrates the synthesis of Synthesis example 6.

[0065] Fig. 7 illustrates the synthesis of Synthesis example 7.

[0066] Fig. 8 illustrates the synthesis of Synthesis example 8.

[0067] Fig. 9 illustrates the synthesis of Synthesis example 9.

[0068] Fig. 10 illustrates the synthesis of Synthesis example 10.

[0069] Fig. 11 illustrates the synthesis of Synthesis example 11.

[0070] Fig. 12 illustrates the synthesis of Synthesis example 11.

[0071] Fig. 13 schematically illustrates an organic EL device according to an embodiment of the invention.

[0072] Fig. 14 is a graph showing an EL waveform that is formed by light emission of the organic EL device.

[0073] Fig. 15 is a graph showing an EL waveform that is formed by light emission of the organic EL device.

[0074] Fig. 16 is a graph showing an EL waveform that is formed by light emission of the organic EL device.

[0075] Fig. 17 is a graph showing an EL waveform that is formed by light emission of the organic EL device.

[0076] Fig. 18 is a graph showing an EL waveform that is formed by light emission of the organic EL device.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

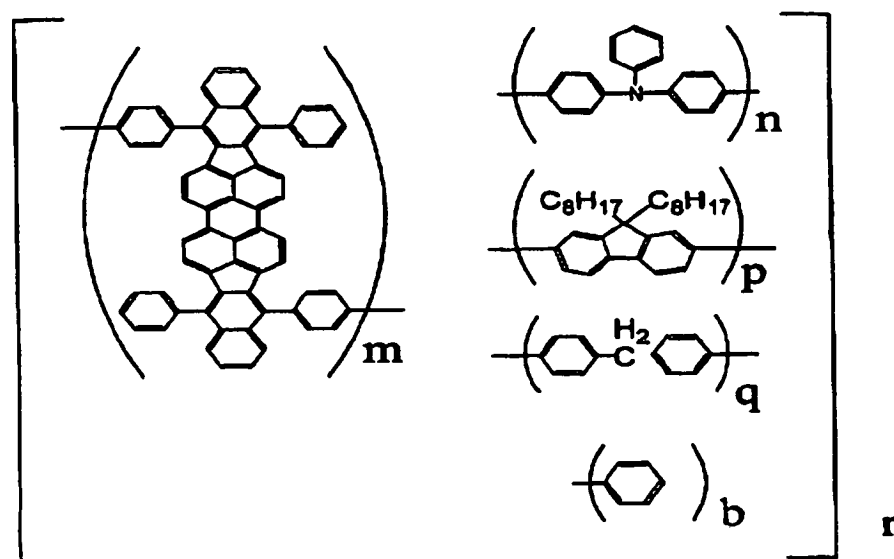
[0077] Hereinafter, exemplary embodiments of the invention will be described in detail.

[0078] First, a description will be given of compounds for organic EL according to embodiments of the invention based on Synthesis examples.

Compound for organic EL

[0079] The polymer molecule shown in the following Formula 7 was produced as a compound for organic EL according to a first embodiment of the invention using synthesis processes of the following Synthesis examples:

Formula 7



[0080] In Formula 7, with respect to theoretical values of the synthetic reaction, $m = 1$, $n = 2$, $p = 4$, $q = 0$, $b = 2$, and $r = 1$.

SYNTHESIS EXAMPLE 1

[0081] 1-bromophenyl-3-phenylisobenzofuran was synthesized using the synthesis process of Fig. 1. The synthesis procedure was as follows.

[0082] First, 5.0 g of 1,4-dibromobenzene (2.12×10^{-2} mol) was weighed and put into a Schlenk tube with a volume of 200 cm³ that was substituted with Ar. 100 cm³ of anhydrous THF (tetrahydrofuran) was added to produce a solution. After the solution was cooled to -50°C, 12.7 cm³ of n-BuLi hexane solution (1.5 mol/l) (1.9×10^{-2} mol) was added, and left for 1.5 hours while agitation was performed and the cooling temperature was maintained. 4 g of 3-phenyl phthalide (1.9×10^{-2} mol) was then added while the cooling temperature was maintained. The temperature was increased to room temperature after 2 hours, and 30 cm³ of 35% hydrochloric acid aqueous solution was added. After 1 hour, extraction was performed using toluene by means of a separatory funnel, and washing was desirably performed using distilled water. The toluene solution was concentrated, and the target substance was obtained through separation using silica gel chromatography (developing solvent containing toluene and hexane mixed at a mixing rate of 1:4).

[0083] Thereby, 4.65 g of yellow solid was produced (yield: 70%), and MS⁺ of 348 and 350 were confirmed.

SYNTHESIS EXAMPLE 2

[0084] Dicyclopenta[cd, lm] perylene (intermediate) was synthesized using the synthesis process of Fig. 2. The synthesis procedure was as follows.

[0085] First, 5 g of 5,6-dibromoacenaphthalene (1.61×10^{-2} mol) and 70 cm³ of dimethylformamide (DMF) dried as a solvent were put into a Schlenk tube with a volume of 200 cm³ that was substituted with Ar, and dissolved at 90°C by heating. 4.5 g of Ni(COD)₂ (1.61×10^{-2} mol), 2.52 g of 2,2'-bipyridine (1.61×10^{-2} mol), and cyclooctadiene (1 cm³) were added and the reaction was performed at 90°C for 5 hours.

[0086] After the reaction, the reaction solution was cooled to room temperature, and 50 cm³ of methanol and 15 cm³ of 45% hydrochloric acid water were added. The precipitate was collected using filtration, and desirably washed using water and methanol.

[0087] Subsequently, the filtrate was dissolved in 300 cm³ of chloroform, and impurities were removed using silica gel.

[0088] Purification was then performed by means of reprecipitation using dichloromethane and hexane.

[0089] Thereby, 0.9 g of black purple crystal was produced (yield: 38%), and MS⁺ of 300 was confirmed.

SYNTHESIS EXAMPLE 3

[0090] Dibromo-dibenzo[f,f']diindeno[1,2,3-cd : 1',2',3'-lm]perylene was synthesized using the synthesis process of Fig. 3. The synthesis procedure was as follows.

[0091] First, 3 g of 1-bromophenyl-3-phenylisobenzofuran (8.6×10^{-3} mol) that was obtained in Synthesis example 1, 1 g of dicyclopenta[cd, lm] perylene (3.43×10^{-3} mol) that was obtained in Synthesis example 2, and 100 cm³ of xylene that was dried by distillation were put into a Schlenk tube with a volume of 200 cm³ that was substituted with Ar, and reacted at 130°C for 20 hours.

[0092] After the reaction, the target intermediate precipitate was filtered.

[0093] Subsequently, the filtrate was washed using 300 cm³ of heated chloroform and the target intermediate was collected.

[0094] Thereby, 2 g of yellow solid was produced as the intermediate (yield: 61%).

[0095] Next, 2 g of the intermediate was put into a flask with a volume of 500 cm³, 200 cm³ of an acetic acid was added, and the resulting substance was heated at 130°C for 1 hour. After the heating, the temperature was reduced to 100°C, and 30 cm³ of 48% HBr aqueous solution was added. Water was added 30 minutes after the heating to enable collection of solids. The solids were desirably washed with distilled water and methanol, and the target substance was separated and purified using silica gel chromatography and reprecipitation.

[0096] Thereby, 0.9 g of black purple solid was produced (yield: 40%), and (MS⁺ + 1) of 963 was confirmed.

SYNTHESIS EXAMPLE 4

[0097] 2-bromo-9,9-di-n-octylfluorenyl-7-borate was synthesized using the synthesis process of Fig. 4. The synthesis procedure was as follows.

[0098] First, 4 g of 2,7-dibromo-9,9-di-n-octylfluorene (7.3×10^{-3} mol) and 100 cm³ of THF that was subjected to sodium drying were put into a Schlenk tube with a volume of 200 cm³ that was substituted with Ar to produce a solution. The solution was cooled to -70°C. 1.5 mol/l of n-butyllithium hexane solution was added in the amount of 4.9 cm³, and left for 1 hour. 1.1 g of triethyl borate (7.5×10^{-3} mol) was added while the cooling temperature was maintained, and the reaction was performed for 1.5 hours. After the reaction, 5 cm³ of 40% HCl aqueous solution was added to the reaction solution

at 5°C. After 1 hour, neutralization was performed using the saturated sodium carbonate aqueous solution so that the pH was 7.

[0099] The organic layer (THF layer) was separated using a separatory funnel. A predetermined amount of magnesium sulfate was added to the separated THF solution to remove the moisture. After magnesium sulfate was removed using a filter paper, hexane was added to precipitate the target substance. Purification was performed using reprecipitation. THF and hexane were used as the solvent.

SYNTHESIS EXAMPLE 5

[0100] 4-bromo-triphenyl aminoborate was synthesized using the synthesis process of Fig. 5. The synthesis procedure was as follows.

[0101] First, 4 g of commercially available 4,4'-dibromotriphenylamine (9.9E-3 mol) and 100 cm³ of THF that had been subjected to sodium drying were put into a Schlenk tube with a volume of 200 cm³ that was substituted with Ar to produce a solution. The solution was then cooled to -70°C. 1.5 mol/l of n-butyllithium hexane solution (1.48E-2 mol) was added in the amount of 9.9 cm³, and left for 1 hour. Subsequently, 1.9 g of triethyl borate (1.3E-2 mol) was added while the cooling temperature was maintained, and the reaction was performed for 1.5 hours. After the reaction, 5 cm³ of 40% HCl aqueous solution was added to the reaction solution at 5°C. After 1 hour, neutralization was performed using the saturated sodium carbonate aqueous solution so that the pH was 7.

[0102] The organic layer (THF layer) was separated using a separatory funnel. Subsequently, a predetermined amount of magnesium sulfate was added to the separated THF solution to remove the moisture. After magnesium sulfate was removed using a filter paper, hexane was added to precipitate the target substance. Purification was performed using reprecipitation. THF and hexane were used as the solvent.

[0103] Thereby, 1.4 g of white solid (to be colored to have a light green color) was produced (yield: 40%).

SYNTHESIS EXAMPLE 6

[0104] 1-(4-bromobenzyl)-4-phenyl borate was synthesized using the synthesis process of Fig. 6. The synthesis procedure was as follows.

[0105] First, 5 g of commercial 4,4'-bisbromophenylmethane (1.5E-2 mol) and 50 cm³ of THF that had been subjected to sodium drying were put into a Schlenk tube with a volume of 200 cm³ that was substituted with Ar to produce a solution. The solution was then cooled to -70°C. 1.5 mol/l of n-butyllithium hexane solution (1.5E-2 mol) was added in the amount of 10.2 cm³, and left for 1 hour. Subsequently, 2.2 g of triethyl borate (1.5E-2 mol) was added while the cooling temperature was maintained, and the reaction was performed for 1.5 hours. After the reaction, 5 cm³ of 40% HCl aqueous solution was added to the reaction solution at 5°C. After 1 hour, neutralization was performed using the saturated sodium carbonate aqueous solution so that the pH was 7.

[0106] The organic layer (THF layer) was separated using a separatory funnel. Subsequently, a predetermined amount of magnesium sulfate was added to the separated THF solution to remove the moisture. After magnesium sulfate was removed using a filter paper, the solvent was removed using an evaporator.

