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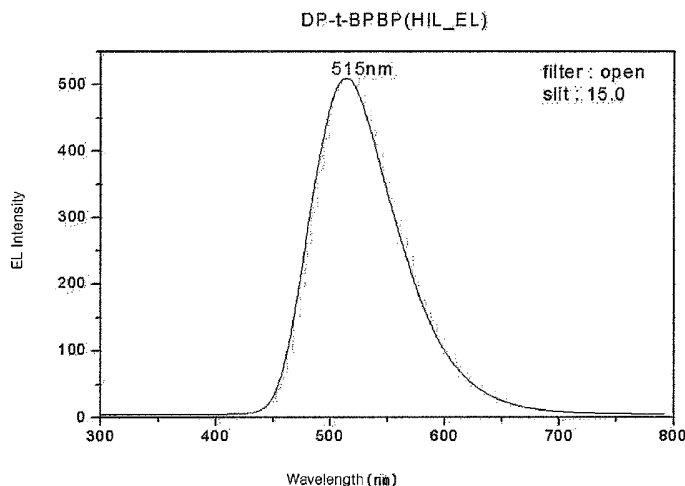
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(54) Title: CHROMOPHORE COMPOUNDS AND ORGANIC ELECTROLUMINESCENCE DISPLAY DEVICE COMPRISING THE SAME



(57) Abstract: The present invention relates to chromophore compounds applicable to any one of a hole injection layer (HIL), a hole transport layer (HTL), an emitting layer (EML), an electron transport layer (ETL) and an electron injection layer (EIL) of an organic electroluminescence display device. The compound is a derivative of phenothiazine, phenoxazine, phenoxathin, acridine, phenazasiline, or 9-aza-10-germa-anthracene. The compound has a substituent selected from the group consisting of a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl. The substituent may include at least one substituent selected from the group consisting of an alkyl, an alkoxy, a cycloalkyl, an alkenyl, an alkynyl, an aryl, a heteroaryl, a halogen such as F, Cl, Br, or I, aliphatic amine, aromatic amine, and an aryloxy.

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TITLE OF THE INVENTION**CHROMOPHORE COMPOUNDS AND ORGANIC ELECTROLUMINESCENCE
DISPLAY DEVICE COMPRISING THE SAME**5 **BACKGROUND OF THE INVENTION****(a) Field of the Invention**

The present invention relates to chromophore compounds for an electroluminescence light-emitting device and an organic electroluminescence display device including the same, and more particularly, to chromophore compounds applicable to any one of a hole injection layer (HIL), a hole transport layer (HTL), an emitting layer (EML), an electron transport layer (ETL), and an electron injection layer (EIL) of an organic electroluminescence display device, and a highly efficient organic electroluminescence display device including the same.

(b) Description of the Related Art

15 These days, as development within the information and communication industry is accelerated, higher performance display devices are required. Such display devices may be classified into luminescence types and non-luminescence types. For the former devices, a Cathode Ray Tube (CRT), an Electroluminescence Display (ELD), a Light Emitting Diode (LED), a Plasma Display Panel (PDP), etc., are exemplified.

For the latter devices, a Liquid Crystal Display (LCD), etc., are exemplified.

The luminescence type and non-luminescence type display devices have basic characteristics such as working voltage, consumption power, brightness, contrast, response time, lifetime, and color display, etc. However, liquid crystal display devices, which have largely been used up till now, have some problems in terms of response time, contrast, and viewing angle among the basic characteristics described above. Displays using a luminescence diode are expected as next generation display devices that can solve the problems of liquid crystal displays since they have a much shorter response time, do not require a backlight due to having self-luminescence properties, and they also have improved brightness, etc.

30 An electroluminescence diode has difficulties in application to a large area electroluminescence display device because an inorganic material with crystalline form is mainly used. Furthermore, in the case of an electroluminescence display device using an inorganic material, there are disadvantages that more than 200 V of driving voltage is required and that it is expensive. Active researches on

electroluminescence display devices comprising an organic materials have been undertaken since the Eastman Kodak Company firstly disclosed a device made from a material having a π -conjugated molecular structure in 1987. In the case of organic materials, there are advantages that a synthetic pathway is relatively simpler and various forms of materials can be synthesized, and thus color tuning is more easier. On the contrary, organic materials have disadvantages in that crystallization by heat occurs due to low mechanical strength.

Organic materials used in an electroluminescence display device are classified into low molecular organic materials and polymeric materials. For low molecular organic materials diamine, diamine derivatives such as N,N'-bis-(4-methylphenyl)-N,N'-bis(phenyl)benzidine (TPD), etc., perylene tetracarboxylic acid derivatives, oxadiazole derivatives, 1,1,4,4-tetraphenyl-1,3-butadiene (TPB), etc., are exemplified.

Generally, in the case of an organic electroluminescence display device, an evaporation method is used for producing a thin film. When applying low molecular compounds, a more uniform thin film can be obtained than when applying polymeric materials, and thus brightness and luminescence efficiency of the device are more improved.

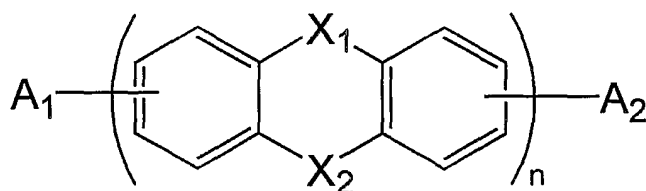
SUMMARY OF THE INVENTION

The object of the present invention is to provide low molecular chromophore compounds for an electroluminescence display device that can be applied to any one of a hole injection layer (HIL), a hole transport layer (HTL), an emitting layer (EML), an electron transport layer (ETL), and an electron injection layer (EIL) of an electroluminescence display device.

Another object of the present invention is to provide an electroluminescence display device having a low driving voltage, various color developments, and a short response time.

The present invention provides, to achieve the objects as described above, chromophore compounds for an electroluminescence display device represented by the following formula 1:

(chemical formula 1)



wherein, X_1 and X_2 are independently selected from the group consisting of CR_1R_2 , O, S, N- R_3 , Si R_4R_5 , and Ge R_6R_7 ,

where R_1 to R_7 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl;

A_1 and A_2 are independently selected from the group consisting of hydrogen, an unsubstituted linear or branched alkyl, an unsubstituted cycloalkyl, an unsubstituted alkenyl, an unsubstituted alkynyl, an unsubstituted alkoxy, an unsubstituted aryl, and an unsubstituted heteroaryl; and

n ranges from 1 to 1000, preferably 1 to 100, more preferably 1 to 50, and still more preferably 1 to 25.

The present invention also provides an electroluminescence display device in which the chromophore compounds are applied to any one of a hole injection layer, a hole transport layer, an emitting layer, an electron transport layer, and an electron injection layer.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view of an organic electroluminescence display device according to the present invention.

FIG. 2a shows a ^1H -NMR spectrum of a compound according to Example 1 of the present invention.

FIG. 2b shows GC-Mass spectrum of a compound according to Example 1 of the present invention.

FIG. 3a shows a ^1H -NMR spectrum of a compound according to Example 2 of the present invention.

FIG. 3b shows GC-Mass spectrum of a compound according to Example 2 of the present invention.

FIG. 4a shows a ^1H -NMR spectrum of a compound according to Example 3 of the present invention.

FIG. 4b shows GC-Mass spectrum of a compound according to Example 3 of the present invention.

FIG. 5a shows a ^1H -NMR spectrum of a compound according to Example 4 of the present invention.

FIG. 5b shows GC-Mass spectrum of a compound according to Example 4

of the present invention.

FIG. 6 shows a ^1H -NMR spectrum of a compound according to Example 5 of the present invention.

FIGs. 7 to 11 show UV-PL spectra of the compounds according to Examples 1 to 5, respectively.

FIG. 12 is a current-voltage (I-V) characteristic of an electroluminescence diode (ITO/t-BPBP/Alq₃/LiF/Al) manufactured according to Example 6 of the present invention which includes a compound of Example 1 in a hole transport layer.

FIG. 13 is an EL spectrum of an electroluminescence diode (ITO/t-BPBP/Alq₃/LiF/Al) manufactured according to Example 6 of the present invention which includes a compound of Example 1 in a hole transport layer.

FIG. 14 is a current-voltage (I-V) characteristic of an electroluminescence diode (ITO/t-BPTP/Alq₃/LiF/Al) manufactured according to Example 7 of the present invention which includes a compound of Example 2 in a hole transport layer.

FIG. 15 is an EL spectrum of an electroluminescence diode (ITO/t-BPTP/Alq₃/LiF/Al) manufactured according to Example 7 of the present invention which includes a compound of Example 2 in a hole transport layer.

FIG. 16 is a current-voltage (I-V) characteristic of an electroluminescence diode (ITO/DP-t-BPBP/Alq₃/LiF/Al) manufactured according to Example 8 of the present invention which includes a compound of Example 3 in a hole transport layer.

FIG. 17 is an EL spectrum of an electroluminescence diode (ITO/DP-t-BPBP/Alq₃/LiF/Al) manufactured according to Example 8 of the present invention which includes a compound of Example 3 in a hole transport layer.

FIG. 18 is a current-voltage (I-V) characteristic of an electroluminescence diode (ITO/t-BPBP/NPB/Alq₃/LiF/Al) manufactured according to Example 9 of the present invention which includes a compound of Example 1 in a hole injection layer.

FIG. 19 is an EL spectrum of an electroluminescence diode (ITO/t-BPBP/NPB/Alq₃/LiF/Al) manufactured according to Example 9 of the present invention which includes a compound of Example 1 in a hole injection layer.

FIG. 20 is a current-voltage (I-V) characteristic of an electroluminescence diode (ITO/t-BPTP/NPB/Alq₃/LiF/Al) manufactured according to Example 10 of the present invention which includes a compound of Example 2 in a hole injection layer.

FIG. 21 is an EL spectrum of an electroluminescence diode (ITO/t-BPTP/NPB/Alq₃/LiF/Al) manufactured according to Example 10 of the present invention which includes a compound of Example 2 in a hole injection layer.

FIG. 22 is a current-voltage (I-V) characteristic of an electroluminescence diode (ITO/DP-t-BPBP/NPB/Alq₃/LiF/Al) manufactured according to Example 11 of the present invention which includes a compound of Example 3 in a hole injection layer.

FIG. 23 is an EL spectrum of an electroluminescence diode (ITO/DP-t-BPBP/NPB/Alq₃/LiF/Al) manufactured according to Example 11 of the present invention which includes a compound of Example 3 in a hole injection layer.

Description of the reference numerals of the drawings

1: substrate	2: anode
3: hole injection layer	4: hole transport layer
5: emitting layer	6: electron transport layer
7: electron injection layer	8: cathode

DETAILED DESCRIPTION OF THE INVENTION

The chromophore compounds in accordance with the present invention can be applied to any one of a hole injection layer, a hole transport layer, an emitting layer, an electron transport layer, and an electron injection layer of an electroluminescence (EL) device. The compound may be an organic compound represented by the formula 1. In particular, the compounds have excellent hole injection and hole transporting properties and thus may be preferably used in a hole injection layer and a hole transport layer.

The compound is a derivative of phenothiazine (in formula 1, either one of X₁ or X₂ is NH and the other one is S), phenoxazine (in formula 1, either one of X₁ or X₂ is NH and the other one is O), phenoxathin (in formula 1, either one of X₁ or X₂ is O and the other one is S), acridine (in formula 1, X₁ is NH and X₂ is CH₂), phenazasiline (in formula 1, X₁ is NH and X₂ is SiH₂), or 9-aza-10-germa-anthracene (in formula 1, X₁ is NH and X₂ is GeH₂). The compound has a substituent selected from the group consisting of a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl. The substituent may include at least one substituent selected from the group consisting of an alkyl, an alkoxy, a cycloalkyl, an alkenyl, an alkynyl, an aryl, a heteroaryl, a halogen such as F, Cl, Br, or I, aliphatic amine, aromatic amine, and an aryloxy.

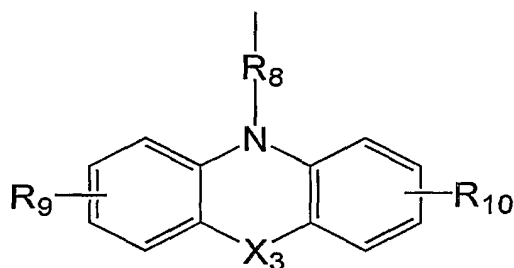
In the present invention, the substituted or unsubstituted linear or branched alkyl or alkoxy may be preferably a C1 to C12 alkyl, or alkoxy, and more preferably a C1 to C7 lower alkyl or alkoxy. The cycloalkyl may be preferably a C3 to C12 cycloalkyl, and more preferably a C3 to C8 cycloalkyl. The alkenyl may be preferably a C2 to C8 alkenyl, and more preferably a C2 to C4 alkenyl. The alkynyl may be preferably a C2 to C8 alkynyl, and more preferably a C2 to C4 alkynyl. The aryl may be preferably a C4 to C20 aryl, and more preferably a C4 to C12 aryl. The heteroaryl may be preferably a C4 to C20 heteroaryl, and more preferably a C4 to C12 heteroaryl which includes 1 to 3 heteroatoms, such as N, S, P, or O, in an aromatic ring. The substituted alkyl, alkoxy, cycloalkyl, alkenyl, alkynyl, aryl, and heteroaryl means that at least one hydrogen thereof is substituted with an alkyl, a cycloalkyl, an alkoxy, an alkenyl, an alkynyl, an aryl, a heteroaryl, a halogen such as F, Cl, Br or I, aliphatic amine, aromatic amine, or an aryloxy. The alkylene may be preferably a C1 to C20 alkylene, and more preferably a C1 to C13 alkylene.

In the above formula 1, X_1 and X_2 are independently selected from the group consisting of CR_1R_2 , O, S, $N-R_3$, SiR_4R_5 , and GeR_6R_7 , where R_1 to R_7 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl, and

X_1 and X_2 are preferably O, S, or $N-R_3$, and the R_3 is hydrogen, an unsubstituted linear or branched alkyl, an unsubstituted cycloalkyl, an unsubstituted alkenyl, an unsubstituted alkynyl, an unsubstituted alkoxy, an unsubstituted aryl, or an unsubstituted heteroaryl. The substituent includes an alkyl, an alkoxy, a cycloalkyl, an alkenyl, an alkynyl, an aryl, a heteroaryl, a halogen such as F, Cl, Br, or I, aliphatic amine, aromatic amine, or an aryloxy. More preferably, R_3 is hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, or an aryl or heteroaryl which is substituted with at least one substituent selected from the group consisting of an alkoxy, an aryl, and an alkyl.

The substituted alkyl or cycloalkyl may be preferably a substituted alkyl represented by the following formula 2:

(chemical formula 2)



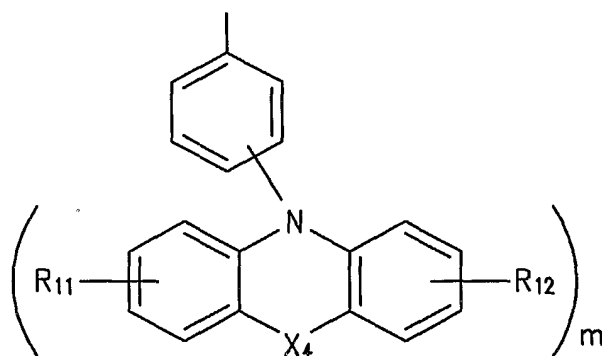
wherein, in the above formula, X_3 is selected from the group consisting of CR_1R_2 , O, S, N- R_3 , SiR_4R_5 and GeR_6R_7 ,

where R_1 to R_7 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl;

R_8 is alkylene; an aryl; alkylene substituted with an alkyl, an alkoxy, or an aryl; an aryl substituted with an alkyl, alkoxy, or an aryl, and preferably methylene, or methylene substituted with an alkyl, an alkoxy, or an aryl; or a phenyl, naphthyl, or anthracenyl substituted with an alkyl, an alkoxy, or an aryl; and

R_9 and R_{10} are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl.

The substituted aryl is preferably represented by the following formula 3:
(chemical formula 3)



wherein, in the above formula, X_4 is independently selected from the group consisting of CR_1R_2 , O, S, N- R_3 , SiR_4R_5 , and GeR_6R_7 ,

where R_1 to R_7 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or

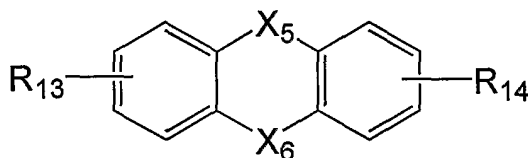
unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl;

5 R_{11} and R_{12} are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl; and

10 m is an integer ranging from 1 to 4, preferably 1 to 3, and more preferably 1 to 2. Substituents may be symmetrically or unsymmetrically bound to phenyl if it does not cause a steric hindrance, and namely, may be bound at ortho, meta, or para positions.

15 A_1 and A_2 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, a substituted or unsubstituted heteroaryl, aliphatic or aromatic amine, and aliphatic or aromatic amine substituted with an aryl, and preferably the phenothiazine, phenoxazine, aromatic amine, or a derivative thereof represented by the following
20 formula 4:

(chemical formula 4)



25 wherein, in the above formula, X_5 and X_6 are independently selected from the group consisting of CR_1R_2 , O, S, N- R_3 , SiR_4R_5 , and GeR_6R_7 , and preferably O, S, or N- R_3 ,

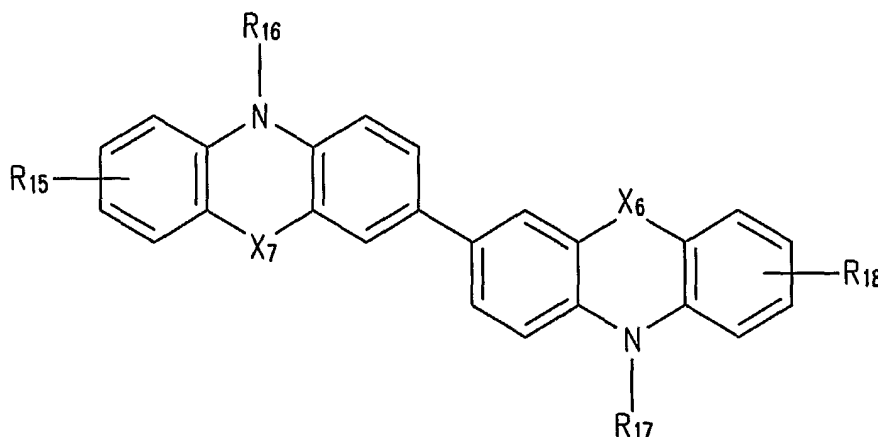
30 where R_1 to R_7 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl; and

R_{13} and R_{14} are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or

unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl.

Suitable examples of the compound represented by the above formula 1 are a dimer of the following formula 5, a trimer of the following formula 6, and a tetramer of the following formula 7:

(chemical formula 5)



wherein, in the above formula, X_7 and X_8 are independently selected from the group consisting of CR_1R_2 , O, S, $N-R_3$, SiR_4R_5 , and GeR_6R_7 , and preferably O, S, or $N-R_3$,

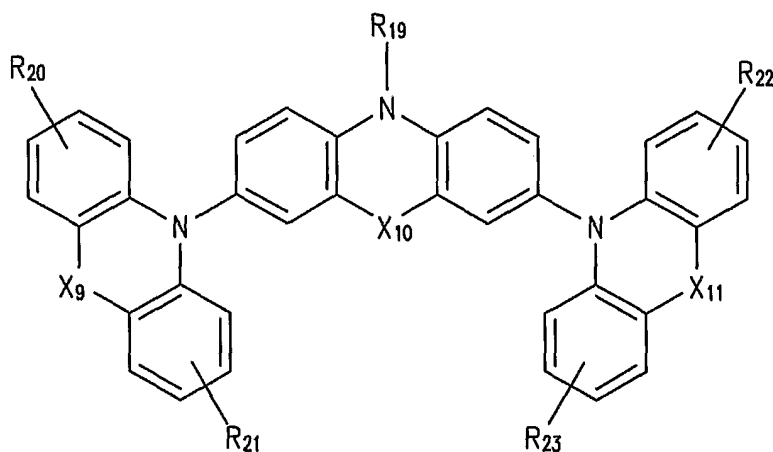
where R_1 to R_7 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl, preferably a substituted or unsubstituted alkyl and a substituted or unsubstituted aryl, and more preferably substituted or unsubstituted phenyl;

R_{15} and R_{18} are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl; and

R_{16} and R_{17} are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl, and preferably

substituted or unsubstituted phenyl, substituted or unsubstituted naphthyl, substituted or unsubstituted anthracenyl:

(chemical formula 6)

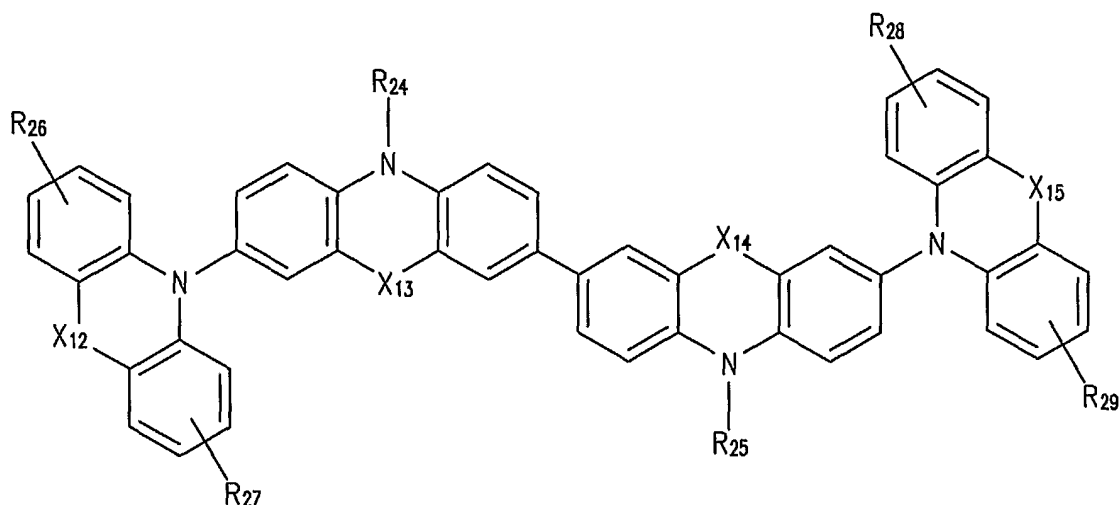


5 wherein, in the above formula, X_9 to X_{11} are independently selected from the group consisting of CR_1R_2 , O, S, N- R_3 , SiR_4R_5 , and GeR_6R_7 , and preferably O, S, or N- R_3 ,

10 where R_1 to R_7 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl, preferably a substituted or unsubstituted alkyl and a substituted or unsubstituted aryl, and more preferably substituted or unsubstituted phenyl; and

15 R_{19} and R_{23} are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl:

20 (chemical formula 7)



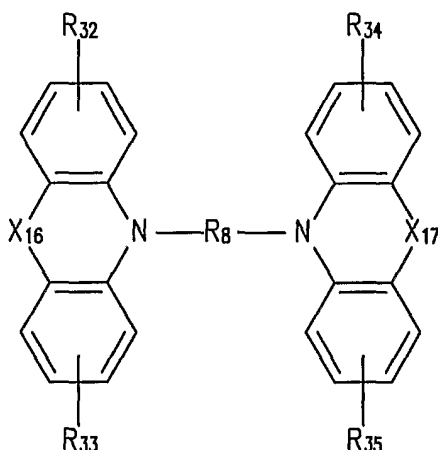
wherein, in the above formula, X₁₂ to X₁₅ are independently selected from the group consisting of CR₁R₂, O, S, N-R₃, SiR₄R₅, and GeR₆R₇, and preferably O, S, or N-R₃,

5 where R₁ to R₇ are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl, preferably a substituted or unsubstituted alkyl and a substituted or unsubstituted aryl, and more preferably substituted or unsubstituted phenyl; and

10 R₂₄ and R₃₁ are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl.

15 The compound of the following formula 8 where the basic structured compounds are bound with each other through an alkyl group and the compound of the following formula 9 where the basic structured compounds are bound with each other through an aryl group are preferable:

20 (chemical formula 8)



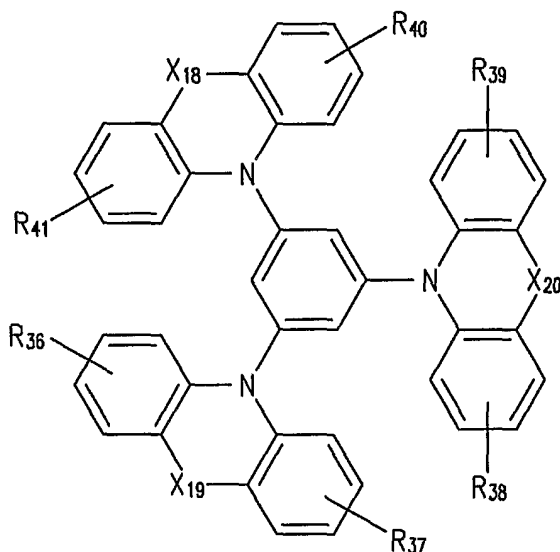
wherein, in the above formula, X_{16} to X_{17} are independently selected from the group consisting of CR_1R_2 , O, S, N- R_3 , SiR_4R_5 , and GeR_6R_7 , and preferably O, S, or N- R_3 ,

5 where R_1 to R_7 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl, preferably a substituted or unsubstituted alkyl and a substituted or unsubstituted aryl, and more preferably substituted or unsubstituted phenyl;

10 R_8 is an alkylene; an alkylene which is substituted with an alkylene; an aryl; an alkyl, an alkoxy, or an aryl; an aryl which is substituted with an alkyl, an alkoxy, or an aryl, and preferably methylene, methylene which is substituted with an alkyl, an alkoxy, or an aryl; or a phenyl, naphthyl, or anthracenyl which is substituted with an alkyl, an alkoxy, or an aryl; and

15 R_{32} to R_{35} are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl:

(chemical formula 9)



wherein, in the above formula, X_{18} to X_{20} are independently selected from the group consisting of CR_1R_2 , O, S, N- R_3 , SiR_4R_5 , and GeR_6R_7 , and preferably O, S, or N- R_3 ,

5 where R_1 to R_7 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl; and

10 R_{36} to R_{41} are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl.

The dimer of the above formula 7 is prepared by the following process:

15 substituents are introduced at an N position of a first monomer of the phenothiazine or phenoxazine using an Ullman coupling reaction or a Pd(0) catalyst; a halogen is introduced at a position of the first monomer where a second phenothiazine or phenoxazine monomer is bound; and a leaving group is bound with the second monomer and then is reacted with the first monomer. Examples of the leaving group may include dioxaborolan. In the case where dioxaborolan is used, the above reaction is carried out using a Suzuki coupling reaction. When only one

20 halogen is introduced at a position of the first monomer where a second phenothiazine or phenoxazine monomer is bound, the reaction can be carried out by a Yamamoto coupling reaction using a Ni (0) catalyst, thereby synthesizing a dimer.

