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Road, London N16 7SB (GB). **SURENDRAKUMAR, Sivagnanasundram** [GB/GB]; 16 Nolton Place, Edgware, Middlesex HA8 6DL (GB).

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(74) Agent: **COHEN, Alan, Nicol**; 3 Grange Close, Westerham, Kent TN16 1AG (GB).

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(71) Applicant (for all designated States except US): **ELAM-T LIMITED** [GB/GB]; LBIC-2, 8 Kinetic Crescent, Innova Park, Enfield EN3 7XU (GB).

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(72) Inventors; and

(75) Inventors/Applicants (for US only): **KATHIRGAMANATHAN, Poopathy** [GB/GB]; The Little Lancaster House, 1 Lancaster Road, North Harrow HA2 7NN (GB). **PRICE, Richard** [GB/GB]; Garden Flat, 5 Raleigh Road, London N8 0JB (GB). **GANESHAMURUGAN, Subramaniam** [LK/GB]; 135 Antill Road, London N15 4BB (GB). **PARAMASWARA, Gnanamoly** [LK/GB]; 19 South way, Totteridge, London N20 8EB (GB). **KUMARAVERL, Muttulingham** [GB/GB]; 9 Fraser Road, Greenford, Middlesex UB6 7AH (GB). **PARTHEEPAN, Arumugam** [GB/GB]; 26 Eldertree Way, Mitcham, Surrey CR4 1AG (GB). **SELVARANJAN, Selvadurai** [GB/GB]; 285A Malden Road, Sutton, Surrey SM3 8ET (GB). **ANTIPÁN-LARA, Juan** [CL/GB]; 29 Jenner

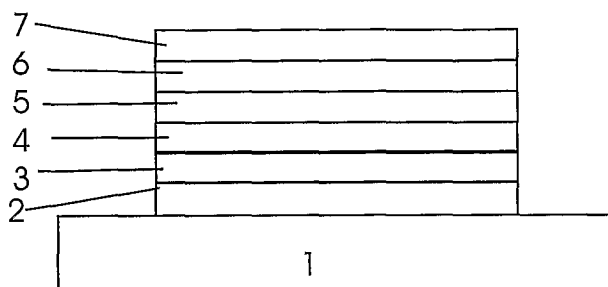
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**WO 2005/080526 A2**

(54) Title: ELECTROLUMINESCENT MATERIALS AND DEVICES



(57) Abstract: Novel iridium complexes are electroluminescent.

## Electroluminescent Materials and Devices

The present invention relates to electroluminescent materials and to electroluminescent devices.

5

Materials which emit light when an electric current is passed through them are well known and used in a wide range of display applications. Liquid crystal devices and devices which are based on inorganic semiconductor systems are widely used; however these suffer from the disadvantages of high energy consumption, high cost  
10 of manufacture, low quantum efficiency and the inability to make flat panel displays.

Organic polymers have been proposed as useful in electroluminescent devices, but it is not possible to obtain pure colours; they are expensive to make and have a relatively low efficiency.

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Another compound which has been proposed is aluminium quinolate, but this requires dopants to be used to obtain a range of colours and has a relatively low efficiency.

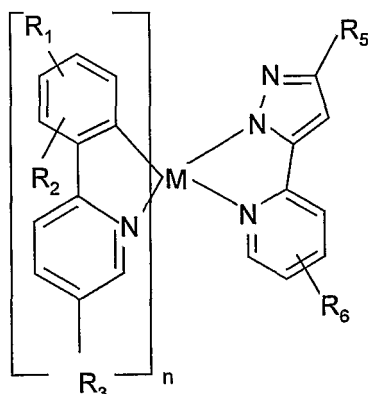
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Patent application WO98/58037 describes a range of transition metal and lanthanide complexes which can be used in electroluminescent devices which have improved properties and give better results. Patent Applications PCT/GB98/01773, PCT/GB99/03619, PCT/GB99/04030, PCT/GB99/04024, PCT/GB99/04028, PCT/GB00/00268 describe electroluminescent complexes, structures and devices  
25 using rare earth chelates.

US Patent 5128587 discloses an electroluminescent device which consists of an organometallic complex of rare earth elements of the lanthanide series sandwiched between a transparent electrode of high work function and a second electrode of low



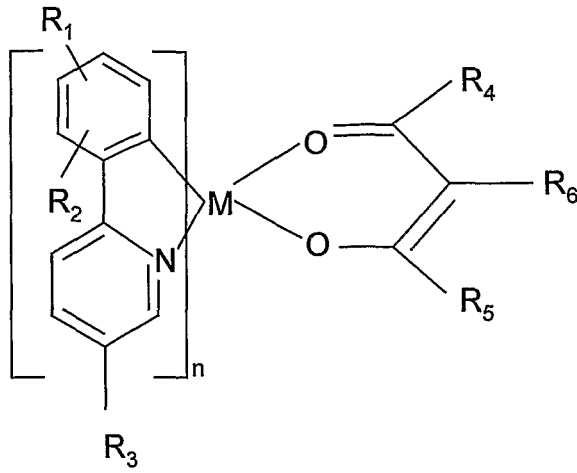
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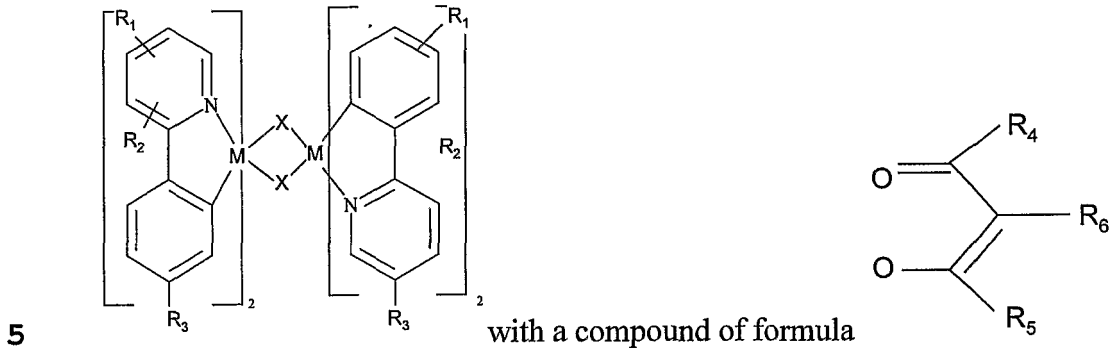
(III)