[0107] Thereby, 4 g of transparent viscous substance was produced, and used during the subsequent reaction.

SYNTHESIS EXAMPLE 7

[0108] The EL material (EL material 1) of Formula 7, that is, the compound for organic EL according to the first embodiment of the invention, was synthesized through the synthesis procedure of Fig. 7 using the synthetic substances produced in Synthesis examples 3 to 6.

[0109] First, 0.5 g of dibromo-dibenzo [f, f'] diindeno [1,2,3-cd: 1',2',3'-1m]perylene (5.2E-4 mol) and 0.38 g of 4-bromo-triphenyl aminoborate (1.04E-3 mol) which had been produced in advance were put into a Schlenk tube with a volume of 200 cm³ that was substituted with Ar to produce a solution, and 50 cm³ of distilled ethanol and 100 cm³ of distilled toluene were added to produce a solution. Additionally, 0.06 g of a tetrakis(triphenylphosphine)palladium complex (Pd(PPh₃)₄) and 30 cm³ of saturated sodium carbonate aqueous solution were added, and heated at 80°C. After 1 hour, 1.1 g of 2-bromo-9,9-di-n-octylfluorenyl-7-borate (2.1E-3 mol) and 0.06 g of the tetrakis(triphenylphosphine)palladium complex (Pd(PPh₃)₄) were added, and the reaction was performed for 5 hours.

[0110] Subsequently, 0.12 g of commercial phenyl borate (1.04E-3 mol) was added, and the additional reaction was performed for 5 hours. After the reaction, air was blown onto the reaction solution for 30 minutes while the solution was heated to make the solution bubble.

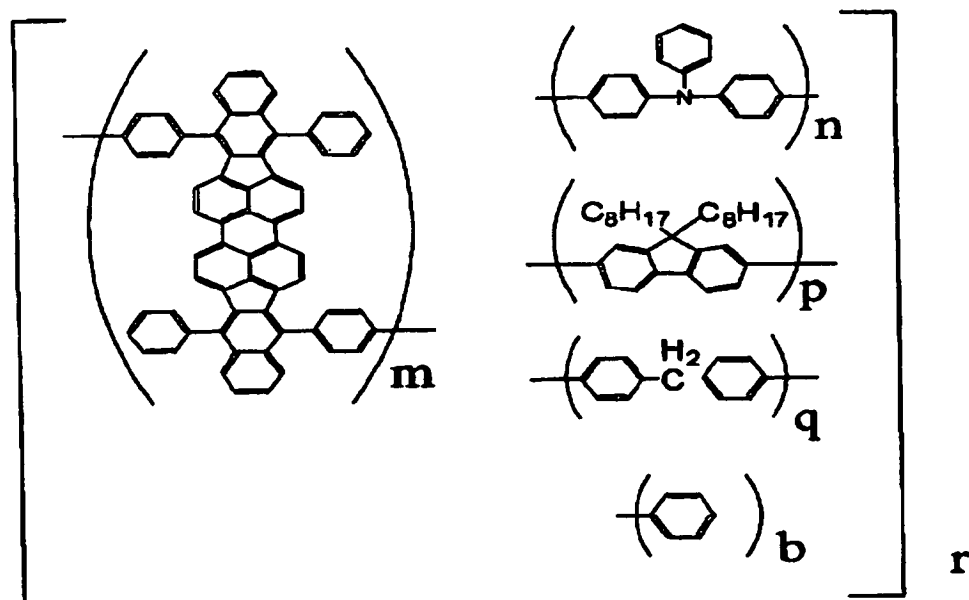
[0111] The reaction solution was cooled to room temperature, transferred to a separatory funnel with a volume of 1 liter to perform extraction using toluene, and desirably washed with distilled water. The toluene layer in the separatory funnel was desirably dried using magnesium sulfate, and then purified using silica gel chromatography and reprecipitation.

[0112] The dichloromethane/hexane system and the dichloromethane/methanol system were used as the solvent that was used to perform the purification using reprecipitation.

[0113] Thereby, 0.5 g of red fluorescent substance was produced (yield: 32%) (the calculation was performed on the basis of a molecular weight of 2998).

[0114] The polymer molecule shown in the following Formula 8 was produced as the compound for organic EL according to a second embodiment of the invention using the synthesis process of the following Synthesis example:

Formula 8



[0115] In Formula 8, with respect to theoretical values of the synthetic reaction, $m = 1$, $n = 2$, $p = 4$, $q = 0$, $b = 2$, and $r = 1$.

SYNTHESIS EXAMPLE 8

[0116] The EL material (EL material 2) of Formula 8 was synthesized through the synthesis procedure of Fig. 8 using the synthetic substances produced in Synthesis examples 3 to 6.

[0117] First, 0.5 g of dibromo-dibenzo[*f,f'*]diindeno[1,2,3-*cd*:1',2',3'-*lm*]perylene (5.2E-4 mol) and 0.38 g of 4-bromo-triphenyl aminoborate (1.04E-3 mol) which had been produced in advance were put into a Schlenk tube with a volume of 200 cm³ that was substituted with Ar, and 50 cm³ of distilled ethanol and 100 cm³ of distilled toluene were added to produce a solution. 0.06 g of a tetrakis(triphenyl)phosphinepalladium complex (Pd(PPh₃)₄) and 30 cm³ of saturated sodium carbonate aqueous solution were added, and heated at 80°C.

[0118] After 1 hour, 0.3 g of 1-(4-bromobenzyl)-4-phenyl borate (1.04E-3 mol) and 0.06 g of the tetrakis(triphenyl)phosphinepalladium complex (Pd(PPh₃)₄) were added, and the reaction was performed. After 2 hours, 1.1 g of 2-bromo-9,9-di-*n*-octylfluorenyl-7-borate (2.1E-3 mol) and 0.06 g of the tetrakis(triphenyl)phosphinepalladium complex (Pd(PPh₃)₄) were added, and the reaction was performed for 5 hours. Subsequently, 0.12 g of commercially available phenyl borate (1.04E-3 mol) was added, and the additional reaction was performed for 5 hours. After the reaction, air was blown onto the reaction solution for 30 minutes while the solution was heated to make the solution bubble.

[0119] The reaction solution was cooled to room temperature, transferred to a separatory funnel of 1 liter to perform extraction using toluene, and desirably washed with distilled water. The toluene layer in the separatory funnel was desirably dried using magnesium sulfate, and then purified using silica gel chromatography and reprecipitation.

[0120] The dichloromethane/hexane system and the dichloromethane/methanol system were used as the solvent that was used to perform the purification using reprecipitation.

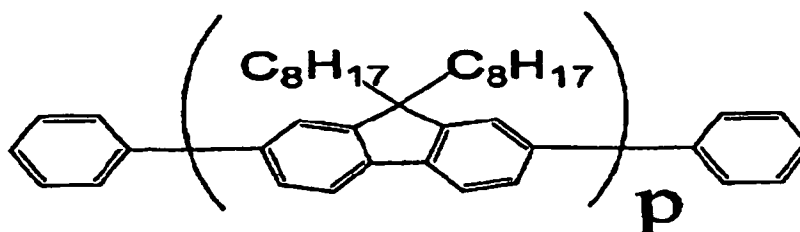
[0121] Thereby, 0.5 g of red fluorescent substance was produced (yield: 29%) (the calculation was performed on the basis of a molecular weight of 3331).

[0122] Next, the host material for EL was produced through the following procedure.

[0123] First, the polymer molecule shown in the following Formula 9 was produced as host 1 using the synthesis

process of the following Synthesis example:

Formula 9



[0124] In Formula 9, with respect to theoretical values of the synthetic reaction, $p = 150$.

SYNTHESIS EXAMPLE 9

[0125] Polyfluorene shown in Formula 9 was synthesized as the host material (host 1) for EL through the synthesis procedure of Fig. 9. The synthesis procedure was as follows.

[0126] First, 5 g of 2-bromo-9,9-di-n-octylfluorenyl-7-borate ($9.7E-3$ mol), 0.008 g of commercially available phenyl borate ($6.6E-5$ mol), and 0.01 g of bromobenzene ($6.6E-5$ mol) which had been produced in advance were weighed and put into a Schlenk tube with a volume of 200 cm^3 that was substituted with Ar. 50 cm^3 of distilled ethanol and 100 cm^3 of distilled toluene were added to produce a solution. Additionally, 0.56 g of a tetrakis(triphenyl)phosphinepalladium complex ($\text{Pd}(\text{PPh}_3)_4$) and 30 cm^3 of saturated sodium carbonate aqueous solution were added, and the reaction was performed at 80°C for 10 hours.

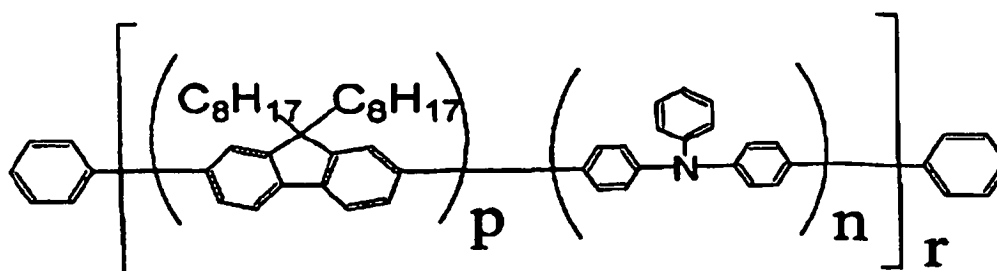
[0127] After the reaction, the reaction solution was cooled to room temperature, transferred to a separatory funnel with a volume of 1 liter to perform extraction using toluene, and desirably washed with distilled water. The toluene layer in the separatory funnel was desirably dried using magnesium sulfate, and then purified using silica gel chromatography and reprecipitation.

[0128] The dichloromethane/hexane system and the dichloromethane/methanol system were used as the solvent that was used to perform purification using reprecipitation.

[0129] Thereby, 2 g of white solid was produced (the yield meant the recovery amount was 52%).

[0130] Next, the polymer molecule of the following Formula 10 was produced as host 2 through the synthesis procedure of the following Synthesis example:

Formula 10



[0131] In Formula 10, with respect to theoretical values of the synthetic reaction, $p = 3$, $n = 1$, and $r = 50$.

SYNTHESIS EXAMPLE 10

[0132] The copolymer of fluorene and triphenylamine shown in Formula 10 was synthesized as the host material (host 2) for EL through the synthesis procedure of Fig. 10. The synthesis procedure was as follows.

[0133] First, 5 g of 2-bromo-9,9-di-n-octylfluorenyl-7-borate ($9.7\text{E-}3$ mol), 1.2 g of 4-bromo-triphenyl aminoborate ($3.2\text{E-}3$ mol), 0.008 g of commercially available phenyl borate ($6.6\text{E-}5$ mol), and 0.01 g of bromobenzene ($6.6\text{E-}5$ mol) which had been produced in advance were weighed and put into a Schlenk tube with a volume of 200 cm^3 that was substituted with Ar. 50 cm^3 of distilled ethanol and 100 cm^3 of distilled toluene were added to produce a solution.