Alternatively, the dimer can be prepared by the following process: substituents are introduced at an N position of a first monomer of the phenothiazine or phenoxazine using an Ullman coupling or a Pd(0) catalyst; a halogen is introduced at a position of the first monomer where a second phenothiazine or phenoxazine monomer is bound; the halogenated first monomer is lithiated; and the first monomer is reacted with the second monomer using a reagent such as CuCl_2 or $\text{Fe}(\text{acac})_3$. In the above description, a dimer synthesis process is described but a trimer, a tetramer, an oligomer over a tetramer, or a polymer may be prepared in accordance with the above method.

The chromophore compounds according to the present invention are applied between an anode made from ITO (indium tin oxide) having a large work function, which injects holes, and a cathode made from metals having various work functions, such as aluminum, lithium fluoride/aluminum, copper, silver, calcium, gold, magnesium, etc., an alloy of magnesium and silver, and an alloy of aluminum and lithium, which injects electrons. The chromophore compounds are applicable to any one of a hole injection layer (HIL), a hole transport layer (HTL), an emitting layer (EML), an electron transport layer (ETL), and an electron injection layer (EIL) of an electroluminescence display device

FIG. 1 shows the sectional structure of an electroluminescence display device, where an anode 2 is formed on a substrate 1 by coating an anode material. The substrate 1 includes a material, such as a glass, a plastic, quartz, a ceramic, or silicon, which has transparency, a flat-surface, and water-repellency and is easy to handle, but is not limited thereto. The anode material may include transparent and high conductive indium tin oxide (ITO), indium zinc oxide (IZO), tin oxide (SnO_2), zinc oxide (ZnO), and so on.

A buffer layer exists to compensate the surface of the anode 2 and helps the injection and flow of holes. Materials used as the buffer are exemplified by high molecular materials such as doped polyaniline (PANI) and doped polyethylenedioxythiophene (PEDOT), and low molecular materials such as alpha-CuPc. A thin film having a thickness from 20 nm to 150 nm was formed by spin coating PANI and PEDOT. Alternatively, a thin film having thickness from 20 nm to 100 nm might be formed by vacuum-deposition of alpha-CuPc.

A hole injection layer (HIL) 3 is formed on the anode or the buffer layer by coating a hole injection material using vacuum thermal deposition, or a spin coating method. Examples of the hole injection material are not particularly limited, but

CuPc or a starburst-type amine such as TCTA, m-MTDATA, m-MTDAPB, and so on, can be used.

5 A hole transport layer (HTL) 4 may be formed on the hole injection layer 3 using vacuum thermal deposition or spin coating. The hole transport layer is formed using a material such as N,N'-bis(3-methylphenyl)-N,N'-diphenyl-[1,1-biphenyl]-4,4'-diamine (TPD), N,N'-bis(naphthalene-1-yl)-N,N'-diphenyl- benzidine (α -NPB), and so on..

10 An emitting layer (EML) 5 is formed on the hole transport layer 4 using vacuum thermal deposition or spin coating of a electroluminescence material. On the emitting, an electron transport layer (ETL) 6 is formed using vacuum deposition or spin coating. The electron transport layer may include a material such as Alq₃ or Bu-PBD.

15 An electron injection layer (EIL) 7 may optionally be formed on the electron transport layer 6, but is not limited to specific materials. Examples of a material suitable for the electron injection layer (EIL) 7 may include LiF, NaCl, CsF, Li₂O, BaO, and so on. Then, a cathode is formed on the electron injection layer (EIL) 7 by coating a cathode metal using vacuum thermal deposition to fabricate an organic EL device. The cathode may include a metal such as lithium (Li), magnesium (Mg), aluminum (Al), aluminum-lithium (Al-Li), calcium (Ca), magnesium-indium (Mg-In),
20 magnesium-silver (Mg-Ag), and so on. A front light-emitting device may be obtained by using a light-permeable cathode which contains ITO, IZO, and so on.

The chromophore compounds are applicable to any one of the hole injection layer 3, the hole transport layer 4, the emitting layer 5, the electron transport layer 6, and the electron injection layer 7 of an EL display device

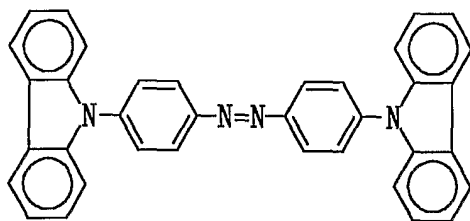
25 In particular, the compounds can preferably be applied to the hole injection layer 3 and the hole transport layer 4.

The chromophore compounds of the present invention can be used as a host or as a dopant in an emitting layer. When the compound is used as a host, it may be used with dopants such as organic compounds having conjugated double bonds. The dopants are organic compounds having conjugated double bonds and materials which have a smaller energy gap than the doped material, and thus a lower maximum wavelength value than the doped material, and good energy transfer and chromophore property. For the dopants, at least one compound selected from the group consisting of dicarbazolyl azobenzene (DCAB), fluorenyl diacetylene (FDA), perylene, carbazole, carbazole derivatives, coumarine
35

compounds and 4-(dicyanomethylene)-2-methyl-6-(1,1,7,7-tetramethyljulodiny-9-enyl)-4H-pyran (DCJT) may be used.

The dicarbazolyl azobenzene (DCAB) has the formula 10.

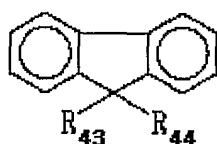
(chemical formula 10)



5

The fluorenyl diacetylene (FDA) has the formula 11:

(chemical formula 11)

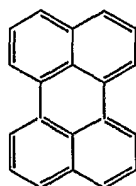


10

wherein, in the above formula R_{43} and R_{44} are independently selected from the group consisting of hydrogen, an alkyl, an aryl, cycloalkyl, and acetyl.

The perylene has the formula 12.

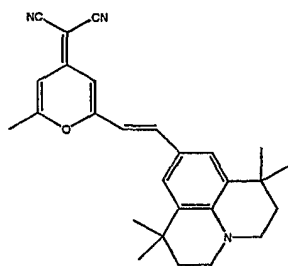
(chemical formula 12)



15

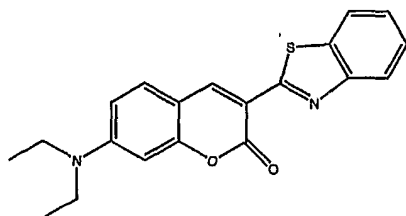
The 4-(dicyanomethylene)-2-methyl-6-(1,1,7,7-tetramethyljulodiny-9-enyl)-4H-pyran has the formula 13.

(chemical formula 13)



For the coumarines compounds, coumarine 6 (manufactured by EXCITON Corp.) having the formula 14 may be preferably used.

(chemical formula 14)



5

The dopants may have more than one substituent to obtain desirable properties such as crystallization degree, thermal stability, solubility, etc.

Dicarbazolyl azobenzene (DCAB), fluorenyl diacetylene (FDA), perylene, carbazole and carbazole derivatives serve as blue dopants, coumarines compounds as green dopants, and 4-(dicyanomethylene)-2-methyl-6-(1,1,7,7-tetramethyljulodiny-9-enyl)-4H-pyran serves as red dopant.

A combination of more than one dopant may be used.

When the chromophore compound is used as a dopant, the conventional chromophore materials may be used.

The amount of said dopants is preferably 0.1 to 30 % by weight, more preferably 5 to 30 % by weight, and most preferably 5 to 10 % by weight, based on the amount of low molecular chromophore compounds.

Examples

Hereinafter, preferred embodiments of the present invention will be described. However, these are presented only for better understanding of the present invention, and the present invention is not limited thereto.

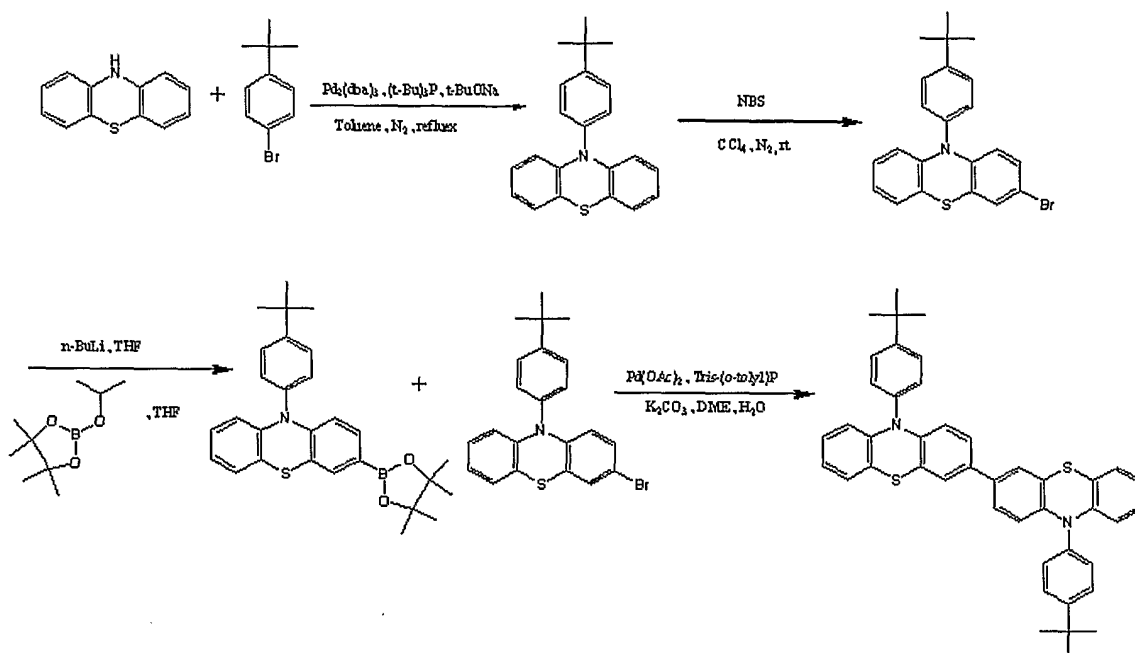
Example 1

Synthesis of 10,10'-bis-(4-tert-butyl-phenyl)-10H, 10'H(3,3')biphenothiaziny-1,10-bis(4-tert-butylphenyl)-10H, 10'H(3,3')biphenothiazine

25

(t-BPBP)

(Reaction Scheme 1)



i) Synthesis of 10-(4-tert-butyl-phenyl)-10H-phenothiazine

3g (15mmol) of phenothiazine, 4.27g (45mmol) of sodium tert-butoxide, and 0.255g (0.45mmol) of tris(dibenzylideneacetone) dipalladium were added into a round flask of 250ml under a nitrogen condition, and thereafter, 1ml of tri-
 5 butylphosphine and 2.88ml (16.5mmol) of 1-bromo-t-butyl-benzene were put thereinto and then were refluxed for a reaction, while agitating them in a toluene solvent. When the reaction was complete by checking the reaction speed with a
 10 TLC, 10ml of 1M HCl was added thereto, and thereafter, an extraction was performed by using water and chloroform. Then, second precipitations were obtained by using chloroform and methanol and thereafter, a short column was performed to gain pure 10-(4-tert-butyl-phenyl)-10H-phenothiazine. The yield of the resulting product was over 80%.

ii) Synthesis of 3-bromo-10-(4-tert-butyl-phenyl)-10H-phenothiazine

15 3g (9mmol) of 10-(4-tert-butyl-phenyl)-10H-phenothiazine and 1.4g (8mmol) of N-bromo succin imide were added into a flask and agitated in a carbon tetrachloride solvent under a nitrogen atmosphere. The product was placed on a column with hexane to gain pure 3-bromo-10-(4-t-butyl-phenyl)-10H-phenothiazine. The yield of the resulting product was about 60%.

20 iii) Synthesis of 10-(4-tert-butyl-phenyl)-3-(4,4,5,5-tetramethyl)-[1,3,2]dioxaborolan-2-yl)-10-phenothiazine

3g (7.3mmol) of the synthesized 3-bromo-10-(4-t-butyl-phenyl)-10H-phenothiazine was agitated under a nitrogen atmosphere in a round flask by adding

tetrahydrofuran. Then, it was cooled down to -78°C , and 9.2ml (15mmol) of *n*-butyl-lithium was added thereto. The resulting product was agitated for 30 minutes, and 3ml (15mmol) of 2-Isopropoxy-4,4,5,5-tetramethyl-1,3,2-dioxaborolane was added thereto. After the reaction was checked by a TLC, an extraction was performed by water and diethyl ether. Then, column chromatography was performed in a condition of *n*-hexane:EA = 19:1 to obtain pure 10-(4-*tert*-butyl-phenyl)-3-(4,4,5,5-tetramethyl)-[1,3,2]dioxaborolan-2-yl)-10-phenothiazine. The yield of the resulting product was about 60%.

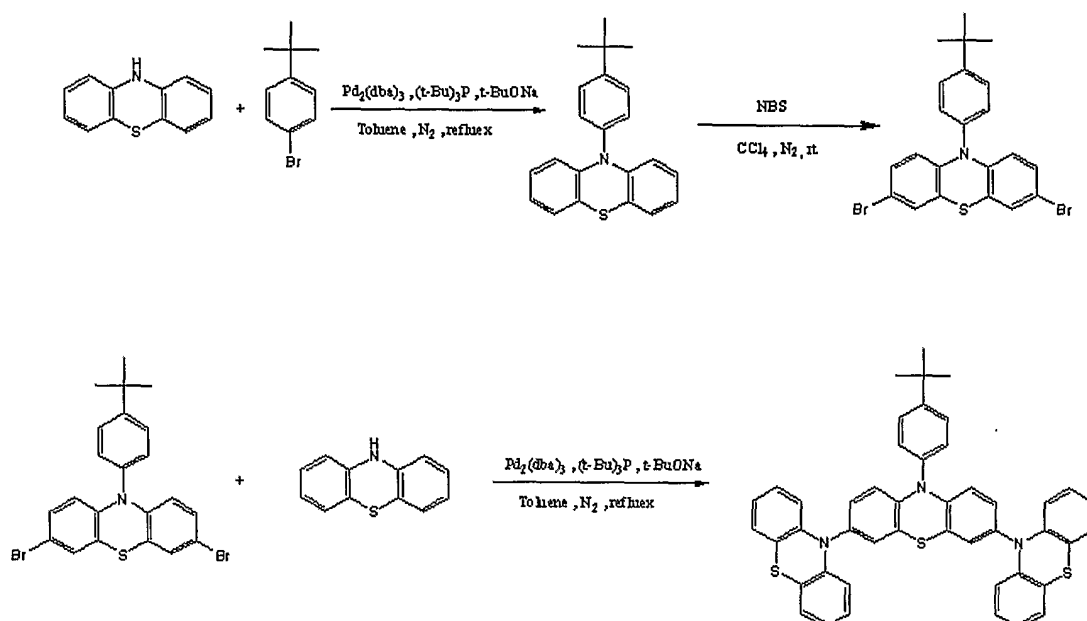
iv) Synthesis of 10,10'-bis-(4-*tert*-butyl-phenyl)-10H,10'H (3,3')biphenothiazinyl (t-BPBP)

1g (2.5mmol) of the synthesized 3-bromo-10-(4-*tert*-butyl-phenyl)-10H-phenothiazine and 1.12g (2.5mmol) of 10-(4-*tert*-Butyl-phenyl)-3-(4,4,5,5-tetramethyl)-[1,3,2]dioxaborolan-2-yl)-10-phenothiazine were poured into a round flask, and 0.17g (0.83mmol) of palladium(II)acetate and 0.1ml of tris(2-methylphenyl)phosphine were added thereto, and then agitated in a 1,2-dimethoxyethane solvent. Then, 1.70g (12.5mmol) of K_2CO_3 was dissolved in a mixed solution of water and DME and added to the above resultant and then refluxed. When a reaction was complete by checking the reaction speed with a TLC, an extraction was performed by using water and diethyl ether, and then, second precipitations were gained by using acetone. The second precipitations were placed in a column in a condition of *n*-hexane : chloroform = 2:1 to obtain pure 10,10'-bis-(4-*tert*-butyl-phenyl)-10H,10'H (3,3')biphenothiazinyl (t-BPBP). The yield of the resulting product was about 60%.

Example 2

Synthesis of 10'-(4-*tert*-butyl-phenyl)-10'H[10,3';7'10"]terphenothiazine (t-BPTP)

(Reaction Scheme 2)



i) Synthesis of 3,7-dibromo-10-(4-tert-butyl-phenyl)-10H-phenothiazine

3g (9mmol) of the synthesized 10-(4-tert-butyl-phenyl)-10H-phenothiazine and 3.5g (20mmol) of N-bromo succin imide were poured into a round flask and agitated in a carbon tetrachloride solvent under a nitrogen atmosphere. The resulting product was placed in a column in a condition of hexane: CHCl_3 = 1:1 to obtain pure 3-bromo-10-(4-t-butyl-phenyl)-10H-phenothiazine. The yield of the resulting product was about 60%.

ii) Synthesis of 10'-(4-tert-butyl-phenyl)-10'H[10,3';7'10'']terphenothiazine (t-BTP)

1g (2mmol) of the synthesized 3,7-dibromo-10-(4-tert-butyl-phenyl)-10H-phenothiazine, 1g (5mmol) of phenothiazine, and 0.255g (0.17mmol) of dipalladium were added into a round flask of 250ml under a nitrogen condition, and then, 0.2ml of tri-t-butylphosphine was added thereto while agitating them in a toluene solvent. Then, the resulting product was refluxed for a reaction.

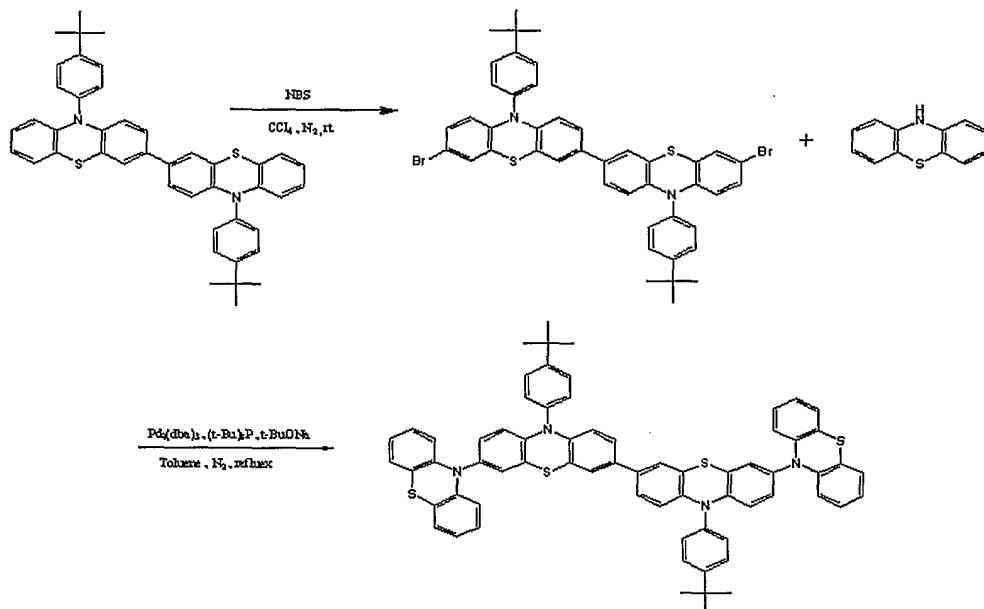
When the reaction was complete by checking the reaction speed, 1M HCl of 10ml was added thereto. Then, an extraction was performed by using water and chloroform, second precipitations were gained by using chloroform and methanol, and thereafter, the resulting product was placed in a column to obtain pure 10'-(4-tert-butyl-phenyl)-10'H[10,3';7'10'']terphenothiazine (t-BTP). The yield of the resulting product was more than 50%.