where  $R_1$ ,  $R_2$ ,  $R_3$ ,  $R_4$ ,  $R_5$  and  $R_6$  can be the same or different and are selected from hydrogen, and substituted and unsubstituted hydrocarbyl groups such as substituted and unsubstituted aliphatic groups, substituted and unsubstituted aromatic, heterocyclic and polycyclic ring structures, fluorocarbons such as trifluoromethyl groups, halogens such as fluorine or thiophenyl groups;  $R_1$ ,  $R_2$  and  $R_3$  can also form substituted and unsubstituted fused aromatic, heterocyclic and polycyclic ring structures and can be copolymerisable with a monomer, e.g. styrene, and where  $R_4$ ,  $R_5$  and  $R_6$  can be the same or different and are selected from hydrogen, and substituted and unsubstituted hydrocarbyl groups such as substituted and unsubstituted aliphatic groups, substituted and unsubstituted aromatic, heterocyclic and polycyclic ring structures, fluorocarbons such as trifluoromethyl groups, halogens such as fluorine or thiophenyl groups;  $R_1$ ,  $R_2$  and  $R_3$  can also form substituted and unsubstituted fused aromatic, heterocyclic and polycyclic ring structures and can be copolymerisable with a monomer, e.g. styrene. M is ruthenium, rhodium, palladium, osmium, iridium or platinum and  $n+2$  is the valency of M; preferably M is iridium and n is 2.

The invention also provides a method of making an electroluminescent compound of formula



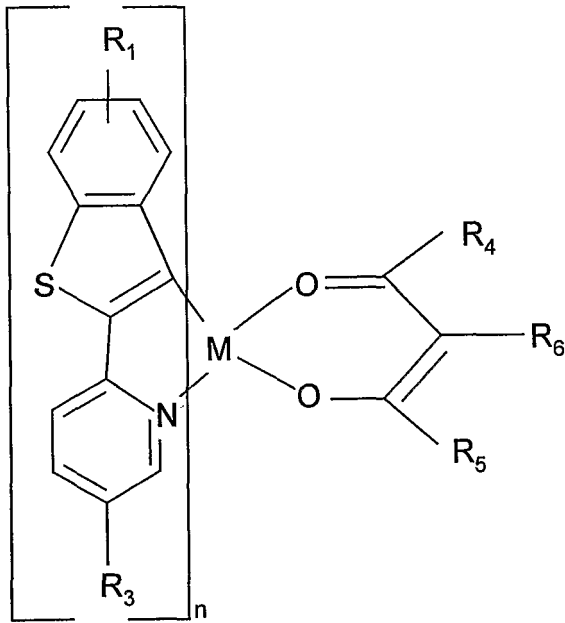
which comprises reacting a compound of formula



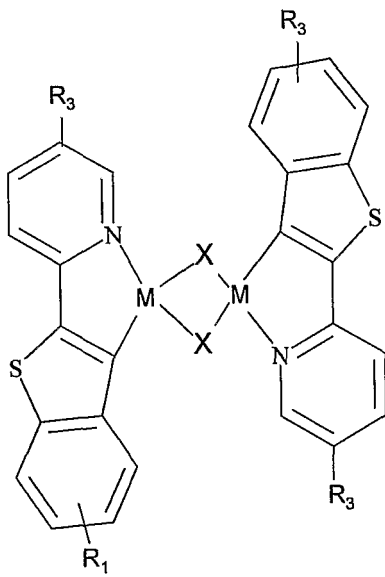
where  $R_1, R_2, R_3, R_4, R_5$  and  $R_6$  are as above,  $X$  is an anion and  $n+2$  is the valency of  $M$ .

10

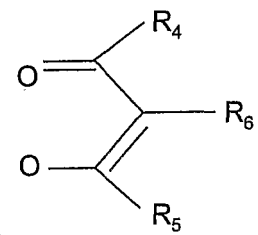
The invention also provides a method of preparing a compound of formula



which comprises reacting a compound of formula

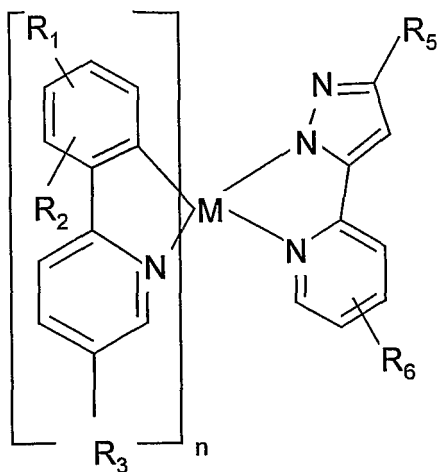


with a compound of formula

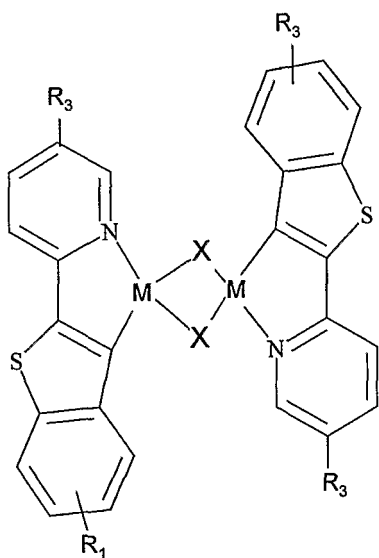


- 5 where  $R_1$ ,  $R_2$ ,  $R_3$ ,  $R_4$ ,  $R_5$  and  $R_6$  are as above, X is an anion and  $n+2$  is the valency of M.

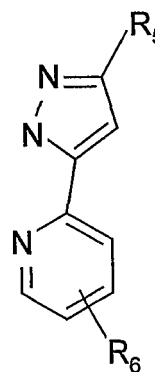
The invention also provides a method of forming a compound of formula



which comprises reacting a compound of formula



with a compound of formula



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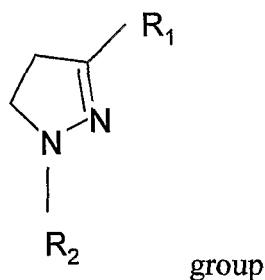
where R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, R<sub>4</sub>, R<sub>5</sub> and R<sub>6</sub> are as above, X is an anion and n+2 is the valency of M.

Some of the dimetal complexes used to form the compounds of the present invention  
 10 are known compounds; for example Tetrakis(2-phenylpyridine-C<sup>2</sup>, N<sup>1</sup>)(μ-chloro)  
 diiridium (Watts et al., J. Am. Chem. Soc., 1985, **107**, 1431.)