Additionally, 0.56 g of a tetrakis(triphenyl)phosphinepalladium complex ($\text{Pd}(\text{PPh}_3)_4$) and 30 cm^3 of saturated sodium carbonate aqueous solution were added, and the reaction was performed at 80°C for 5 hours.

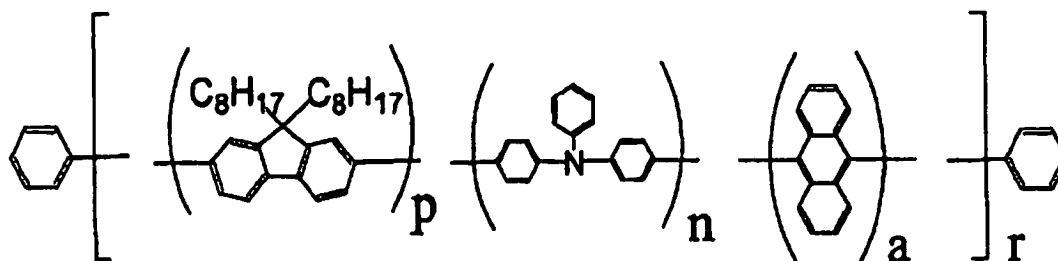
[0134] After the reaction, the reaction solution was cooled to room temperature, transferred to a separatory funnel with a volume of 1 liter to perform extraction using toluene, and desirably washed with distilled water. The toluene layer in the separatory funnel was desirably dried using magnesium sulfate, and then purified using silica gel chromatography and reprecipitation.

[0135] The dichloromethane/hexane system and the dichloromethane/methanol system were used as the solvent that was used to perform purification using reprecipitation.

[0136] Thereby, 1.5 g of white solid was produced (the yield meant the recovery amount was 33%).

[0137] Next, the polymer molecule of the following Formula 11 was produced as host 3 through the synthesis procedure of the following Synthesis example:

Formula 11



[0138] In Formula 11, with respect to theoretical values of the synthetic reaction, $p = 3$, $n = 1$, $a = 1$, and $r = 50$.

SYNTHESIS EXAMPLE 11

[0139] The copolymer of fluorene, triphenylamine, and anthracene shown in Formula 11 was synthesized as the host material (host 3) for EL using the process of synthesizing the raw material according to Fig. 11 and the process of synthesizing the host material according to Fig. 12. The synthesis processes were as follows.

Synthesis of the raw material: Synthesis of 9-bromoanthracene-10-yl-borate

[0140] First, 2 g of 9,10-dibromoanthracene ($5.9\text{E-}3$ mol) and 50 cm^3 of THF that was subjected to sodium drying were put into a Schlenk tube with a volume of 200 cm^3 that was substituted with Ar to produce a dispersion solution. The solution was then cooled to -70°C . 1.5 mol/l of n-butyllithium hexane solution ($5.9\text{E-}3$ mol) was added in the amount of 4 cm^3 , and left for 1 hour. 0.87 g of triethyl borate ($5.9\text{E-}3$ mol) was added while the cooling was maintained, and the reaction was performed for 1.5 hour. After the reaction, 5 cm^3 of 40% HCl aqueous solution was added to the reaction solution at 5°C . After 1 hour, 100 cm^3 of THF was added to completely dissolve the resulting solution, and the neutralization was then performed using the saturated sodium carbonate aqueous solution so that the pH was 7.

[0141] The organic layer (THF layer) was separated using a separatory funnel. The predetermined amount of magnesium sulfate was added to the separated THF solution to remove the moisture. After magnesium sulfate was removed using the filter paper, the solvent was removed using the evaporator, and hexane was added to precipitate the target substance. The purification was performed using the reprecipitation. THF and hexane were used as the solvent.

[0142] Thereby, 1 g of light yellow white solid (to be colored to have a light green color) was produced (yield: 56%).

Synthesis of the host material

[0143] First, 5 g of 2-bromo-9,9-di-n-octylfluorenyl-7-borate ($9.7\text{E-}3$ mol), 1.2 g of 4-bromo-triphenyl aminoborate ($3.2\text{E-}3$ mol), 0.96 g of 9-bromoanthracene-10-yl-borate ($3.2\text{E-}3$ mol), 0.008 g of commercial phenyl borate ($6.6\text{E-}5$ mol), and 0.01 g of bromobenzene ($6.6\text{E-}5$ mol) which were already produced were weighed and put into a Schlenk tube with

a volume of 200 cm³ that was substituted with Ar. 50 cm³ of distilled ethanol and 100 cm³ of distilled toluene were added to produce a solution. Additionally, 0.7 g of a tetrakis(triphenyl)phosphinepalladium complex (Pd(PPh₃)₄) and 30 cm³ of saturated sodium carbonate aqueous solution were added, and the reaction was performed at 80°C for 5 hours.

[0144] After 5 hours, 0.2 g of phenyl borate (1.65E-3 mol) was added, and the additional reaction was performed for 1 hour. After 1 hour, the reaction solution was cooled to room temperature, transferred to the separatory funnel of 1 liter to perform extraction using toluene, and desirably washed with distilled water. The toluene layer in the separatory funnel was desirably dried using magnesium sulfate, and then purified using the silica gel chromatography and the reprecipitation.

[0145] The dichloromethane/hexane system and the dichloromethane/methanol system were used as the solvent that was used to perform the purification using the reprecipitation.

[0146] Thereby, 2.1 g of the light yellow white solid was produced (the yield that meant the recovery amount was 41%).

[0147] EL materials 1 and 2 (the compounds for organic EL according to the embodiments of the invention) were used as the light emitting dopant material, and mixed with the host materials for EL (hosts 1, 2, and 3) at a predetermined mixing ratio as described below to form the materials for the light emitting layer of the organic EL device.

[0148] The syntheses were performed with reference to the following literatures: J. Am. Chem. Soc. 118, 2374-2379 (1996) Polymers for Advanced Technologies, 15 (5), 266-269; 2004 Eur. Pat. Appl., 1298117, 02 Apr 2003 Helvetica Chimica Acta, 85 (7), 2195-2213; 2002 Organometallics, 20 (24), 5162-5170; 2001 Journal of Organic Chemistry, 69 (3), 987-990; 2004 Advanced Functional Materials, 13 (12), 967-973; 2003 Journal of Chemistry (1992), 70 (4), 1015-21.

Organic EL device

[0149] A description will be given of the organic EL device according to the embodiment of the invention with reference to Fig. 13.

[0150] In Fig. 13, reference numeral 100 denotes the organic EL device. The organic EL device 100 includes a light-transmissive anode (a first electrode) 102 and a cathode (a second electrode) 105 on a light-transmissive substrate 101, and a functional layer is interposed between the anode 102 and the cathode 105. A hole injection/transport layer 103 and a light emitting layer 104 are layered to form the functional layer. The organic EL device 100 is a bottom emission type that emits light from the light emitting layer 104 through the light-transmissive substrate 101.

[0151] The substrate 101 includes driving elements composed of TFT elements on the transparent substrate such as a glass substrate, or various wires. The anode 102 is formed on the driving elements or the wires while an insulating layer or a planarization film is interposed between the anode and the elements or the wires. The anode 102 is patterned with respect to all pixels formed on the substrate 101, and connected to the driving elements composed of the TFT elements or the wires. In this embodiment, the anode is formed of ITO.

[0152] The hole injection/transport layer 103 transports the holes from the anode 102 to the light emitting layer 104, and is formed of 3,4-polyethylenedioxythiophene/polystyrene sulfonic acid (PEDOT/PSS). The light emitting layer 104 is formed of the material containing the compound for organic EL according to the embodiment of the invention. In connection with this, the red light emitting layer having the light emitting wavelength band of the red color is provided. Accordingly, the organic EL device 100 displays the red color.

[0153] The cathode 105 is formed to cover all the pixel regions, and LiF, Ca, and Al layers are sequentially layered on the light emitting layer 104 to form the cathode 105. A sealing material 200 is formed on the cathode 105 to attach a sealing substrate 201. The sealing material 200 is made of a thermosetting resin or a UV-curable resin.

[0154] A description will be given of a method of producing the organic EL device 100. The method includes an anode forming process, a substrate treating process (plasma treating process), a hole injection/transport layer forming process, a light emitting layer forming process, a cathode forming process, and a sealing process.

Anode forming process

[0155] A transparent substrate (not shown) formed of, for example, glass was formed, and thin film transistor (TFT) elements or various wires (not shown) were formed on the transparent substrate using a known process. After an interlayer insulating layer or a planarization film was formed, an indium tin oxide (ITO) film was formed on the entire surface of the resulting structure using a deposition process, and patterned with respect to all pixels using a photolithography process to produce the pixel electrode (anode) 102. A light-transmissive conductive material may be used as the pixel electrode 102, and indium zinc oxide may be used instead of ITO.

Substrate treating process

[0156] The glass substrate constituting the anode (pixel electrode) 102 was subjected to ultrasonic washing using a neutral detergent, acetone, or ethanol, drawn from boiled ethanol, and dried. Subsequently, the surface of the transparent

electrode was subjected to oxygen plasma treatment at the atmospheric pressure, reformed to have hydrophilicity, and applied to a spin coat holder in the atmosphere.

Hole injection/transport layer forming process

[0157] The solution of PEDOT/PSS (weight ratio of 1 : 2.5) dispersed in water (commercial name: BAYTRON P, manufactured by H.C. Starck, Inc.) was applied on the substrate on which the anode (pixel electrode) 102 was formed as the material for forming the hole injection/transport layer using spin coating in the atmosphere, and then dried in a nitrogen atmosphere at 100°C for 30 minutes to form the hole injection/transport layer 103. After the drying, the layer was 50 nm in thickness.

Light emitting layer forming process

[0158] Mixtures including EL materials 1 and 2 (light emitting dopant material) which were the compound for organic EL according to the first embodiment of the invention and host materials 1, 2, and 3 for EL were produced as the material for forming the light emitting layer 104. As described in the following Table, the mixtures of EL materials 1 and 2 (light emitting dopant material) and host materials 1, 2, and 3 for EL were used in Examples 1 to 6. For comparison, materials including only host materials 1, 2, and 3 for EL were used in Comparative examples 1 to 3.

[0159] EL materials 1 and 2 (light emitting dopant material) and host materials 1, 2, and 3 for EL were mixed at a predetermined mixing ratio, and dissolved in a solvent to form solutions (ink). The solutions were applied on the surface of the hole injection/transport layer 103 using the spin coating process to the thickness of, for example, 100 nm to form the light emitting layer 104. After the application to form the layer, the drying was performed in a nitrogen atmosphere at 100°C for 30 minutes. When the layer was formed using the solution, the hole injection/transport layer 103 was not compatible to the solution.

[0160] The layer may be formed using the solution by means of the liquid droplet jet process (ink-jet process) instead of the spin coating process.

Cathode forming process

[0161] After the light emitting layer 104 was formed, the vacuum was set to 10^{-7} to 10^{-8} Torr using a vacuum deposition device, and LiF, Ca, and Al were sequentially applied to the thickness of 4, 10, and 200 nm, respectively. The cathode 105 was then formed.