Example 3

Synthesis of 7,7'-Diphenothiazyl-10,10'-bis-(4-tert-butyl-phenyl)-

10H,10'H[3,3']biphenothiazinyl (DP-t-BPBP)

(Reaction Scheme 3)



5

i) Synthesis of 7,7'-dibromo-10,10'-bis-(4-tert-butyl-phenyl)-10H,10'H[3,3']biphenothiazinyl

1g (1.5mmol) of the synthesized 10,10'-bis-(4-tert-butyl-phenyl)-10H,10'H[3,3']biphenothiazinyl (t-BPBP) and 0.6g (3.4mmol) of N-bromo succinimide were poured into a flask and agitated in a carbon tetrachloride solvent under a nitrogen atmosphere. The obtained product was placed in a column in a condition of hexane:CHCl₃ = 1:1 to gain pure 7,7'-dibromo-10,10'-bis-(4-tert-butyl-phenyl)-10H,10'H[3,3']biphenothiazinyl. The yield of the resulting product was about 60%.

ii) Synthesis of 7,7'-diphenothiazyl-10,10'-bis-(4-tert-butyl-phenyl)-10H,10'H[3,3']biphenothiazinyl (DP-t-BPBP)

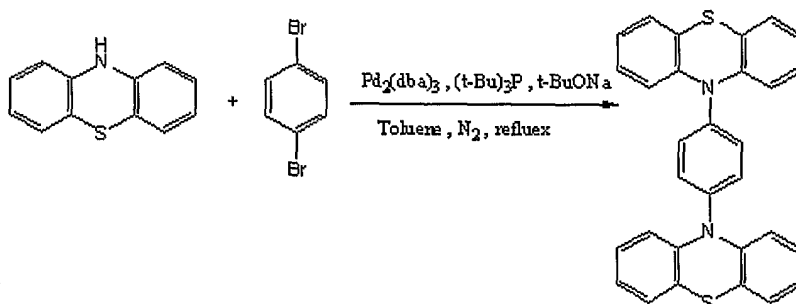
1g (1.2mmol) of the synthesized 7,7'-dibromo-10,10'-bis-(4-tert-butyl-phenyl)-10H,10'H[3,3']biphenothiazinyl, 0.6g (3mmol) of phenothiazine, 1.5g (16mmol) of sodium tert-butoxide, and 0.1g (0.07mmol) of tris(dibenzylideneacetone)dipalladium were poured into a round flask of 250ml under a nitrogen condition and agitated in a toluene solvent. Then, 1 ml of tri-tert-butylphosphine was added thereto and refluxed for a reaction. When the reaction was complete by checking the reaction speed with a TLC, 10ml of 1M HCl was added thereto, and thereafter, an extraction was performed by using water and chloroform. Then, second precipitations were gained by using chloroform and

methanol, and the resulting product was placed in a column in a condition of n-hexane:toluene = 2:1 to obtain pure 7,7'-diphenothiazyl-10,10'-bis-(4-tert-butyl-phenyl)-10H,10'H[3,3']biphenothiazinyl (DP-t-BPBP). The yield of the resulting product was more than 40%.

Example 4

Synthesis of 1,4-diphenothiazyl-benzene (DPB)

(Reaction Scheme 4)

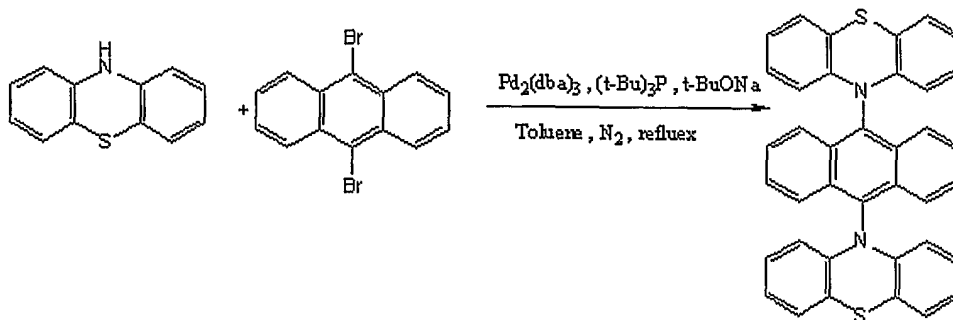


1g (4.15mmol) of 1,4-dibromobenzene, 1.8g (9.1mmol) of phenothiazine, 2.65g (24.9mmol) of sodium tert-butoxide, and 0.228g (0.25mmol) of tris(dibenzylideneacetone) dipalladium were added into a round flask of 250ml under a nitrogen condition, and thereto, 1ml of tri-t-butylphosphine was added while agitating them in a toluene solvent and refluxed for a reaction. When the reaction was complete by checking the reaction speed with a TLC, 10ml of 1M HCl was added thereto, and an extraction was performed by using water and chloroform. Then, second precipitations were gained by using chloroform and methanol and thereafter, a short column was performed to obtain pure 1,4-diphenothiazyl-benzene (DPB). The yield of the resulting product was more than 95%.

Example 5

Synthesis of 2,9,10-diphenothiazyl-antracene (DPA)

(Reaction Scheme 5)



1g (3mmol) of 9,10-dibromoanthracene, 1.31g (6.6mmol) of phenothiazine, 1.73g (18mmol) of sodium tert-butoxide, and 0.165g (0.18mmol) of tris(dibenzylideneacetone) dipalladium were added into a round flask of 250ml under a nitrogen condition, and 1 ml of tri-*t*-butylphosphine was added thereto, while
 5 agitating them in a toluene solvent and refluxed for a reaction. When the reaction was complete by checking the reaction speed with a TLC, 1M HCl of 10ml was added thereto and an extraction was performed by using water and chloroform. Then, second precipitations were gained by using chloroform and methanol, and
 10 thereafter, a short column was performed to obtain pure 1,4-diphenothiazyl-benzene (DPB). The yield of the resulting product was more than 85%.

Structure confirmation of a chromophore compound

FIG. 2a illustrates a ¹H-NMR spectrum of 10,10'-bis- (4-*tert*-butyl-phenyl)-10H,10'H(3,3')biphenothiazinyl(t-BPBP) prepared according to Example 1, and FIG. 2b illustrates GC-Mass of the compound. FIG. 3a illustrates a ¹H-NMR spectrum of 10'- (4-*tert*-butyl-phenyl)-10'H[10,3';7'10'']terphenothiazine(t-BPTP) prepared according to Example 2, and FIG. 3b illustrates GC-Mass of the compound. FIG. 4a illustrates a ¹H-NMR spectrum of 7,7'-diphenothiazyl-10,10'-bis- (4-*tert*-butyl-phenyl)-10H,10'H[3,3']biphenothiazyl (DP-t-BPBP) prepared according to Example 3, and FIG. 4b illustrates GC-Mass of the compound. FIG. 5a illustrates a ¹H-NMR spectrum of 1,4-diphenothiazylbenzene (DPB) prepared according to Example 4, and FIG. 5b illustrates GC-Mass of the compound. FIG. 6 illustrates a ¹H-NMR spectrum of 9,10-diphenothiazylanthracene(DPA) prepared according to Example 5.

Electroluminescence characteristics of chromophore compounds

25 FIG. 7 illustrates the UV and PL spectrum of a compound prepared according to Example 1. As shown in FIG. 7, the UV-vis spectrum shows an absorption band at 338nm. The band is regarded by a $\pi \rightarrow \pi^*$ transition of a conjugated double bond. Referring to the PL spectrum, when the excitation wavelength was 338nm, a luminescent color had a maximum blue wavelength of

460nm. This corresponded to quantum energy of 2.79eV, and HOMO and LUMO values were decided by measuring CV. The HOMO value of 5.06 and LUMO value of 2.27 are appropriate to be used for a HTL or HIL.

FIG. 8 illustrates UV and PL spectra of a compound prepared according to Example 2. Referring to FIG. 8, the UV-vis spectrum was 329nm, which was slightly shifted to blue compared to that of t-BPBP shown in FIG. 7. The PL spectrum had a blue wavelength of 457nm, which came to quantum energy of 3.10eV.

The HOMO / LUMO values measured by CV were 4.84/1.74 respectively.

FIG. 9 illustrates the UV and PL spectra of a compound prepared according to Example 3. The UV-vis spectrum had 347nm, which was slightly shifted to red compared to that of t-BPBP shown in FIG. 7. The PL spectrum had a blue wavelength of 461nm, which came to quantum energy of 2.94eV. HOMO/LUMO values by measuring CV of t-BPBP, DP-t-BPBP were 5.01/2.07, which were also appropriate to be used in HTL or HIL.

FIG. 10 illustrates the UV and PL spectra of a compound prepared according to Example 4. As shown in FIG. 10, the UV-vis spectrum showed an absorption band at 314nm. The band is regarded by a $\pi \rightarrow \pi^*$ transition of a conjugated double bond. Referring to the PL spectrum, when the excitation wavelength was 314nm, a luminescent color had a maximum blue wavelength of 445nm.

FIG. 11 illustrates UV and PL spectra of a compound prepared according to Example 5. The UV-vis spectrum was 444nm, which was shifted to red compared to that of DPB. The reason is that anthracene has a smaller band gap than benzene. The PL spectrum appeared at a red wavelength of 615nm.

Fabrication of an electroluminescence display device

Examples 6 to 8

An ITO layer was formed as an anode on a glass substrate, and thereon, compounds prepared according to Examples 1 to 3 were vacuum-deposited to be 50nm thick, respectively forming a hole transport layer (HTL). Then, Alq₃ was also vacuum-deposited to form a 50nm-thick emitting layer, and thereon, 1 nm-thick LiF and a 200 nm-thick aluminum metal were vacuum-deposited to fabricate a diode. The vacuum deposition was performed at a speed of 1 Å/second under a 1×10^{-6} torr vacuum condition to form a 9 mm² area. The thickness and growing speed of the layer during the depositions were regulated using a layer thickness monitor.

Examples 9 to 11

An ITO layer was formed as an anode on a glass substrate, and then, compounds prepared according to Examples 1 to 3 were respectively vacuum-deposited to form a hole injection layer (HIL) with a thickness of 60nm. Then, NPD (N,N'-bis(naphthalene-1-yl)-N,N'-diphenylbenzidine) was vacuum-deposited to form a 15nm-thick hole transport layer, Alq₃ was also vacuum-deposited to form a 70nm-thick emitting layer, and thereafter, 1 nm-thick LiF and a 200 nm-thick aluminum metal were vacuum-deposited to fabricate a electroluminescent diode. The vacuum deposition was performed under a 1X10⁻⁶ torr vacuum condition at a speed of 1 Å/second to form a 9 mm² area. The thickness and growing speed of a layer during the deposition was regulated by a layer thickness monitor.

Comparative Example 1

A electroluminescent diode was fabricated using the same method as in Examples 9 to 11 except that MTDATA (4,4',4''-tris{N-(methylphenyl)-N-phenylamino}triphenylamine) was used as a hole transport layer.

Characteristic measurement of an electroluminescence display device

The electroluminescent diodes of Examples 6 to 11 were applied with an electric field to estimate I-V and EL characteristics. FIG. 12 shows I - V characteristics of a electroluminescent diode (ITO/t-BPBP/Alq₃/LiF/Al) of Example 6, which includes the compound of Example 1 as a hole transport layer. FIG. 13 shows EL characteristics of the diode. FIG. 14 shows I - V characteristics of a electroluminescent diode (ITO/t-BPTP/Alq₃/LiF/Al) of Example 7, which includes the compound of Example 2 as a hole transport layer. FIG. 15 shows EL characteristics of the diode. FIG. 16 shows I - V characteristics of a electroluminescent diode (ITO/DP-t-BPBP/Alq₃/LiF/Al) of Example 8, which includes the compound of Example 3 as a hole transport layer. FIG. 17 shows EL characteristics of the diode. I-V characteristics of the electroluminescent diodes were measured using Keithley SMU238. Here, a forward bias voltage of a direct current voltage was used. FIGs. 12, 14, and FIG. 16 have a curved line showing typical diode I - V characteristics and a turn-on voltage of 4-5 V.

FIGs. 13, 15, and 17 show EL spectra of Alq₃ ranging from 507 to 520nm, accomplishing a regular device.

Brightness, color coordinates, electric power efficiency, and luminescence efficiency characteristics of a diode fabricated according to Example 6 were measured using a brightness meter, PR650. Table 1 shows the results.

Table 1

Current (mA)	Current Density (mA/cm ²)	Voltage (V)	Brightness (cd/m ²)	CIE coordinates (x, y)	luminescence Efficiency (cd/A)	Power Efficiency (lm/w)
0.9	10	5.48	100	(0.298, 0.537)	1	0.57
2.25	25	6.6	278	(0.298, 0.537)	1.11	0.53
4.5	50	7.7	573	(0.297, 0.536)	1.15	0.47
9	100	9.1	1160	(0.295, 0.535)	1.16	0.40

Brightness, color coordinates, power efficiency, and luminescence efficiency characteristics of a diode fabricated according to Example 7 were measured using a brightness meter, PR650. Table 2 shows the results.

Table 2

Current (mA)	Current Density (mA/cm ²)	Voltage (V)	(cd/m ²)	CIE coordinates (x, y)	luminescence Efficiency (cd/A)	Power Efficiency (lm/w)
0.9	10	8.5	154	(0.291, 0.533)	1.54	0.57
2.25	25	9.18	368	(0.292, 0.532)	1.47	0.50
4.5	50	11.17	724	(0.291, 0.532)	1.45	0.41
9	100	12.24	1390	(0.290, 0.530)	1.39	0.36

Brightness, color coordinates, power efficiency, and luminescence efficiency characteristics of a diode fabricated according to Example 8 were measured using a brightness meter, PR650. Table 3 shows the results.

Table 3

Current (mA)	Current Density (mA/cm ²)	Voltage (V)	Brightness (cd/m ²)	CIE coordinates (x, y)	luminescence Efficiency (cd/A)	Power Efficiency (lm/w)
0.9	10	9.20	13.2	(0.388, 0.486)	0.13	0.044
2.25	25	10.92	34.7	(0.368, 0.488)	0.14	0.040
4.5	50	12.25	70.8	(0.355, 0.491)	0.14	0.036
9	100	13.6	138	(0.344, 0.492)	0.14	0.032

FIG. 18 shows I - V characteristics of a electroluminescent diode (ITO/DP-t-BPBP/Alq₃/LiF/Al) of Example 9, which includes the compound of Example 1 as a hole transport layer. FIG. 19 shows EL characteristics of the diode. FIG. 20 shows I - V characteristics of a electroluminescent diode (ITO/DP-t-BPBP/Alq₃/LiF/Al) of Example 9, which has the compound of Example 2 as a hole transport layer. FIG. 21 shows EL characteristics of the diode. FIG. 22 shows I - V characteristics of a electroluminescent diode (ITO/DP-t-BPBP/Alq₃/LiF/Al) of Example 9, which has the compound of Example 3 as a hole transport layer. FIG. 23 shows EL characteristics of the diode. FIGs. 18, 20, and 22 have a curved line showing typical diode I - V characteristics and a turn-on voltage of 4-5 V. FIGs. 19, 21, and 23 show Alq₃ EL spectrum results ranging 504 to 523nm, accomplishing a regular device.

Brightness, color coordinates, power efficiency, and luminescence efficiency characteristics of the electroluminescent diode according to Example 9 were measured using a brightness meter, PR650. The results are shown in the following Table 4.

Table 4

Current (mA)	Current density (mA/cm ²)	Voltage (V)	Brightness (cd/m ²)	CIE coordinates (x, y)	Luminescence efficiency (cd/A)	Power efficiency (lm/w)
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0.9	10	7.3	409	(0.309, 0.552)	4.09	1.76
2.25	25	8.5	1230	(0.309, 0.553)	4.92	1.82
4.5	50	9.5	2450	(0.309, 0.552)	4.90	1.62
9	100	10.6	4880	(0.308, 0.552)	4.88	1.44

Brightness, color coordinates, power efficiency, and luminescence efficiency characteristics of the electroluminescent diode according to Example 10 were measured using a brightness meter, PR650. The results are shown in the following Table 5.

5

Table 5

Current (mA)	Current density (mA/cm ²)	Voltage (V)	Brightness (cd/m ²)	CIE coordinates (x, y)	Luminescence efficiency (cd/A)	Power efficiency (lm/w)
0.9	10	9.2	298	(0.297, 0.540)	2.98	1.02
2.25	25	10.5	718	(0.297, 0.540)	2.87	0.86
4.5	50	11.5	1380	(0.296, 0.540)	2.76	0.75
9	100	12.5	2620	(0.296, 0.538)	2.62	0.66

Brightness, color coordinates, electric power efficiency, and luminescence efficiency characteristics of the electroluminescent diode according to Example 11 were measured using a brightness meter, PR650. The results are shown in the following Table 6.

10

Table 6

Current (mA)	Current density (mA/cm ²)	Voltage (V)	Brightness (cd/m ²)	CIE coordinates (x, y)	Luminescence efficiency (cd/A)	Power efficiency (lm/w)
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0.9	10	16	413	(0.329,0.555)	4.13	0.81
2.25	25	18.5	1030	(0.329, 0.554)	4.12	0.70
4.5	50	20.1	1910	(0.329, 0.553)	3.82	0.60
9	100	21.6	3560	(0.329, 0.551)	3.56	0.52

Brightness, color coordinates, power efficiency, and luminescence efficiency characteristics of the electroluminescent diode according to Comparative Example 1 using MTDATA in a hole transport layer were measured using a brightness meter, PR650. The results are shown in the following Table 7.

Table 7

Current (mA)	Current density (mA/cm ²)	Voltage (V)	Brightness (cd/m ²)	CIE coordinates (x, y)	Luminescence efficiency (cd/A)	Power efficiency (lm/W)
0.9	10	11.3	554	(0.347 0.515)	5.54	1.54
2.25	25	13	1490	(0.347 0.554)	5.96	1.44
4.5	50	14.3	2880	(0.347 0.554)	5.76	1.26
9	100	15.4	5930	(0.346 0.552)	5.93	1.21

As shown in Tables 4 to 6, the electroluminescent diodes according to Examples 8 and 10 using t-BPBP and DP-t-BPBP in a hole transport layer, respectively showed excellent electroluminescent efficiency of more than 4 cd/A. Particularly, the resultant efficiency (lm/W) considering a voltage was a maximum 1.82 lm/W in the case of t-BPBP indicating high electric power efficiency. On the contrary, Comparative Example 1 showed electric power efficiency of a maximum 1.54 lm/W. Therefore, the diodes according to the Examples including the compounds of the present invention showed 120 % higher efficiency values than that of the Comparative Example indicating that the diodes according to the

Examples have improved performance characteristics.

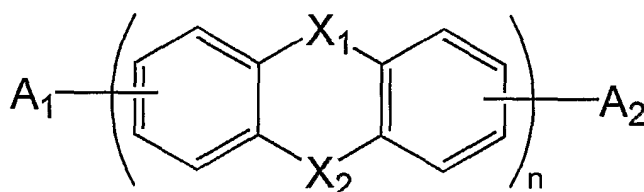
5 The organic compound for an electroluminescence display device can be applied to one or all of a hole transport layer, a hole injection layer, an emitting layer, an electron injection layer, and an electron transport layer. The organic compound
10 of the present invention has good hole transport properties and hole injection properties and thus is applicable to a hole transport layer and a hole injection layer. In the case that the chromophore compounds are applied, an electroluminescence display device emitting blue color can be driven at low voltage. Furthermore, suitable host or doping materials which are organic compounds with conjugated
15 double bonds may be used along with the chromophore compounds to form a good energy transfer device which makes various color realization at low energy possible, and improves the brightness and luminescence efficiency.

The simple modifications and changes of the present invention may be made by those skilled in the art, without departing from the scope of the invention.

WHAT IS CLAIMED IS:

1. A chromophore compound for an electroluminescence display device comprising a chromophore compound represented by the following formula 1:

(chemical formula 1)



wherein X_1 and X_2 are independently selected from the group consisting of CR_1R_2 , O, S, N- R_3 , SiR_4R_5 , and GeR_6R_7 ,

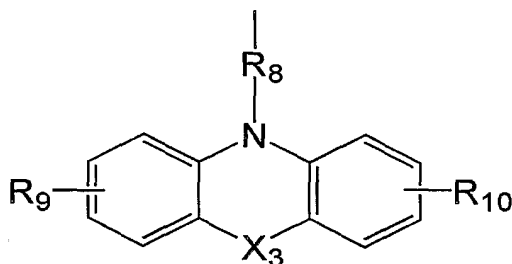
where R_1 to R_7 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl;

A_1 and A_2 are independently selected from the group consisting of hydrogen, an unsubstituted linear or branched alkyl, an unsubstituted cycloalkyl, an unsubstituted alkenyl, an unsubstituted alkynyl, an unsubstituted alkoxy, an unsubstituted aryl, and an unsubstituted heteroaryl; and

n ranges from 1 to 1000.

2. The chromophore compound for an electroluminescence display device of claim 1, wherein the substituted alkyl is represented by the following formula 2:

(chemical formula 2)



wherein, in the above formula, X_3 is selected from the group consisting of CR_1R_2 , O, S, N- R_3 , SiR_4R_5 and GeR_6R_7 ,

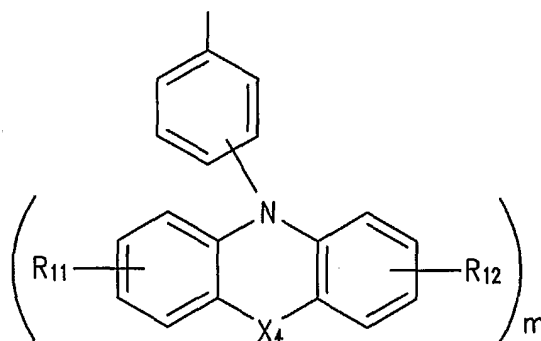
where R_1 to R_7 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl;

R_8 is alkylene; an aryl; alkylene substituted with an alkyl, an alkoxy, or an aryl; or an aryl substituted with an alkyl, alkoxy, or an aryl; and

R_9 and R_{10} are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl.

3. The chromophore compound for an electroluminescence display device of claim 1, wherein the substituted aryl is represented by the following formula 3:

(chemical formula 3)



wherein, in the above formula, X_4 is independently selected from the group consisting of CR_1R_2 , O, S, $N-R_3$, SiR_4R_5 , and GeR_6R_7 ,

where R_1 to R_7 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl;

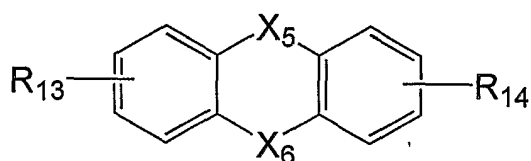
R_{11} and R_{12} are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or

unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl; and

m is an integer ranging from 1 to 4.

- 5 4. The chromophore compound for an electroluminescence display device of claim 1, wherein A_1 or A_2 is represented by the following formula 4:

(chemical formula 4)



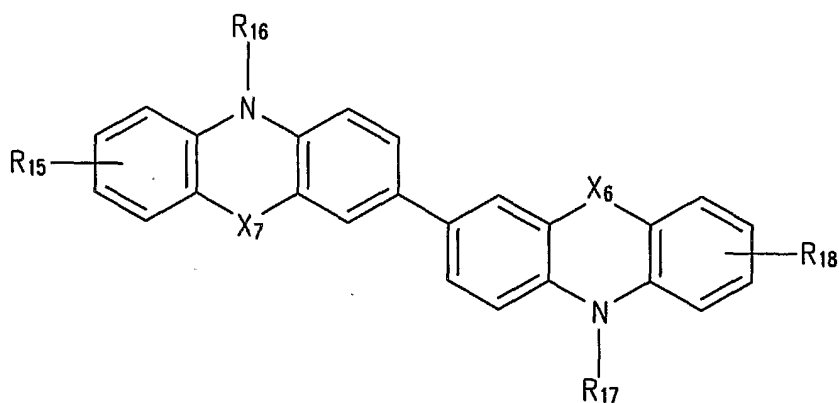
10 wherein, in the above formula, X_5 and X_6 are independently selected from the group consisting of CR_1R_2 , O, S, N- R_3 , Si R_4R_5 , and Ge R_6R_7 ,

15 where R_1 to R_7 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl; and

20 R_{13} and R_{14} are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl.

- 25 5. The chromophore compound for an electroluminescence display device of claim 1, which is represented by the following formula 5:

(chemical formula 5)



wherein, in the above formula, X_7 and X_8 are independently selected from the group consisting of CR_1R_2 , O, S, N- R_3 , SiR_4R_5 , and GeR_6R_7 ,

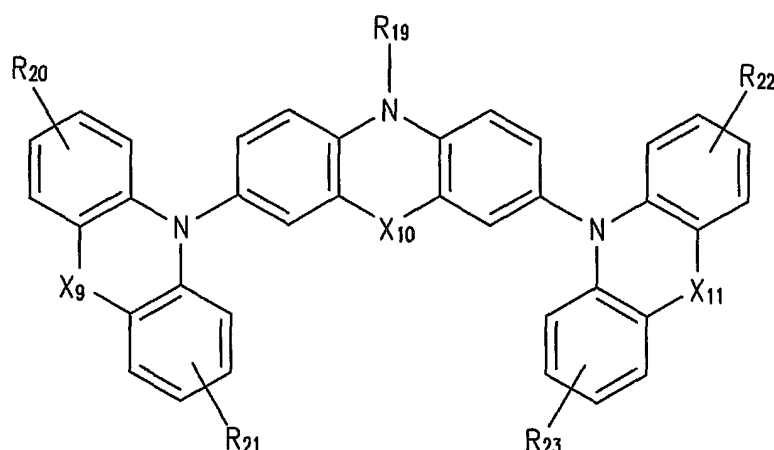
where R_1 to R_7 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl;

R_{15} and R_{18} are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl; and

R_{16} and R_{17} are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl.