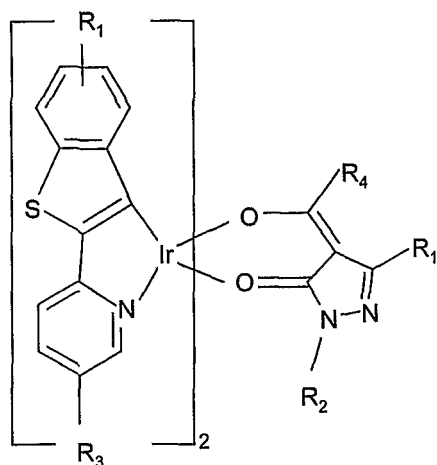
Examples of R<sub>1</sub> and/or R<sub>2</sub> and/or R<sub>3</sub> and/or R<sub>4</sub> and/or R<sub>5</sub> and/or R<sub>6</sub> include aliphatic, aromatic and heterocyclic alkoxy, aryloxy and carboxy groups, substituted and substituted phenyl, fluorophenyl, biphenyl, phenanthrene, anthracene, naphthyl and fluorene groups alkyl groups such as t-butyl, heterocyclic groups such as carbazole.

5

Preferred compounds (I) are those in which R<sub>5</sub> and R<sub>6</sub> form a

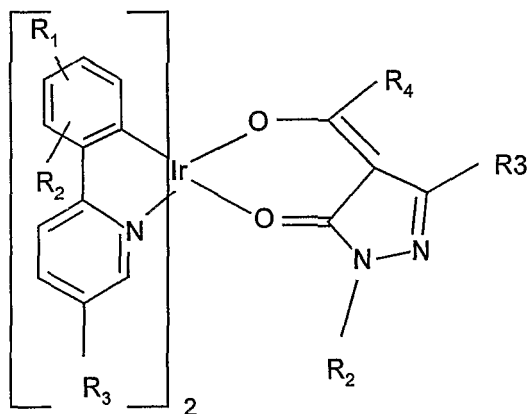


e.g.



(IV)

and



(V)

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preferably R<sub>2</sub> is a phenyl or substituted phenyl group.

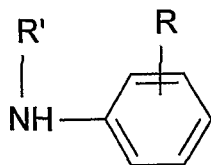
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The invention also provides an electroluminescent device which comprises (i) a first electrode (ii) a layer of an electroluminescent material of formula (I) or (II) above and (iii) a second electrode.

The first electrode can function as the anode and the second electrode can function as the cathode and preferably there is a layer of a hole transporting material between the anode and the layer of the electroluminescent compound.

- 5 The hole transporting material can be any of the hole transporting materials used in electroluminescent devices.

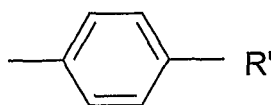
The hole transporting material can be an amine complex such as poly (vinylcarbazole), N, N'-diphenyl-N, N'-bis (3-methylphenyl) -1,1' -biphenyl -4,4'-  
 10 diamine (TPD), an unsubstituted or substituted polymer of an amino substituted aromatic compound, a polyaniline, substituted polyanilines, polythiophenes, substituted polythiophenes, polysilanes etc. Examples of polyanilines are polymers of



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(VI)

where R is in the ortho – or meta-position and is hydrogen, C1-18 alkyl, C1-6 alkoxy, amino, chloro, bromo, hydroxy or the group

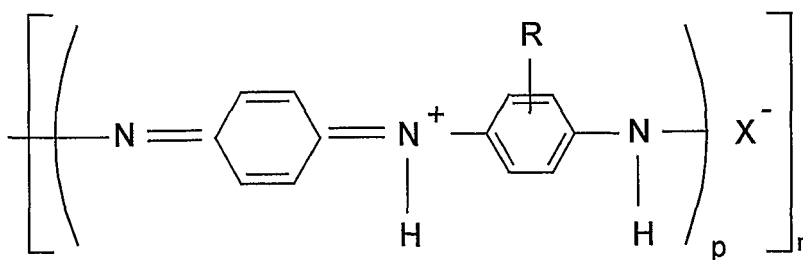


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where R is alkyl or aryl and R' is hydrogen, C1-6 alkyl or aryl with at least one other monomer of formula I above.

Or the hole transporting material can be a polyaniline; polyanilines which can be used in the present invention have the general formula

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(VII)

where p is from 1 to 10 and n is from 1 to 20, R is as defined above and X is an anion, preferably selected from Cl, Br, SO<sub>4</sub>, BF<sub>4</sub>, PF<sub>6</sub>, H<sub>2</sub>PO<sub>3</sub>, H<sub>2</sub>PO<sub>4</sub>, arylsulphonate, arenedicarboxylate, polystyrenesulphonate, polyacrylate alkylsulphonate, vinylsulphonate, vinylbenzene sulphonate, cellulose sulphonate, camphor sulphonates, cellulose sulphate or a perfluorinated polyanion.

Examples of arylsulphonates are p-toluenesulphonate, benzenesulphonate, 9,10-anthraquinone-sulphonate and anthracenesulphonate; an example of an arenedicarboxylate is phthalate and an example of arencarboxylate is benzoate.

We have found that protonated polymers of the unsubstituted or substituted polymer of an amino substituted aromatic compound such as a polyaniline are difficult to evaporate or cannot be evaporated. However we have surprisingly found that if the unsubstituted or substituted polymer of an amino substituted aromatic compound is deprotonated, then it can be easily evaporated, i.e. the polymer is evaporable.

Preferably evaporable deprotonated polymers of unsubstituted or substituted polymer of an amino substituted aromatic compound are used. The de-protonated unsubstituted or substituted polymer of an amino substituted aromatic compound can be formed by deprotonating the polymer by treatment with an alkali such as ammonium hydroxide or an alkali metal hydroxide such as sodium hydroxide or potassium hydroxide.

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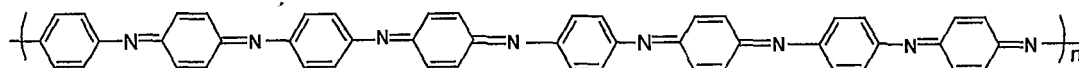
The degree of protonation can be controlled by forming a protonated polyaniline and de-protonating. Methods of preparing polyanilines are described in the article by A. G. MacDiarmid and A. F. Epstein, Faraday Discussions, Chem Soc.88 P319 1989.