Sealing process

[0162] In the final process, that is, the sealing process, the sealing material 200 including the thermosetting resin or the UV-curable resin was applied on the entire surface of the cathode 105 to form the sealing layer. Additionally, a sealing substrate 201 was attached to the sealing layer (sealing material 200). It is preferable that the sealing process be performed in an inert gas atmosphere including nitrogen, argon, or helium.

[0163] The organic EL device 100 of Fig. 13 was produced through the above-referenced procedure.

[0164] In the organic EL device 100, when the light emitting layer 104 is formed using the compound for organic EL according to the embodiment of the invention, the luminescence characteristic (luminance) and the reliability (the half-life of luminance) are excellent in comparison with the test results as described below. Accordingly, high efficiency and a long life span of light emission are assured.

Examples 1 to 6 and Comparative examples 1 to 3

[0165] The material of the light emitting layer 104 is described in the following Table 1:

[Table 1]

	Host material	Light emitting material	Chromaticity (CIE1931)	Luminance (cd/m ²) (100mA/cm ²)	Required voltage(V) (100mA/cm ²)	Half-life of luminance (hr) (100mA/cm ²)
Example 1	Host 1	EL material 1	(0.66,0.34)	3000	6.0	60
Example 2	Host 1	EL material 2	(0.67,0.33)	3300	6.0	75

(continued)

	Host material	Light emitting material	Chromaticity (CIE1931)	Luminance (cd/m ²) (100mA/cm ²)	Required voltage(V) (100mA/cm ²)	Half-life of luminance (hr) (100mA/cm ²)
Example 3	Host 2	EL material 1	(0.66,0.34)	3550	5.8	95
Example 4	Host 2	EL material 2	(0.67,0.33)	3800	5.8	100
Example 5	Host 3	EL material 1	(0.66,0.34)	3600	5.5	120
Example 6	Host 3	EL material 2	(0.67,0.33)	3900	5.5	140
Comparative example 1	Host 1	None	(0.17,0.14)	500	6.0	20
Comparative example 2	Host 2	None	(0.16,0.04)	650	5.8	35
Comparative example 3	Host 3	None	(0.15,0.09)	900	5.5	45

[0166] In Example 1, EL material 1 shown in Formula 7 and host 1 shown in Formula 9 were mixed at a mixing ratio (weight ratio) of 1:17, and dissolved in chloroform to produce a solution (ink) containing 1.5 wt% of solids. As described above, the light emitting layer 104 was formed using the solution (ink) to produce the organic EL device of Example 1.

[0167] In Example 2, EL material 2 shown in Formula 8 and host 1 shown in Formula 9 were mixed at a mixing ratio (weight ratio) of 1:17, and dissolved in chloroform to produce a solution (ink) containing 1.5 wt% of solids. As described above, the light emitting layer 104 was formed using the solution (ink) to produce the organic EL device of Example 2.

[0168] In Example 3, EL material 1 shown in Formula 7 and host 2 shown in Formula 10 were mixed at a mixing ratio (weight ratio) of 1:17, and dissolved in chloroform to produce a solution (ink) containing 1.5 wt% of solids. As described above, the light emitting layer 104 was formed using the solution (ink) to produce the organic EL device of Example 3.

[0169] In Example 4, EL material 2 shown in Formula 8 and host 2 shown in Formula 10 were mixed at a mixing ratio (weight ratio) of 1:17, and dissolved in chloroform to produce a solution (ink) containing 1.5 wt% of solids. As described above, the light emitting layer 104 was formed using the solution (ink) to produce the organic EL device of Example 4.

[0170] In Example 5, EL material 1 shown in Formula 7 and host 3 shown in Formula 11 were mixed at a mixing ratio (weight ratio) of 1:17, and dissolved in chloroform to produce a solution (ink) containing 1.5 wt% of solids. As described above, the light emitting layer 104 was formed using the solution (ink) to produce the organic EL device of Example 5.

[0171] In Example 6, EL material 2 shown in Formula 8 and host 3 shown in Formula 11 were mixed at a mixing ratio (weight ratio) of 1:17, and dissolved in chloroform to produce a solution (ink) containing 1.5 wt% of solids. As described above, the light emitting layer 104 was formed using the solution (ink) to produce the organic EL device of Example 6.

[0172] In Comparative example 1, only host 1 shown in Formula 9 was dissolved in chloroform to produce a solution (ink) containing 1.5 wt% of solids. As described above, the light emitting layer 104 was formed using the solution (ink) to produce the organic EL device of Comparative example 1.

[0173] In Comparative example 2, only host 2 shown in Formula 10 was dissolved in chloroform to produce a solution (ink) containing 1.5 wt% of solids. As described above, the light emitting layer 104 was formed using the solution (ink) to produce the organic EL device of Comparative example 2.

[0174] In Comparative example 3, only host 3 shown in Formula 11 was dissolved in chloroform to produce a solution (ink) containing 1.5 wt% of solids. As described above, the light emitting layer 104 was formed using the solution (ink) to produce the organic EL device of Comparative example 3.

Evaluation of the device

[0175] Voltage was applied to the organic EL device so that a direct current of 100 mA/cm² flew through the light emitting layer 104, thereby emitting light.

[0176] The resulting EL waveforms are shown in Figs. 14 to 18. Fig. 14 shows the EL waveforms of Examples 1, 3, and 5, Fig. 15 shows the EL waveforms of Examples 2, 4, and 6, Fig. 16 shows the EL waveform of Comparative example 1, Fig. 17 shows the EL waveform of Comparative example 2, and Fig. 18 shows the EL waveform of Comparative example 3.

[0177] Chromaticity, luminance, and the half-life of luminance of emitted light (the time required for half of the luminance to vanish with respect to the initial luminance) were measured, and the results are described in Table 1.

[0178] In Example 1, a voltage of 6.0 V was applied to generate the current.

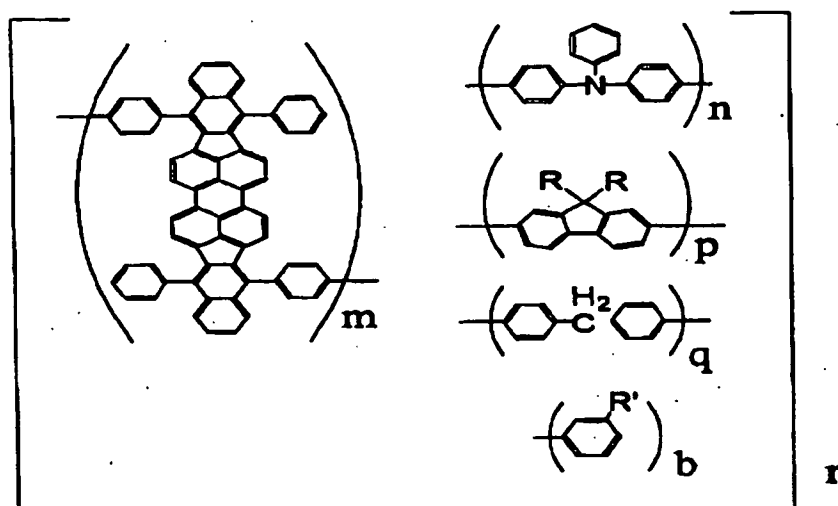
[0179] A voltage of 6.0 V was applied in Example 2, a voltage of 5.8 V was applied in Example 3, a voltage of 5.8 V was applied in Example 4, a voltage of 5.5 V was applied in Example 5, a voltage of 5.5 V was applied in Example 6, a voltage of 6.0 V was applied in Comparative example 1, a voltage of 5.8 V was applied in Comparative example 2, and a voltage of 5.5 V was applied in Comparative example 3.

[0180] From the above results, it can be seen that the organic EL device including the light emitting layer 104 formed using the compound for organic EL according to the aspect of the invention has excellent luminance and the half-life of luminance in comparison with the devices of Comparative examples. Accordingly, the luminescence characteristic (luminance) and the reliability (the half-life of luminance) are excellent. Therefore, the organic EL device according to the aspect of the invention has high efficiency and a long life span.

Claims

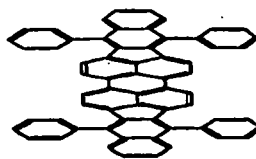
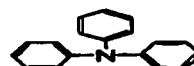
1. An organic electroluminescent device, wherein a compound for organic electroluminescence comprising a polymer molecule which is represented by the following Formula 6, is applied to a light emitting layer:

Formula 6



wherein R is an alkyl group, an aryl group, or an alkylaryl group, R' is hydrogen, an alkyl group, or an alkylaryl group, m, n, and p are each an integer of 1 or more, q and b are each an integer of 0 or more, and r is an integer of 1 or more.

2. The organic electroluminescent device according to Claim 1, wherein m in an oligomer unit of Formula 6 is 1 or 2.
3. The organic electroluminescent device according to Claim 1 or 2, wherein n in an oligomer unit of Formula 6 is 2 or more.
4. The organic electroluminescent device according to any one of Claims 1 to 3, wherein p in an oligomer unit of Formula 6 is 1 to 4.
5. The organic electroluminescent device according to any one of Claims 1 to 4, wherein a unit of Formula 1 and a unit of Formula 2 are directly connected to each other at one point or more in the structure of an oligomer unit of Formula 6.

Formula 1**Formula 2**

6. An organic electroluminescent device according to Claim any one of claims 1 to 5, wherein the compound for organic electroluminescence is used as a light emitting dopant material of the light emitting layer.
7. The organic electroluminescent device according to Claim 6, wherein the light emitting layer is formed of the light emitting dopant material and a host material so that k shown in the following Equation 7 is 0.5 to 10.0 wt%:

Equation 7

$$k = (a / (b + c)) \times 100,$$

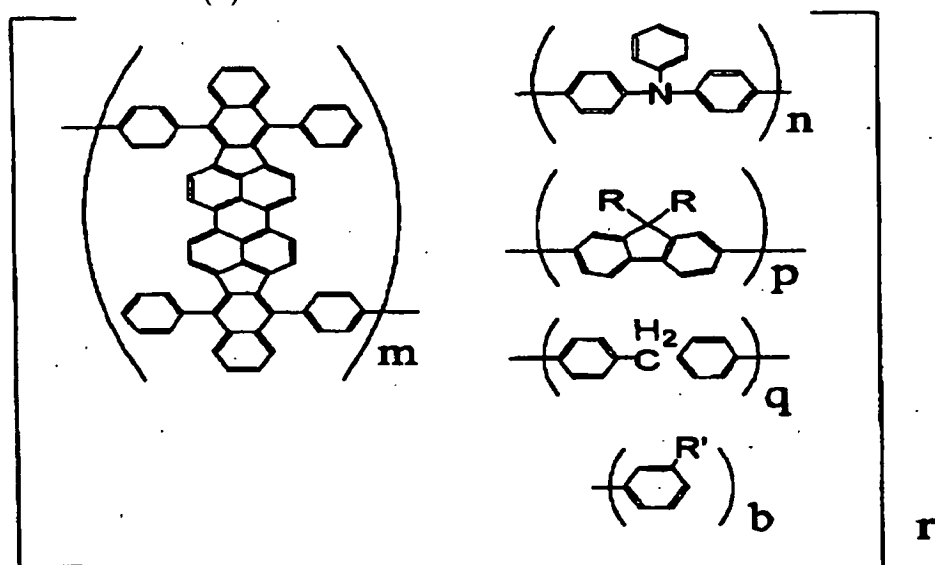
wherein a is the weight of a unit of Formula 1 of the light emitting dopant material, b is the weight of the light emitting dopant material, and c is the weight of the host material.