6. The chromophore compound for an electroluminescence display device of claim 1, which is represented by the following formula 6:

(chemical formula 6)



wherein, in the above formula, X_9 to X_{11} are independently selected from the group consisting of CR_1R_2 , O, S, N- R_3 , SiR_4R_5 , and GeR_6R_7 ,

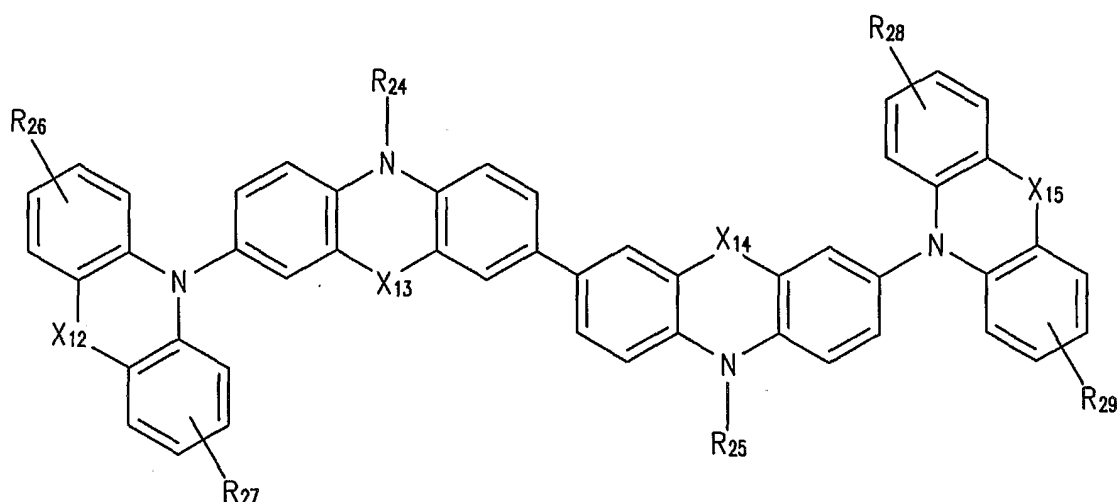
where R_1 to R_7 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or

unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl; and

R_{19} and R_{23} are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl.

7. The chromophore compound for an electroluminescence display device of claim 1, which is represented by the following formula 7:

(chemical formula 7)



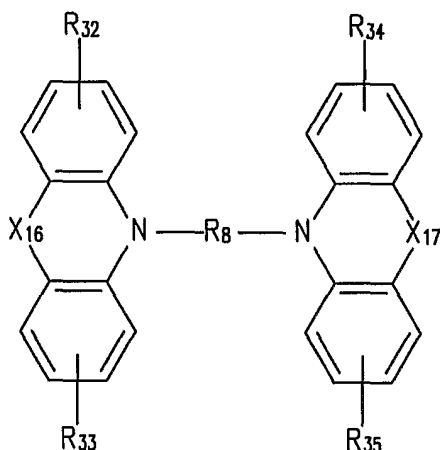
wherein, in the above formula, X_{12} to X_{15} are independently selected from the group consisting of CR_1R_2 , O, S, N- R_3 , Si R_4R_5 , and Ge R_6R_7 ,

where R_1 to R_7 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl; and

R_{24} and R_{31} are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl.

8. The chromophore compound for an electroluminescence display device of claim 1, which is represented by the following formula 8:

(chemical formula 8)



5

wherein, in the above formula, X_{16} to X_{17} are independently selected from the group consisting of CR_1R_2 , O, S, $N-R_3$, SiR_4R_5 , and GeR_6R_7 ,

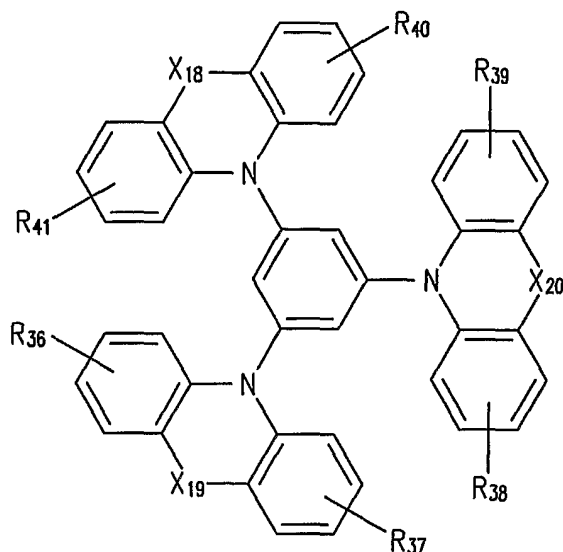
where R_1 to R_7 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl;

R_8 is an alkylene; an alkylene which is substituted with an alkylene, an aryl, an alkyl, an alkoxy, or an aryl; or an aryl which is substituted with an alkyl, an alkoxy, or an aryl; and

R_{32} to R_{35} are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl.

9. The chromophore compound for an electroluminescence display device of claim 1, which is represented by the following formula 9:

(chemical formula 9)



wherein, in the above formula, X₁₈ to X₂₀ are independently selected from the group consisting of CR₁R₂, O, S, N-R₃, SiR₄R₅, and GeR₆R₇,

where R₁ to R₇ are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl; and

R₃₆ to R₄₁ are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl.

10. An organic electroluminescence display device which comprises the chromophore compound according to one claim of claims 1 to 9 in at least one selected from the group of a hole transport layer, a hole injection layer, an emitting layer, an electron injection layer, and an electron transport layer.

11. The organic electroluminescence display device of claim 10, wherein the emitting layer comprises the chromophore compound of any one of claims 1 to 9, and a dopant which is an organic compound having conjugated double bonds and materials which have a smaller energy gap than the doped material, and thus a lower maximum wavelength value than the doped material, and good energy transfer and chromophore property.

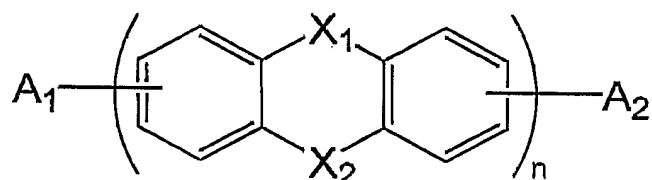
12. The organic electroluminescence display device of claim 10, wherein the emitting layer comprises a dopant comprising the chromophore compound according to any one of claims 1 to 9.

AMENDED CLAIMS

received by the International Bureau on 27 March 2006 (27.03.2006)

1. (amended) A chromophore compound for an electroluminescence display device comprising a chromophore compound represented by the following formula 1:

(chemical formula 1)



wherein X_1 and X_2 are independently selected from the group consisting of CR_1R_2 , O, S, $N-R_3$, SiR_4R_5 , and GeR_6R_7 , where X_2 is not $N-R_3$ when X_1 is O, and both X_1 and X_2 are not $N-R_3$,

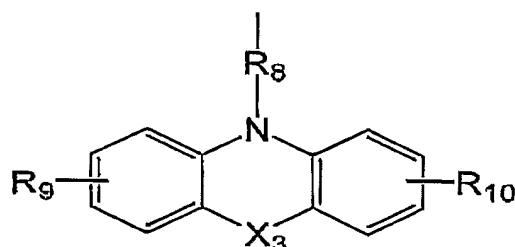
where R_1 to R_7 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl;

A_1 and A_2 are independently selected from the group consisting of hydrogen, an unsubstituted linear or branched alkyl, an unsubstituted cycloalkyl, an unsubstituted alkenyl, an unsubstituted alkynyl, an unsubstituted alkoxy, an unsubstituted aryl, and an unsubstituted heteroaryl; and

n ranges from 1 to 1000.

2. (unchanged) The chromophore compound for an electroluminescence display device of claim 1, wherein the substituted alkyl is represented by the following formula 2:

(chemical formula 2)



wherein, in the above formula, X_3 is selected from the group consisting of

CR_1R_2 , O, S, N- R_3 , SiR_4R_5 and GeR_6R_7 ,

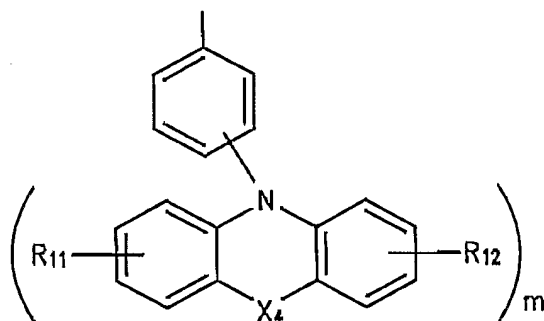
where R_1 to R_7 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl;

R_8 is alkylene; an aryl; alkylene substituted with an alkyl, an alkoxy, or an aryl; or an aryl substituted with an alkyl, alkoxy, or an aryl; and

R_9 and R_{10} are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl.

3. (unchanged) The chromophore compound for an electroluminescence display device of claim 1, wherein the substituted aryl is represented by the following formula 3:

(chemical formula 3)



wherein, in the above formula, X_4 is independently selected from the group consisting of CR_1R_2 , O, S, N- R_3 , SiR_4R_5 , and GeR_6R_7 ,

where R_1 to R_7 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl;

R_{11} and R_{12} are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or

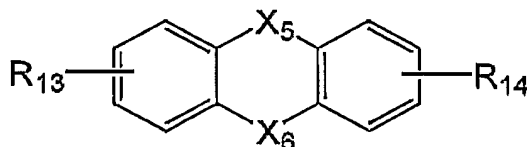
unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl; and

m is an integer ranging from 1 to 4.

5

4. (unchanged) The chromophore compound for an electroluminescence display device of claim 1, wherein A₁ or A₂ is represented by the following formula 4:

(chemical formula 4)



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wherein, in the above formula, X₅ and X₆ are independently selected from the group consisting of CR₁R₂, O, S, N-R₃, SiR₄R₅, and GeR₆R₇,

where R₁ to R₇ are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl; and

15

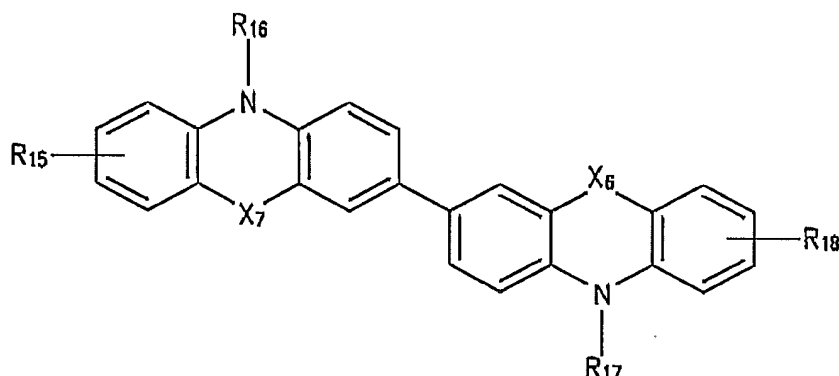
R₁₃ and R₁₄ are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl.

20

5. (amended) The chromophore compound for an electroluminescence display device of claim 1, which is represented by the following formula 5:

25

(chemical formula 5)



wherein, in the above formula, X_7 and X_8 are independently selected from the group consisting of CR_1R_2 , O, S, SiR_4R_5 , and GeR_6R_7 ,

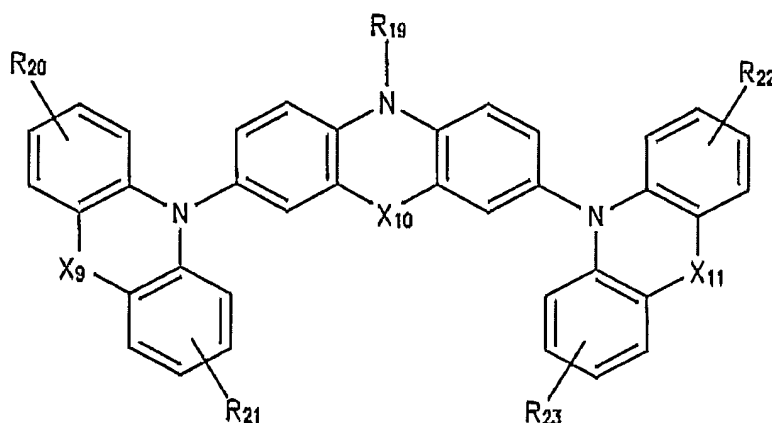
where R_1 to R_7 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl;

R_{15} and R_{18} are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl; and

R_{16} and R_{17} are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl.

6. (amended) The chromophore compound for an electroluminescence display device of claim 1, which is represented by the following formula 6:

(chemical formula 6)



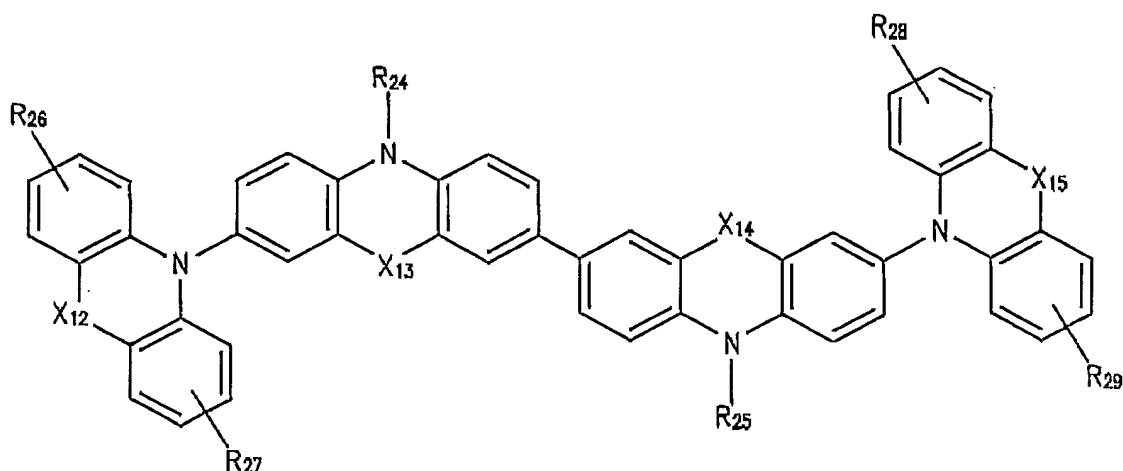
wherein, in the above formula, X_9 to X_{11} are independently selected from the group consisting of CR_1R_2 , O, S, SiR_4R_5 , and GeR_6R_7 ,

where R_1 to R_7 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl; and

R_{19} and R_{23} are independently selected from the group consisting of a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl.

7. (amended) The chromophore compound for an electroluminescence display device of claim 1, which is represented by the following formula 7:

(chemical formula 7)



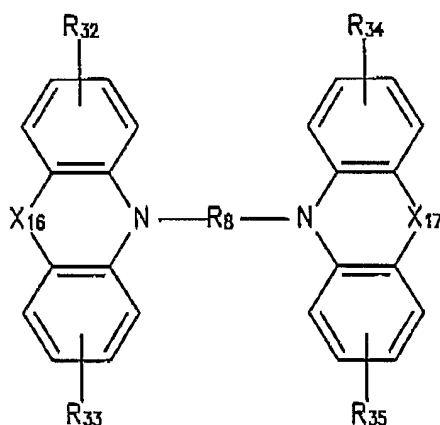
wherein, in the above formula, X_{12} to X_{15} are independently selected from the group consisting of CR_1R_2 , O, S, SiR_4R_5 , and GeR_6R_7 ,

where R_1 to R_7 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl; and

R_{24} and R_{31} are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl.

8. (amended) The chromophore compound for an electroluminescence display device of claim 1, which is represented by the following formula 8:

(chemical formula 8)



wherein, in the above formula, X_{16} to X_{17} are independently selected from the group consisting of CR_1R_2 , O, S, $N-R_3$, SiR_4R_5 , and GeR_6R_7 ,

where R_1 to R_7 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl;

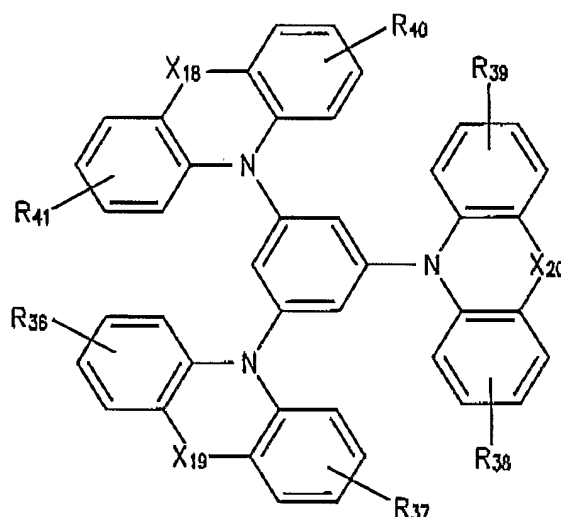
R_8 is an aryl; or an aryl which is substituted with an alkyl, an alkoxy, or an

aryl; and

R_{32} to R_{35} are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl.

9. (unchanged) The chromophore compound for an electroluminescence display device of claim 1, which is represented by the following formula 9:

(chemical formula 9)



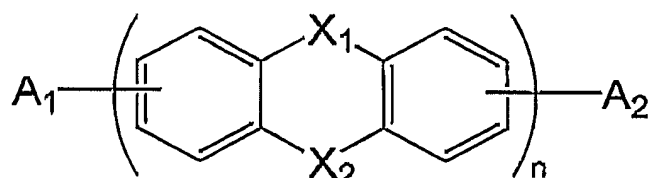
wherein, in the above formula, X_{18} to X_{20} are independently selected from the group consisting of CR_1R_2 , O, S, N- R_3 , SiR_4R_5 , and GeR_6R_7 ,

where R_1 to R_7 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl; and

R_{36} to R_{41} are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl.

10. (added) A chromophore compound for an electroluminescence display device comprising a chromophore compound represented by the following formula 1:

(chemical formula 1)



wherein X_1 is O and X_2 is N- R_3 ,

where R_1 to R_7 are independently selected from the group consisting of hydrogen, a substituted or unsubstituted linear or branched alkyl, a substituted or unsubstituted cycloalkyl, a substituted or unsubstituted alkenyl, a substituted or unsubstituted alkynyl, a substituted or unsubstituted alkoxy, a substituted or unsubstituted aryl, and a substituted or unsubstituted heteroaryl;

A_1 and A_2 are independently selected from the group consisting of hydrogen, an unsubstituted linear or branched alkyl, an unsubstituted cycloalkyl, an unsubstituted alkenyl, an unsubstituted alkynyl, an unsubstituted alkoxy, an unsubstituted aryl, and an unsubstituted heteroaryl; and

n ranges from 1 to 4.

11. (amended) An organic electroluminescence display device which comprises the chromophore compound according to one claim of claims 1 to 10 in at least one selected from the group of a hole transport layer, a hole injection layer, an emitting layer, an electron injection layer, and an electron transport layer.

12. (amended) The organic electroluminescence display device of claim 11, wherein the emitting layer comprises the chromophore compound of any one of claims 1 to 10, and a dopant which is an organic compound having conjugated double bonds and materials which have a smaller energy gap than the doped material, and thus a lower maximum wavelength value than the doped material, and good energy transfer and chromophore property.

13. (amended) The organic electroluminescence display device of claim 11, wherein the emitting layer comprises a dopant comprising the chromophore compound according to any one of claims 1 to 10.

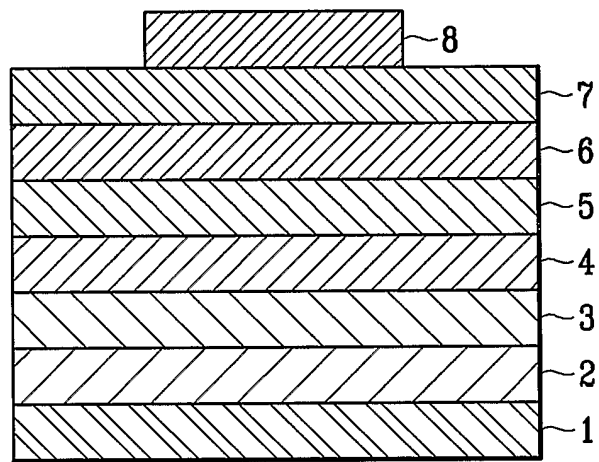
STATEMENT UNDER ARTICLE 19 (1)

The Applicant, who received the International Search Report relating to the above-identified International Application transmitted on January 27, 2006, hereby files amendment under Article 19 as in the attached sheet.

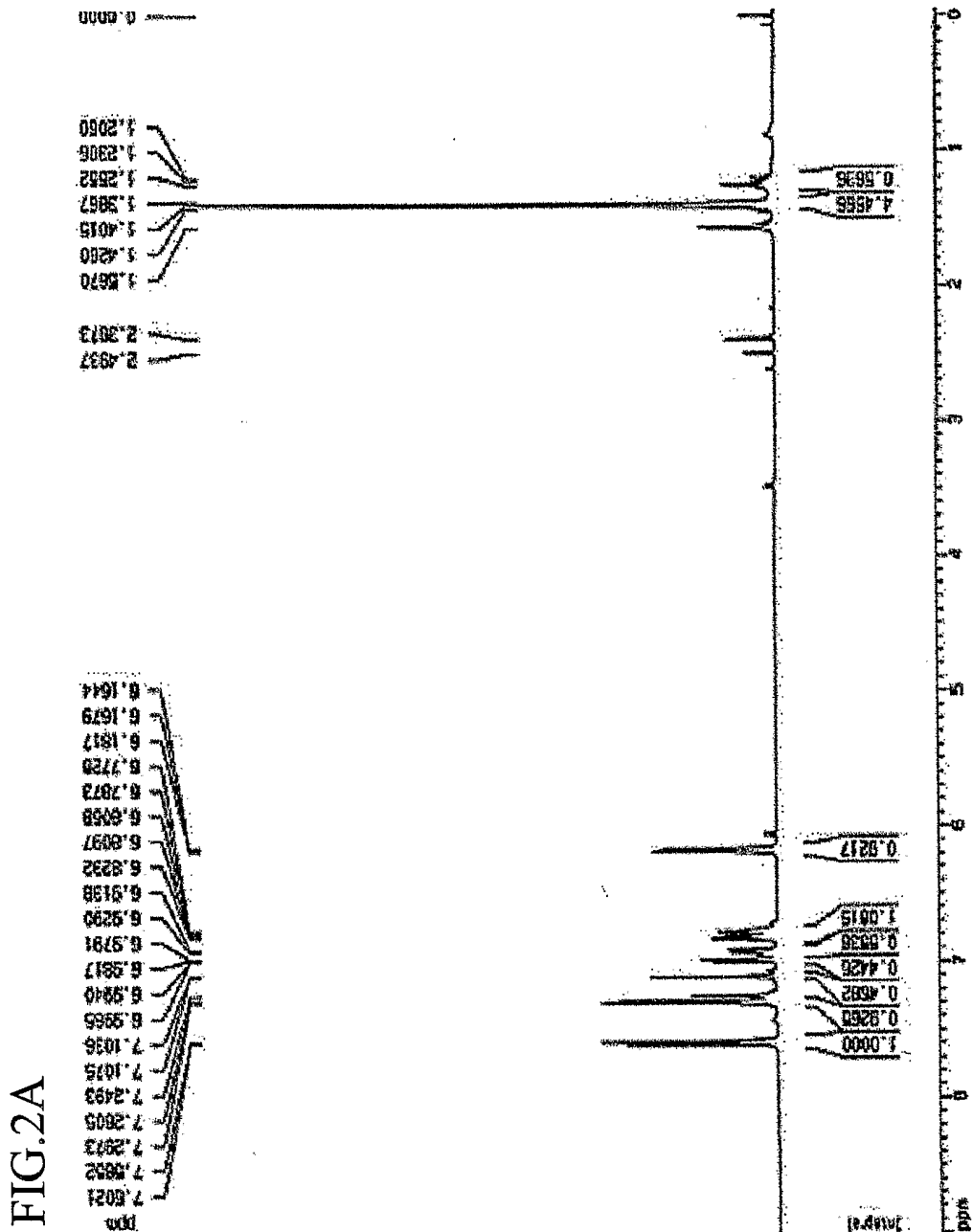
Therefore, the Applicant hereby amends claims 1, 5-8, and 11-13, and add new claim 10 as originally filed at the international filing date. Please substitute the enclosed new set of claims for all the claims as originally filed.