- 5 The conductivity of the polyaniline is dependent on the degree of protonation with the maximum conductivity being when the degree of protonation is between 40 and 60%, for example, about 50%.

Preferably the polymer is substantially fully deprotonated.

10

A polyaniline can be formed of octamer units. i.e. p is four, e.g.



- 15 The polyanilines can have conductivities of the order of  $1 \times 10^{-1}$  Siemen  $\text{cm}^{-1}$  or higher.

The aromatic rings can be unsubstituted or substituted, e.g. by a C1 to 20 alkyl group such as ethyl.

- 20 The polyaniline can be a copolymer of aniline and preferred copolymers are the copolymers of aniline with o-anisidine, m-sulphanilic acid or o-aminophenol, or o-toluidine with o-aminophenol, o-ethylaniline, o-phenylene diamine or with amino anthracenes.

- 25 Other polymers of an amino substituted aromatic compound which can be used include substituted or unsubstituted polyaminonaphthalenes, polyaminoanthracenes, polyaminophenanthrenes, etc. and polymers of any other condensed polyaromatic compound. Polyaminoanthracenes and methods of making them are disclosed in US

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Patent 6,153,726. The aromatic rings can be unsubstituted or substituted, e.g. by a group R as defined above.

5 Other hole transporting materials are conjugated polymer and the conjugated polymers which can be used can be any of the conjugated polymers disclosed or referred to in US 5807627, PCT/WO90/13148 and PCT/WO92/03490.

10 The preferred conjugated polymers are poly (p-phenylenevinylene)-PPV and copolymers including PPV. Other preferred polymers are poly(2,5 dialkoxyphenylene vinylene) such as poly (2-methoxy-5-(2-methoxypentyloxy)-1,4-phenylene vinylene), poly(2-methoxypentyloxy)-1,4-phenylenevinylene), poly(2-methoxy-5-(2-dodecyloxy-1,4-phenylenevinylene) and other poly(2,5 dialkoxyphenylenevinylenes) with at least one of the alkoxy groups being a long chain solubilising alkoxy group, poly fluorenes and oligofluorenes, polyphenylenes and oligophenylenes, 15 polyanthracenes and oligo anthracenes, ploythiophenes and oligothiophenes.

In PPV the phenylene ring may optionally carry one or more substituents, e.g. each independently selected from alkyl, preferably methyl, alkoxy, preferably methoxy or ethoxy.

20 Any poly(arylenevinylene) including substituted derivatives thereof can be used and the phenylene ring in poly(p-phenylenevinylene) may be replaced by a fused ring system such as anthracene or naphthlyene ring and the number of vinylene groups in each polyphenylenevinylene moiety can be increased, e.g. up to 7 or higher.

25 The conjugated polymers can be made by the methods disclosed in US 5807627, PCT/WO90/13148 and PCT/WO92/03490.

The thickness of the hole transporting layer is preferably 20nm to 200nm.

30

- 12 -

The polymers of an amino substituted aromatic compound such as polyanilines referred to above can also be used as buffer layers with or in conjunction with other hole transporting materials.

- 5 The structural formulae of some other hole transporting materials are shown in Figures 4, 5, 6, 7 and 8 of the drawings, where  $R_1$ ,  $R_2$  and  $R_3$  can be the same or different and are selected from hydrogen, and substituted and unsubstituted hydrocarbyl groups such as substituted and unsubstituted aliphatic groups, substituted and unsubstituted aromatic, heterocyclic and polycyclic ring structures, fluorocarbons
- 10 such as trifluoromethyl groups, halogens such as fluorine or thiophenyl groups;  $R_1$ ,  $R_2$  and  $R_3$  can also form substituted and unsubstituted fused aromatic, heterocyclic and polycyclic ring structures and can be copolymerisable with a monomer, e.g. styrene. X is Se, S or O, Y can be hydrogen, substituted or unsubstituted hydrocarbyl groups, such as substituted and unsubstituted aromatic, heterocyclic and polycyclic
- 15 ring structures, fluorine, fluorocarbons such as trifluoromethyl groups, halogens such as fluorine or thiophenyl groups or nitrile.

Examples of  $R_1$  and/or  $R_2$  and/or  $R_3$  include aliphatic, aromatic and heterocyclic alkoxy, aryloxy and carboxy groups, substituted and unsubstituted phenyl, fluorophenyl,

20 biphenyl, phenanthrene, anthracene, naphthyl and fluorene groups alkyl groups such as t-butyl, heterocyclic groups such as carbazole.

Optionally there is a layer of an electron injecting material between the anode and the electroluminescent material layer. The electron injecting material is a material which

25 will transport electrons when an electric current is passed through electron injecting materials include a metal complex such as a metal quinolate, e.g. an aluminium quinolate, lithium quinolate, zirconium quinolate, a cyano anthracene such as 9,10 dicyano anthracene, cyano substituted aromatic compounds, tetracyanoquinodimethane a polystyrene sulphonate or a compound with the

- 13 -

structural formulae shown in figures 2 or 3 of the drawings in which the phenyl rings can be substituted with substituents R as defined above.

The first electrode is preferably a transparent substrate such as a conductive glass or plastic material which acts as the anode; preferred substrates are conductive glasses such as indium tin oxide coated glass, but any glass which is conductive or has a conductive layer such as a metal or conductive polymer can be used. Conductive polymers and conductive polymer coated glass or plastics materials can also be used as the substrate.

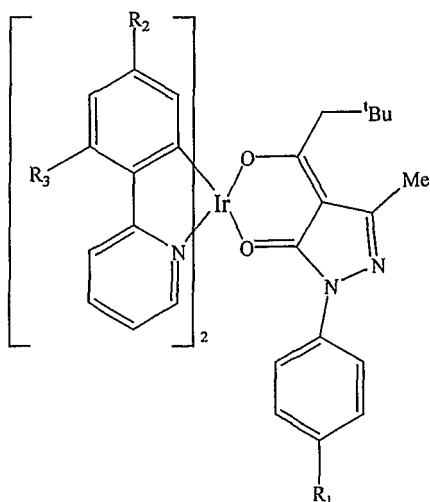
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The cathode is preferably a low work function metal, e.g. aluminium, calcium, lithium, silver/magnesium alloys, rare earth metal alloys etc; aluminium is a preferred metal. A metal fluoride such as an alkali metal, rare earth metal or their alloys can be used as the second electrode, for example by having a metal fluoride layer formed on a metal.