8. The organic electroluminescent device according to Claim 6 or 7, wherein the light emitting layer is formed of the light emitting dopant material and a host material, and the host material is a homopolymer or a copolymer having at least one material selected from fluorene, arylamine, and anthracene.
9. The organic electroluminescent device according to any one of Claims 1 to 8, wherein at least one hole injection or hole transport layer is formed between the light emitting layer and an anode.
10. The organic electroluminescent device according to anyone of Claims 1 to 9, wherein the light emitting layer is formed through coating using a spin coating process or a liquid droplet jet process.

Patentansprüche

1. Organische Elektrolumineszenzvorrichtung, worin eine Verbindung für organische Elektrolumineszenz, die ein Polymermolekül der folgenden Formel (6) umfasst, in einer Licht-emittierenden Schicht bereitgestellt wird:

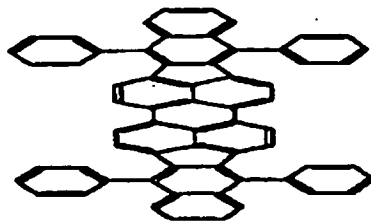
Formel (6):



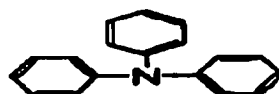
worin R eine Alkylgruppe, eine Arylgruppe oder eine Alkylarylgruppe ist, R' Wasserstoff, eine Alkylgruppe oder eine Alkylarylgruppe ist, m, n und p jeweils eine ganze Zahl von 1 oder mehr sind, q und b jeweils eine ganze Zahl von 0 oder mehr sind, und r eine ganze Zahl von 1 oder mehr ist.

2. Organische Elektrolumineszenzvorrichtung gemäss Anspruch 1, worin m in einer Oligomereinheit der Formel (6) 1 oder 2 ist.
3. Organische Elektrolumineszenzvorrichtung gemäss Anspruch 1 oder 2, worin n in einer Oligomereinheit der Formel (6) 2 oder mehr ist.
4. Organische Elektrolumineszenzvorrichtung gemäss einem der Ansprüche 1 bis 3, worin p in einer Oligomereinheit der Formel (6) 1 bis 4 ist.
5. Organische Elektrolumineszenzvorrichtung gemäss einem der Ansprüche 1 bis 4, worin eine Einheit der Formel (1) und eine Einheit der Formel (2) an einer oder mehreren Stelle(n) in der Struktur einer Oligomereinheit der Formel (6) direkt miteinander verbunden sind:

Formel (1):



Formel (2):



6. Organische Elektrolumineszenzvorrichtung gemäss einem der Ansprüche 1 bis 5, worin die Verbindung für organische Elektrolumineszenz als Licht-emittierendes Dotierungsmaterial der Licht-emittierenden Schicht verwendet wird.
7. Organische Elektrolumineszenzvorrichtung gemäss Anspruch 6, worin die Licht-emittierende Schicht aus dem Licht-emittierenden Dotierungsmaterial und einem Wirtsmaterial gebildet ist, so dass k in der folgenden Gleichung 7 0,5 bis 10,0 Gew.% beträgt:

Gleichung 7:

$$k = (a / (b+c)) \times 100,$$

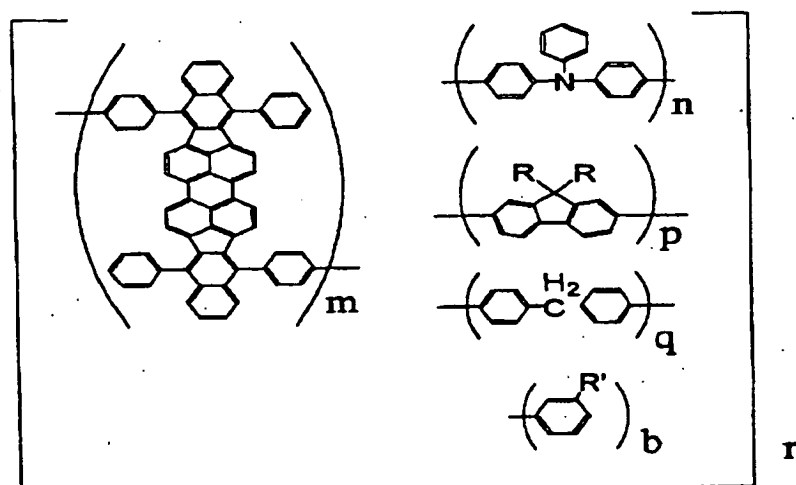
worin a das Gewicht einer Einheit der Formel (1) des Licht-emittierenden Dotierungsmaterials ist, b das Gewicht des Licht-emittierenden Dotierungsmaterials ist und c das Gewicht des Wirtsmaterials ist.

8. Organische Elektrolumineszenzvorrichtung gemäss Anspruch 6 oder 7, worin die Licht-emittierende Schicht aus dem Licht-emittierenden Dotierungsmaterial und einem Wirtsmaterial gebildet ist, und das Wirtsmaterial ein Homopolymer oder ein Copolymer mit mindestens einem Material, ausgewählt aus Fluoren, Arylamin und Anthracen, ist.
9. Organische Elektrolumineszenzvorrichtung gemäss einem der Ansprüche 1 bis 8, worin mindestens eine Lochinjektionsschicht oder Lochtransportschicht zwischen der Licht-emittierenden Schicht und der Anode gebildet wird.
10. Organische Elektrolumineszenzvorrichtung gemäss einem der Ansprüche 1 bis 9, worin die Licht-emittierende Schicht durch Beschichtung unter Verwendung eines Rotationsbeschichtungsverfahrens oder eines Flüssigtröpfchen-Strahlverfahrens gebildet wird.

Revendications

1. Dispositif électroluminescent organique, dans lequel un composé pour de l'électroluminescence organique, comprenant une molécule polymère qui est représentée par la Formule 6 suivante, est appliqué à une couche émettrice de lumière :

Formule 6

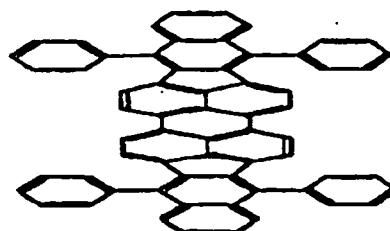


dans laquelle R est un groupe alkyle, un groupe aryle ou un groupe alkylaryle, R' est un hydrogène, un groupe

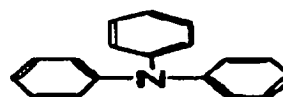
alkyle ou un groupe alkylaryle, m, n et p sont chacun un nombre entier valant 1 ou davantage, q et b sont chacun un nombre entier de 0 ou davantage, et r représente un nombre entier de 1 ou davantage.

2. Dispositif électroluminescent organique selon la revendication 1, dans lequel m dans une unité oligomère de Formule 6 vaut 1 ou 2.
3. Dispositif électroluminescent organique selon la revendication 1 ou 2, dans lequel n dans une unité oligomère de Formule 6 vaut 2 ou davantage.
4. Dispositif électroluminescent organique selon l'une quelconque des revendications 1 à 3, dans lequel p dans une unité oligomère de Formule 6 vaut 1 à 4.
5. Dispositif électroluminescent organique selon l'une quelconque des revendications 1 à 4, dans lequel une unité de Formule 1 et une unité de Formule 2 sont directement reliées l'une à l'autre en un ou plusieurs points dans la structure d'une unité oligomère de Formule 6.

Formule 1



Formule 2



6. Dispositif électroluminescent organique selon l'une quelconque des revendications 1 à 5, dans lequel le composé pour électroluminescence organique est utilisé en tant que matériau de dopage émetteur de lumière de la couche émettrice de lumière.
7. Dispositif électroluminescent organique selon la revendication 6, dans lequel la couche émettrice de lumière est formée du matériau de dopage émetteur de lumière et d'un matériau hôte de telle sorte que k présenté dans l'Equation 7 suivante est de 0,5 à 10,0 % en poids :

Equation 7

$$k = (a / (b + c)) \times 100,$$

dans laquelle a est le poids d'une unité de Formule 1 du matériau de dopage émetteur de lumière, b est le poids du matériau de dopage émetteur de lumière, et c est le poids du matériau hôte.

8. Dispositif électroluminescent organique selon la revendication 6 ou 7, dans lequel la couche émettrice de lumière est formée du matériau de dopage émetteur de lumière et d'un matériau hôte, et le matériau hôte est un homopolymère ou un copolymère ayant au moins un matériau sélectionné parmi le fluorène, l'arylamine et l'anthracène.

9. Dispositif électroluminescent organique selon l'une quelconque des revendications 1 à 8, dans lequel au moins une couche d'injection de trous ou une couche de transport de trous est formée entre la couche émettrice de lumière et une anode.

5 **10.** Dispositif électroluminescent organique selon l'une quelconque des revendications 1 à 9, dans lequel la couche émettrice de lumière est formée par l'intermédiaire d'un revêtement en utilisant un procédé de revêtement par rotation ou un procédé à jet de gouttelettes de liquide.