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FIG.1

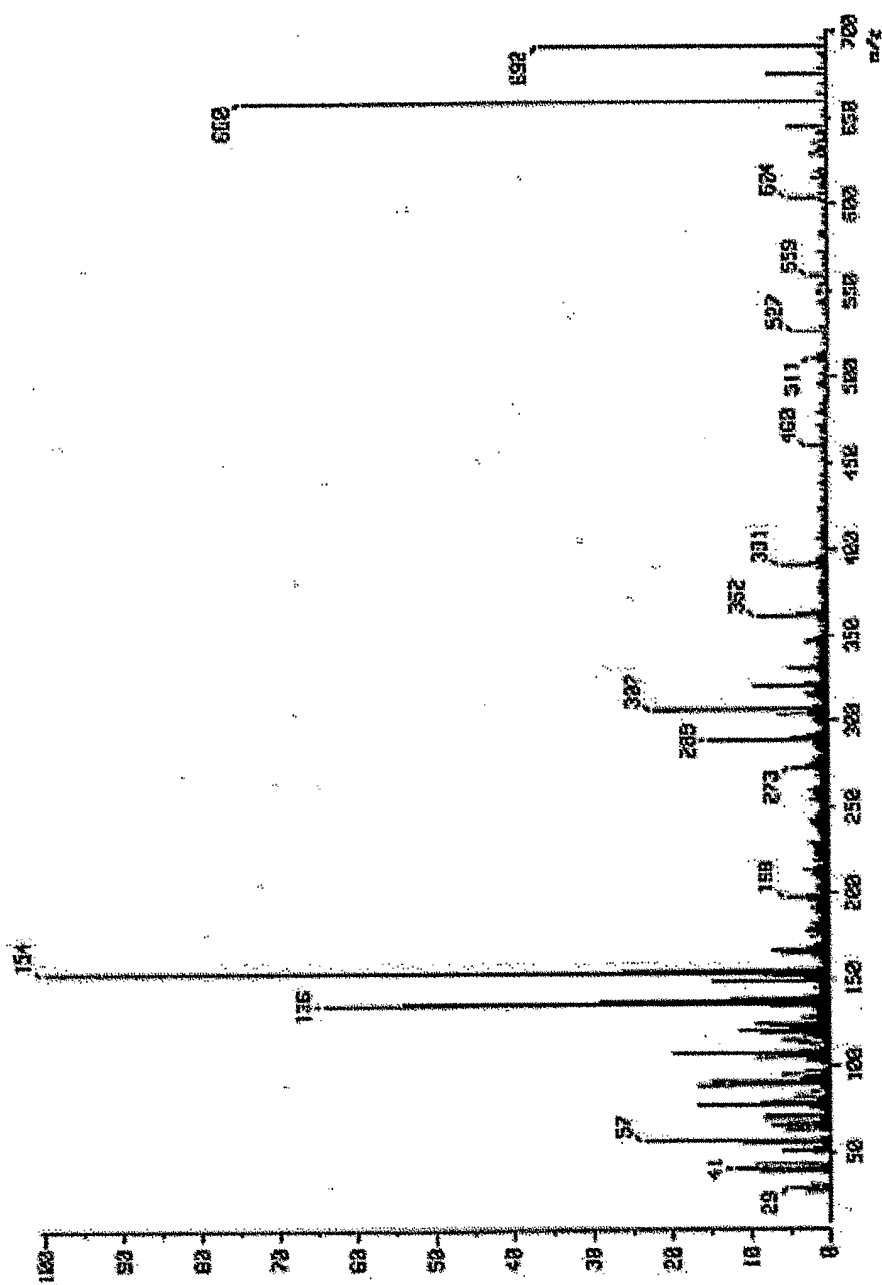


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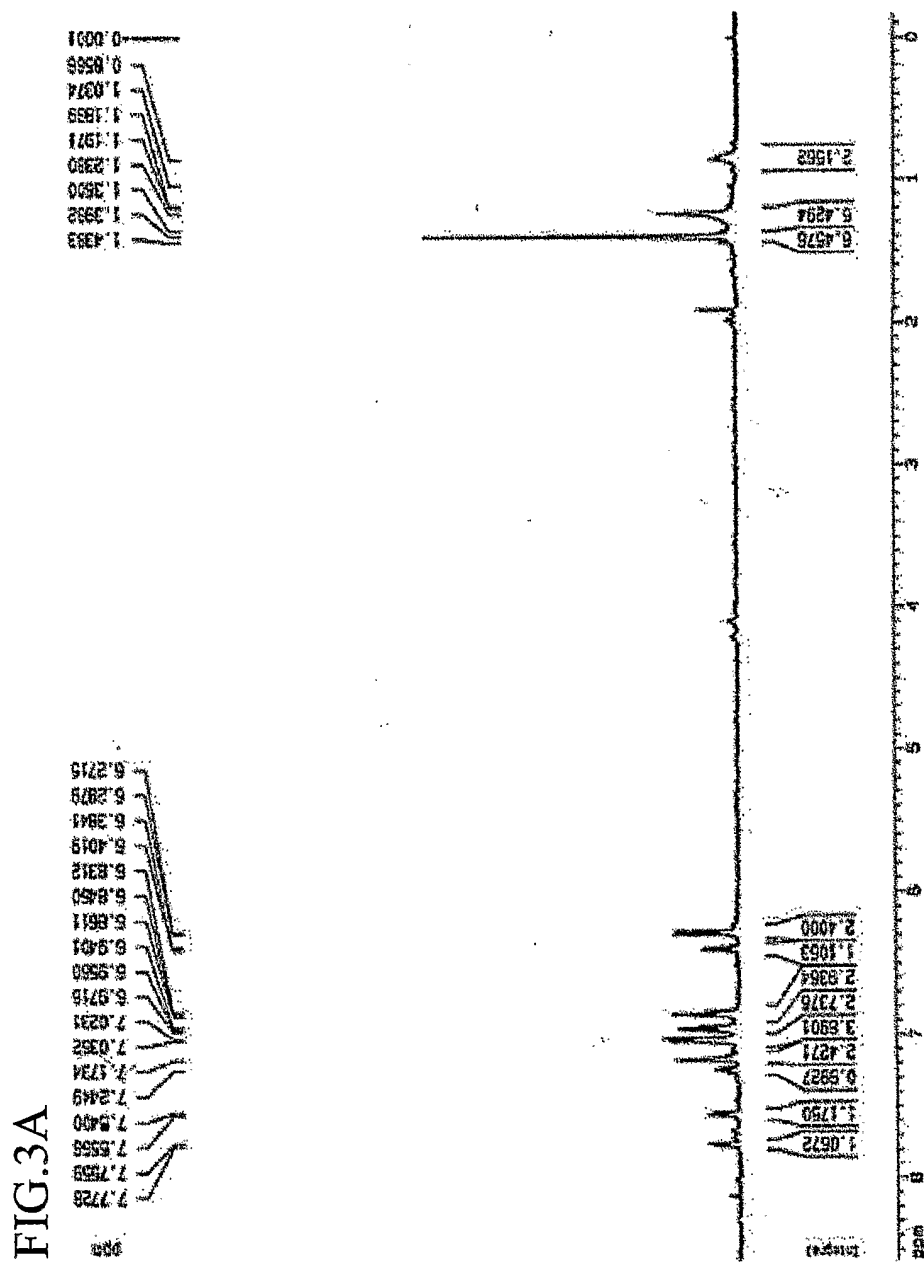


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FIG. 2B

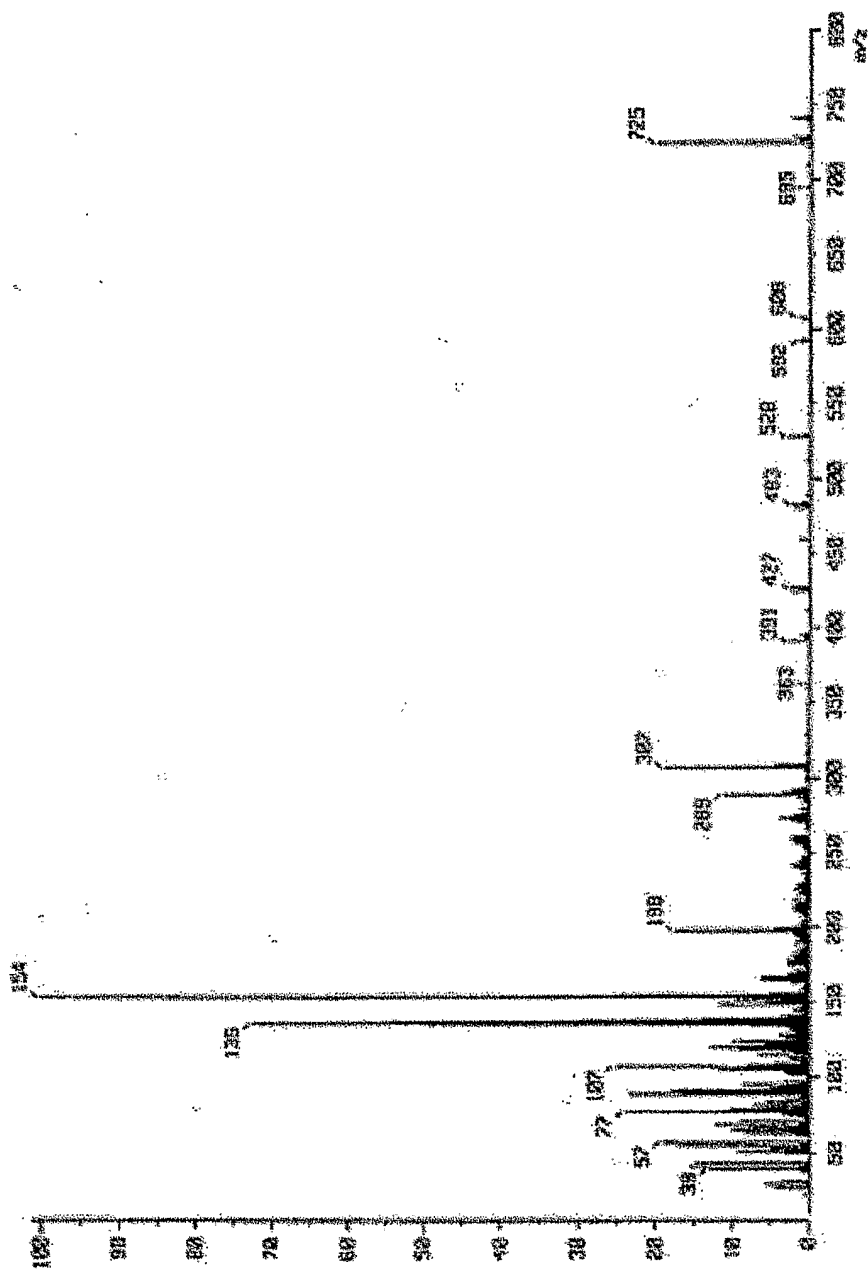


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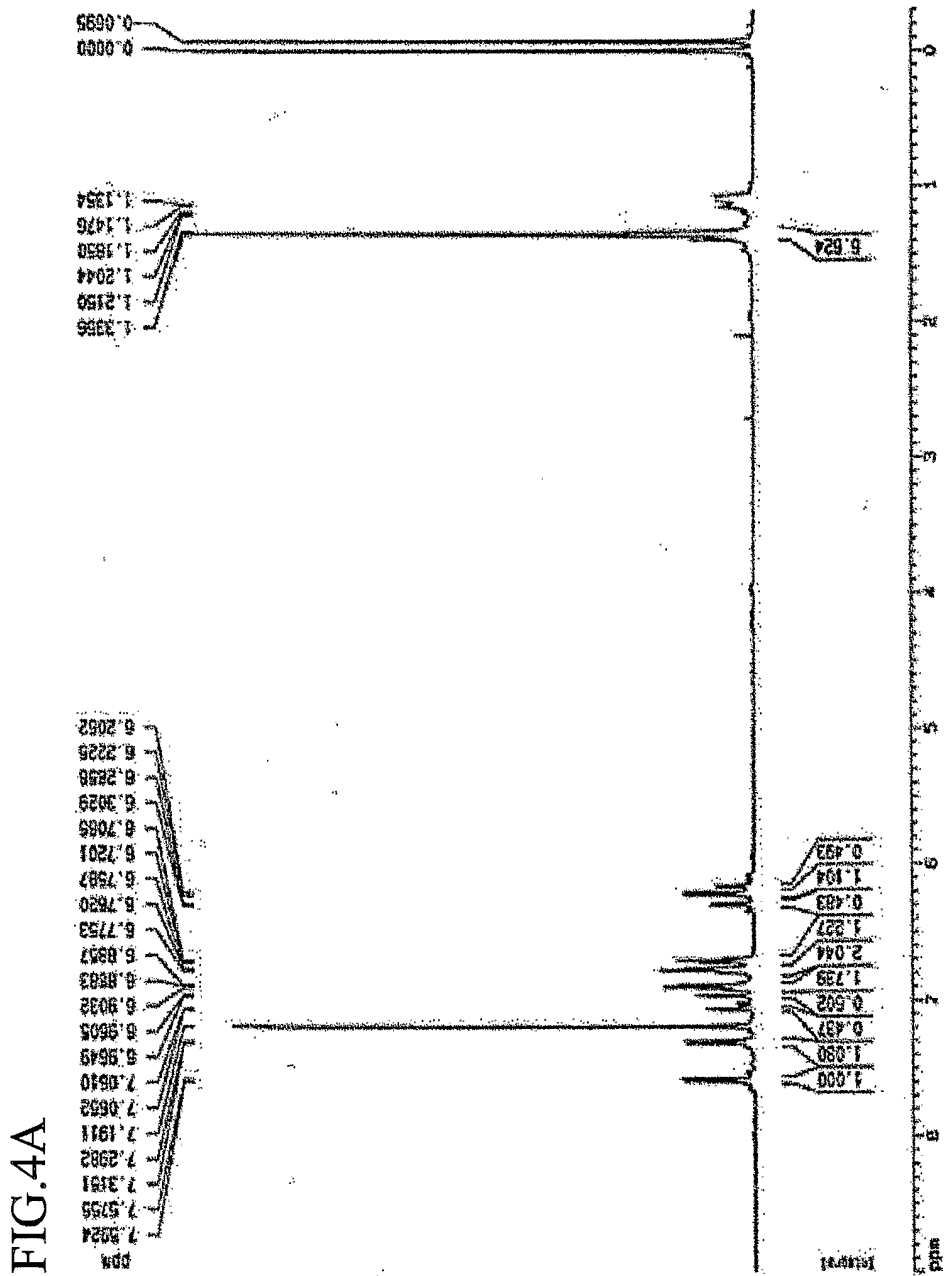


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FIG.3B

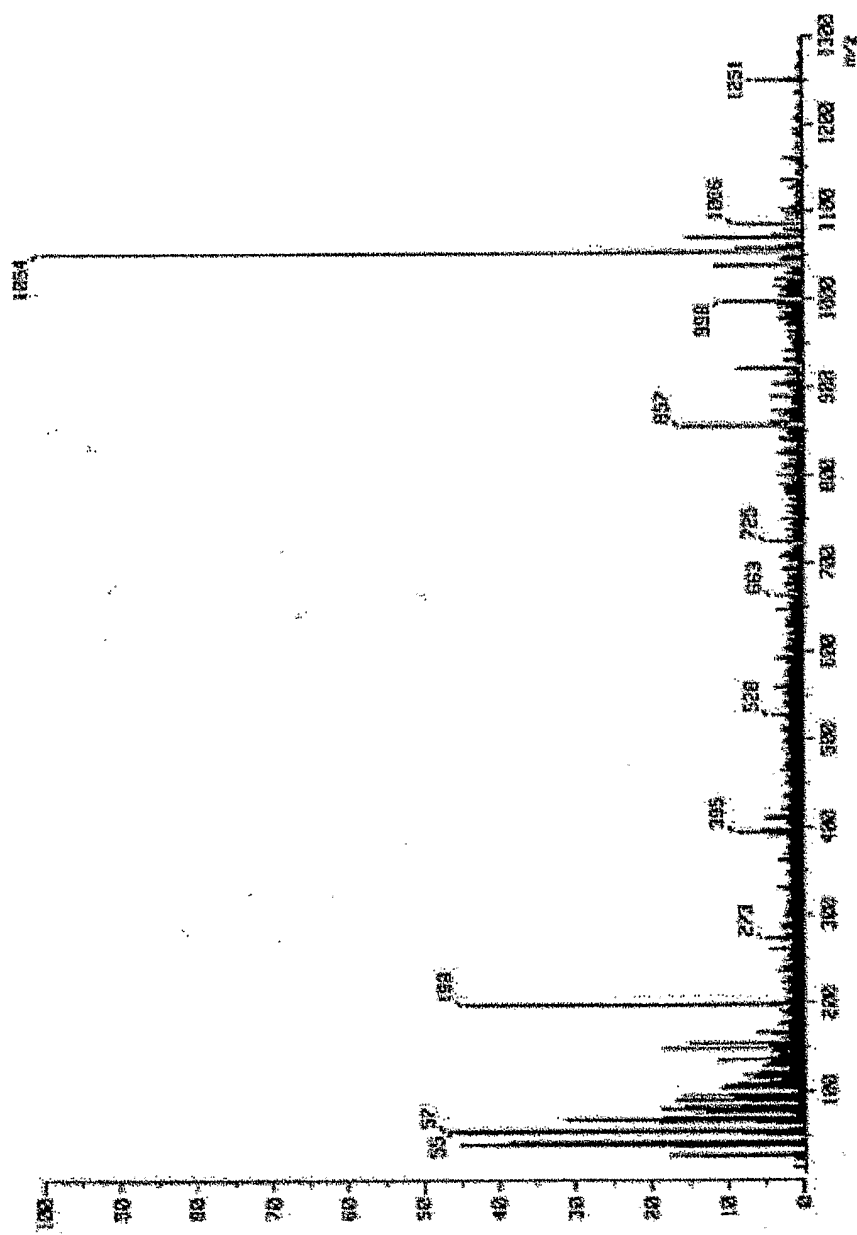


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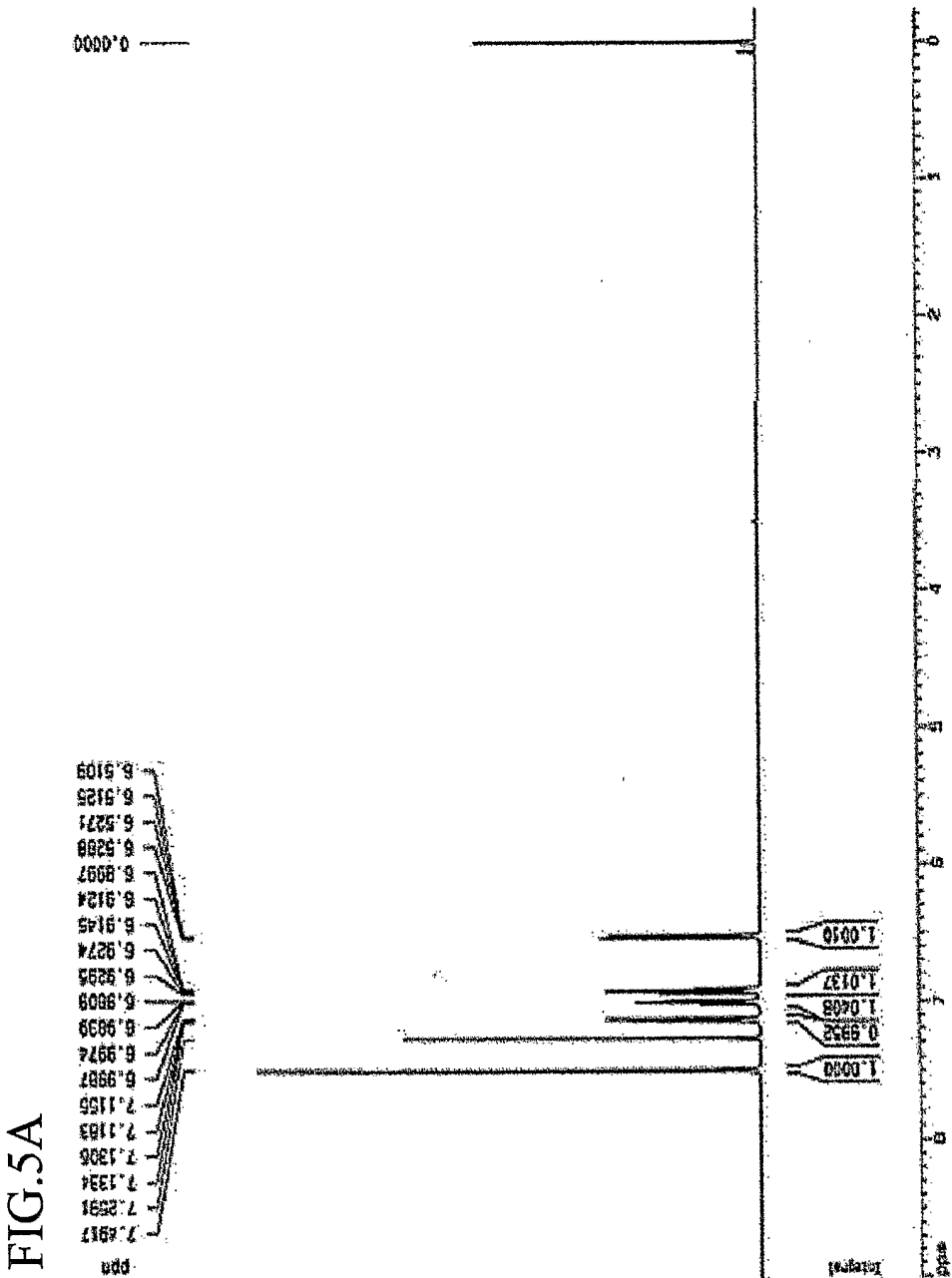