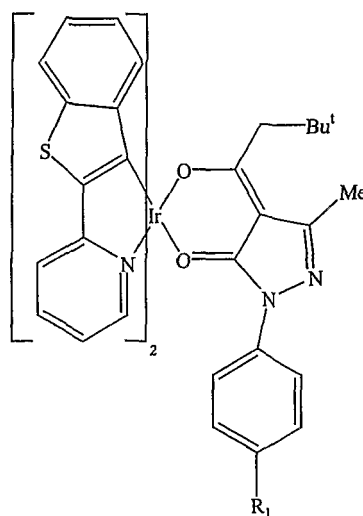
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The invention is illustrated in the Examples.

#### Summary of bis(phenylpyridine)(pyrazolone) iridium complexes:



Compound A - D



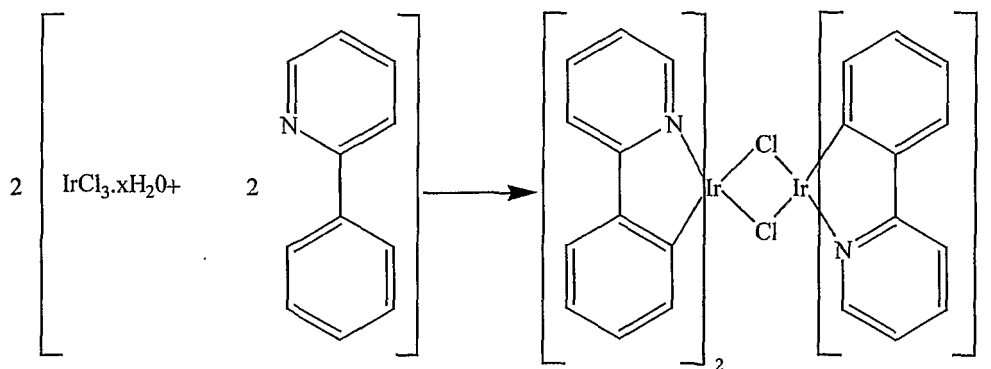
Compound E

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Cpd	R <sub>1</sub>	R <sub>2</sub>	R <sub>3</sub>	m.p./°C	PL <sub>em</sub> peak/ nm	Elemental analysis (CHN observed, found)		
A	H	H	H	271-275 (110 - T <sub>g</sub> )	526 (solid state)	59.05	4.57	7.25
						58.81	4.55	7.15
B	H	F	H	250	522 (solid state) 493 (DCM)	56.49	4.12	6.93
						57.49	4.51	6.47
C	H	F	F	282-284	500 (solid state) 483 (DCM)	54.81	3.70	6.64
						54.71	3.61	6.49
D	F	F	F	277-280	508 (solid state) 484 (DCM)	52.96	3.51	6.50
						52.99	3.48	6.35
E	H	Compound E		Not observed	615 (DCM)	61.16	4.55	6.48
						61.00	4.43	6.30

**Tetrakis(2-phenylpyridine-C<sup>2</sup>, N')( $\mu$ -chloro) diiridium** (Watts et al., J. Am. Chem. Soc., 1985, **107**, 1431.)

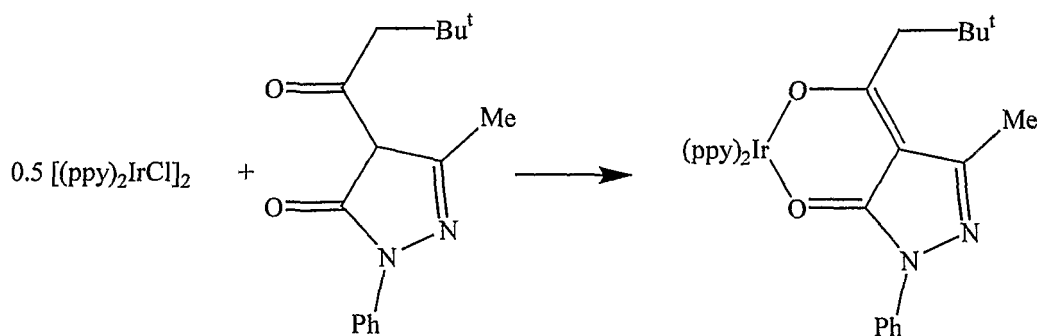


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Iridium trichloride hydrate (0.39g, 1.3mmol) was combined with 2-phenylpyridine (0.76g, 4.9mmol), dissolved in a mixture of 2-ethoxyethanol (30mL, dried and distilled over  $\text{MgSO}_4$ , degassed) and water (10mL, degassed), and refluxed for 24 hours. The solution was cooled to room temperature and the yellow/green precipitate collected on a glass sinter. The precipitate was washed with ethanol (60mL, 95%), acetone (60mL), and then dissolved in dichloromethane (75mL) and filtered. Toluene (25mL) and hexane (10mL) were added to the filtrate and the volume reduced *in vacuo* to about 50mL. Cooling yielded crystals (yellow/green) of the desired product (0.43g, 62%). This was used without further purification.

10

**(A) Bis(2-phenylpyridine-C<sup>2</sup>, N') (4-*tert*-butylacetyl-3-methyl-1-phenyl-pyrazol-5-onato) iridium**



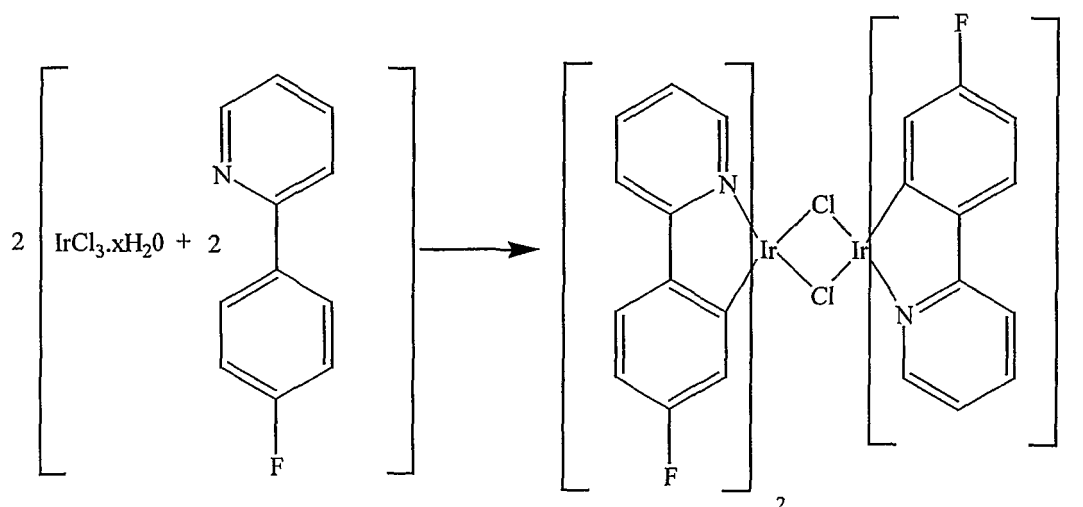
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Tetrakis(2-phenylpyridine-C<sup>2</sup>, N')( $\mu$ -chloro) diiridium (2.5g, 2.35mmol), 4-*tert*-butylacetyl-3-methyl-1-phenyl-pyrazol-5-one (2.72g, 10mmol) and sodium carbonate (dried at 100°C, 2.5g, 23.6mmol) were refluxed under an inert atmosphere (nitrogen) in 2-ethoxyethanol (dried and distilled over magnesium sulfate, 200mL) for 16 hours.