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FIG. 1

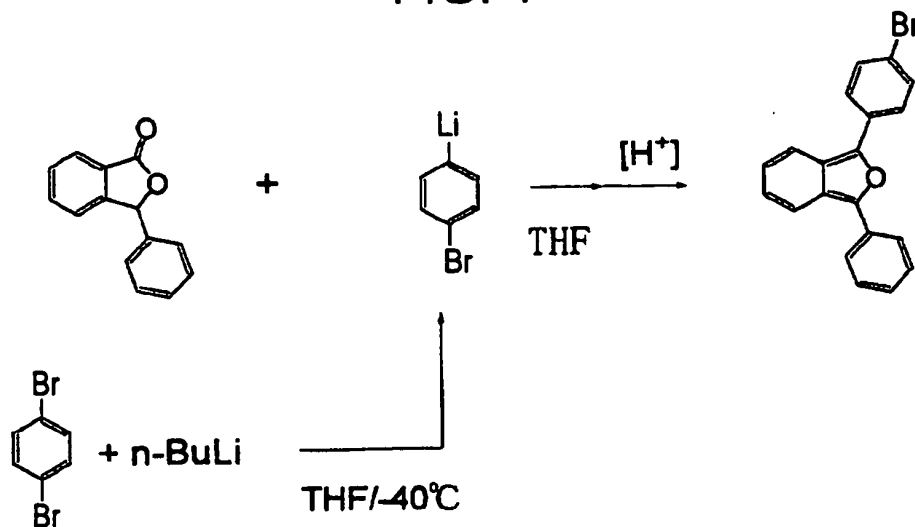


FIG. 2

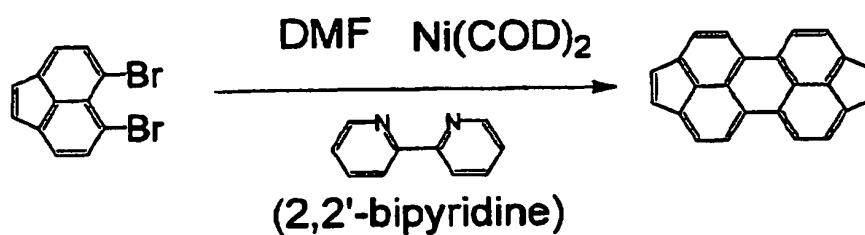


FIG. 3

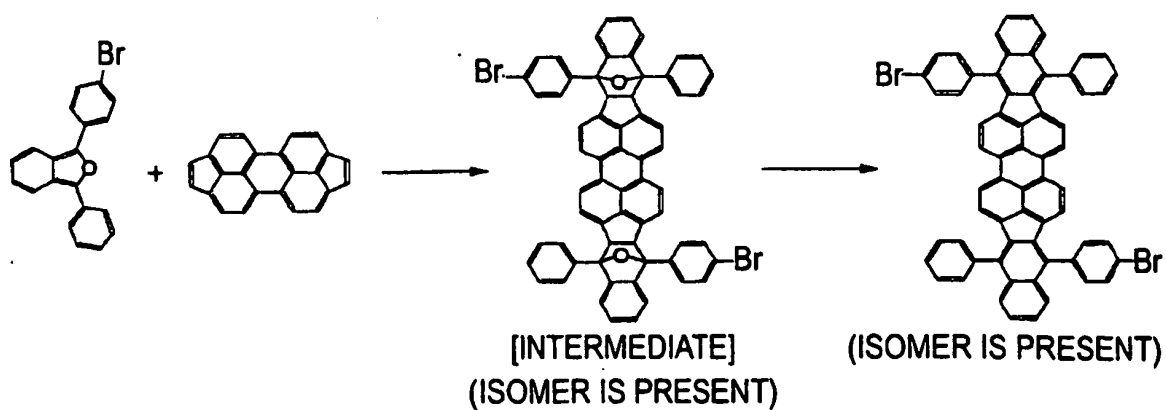


FIG. 4

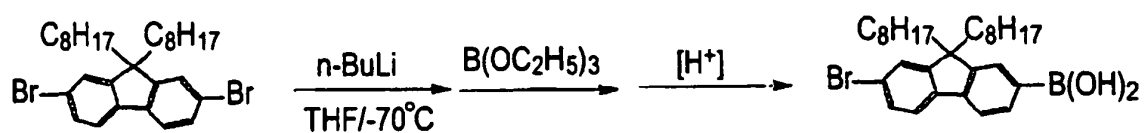


FIG. 5

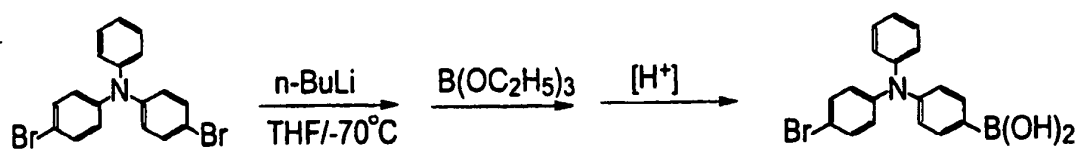


FIG. 6

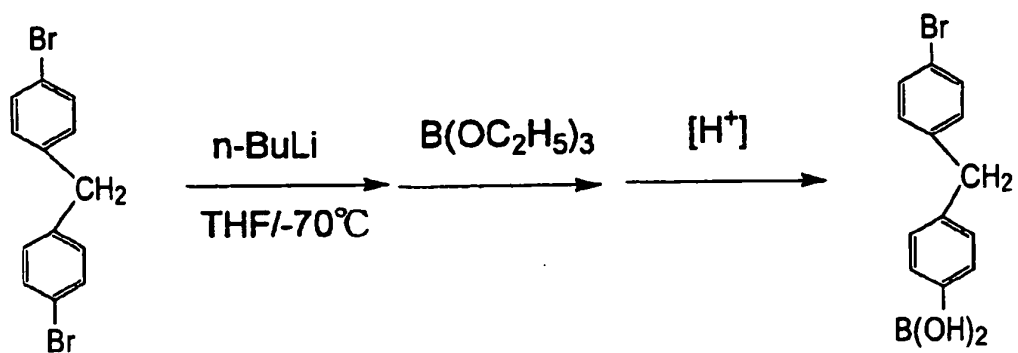


FIG. 7

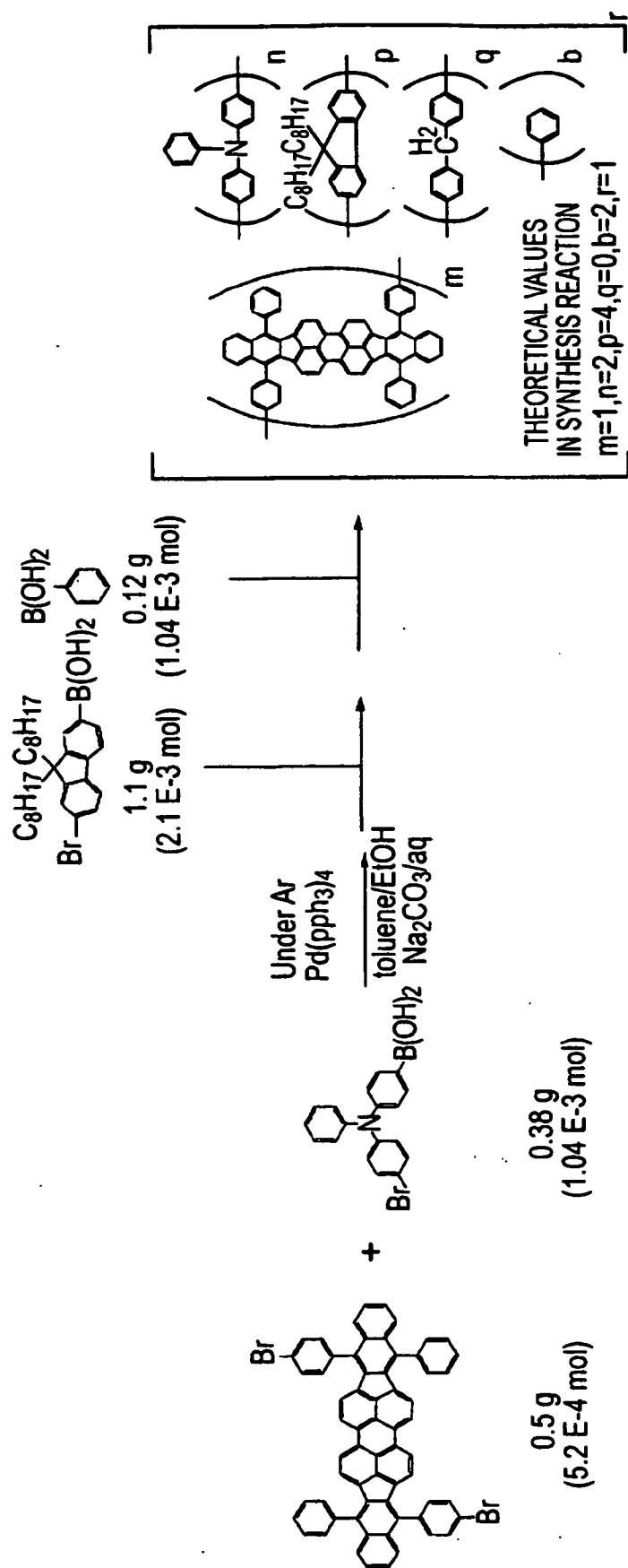


FIG. 8