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FIG. 4B

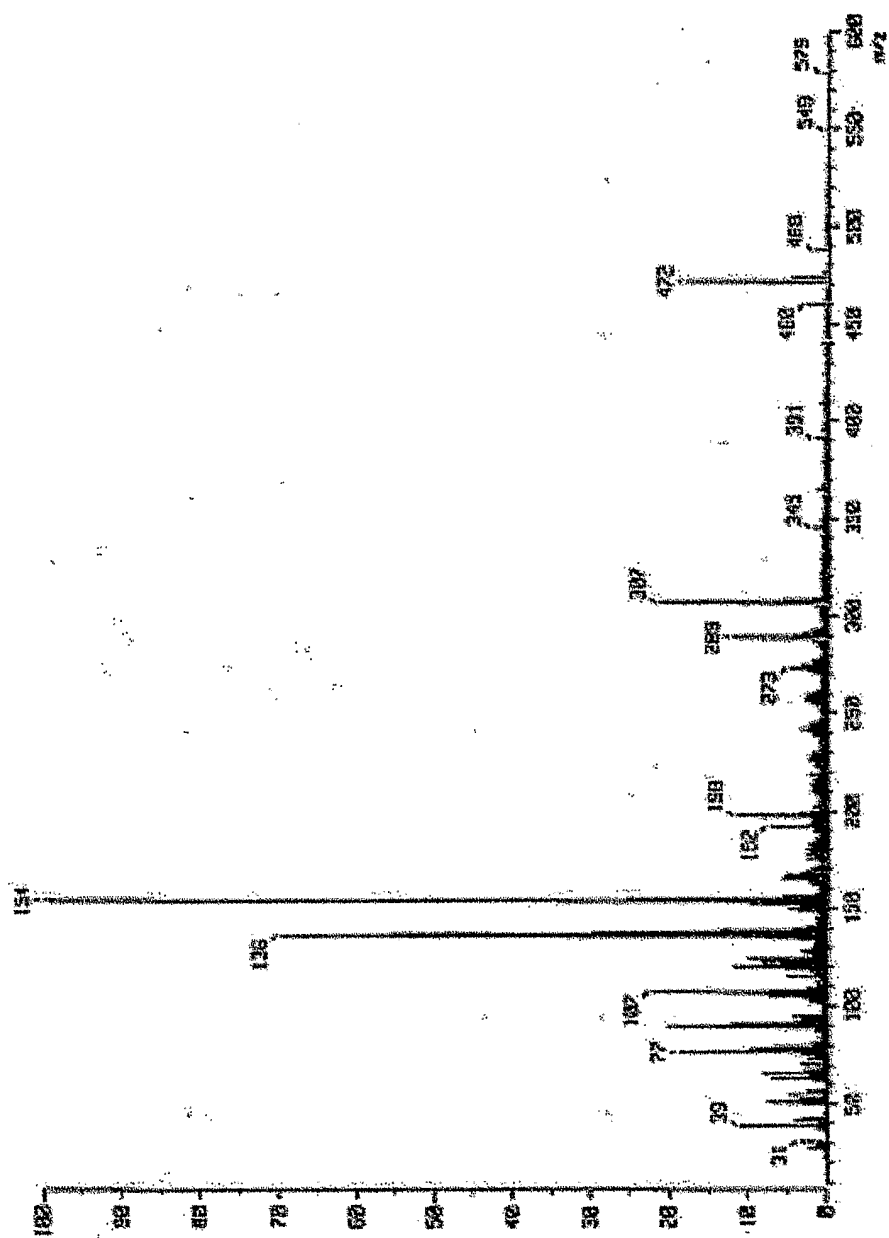


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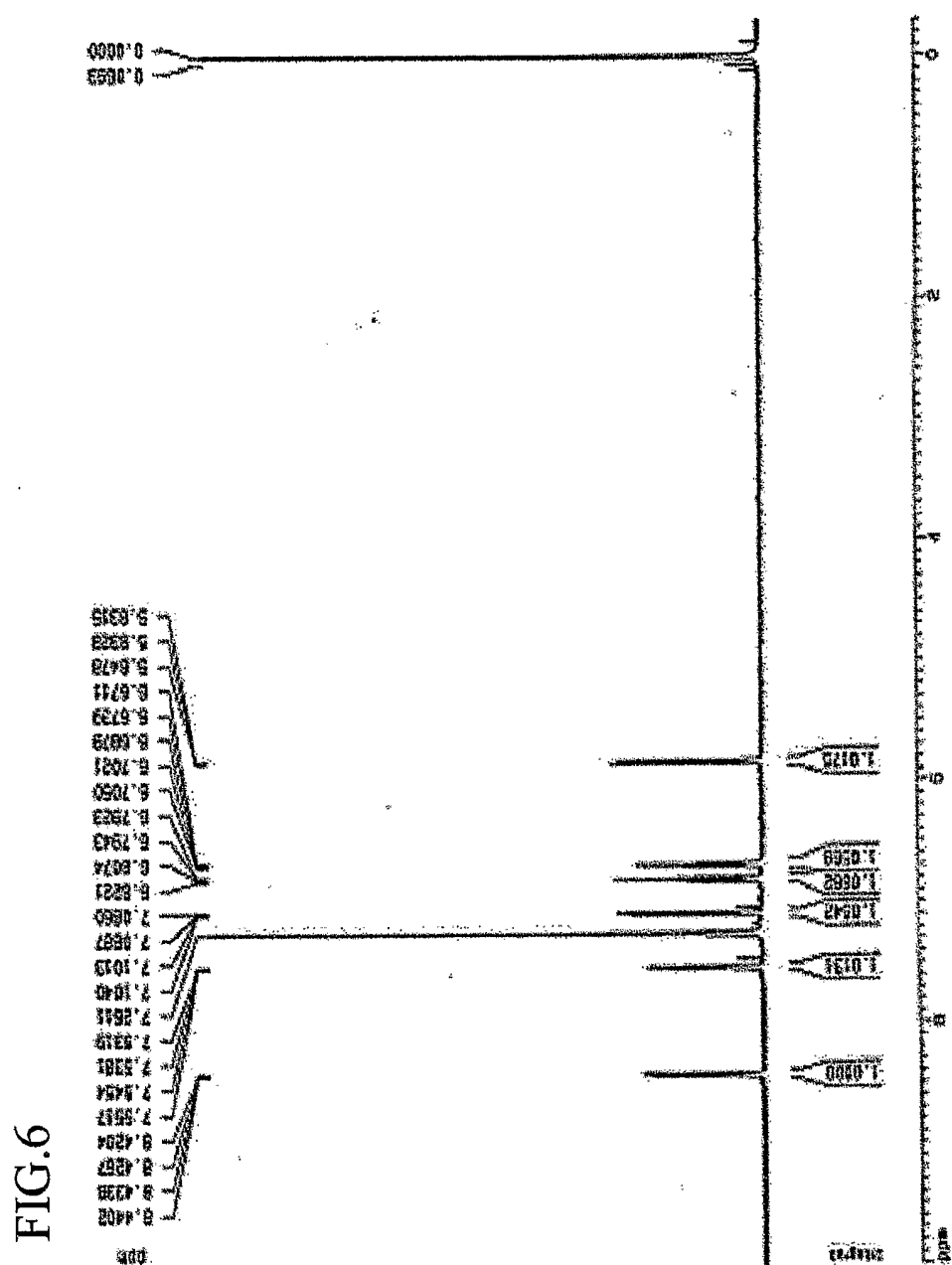


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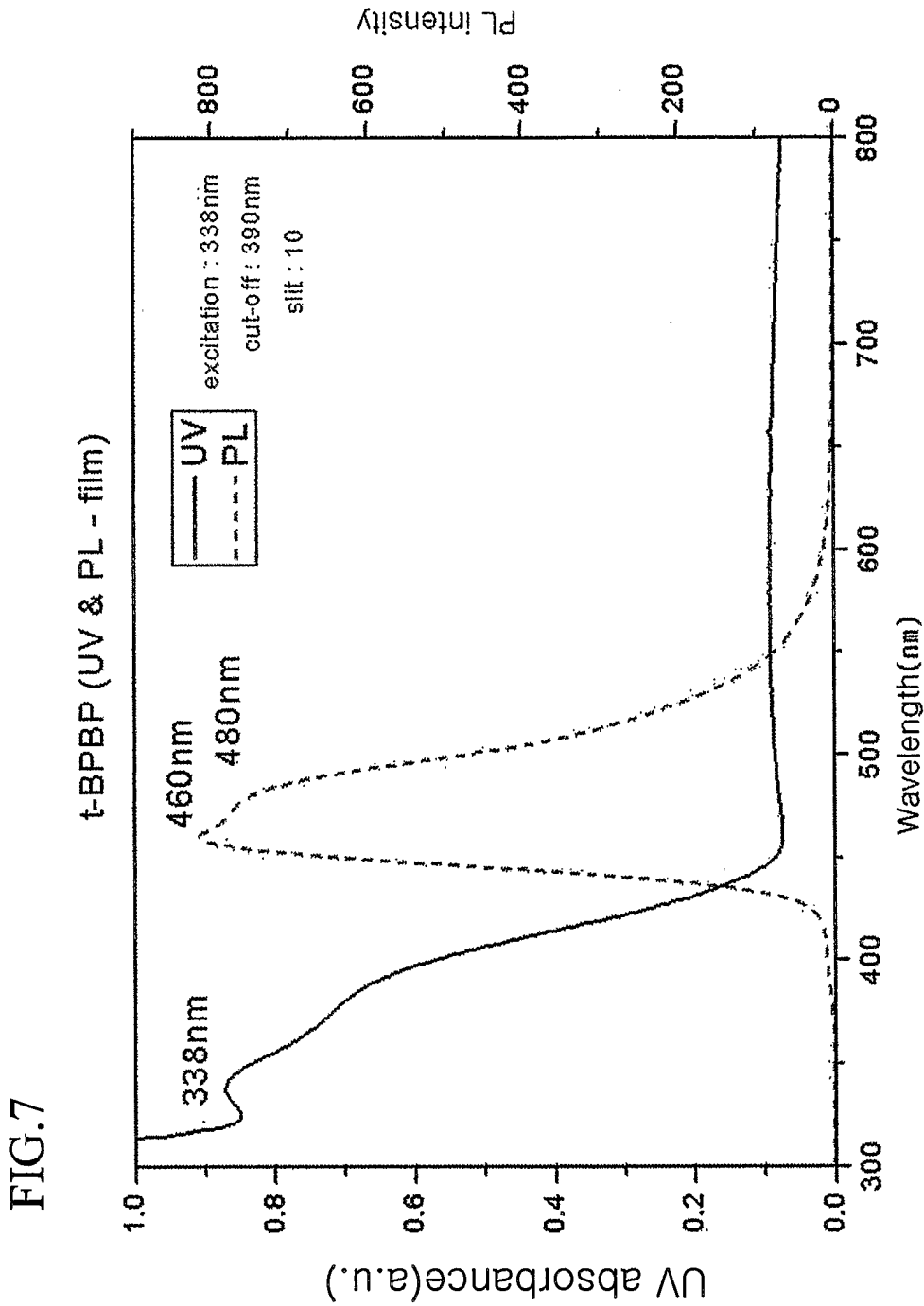
FIG.5B



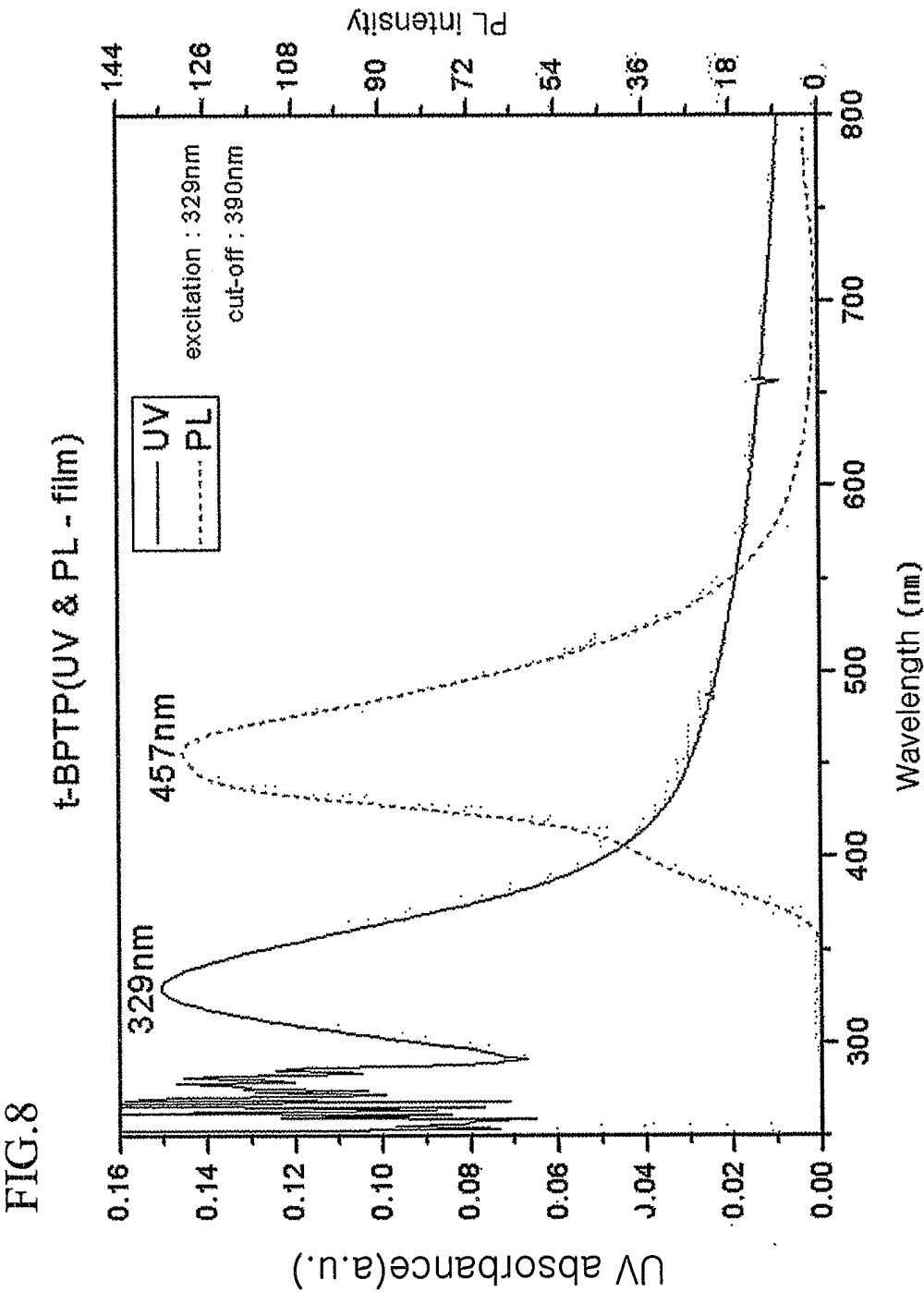
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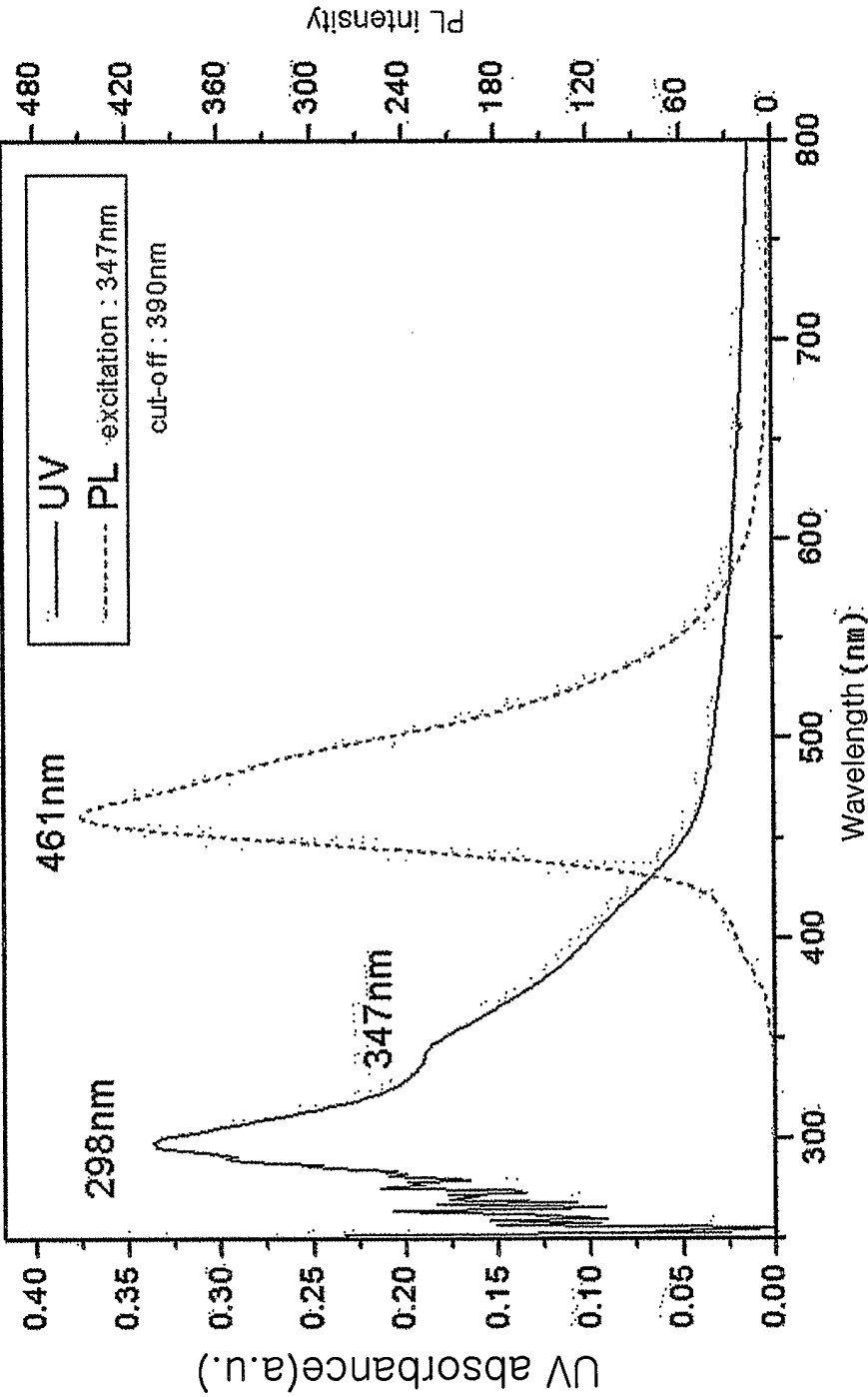
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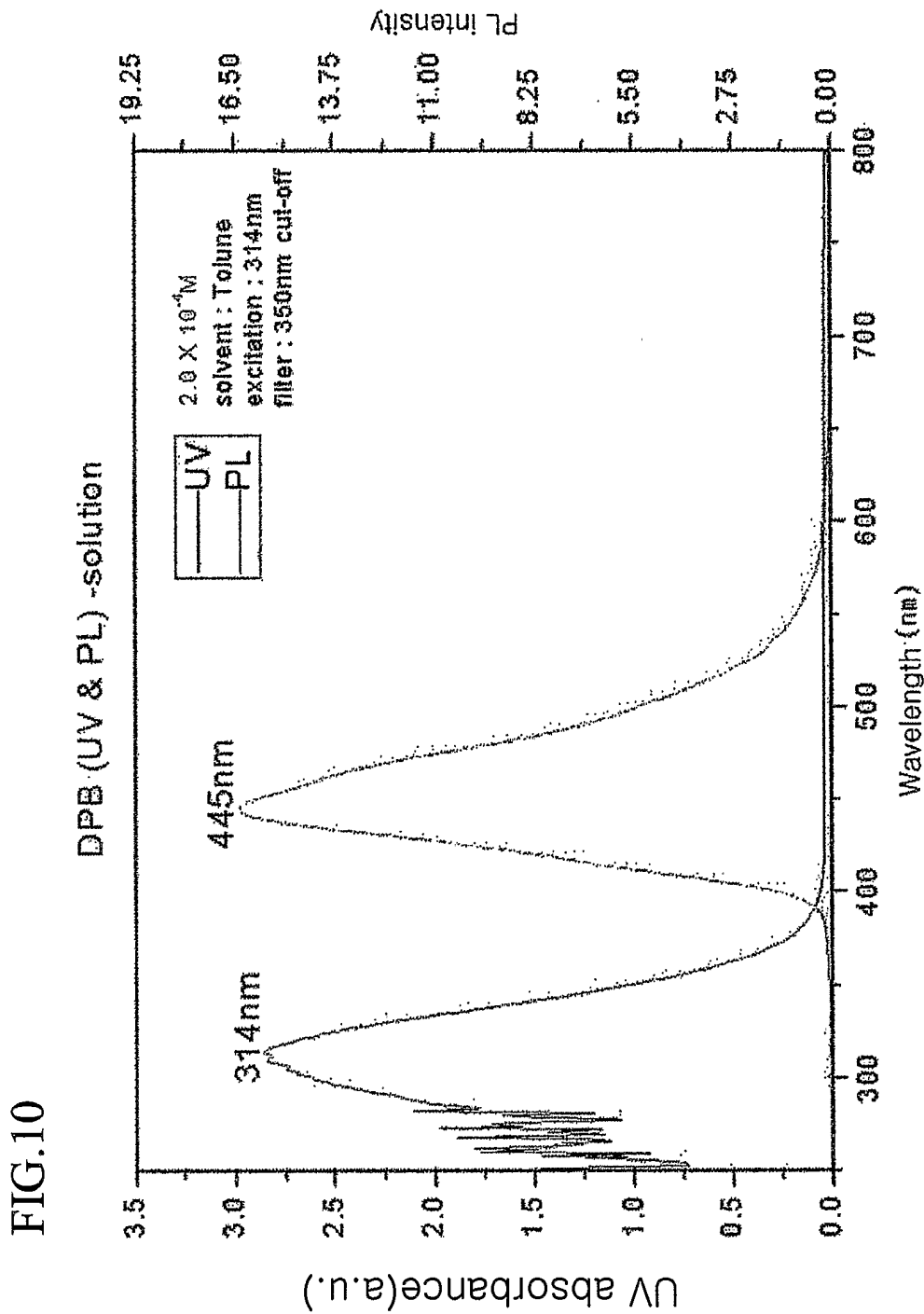
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FIG.9