- 5 On cooling to room temperature, a yellow solution with a small amount of residue was observed. The solvent was reduced to approx. 5-10mL under reduced pressure (10<sup>-1</sup> Torr) and elevated temperature (60°C). Water (100mL) was slowly added to the solution and the resulting yellow/orange precipitate (some darkly coloured impurities may also remain) filtered onto a glass frit (porosity 2 or 3). This was washed with
- 10 further water and then petroleum spirit (40-60°C). The crude product (after drying to remove water) was first purified by filtration through a short silica-gel pad and washing with dichloromethane (darkly coloured impurities remain on the silica-gel). Two products are identifiable by TLC. These can be separated on a flash silica-gel column using toluene (100mL), then dichloromethane (200mL) and finally
- 15 dichloromethane:ethyl acetate (4:1, 200mL) as eluents. Yield: 2.0g (55%). The product may be further purified by sublimation (220°C, 2x10<sup>-7</sup> Torr). M.p. 271-5°C.

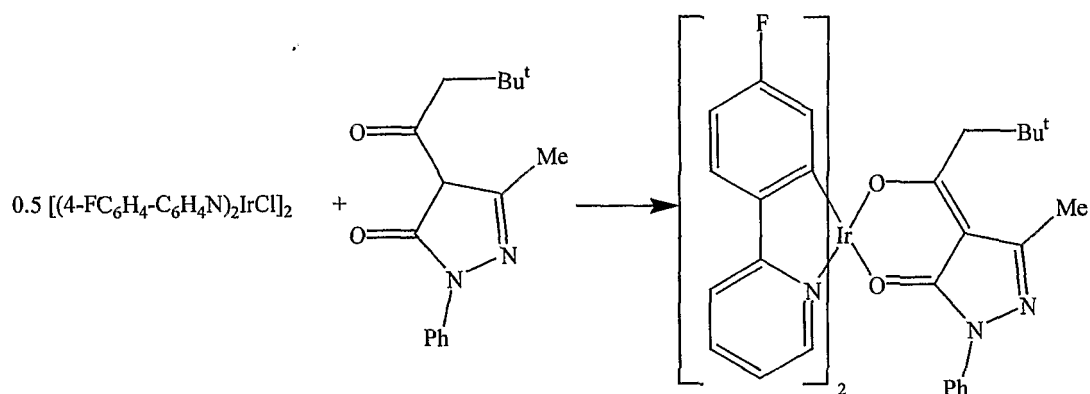
**Tetrakis[2-(4-fluorophenyl)pyridine-C<sup>2</sup>, N']( $\mu$ -chloro) diiridium**



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Iridium trichloride hydrate (1.64g, 5.5mmol) was combined with 2-(4-fluorophenyl) pyridine (2.84g, 16.4mmol), dissolved in a mixture of 2-ethoxyethanol (60mL, dried and distilled over  $\text{MgSO}_4$ , degassed) and water (20mL, degassed), and refluxed for 24 hours. The solution was cooled to room temperature and the yellow/green precipitate collected on a glass sinter. The precipitate was washed with ethanol (60mL, 95%), acetone (60mL), and hexane. This was dried and used without further purification. Yield (1.6g, 51%)

**(B) Bis[2-(4'-fluorophenyl)pyridine- $\text{C}^2$ ,  $\text{N}'$ ] (4-*tert*-butylacetyl-3-methyl-1-phenyl-pyrazol-5-onato) iridium**

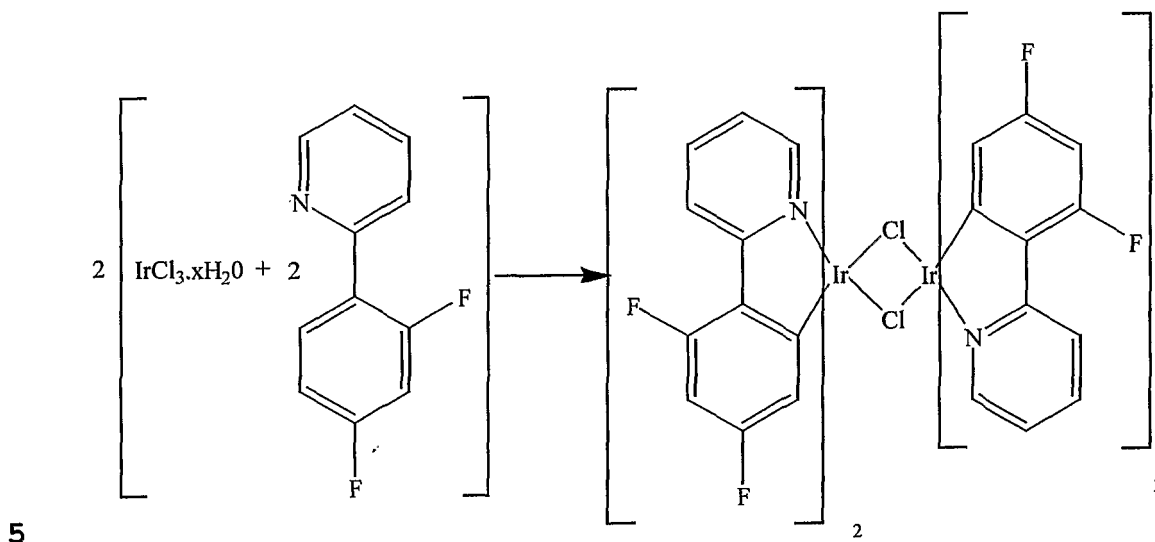


Tetrakis[2-(4'-fluorophenyl)pyridine- $\text{C}^2$ ,  $\text{N}'$ ]( $\mu$ -chloro) diiridium (0.75g, 0.66mmol), 4-*tert*-butylacetyl-3-methyl-1-phenyl-pyrazol-5-one (0.7g, 2.62mmol) and sodium carbonate (dried at 100°C, 0.7g, 6.6mmol) were refluxed under an inert atmosphere in 2-ethoxyethanol (dried and distilled over magnesium sulfate, 40mL) for 16 hours. On cooling to room temperature, a yellow solution with a small amount of residue was observed. The solution was filtered, washed with a little ethanol and the solvent was removed under reduced pressure ( $10^{-1}$  Torr) and elevated temperature (60°C). The crude product was dissolved in dichloromethane and initially purified by filtration through a short silica-gel pad and washing with dichloromethane (darkly coloured impurities remain on the silica-gel). Final purification is performed by flash column