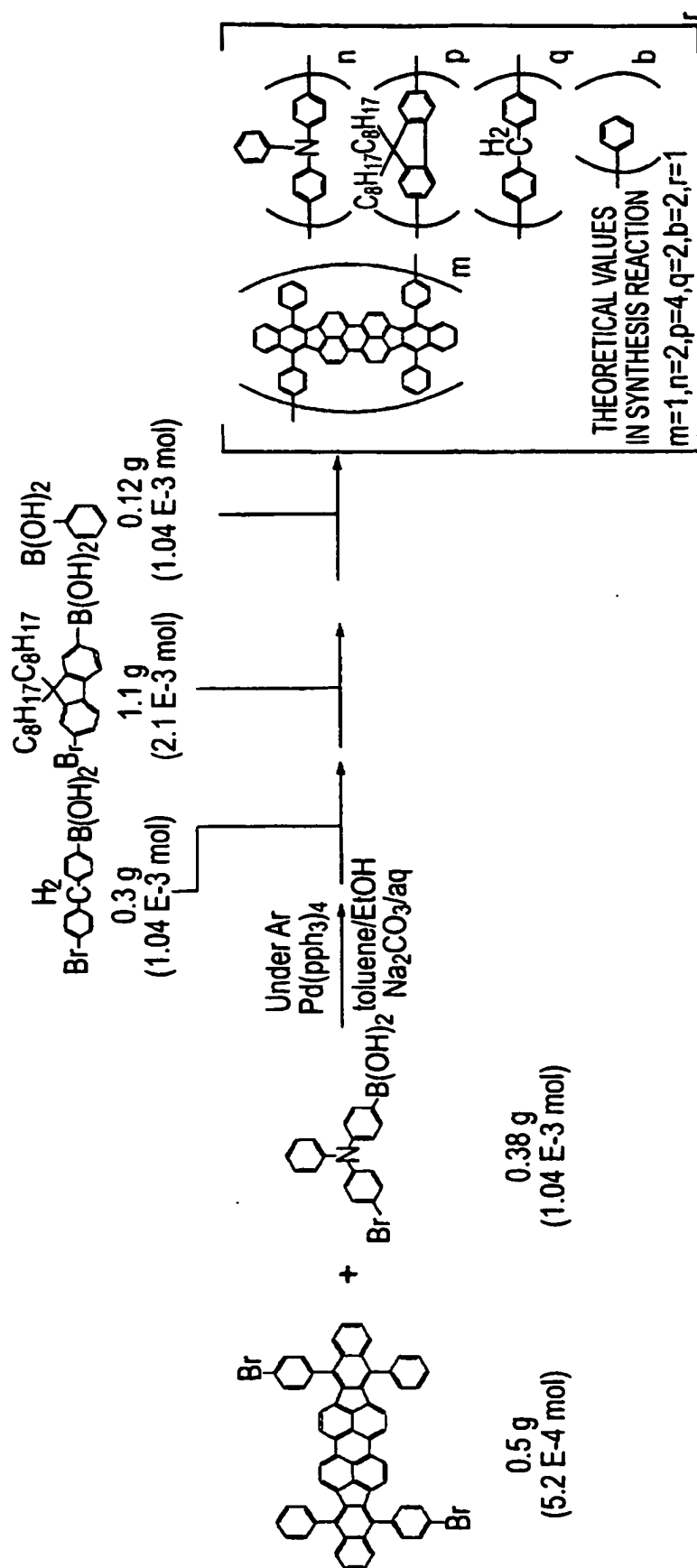


FIG. 9

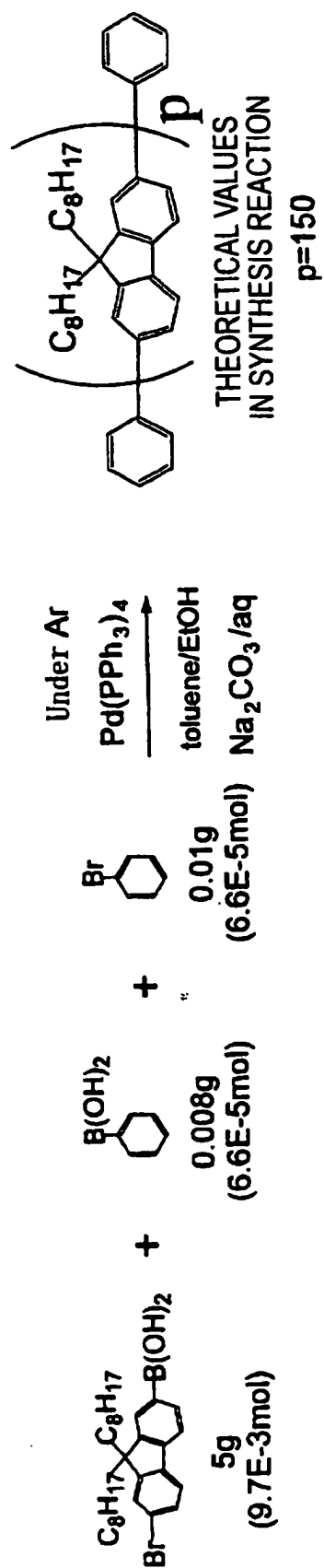


FIG. 10

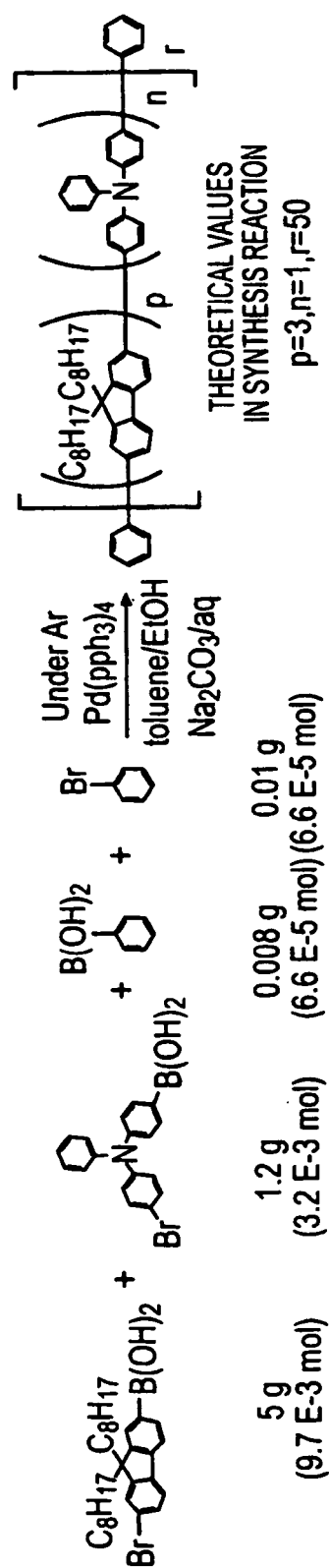


FIG. 11

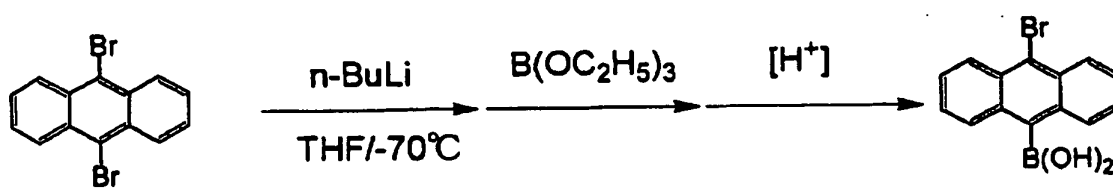


FIG. 12

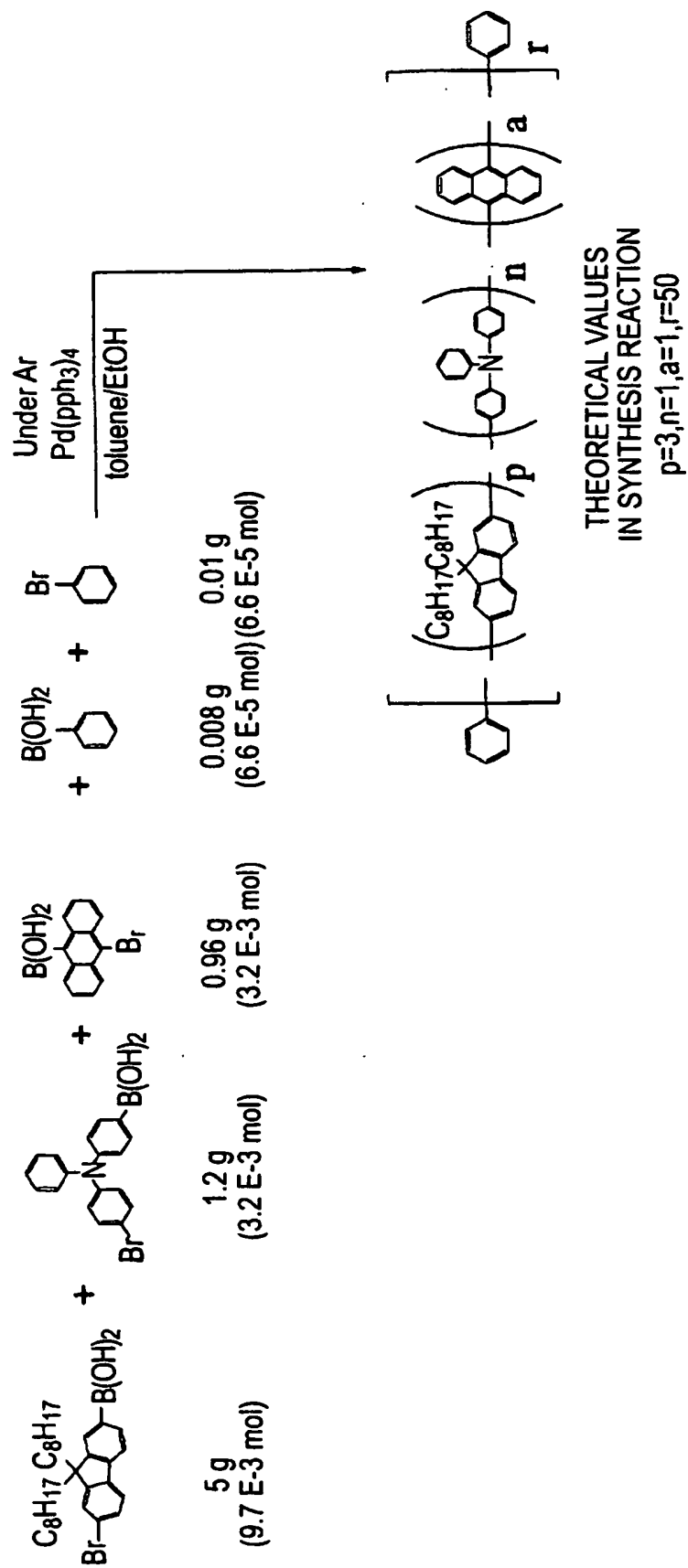


FIG. 13

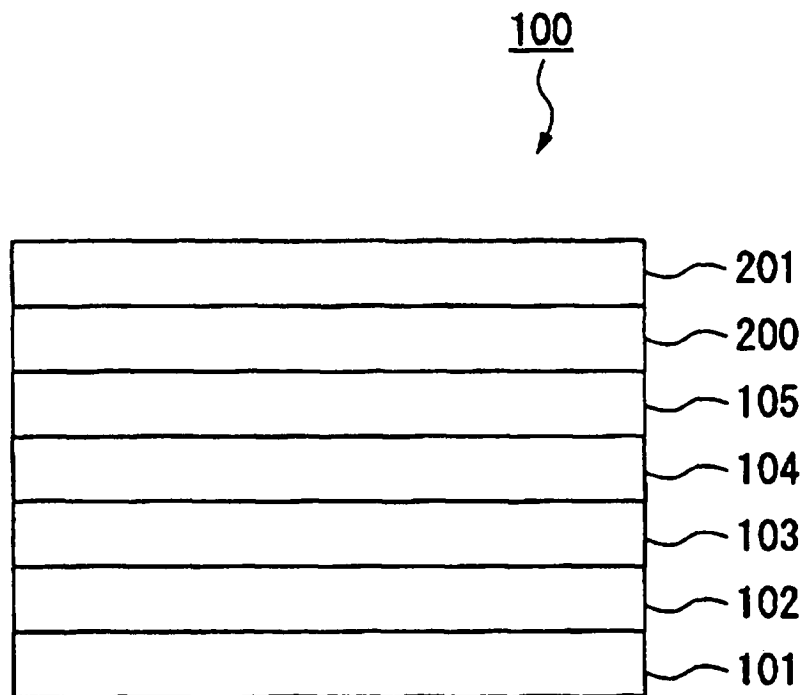


FIG. 14

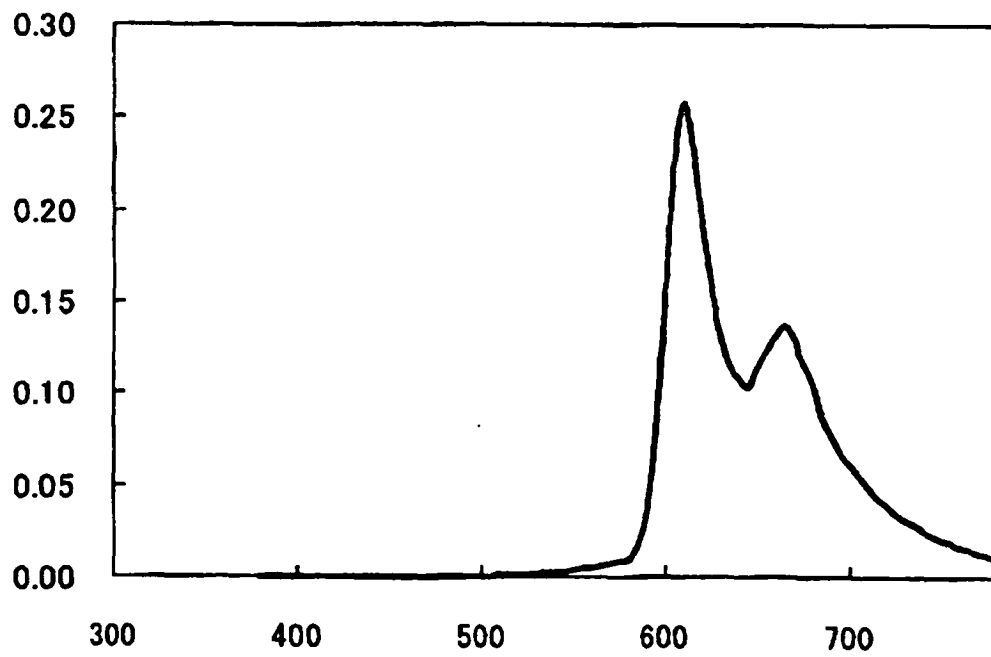


FIG. 15

EL WAVEFORM OF EXAMPLE 2
(THE SAME WAVEFORM IS SHOWN IN EXAMPLES 4 AND 6)