DP-t-BPBP(UV & PL) -film

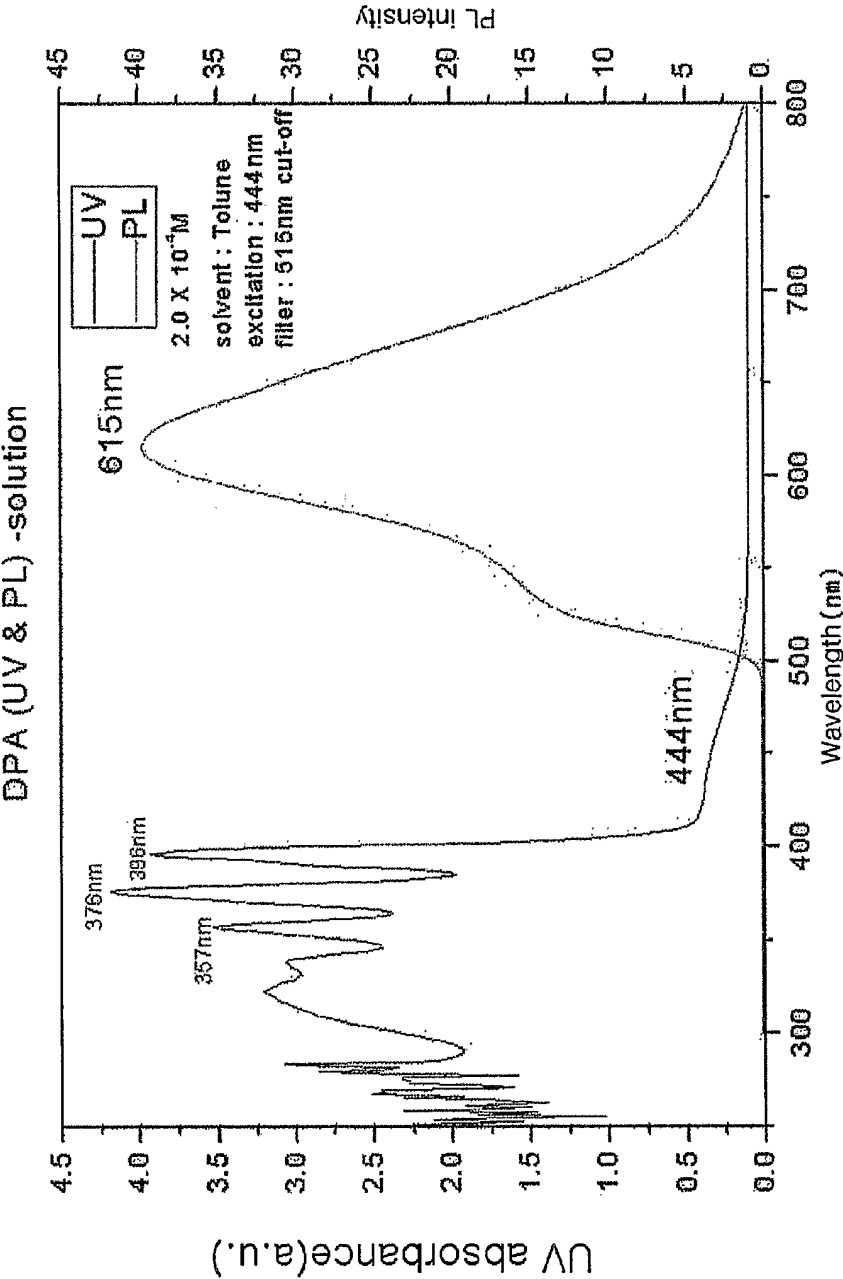


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FIG.11



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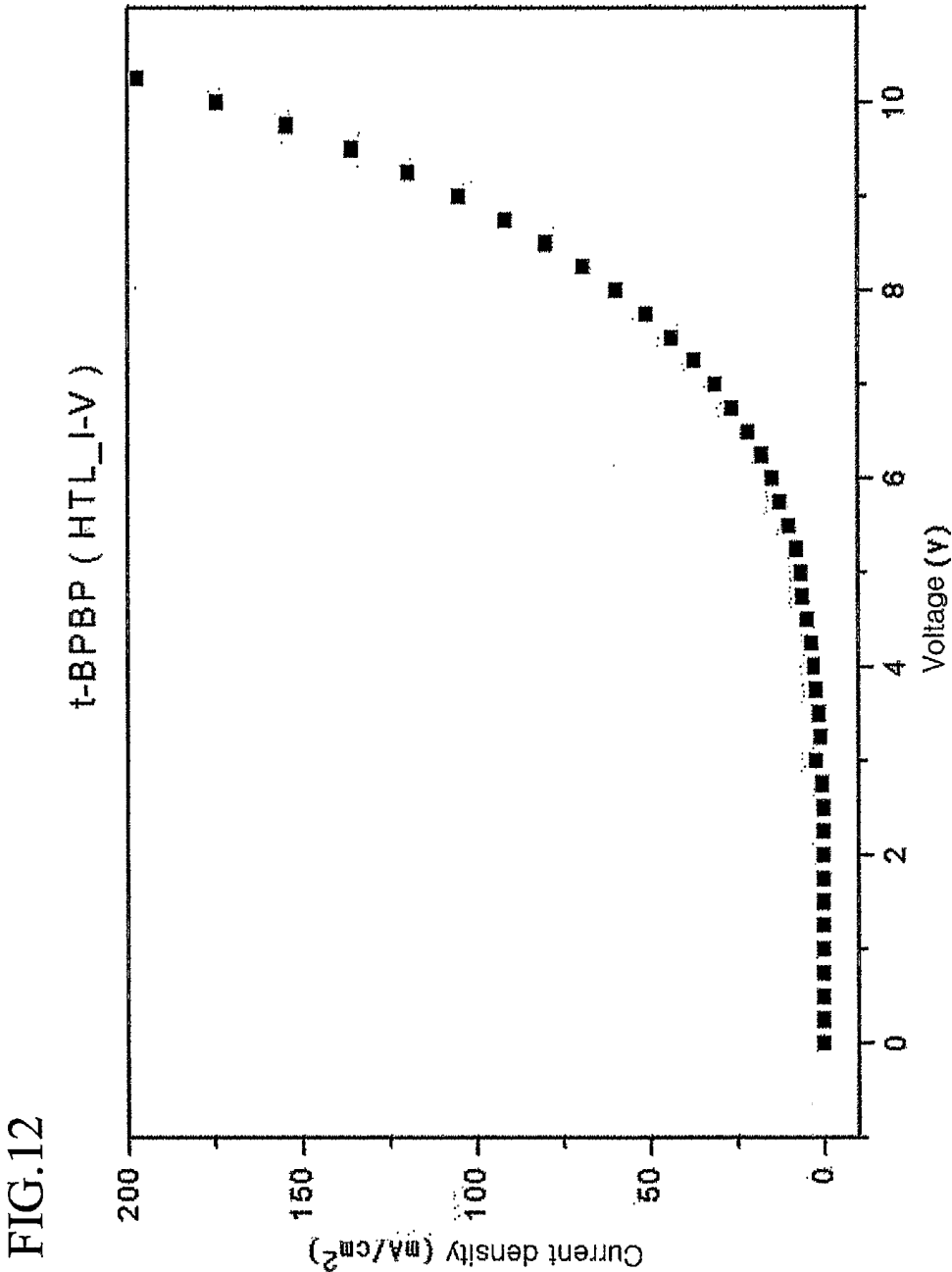
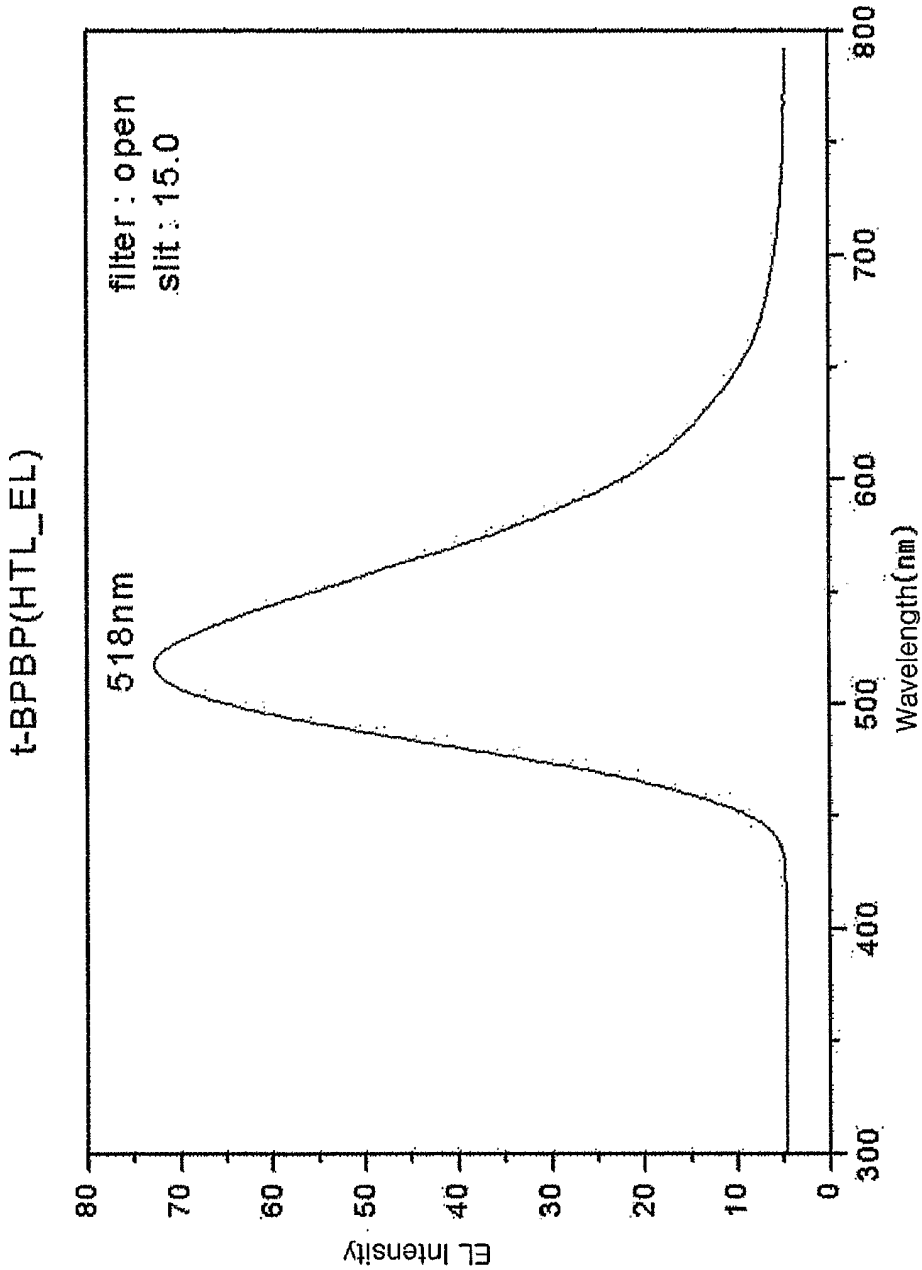
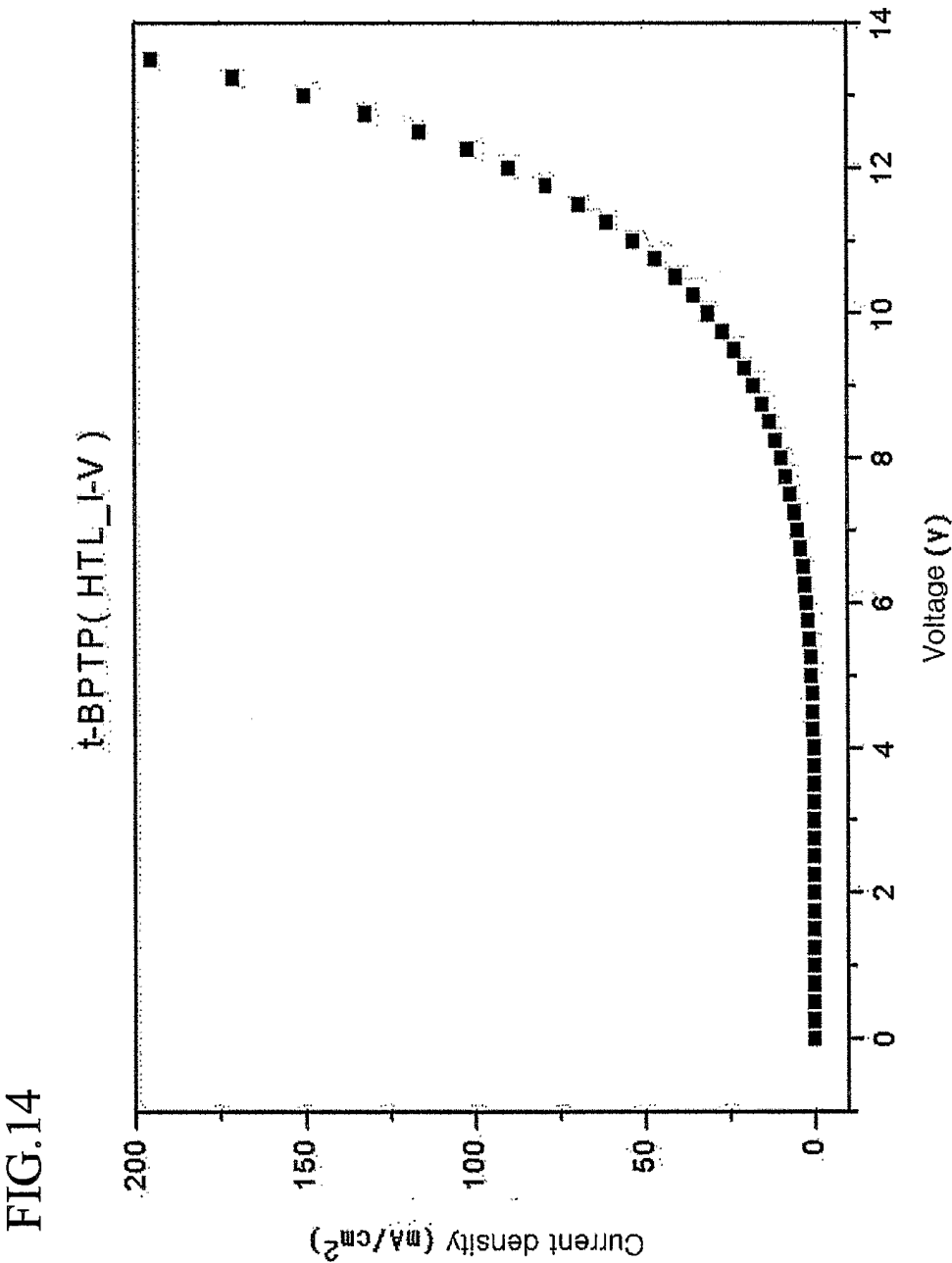


FIG.13



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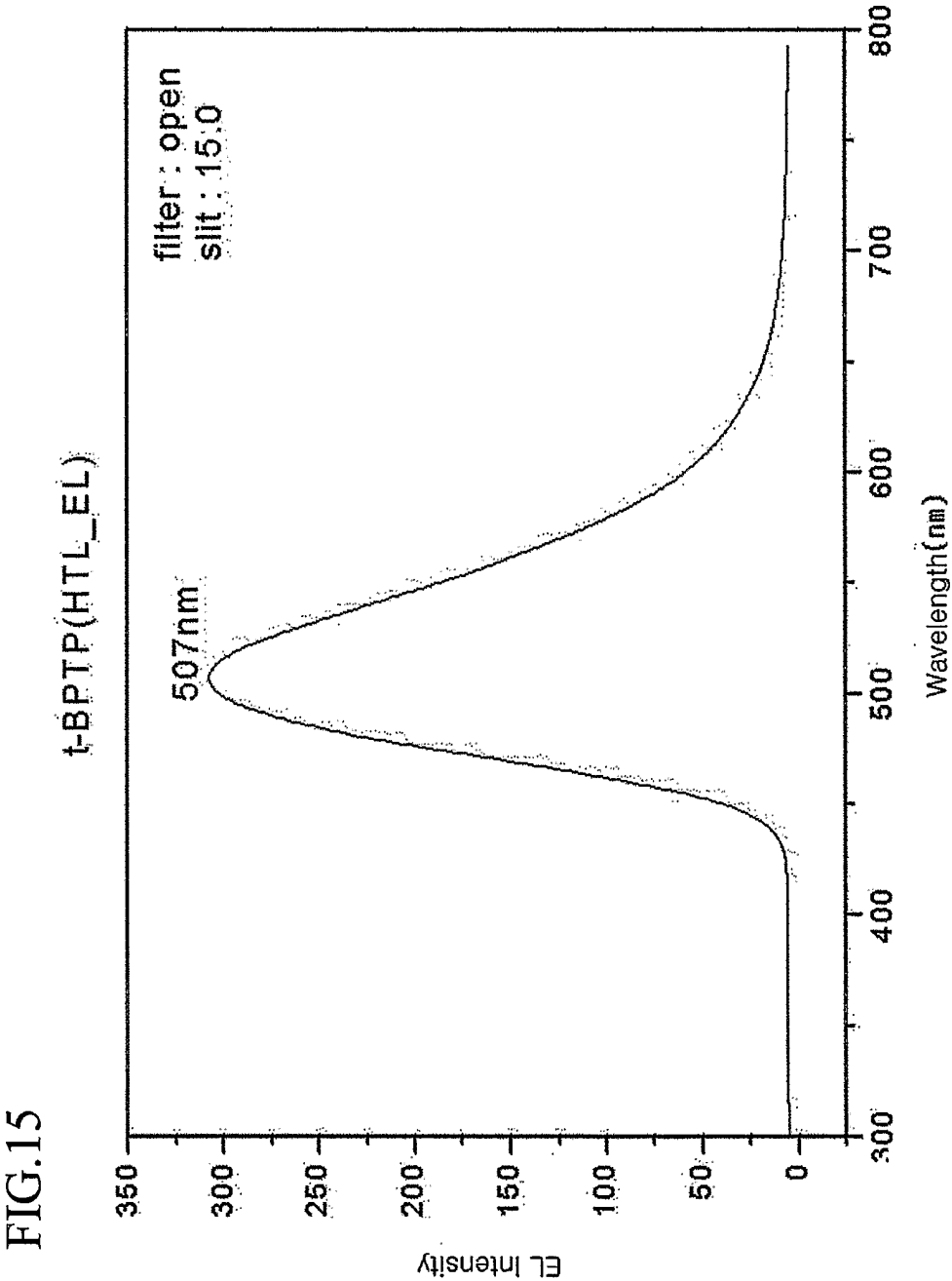


FIG.16

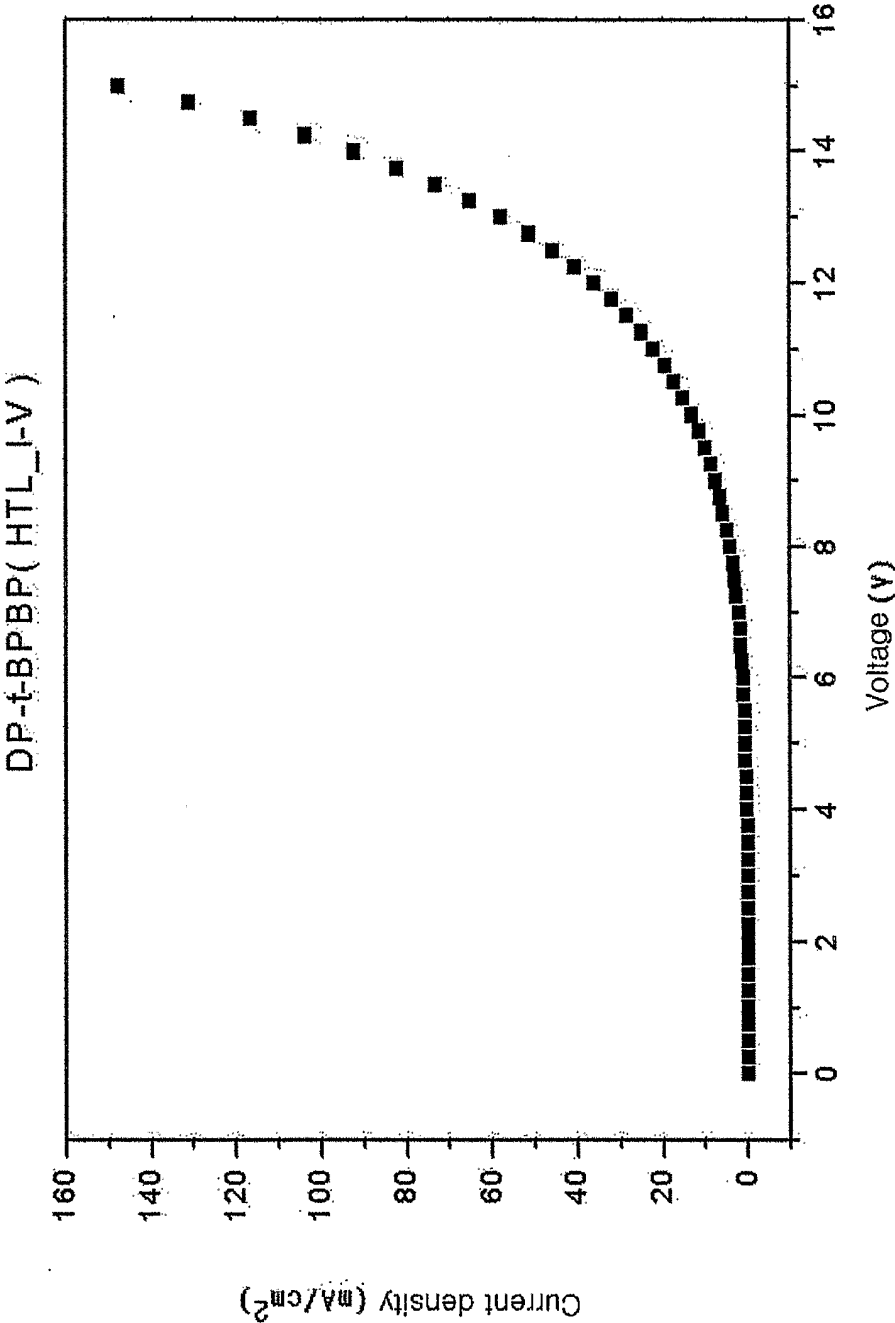
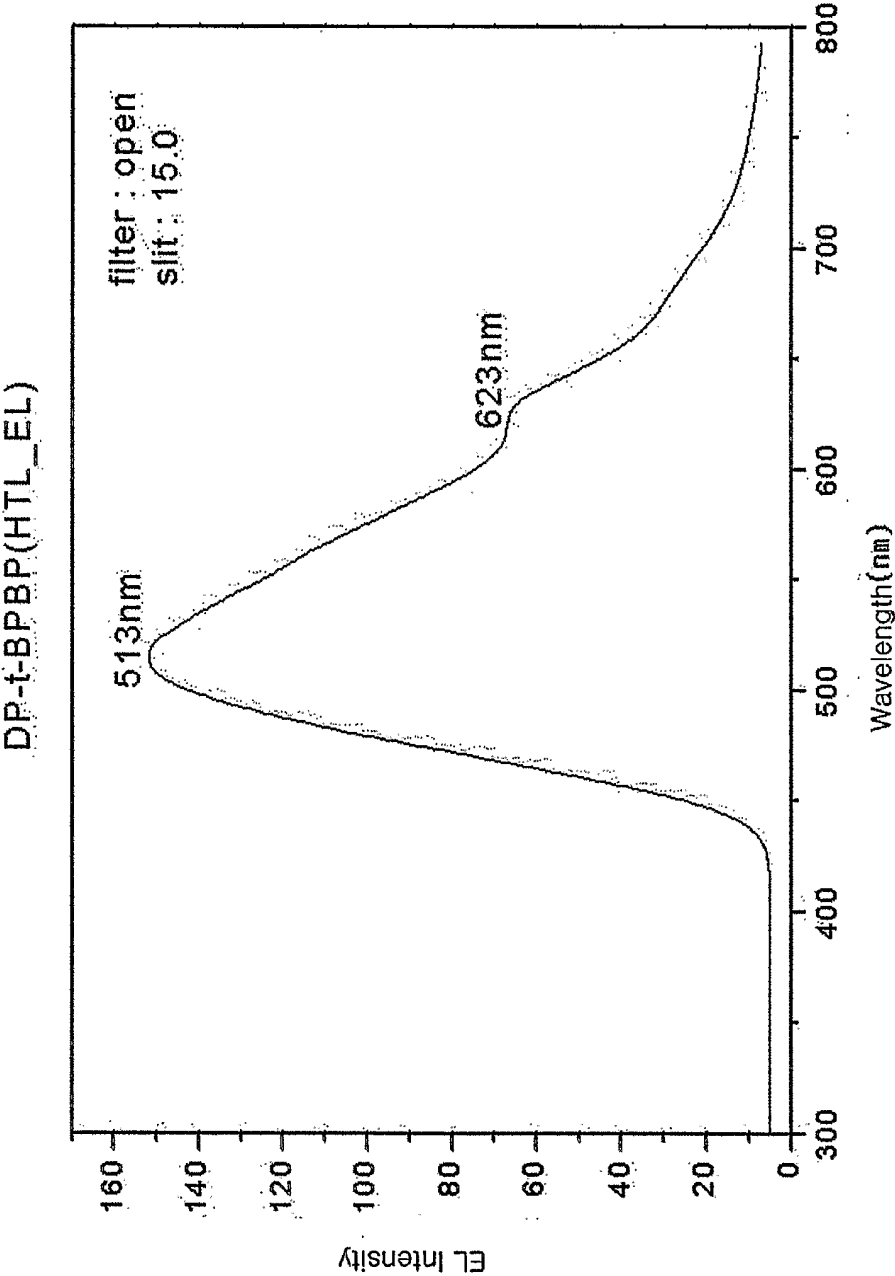