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chromatography [dichloromethane:petroleum ether 60-80 (2:1 then 4:1)], discarding the first fraction and keeping the second, highly-luminescent fraction. M.p. 250°C.

**Tetrakis[2-(2',4'-difluorophenyl)pyridine-C<sup>2</sup>, N']( $\mu$ -chloro) diiridium**



Iridium trichloride hydrate (2.81g, 9.42mmol) was combined with 2-(2',4'-difluorophenyl) pyridine (5.4g, 28.3mmol), dissolved in a mixture of 2-ethoxyethanol (70mL, dried and distilled over  $\text{MgSO}_4$ , degassed) and water (20mL, degassed), and refluxed for 24 hours. The solution was cooled to room temperature and the yellow/green precipitate collected on a glass sinter. The precipitate was washed with ethanol (60mL, 95%), acetone (60mL), and hexane. This was dried and used without further purification. Yield (3.5g, 61%).

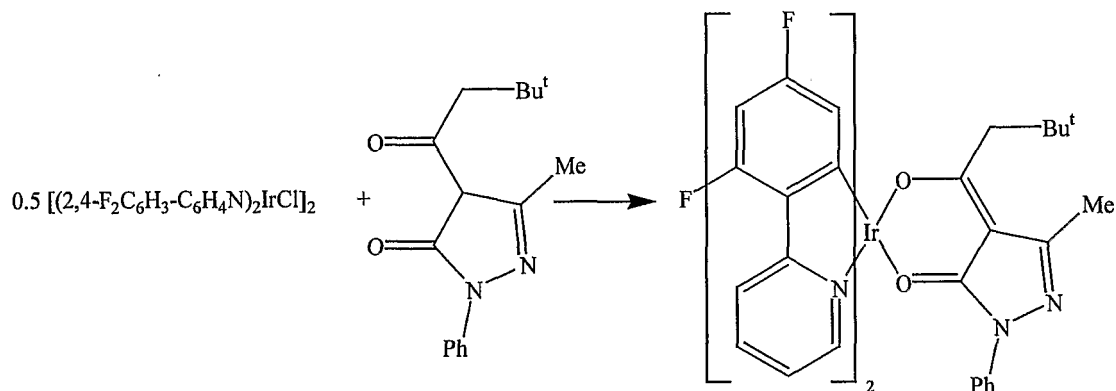
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- 19 -

(C) Bis[2-(2',4'-difluorophenyl)pyridine-C<sup>2</sup>, N'] (4-*tert*-butylacetyl-3-methyl-1-phenyl-pyrazol-5-onato) iridium



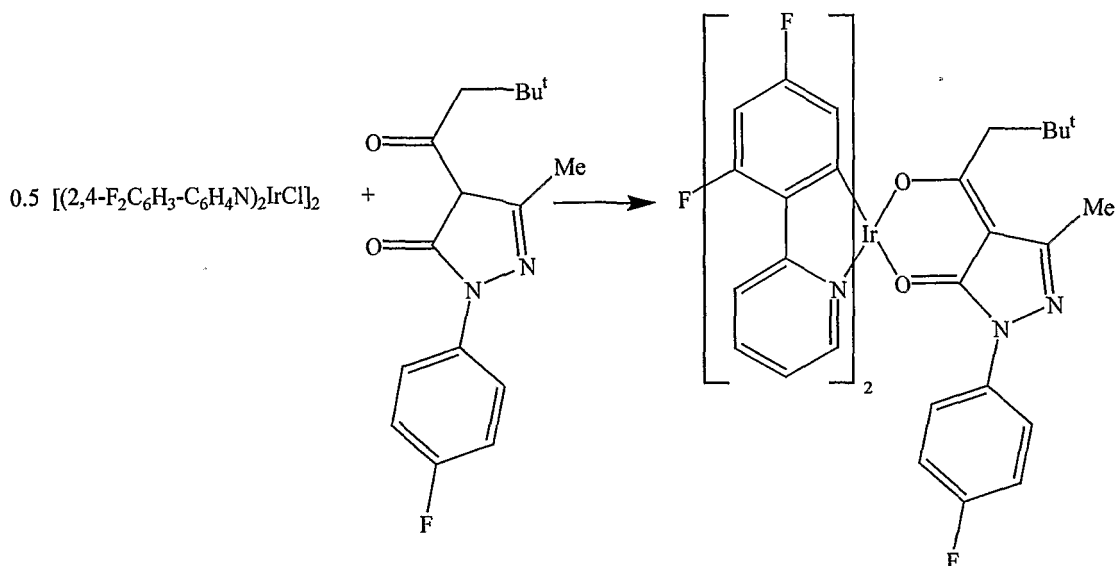
5

Tetrakis[2-(2',4'-difluorophenyl)pyridine-C<sup>2</sup>, N']( $\mu$ -chloro) diiridium (1.0g, 0.82mmol), 4-*tert*-butylacetyl-3-methyl-1-phenyl-pyrazol-5-one (0.571g, 2.1mmol) and sodium carbonate (dried at 100°C, 0.63g, 5mmol) were refluxed under an inert atmosphere in 2-ethoxyethanol (dried and distilled over magnesium sulfate, 40mL) for 16 hours. On cooling to room temperature, a yellow solution with a small amount of residue was observed. The solution was filtered, washed with a little ethanol and the solvent was removed under reduced pressure (10<sup>-1</sup> Torr) and elevated temperature (60°C). The crude product was dissolved in dichloromethane and initially purified by filtration through a short silica-gel pad and washing with dichloromethane (darkly coloured impurities remain on the silica-gel). Final purification was performed by flash column chromatography [chloroform:hexane (2:1, then 4:1)], discarding the first fraction and keeping the second, highly-luminescent fraction. Yield: 1.0g (72%). M.p. 282°C.