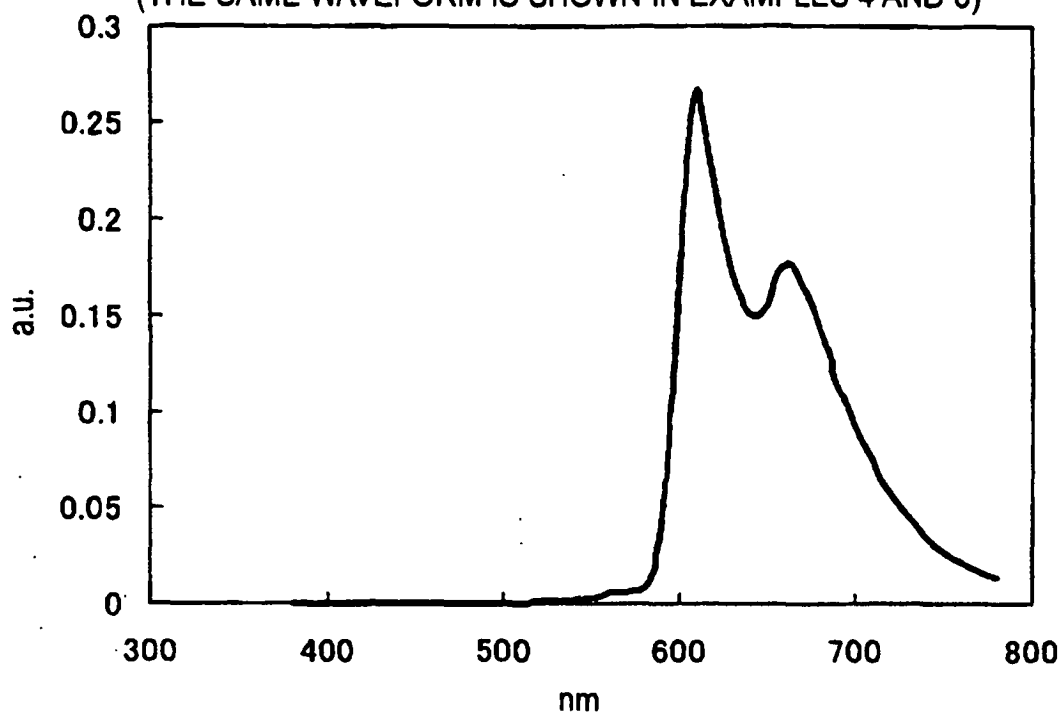


FIG. 16

LUMINESCENCE WAVEFORM OF HOST 1
(COMPARATIVE EXAMPLE 1)

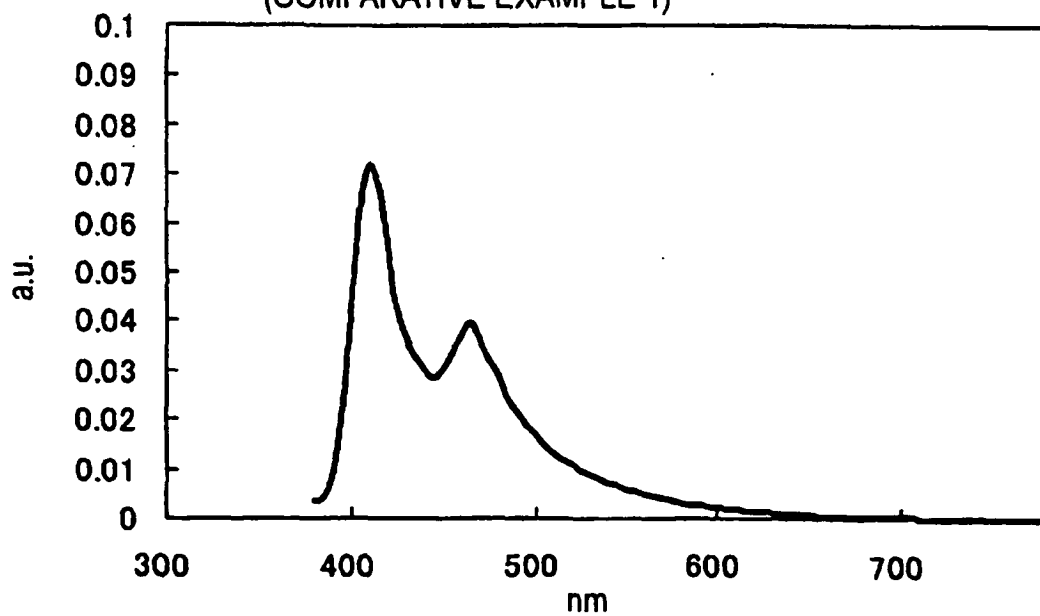


FIG. 17

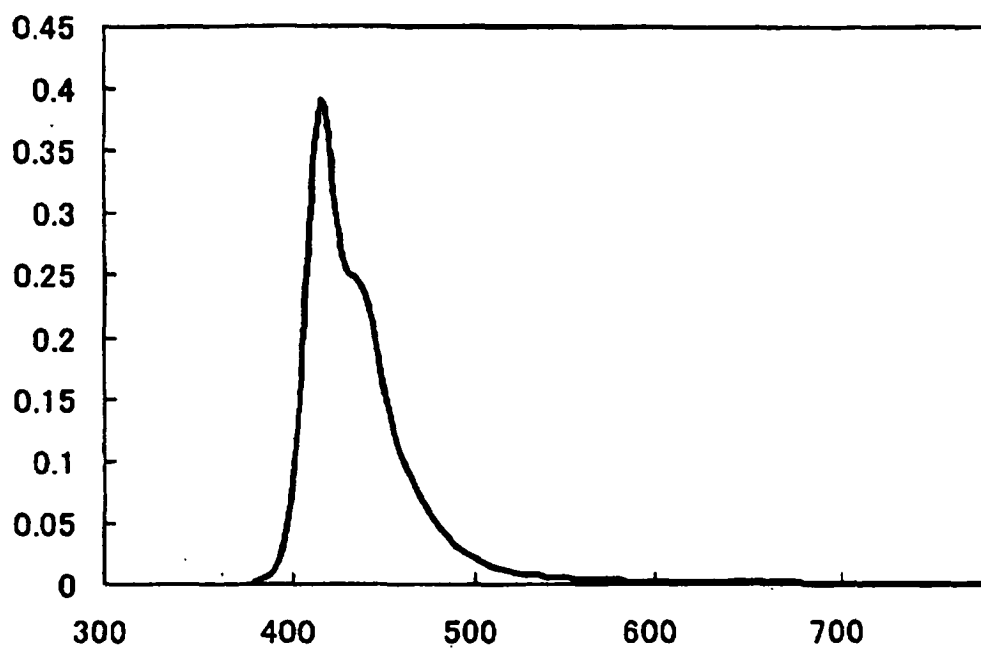
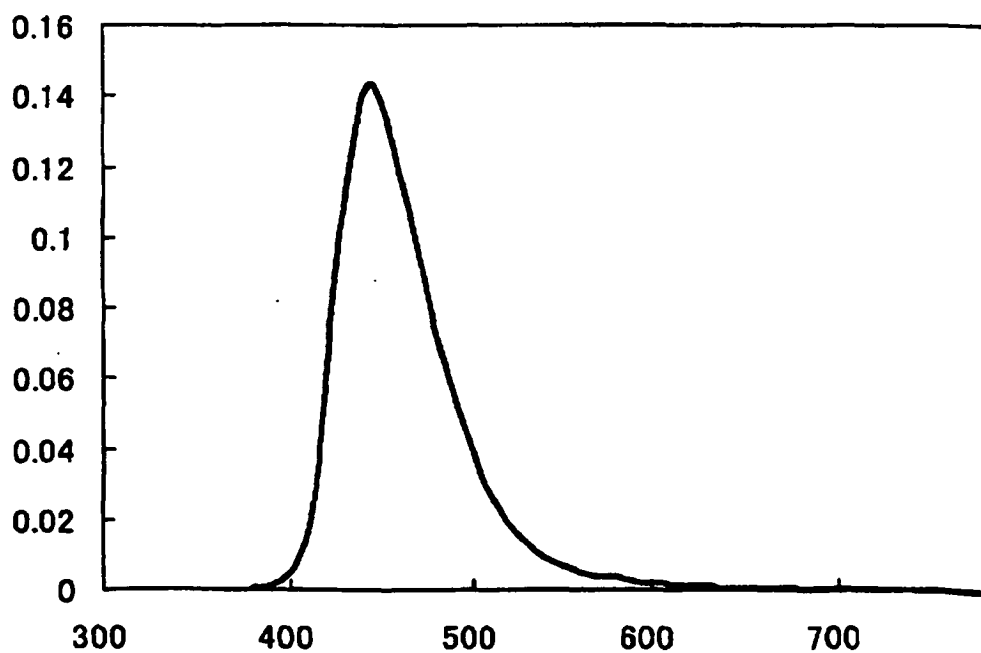


FIG. 18



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2000323276 A [0002]
- JP 2002536492 T [0002]
- EP 1298117 A [0148]

Non-patent literature cited in the description

- *J. Am. Chem. Soc.*, 1996, vol. 118, 2374-2379 [0148]
- *Polymers for Advanced Technologies*, 2004, vol. 15 (5), 266-269 [0148]
- *Helvetica Chimica Acta*, 2002, vol. 85 (7), 2195-2213 [0148]
- *Organometallics*, 2001, vol. 20 (24), 5162-5170 [0148]
- *Journal of Organic Chemistry*, 2004, vol. 69 (3), 987-990 [0148]
- *Advanced Functional Materials*, 2003, vol. 13 (12), 967-973 [0148]
- *Journal of Chemistry*, 1992, vol. 70 (4), 1015-21 [0148]

专利名称(译)	用于有机电致发光的化合物和有机电致发光器件		
公开(公告)号	EP1840182B1	公开(公告)日	2011-06-08
申请号	EP2007006146	申请日	2007-03-26
[标]申请(专利权)人(译)	精工爱普生株式会社		
申请(专利权)人(译)	SEIKO EPSON CORPORATION		
当前申请(专利权)人(译)	SEIKO EPSON CORPORATION		
[标]发明人	FUJITA TETSUJI		
发明人	FUJITA, TETSUJI		
IPC分类号	C09K11/06 H01L51/00 H01L51/50		
CPC分类号	C09K11/06 C08G61/02 C08G61/10 C08G73/026 C09K2211/1011 C09K2211/1416 C09K2211/1425 H01L51/0035 H01L51/0039 H01L51/0043 H01L51/0056 H01L51/0058 H01L51/006 H01L51/5012 Y10S428/917		
优先权	2006084406 2006-03-27 JP		
其他公开文献	EP1840182A3 EP1840182A2		
外部链接	Espacenet		

摘要(译)

用于有机EL的化合物包括具有衍生自由下式1至5表示的分子的构成单元的聚合物分子，其中R是烷基，芳基或烷芳基，其中R'是氢，烷基或烷基芳基。