FIG.17



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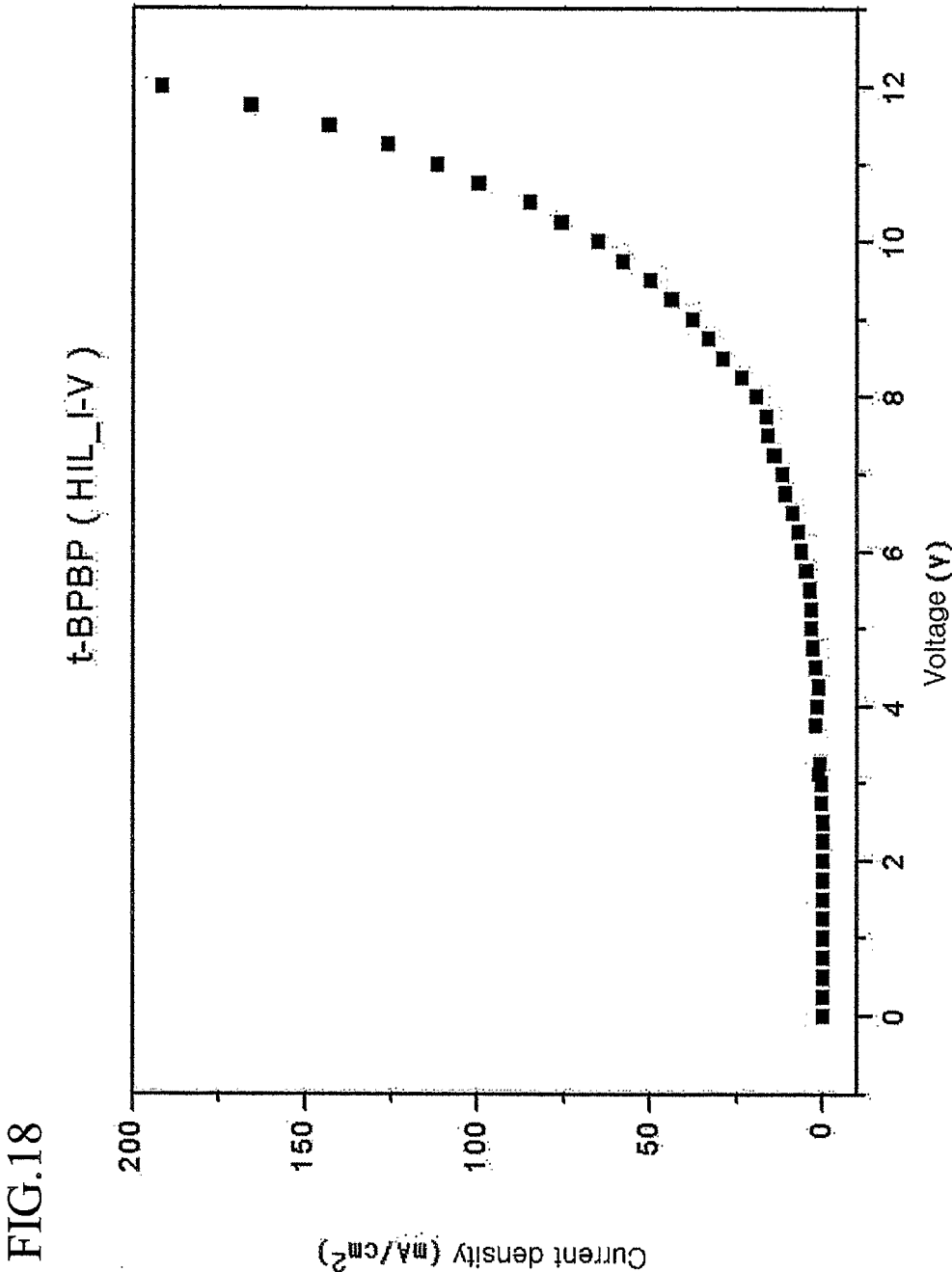
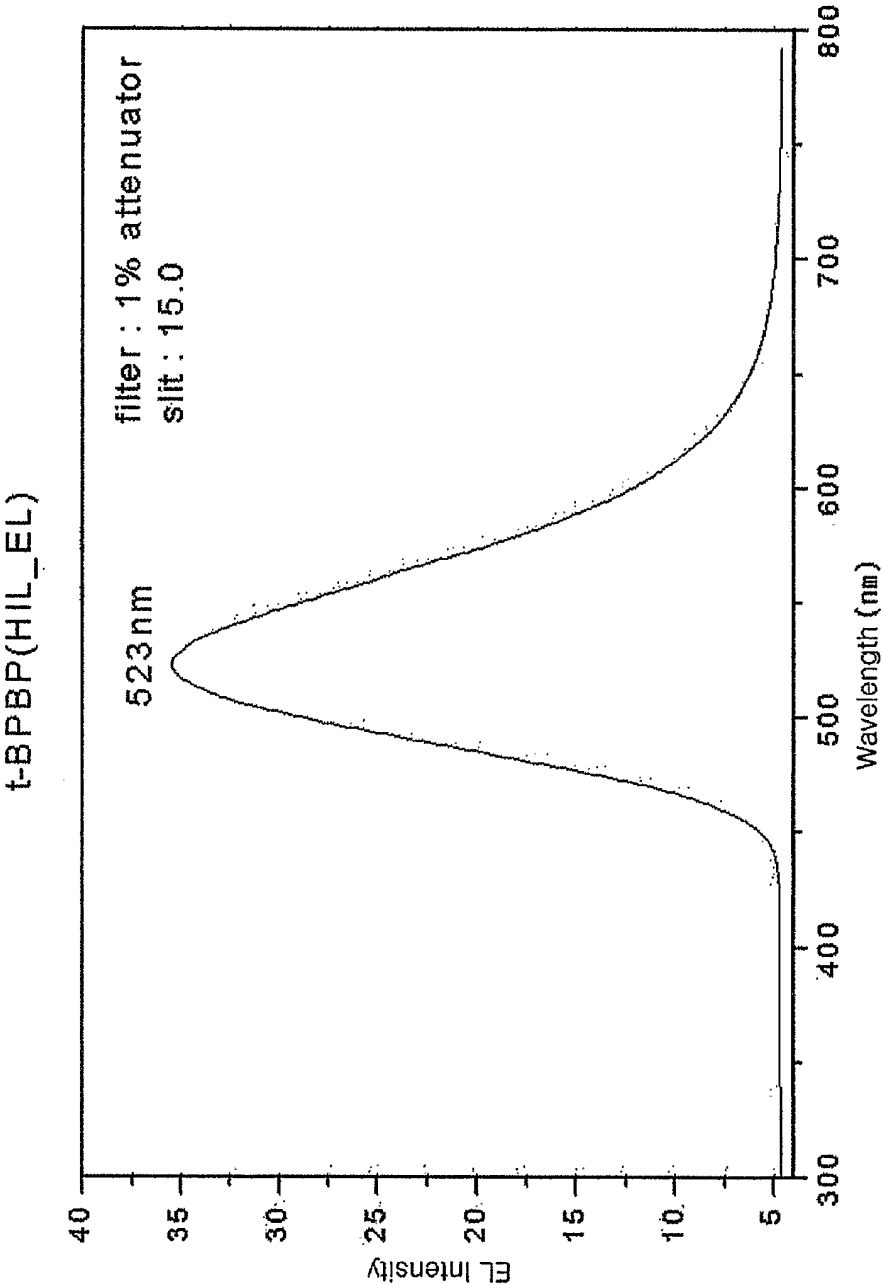
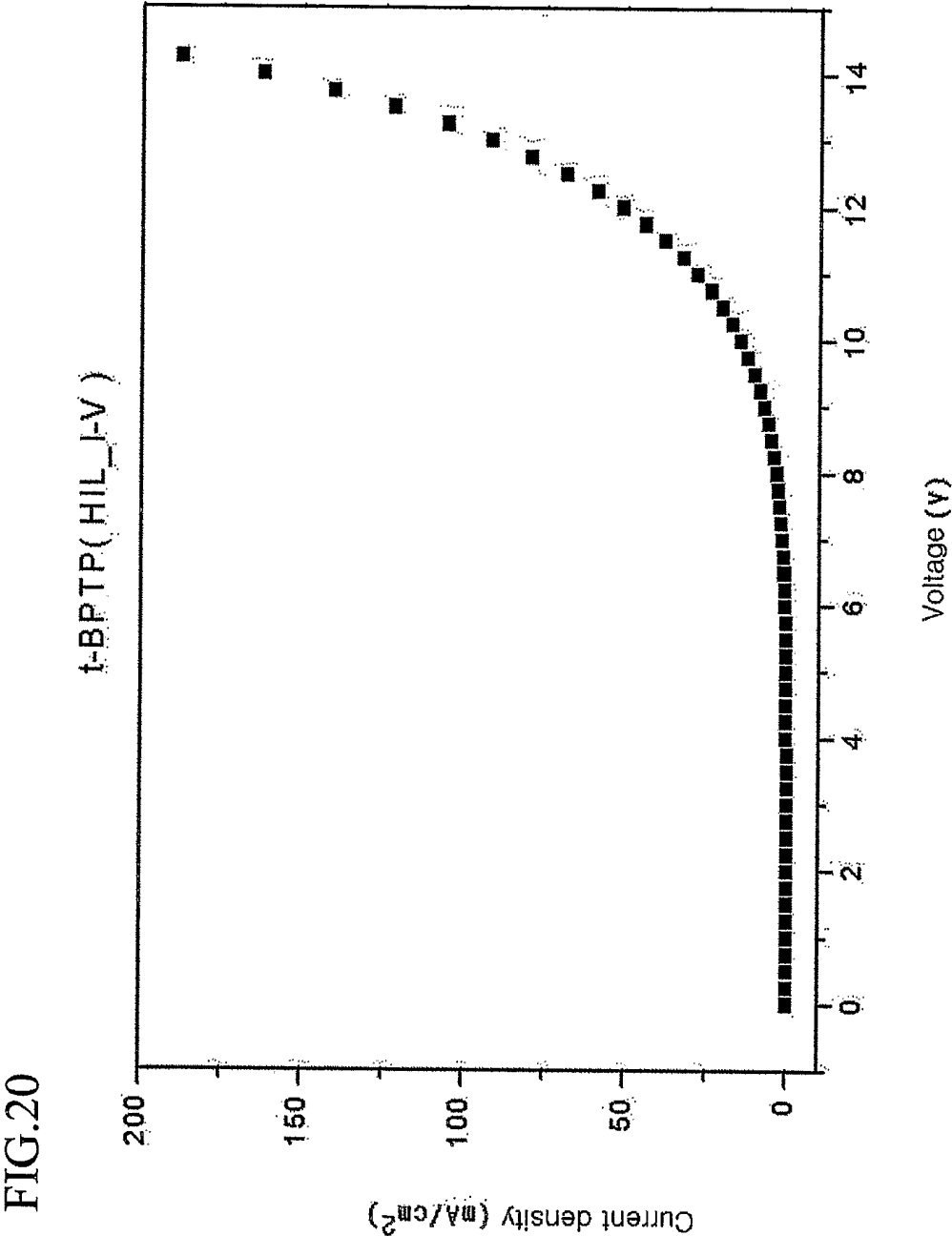
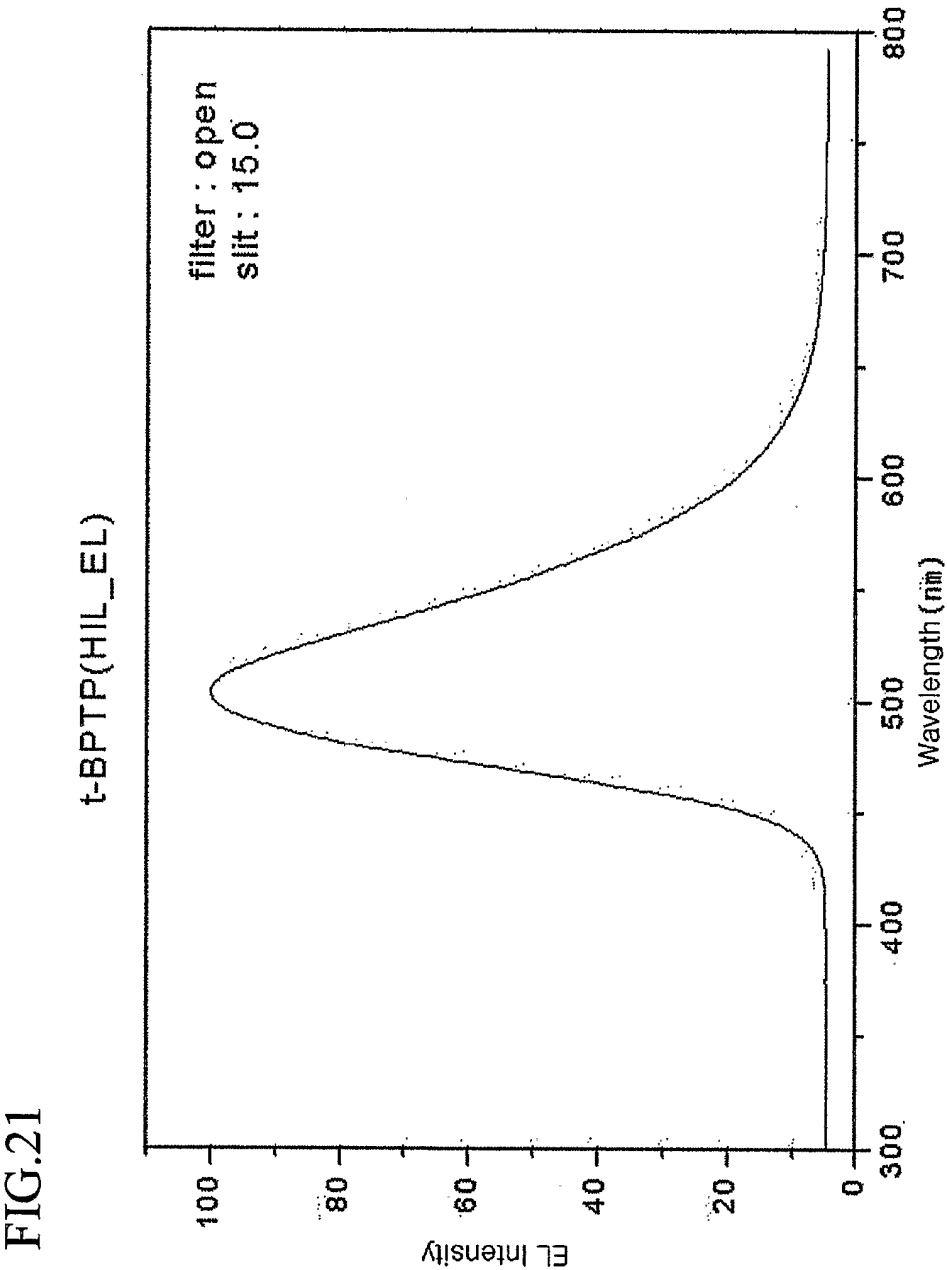


FIG.19







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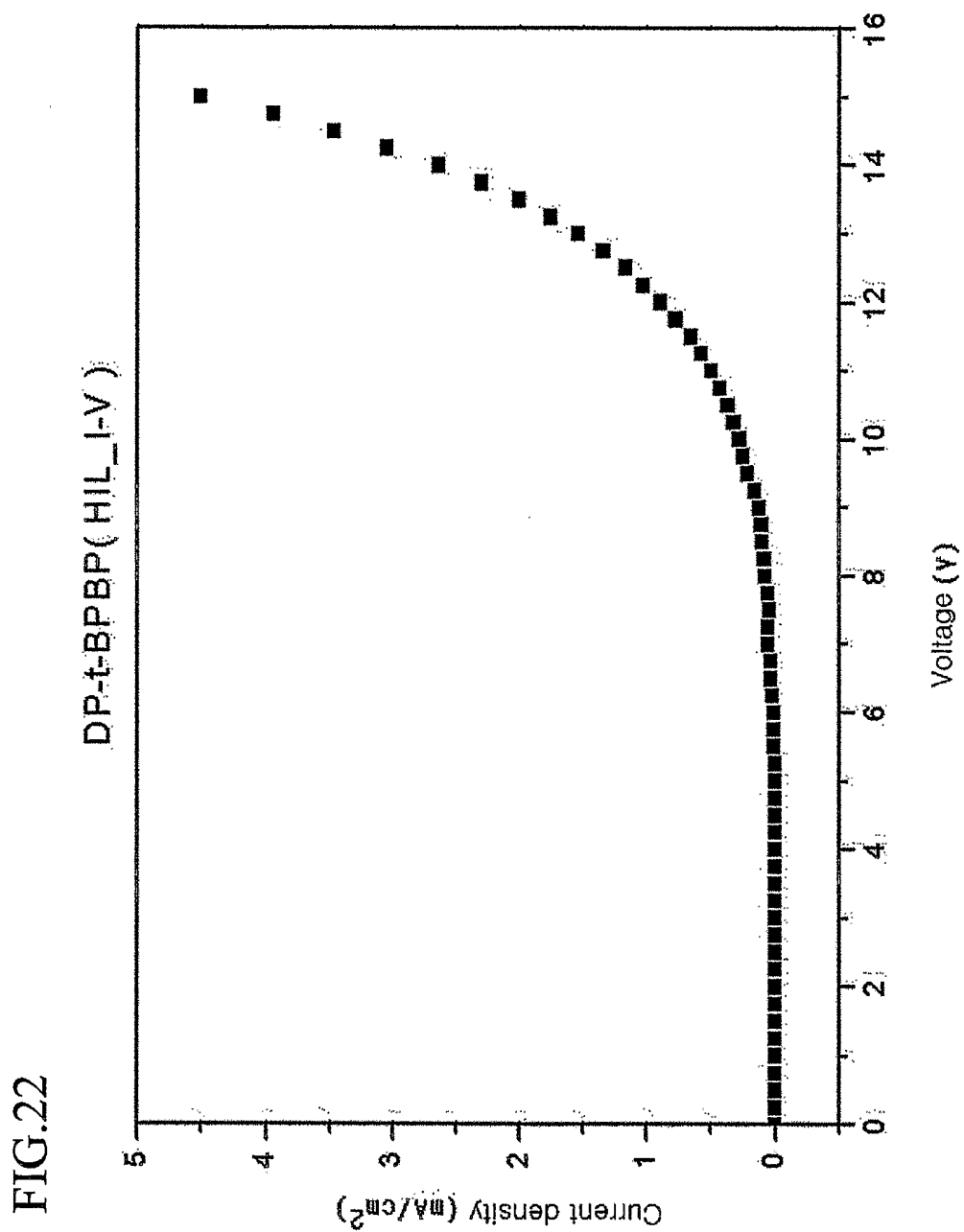
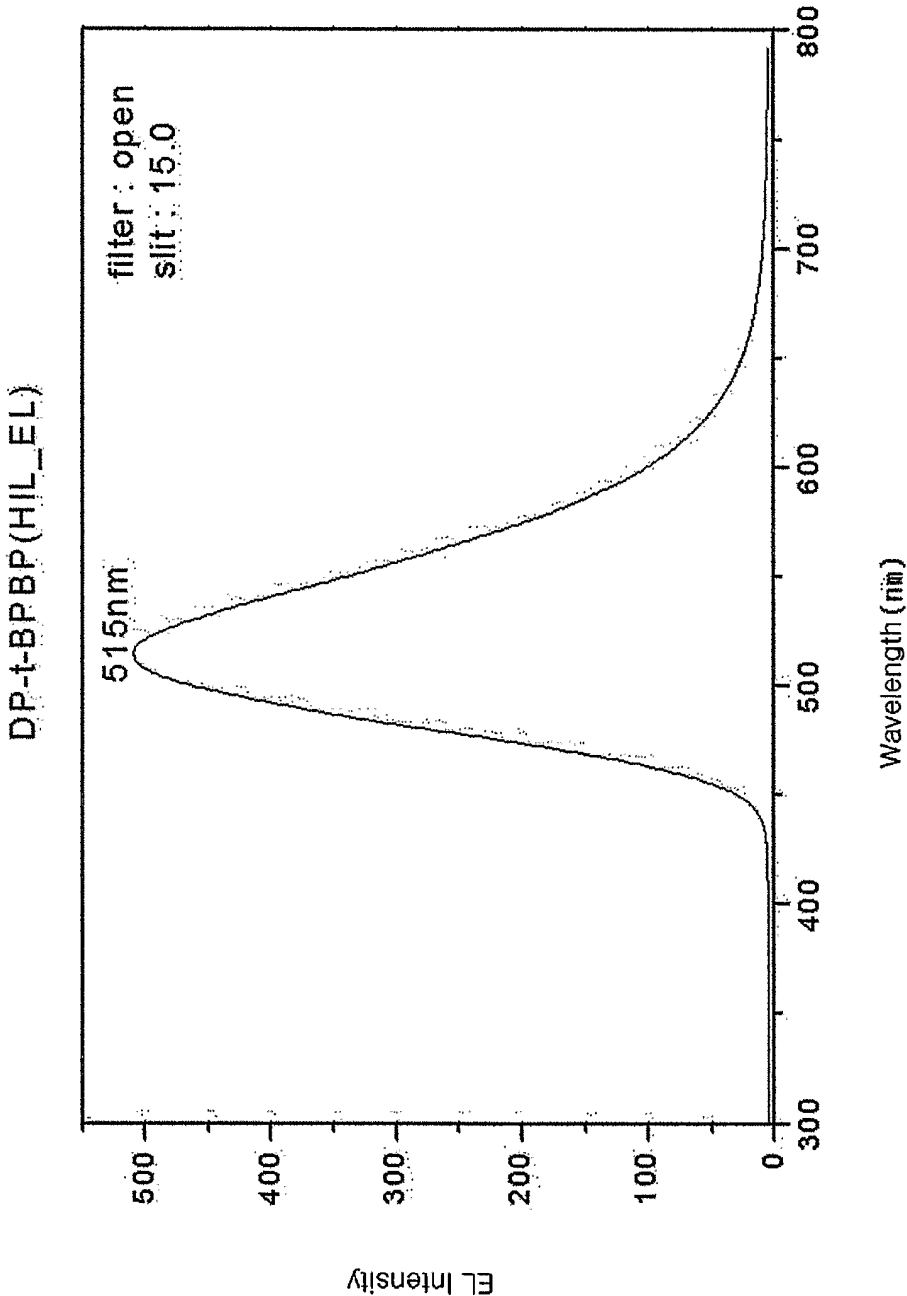


FIG.23



INTERNATIONAL SEARCH REPORT

 International application No.
PCT/KR2005/003424
A. CLASSIFICATION OF SUBJECT MATTER**C09K 11/06(2006.01)i**

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC8 C09K, C07D, H05B

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

Korean Patents and applications for inventions since 1975

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

STN, USPAT, PAJ, NPS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP2003-165829 A2 (Toppan Printing Co., Ltd.) 10 Jun. 2003 Abstract, Claim 1, Formula (I)	1-12
X	JP2000-21574 A2 (Cannon K. K.) 21 Jan. 2000 Abstract, Claims Formula (I)	1-12
X	Journal of the American Chemical Society (2003), 125(41), 12631-12639 Lai, Rebecca Y. et. al. "Synthesis, cyclic voltametric studies, and electrogenerated chemiluminescence of a new phenylauinoline-biphenothiazine donor-acceptor molecule"	5, 7
X	Tetrahedron Letters(2001), 42(49), 8619-8624 Kramer, C. S. et. al. "First synthesis and electronic properties of (hetero)aryl bridged and directly linked redox active phenothiazinyl dyades and triades"	5, 7
X	US 6,242,602 B1 (Gentex Corporation) 5 Jun. 2001 Abstract, Column 10-15, Examples, Compounds 12, 13, 14	5, 7
X	Organic Letters (2004), 6(20), 3493-3496 Okamoto, Toshihiro et. al. "Remarkable structure deformation in phenothiazine trimer radical cation"	6

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

☐ See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

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

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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

"&" document member of the same patent family

Date of the actual completion of the international search

27 JANUARY 2006 (27.01.2006)

Date of mailing of the international search report

27 JANUARY 2006 (27.01.2006)

Name and mailing address of the ISA/KR


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Republic of Korea

Facsimile No. 82-42-472-7140

Authorized officer

LEE, Tae Young

Telephone No. 82-42-481-5575



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2005/003424

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 60-237453 A2 (Toyo Ink Mfg.Co., Ltd.) 26 Nov. 1985 Claim 1, page3 Formula 3 and 4	8
A	JP 04-319959 A2 (Mitsubishi Paper Mills, Ltd.) 10 Nov. 1992 Abstract, Claim 1, Formula (1)	8
X	JP 2004-75750 A2 (Dainippon Printing Co., Ltd.) 11 Mar. 2004 Abstract, Claim 1, Formula (1)	8
A	Molecular Crystals and Liquid Crystals Science and Technology, Section A: Molecular Crystals and Liquid Crystals (1997), 306, 301-306 Okada, Keiji et. al. " Invalidity of simple application of spon-prediction topology rule to heteroaromatic π -conjugated systems ... "	9
A	Journal of the Chemical Society, Perkin Transaction 2: Physical Organic Chemistry (1997), (6), 1059-1060 Okada, Keiji et. al. "10, 10', 10''-(Benzene-1,3,5-triyl)triphenothiazine trication"	9