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- 20 -

**(D) Bis[2-(2',4'-difluorophenyl)pyridine-C<sup>2</sup>, N'] [4-*tert*-butylacetyl-3-methyl-1-(4-fluorophenyl)-pyrazol-5-onato] iridium**



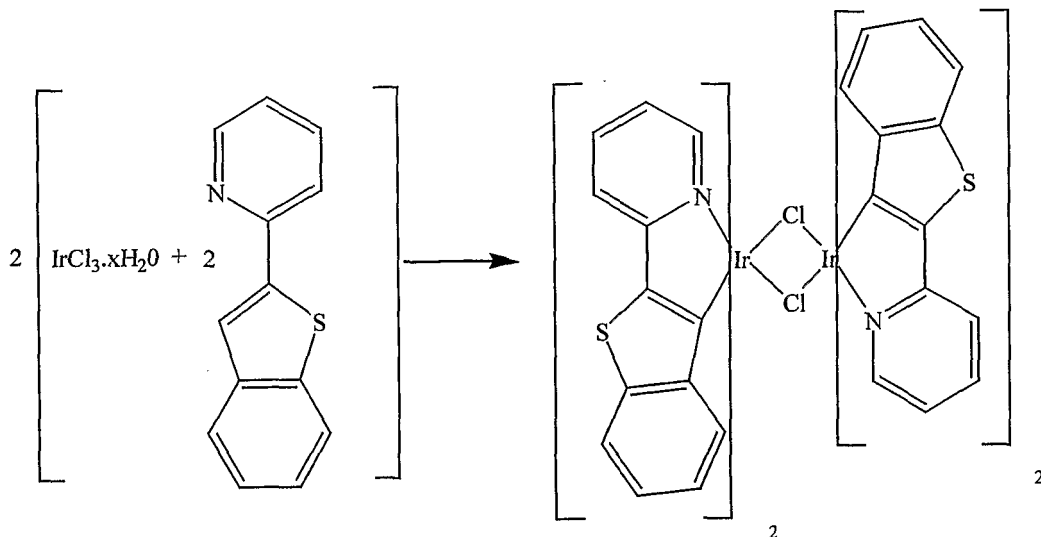
5

Tetrakis[2-(2',4'-difluorophenyl)pyridine-C<sup>2</sup>, N']( $\mu$ -chloro) diiridium (1.0g, 0.82mmol), 4-*tert*-butylacetyl-3-methyl-1-(4'-fluorophenyl)-pyrazol-5-one (0.64g, 2.2mmol) and sodium carbonate (dried at 100°C, 0.63g, 5mmol) were refluxed under an inert atmosphere in 2-ethoxyethanol (dried and distilled over magnesium sulfate, 60mL) for 16 hours. On cooling to room temperature, a yellow solution with a small amount of residue was observed. The solution was filtered, washed with a little ethanol and the solvent was removed under reduced pressure (10<sup>-1</sup> Torr) and elevated temperature (60°C). The crude product was dissolved in dichloromethane and initially purified by filtration through a short silica-gel pad and washing with dichloromethane (darkly coloured impurities remain on the silica-gel). Final purification was performed by flash column chromatography [chloroform:hexane (2:1, then 4:1)], discarding the first fraction and keeping the second, highly-luminescent fraction. Yield: 1.0g (72%). M.p. 277°C.

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- 21 -

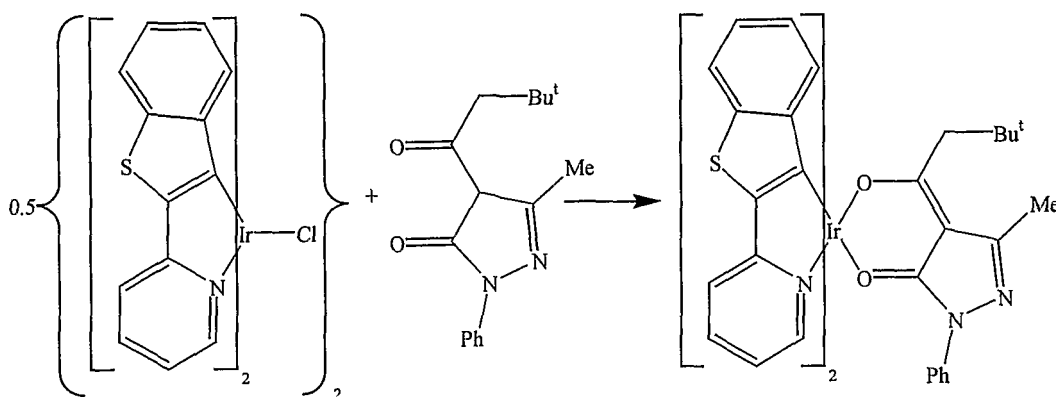
**Tetrakis[2-benzo[b]thiophen-2-yl-pyridine-C<sup>2</sup>, N<sup>1</sup>]( $\mu$ -chloro) diiridium**



Iridium trichloride hydrate (0.97g, 3.24mmol) was combined with 2-benzo[b]thiophen-2-yl-pyridine (2.05g, 9.7mmol), dissolved in a mixture of 2-ethoxyethanol (70mL, dried and distilled over MgSO<sub>4</sub>, degassed) and water (20mL, degassed), and refluxed for 24 hours. The solution was cooled to room temperature and the yellow/green precipitate collected on a glass sinter. The precipitate was washed with ethanol (60mL, 95%), acetone (60mL), and hexane. This was dried and used without further purification. Yield (1.5g, 71%)

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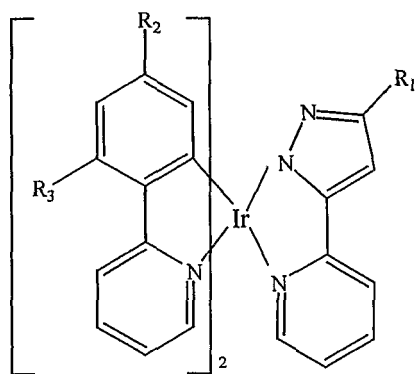
**(E) Bis[2-benzo[b]thiophen-2-yl-pyridine-C<sup>2</sup>, N<sup>1</sup>] (4-*tert*-butylacetyl-3-methyl-1-phenyl-pyrazol-5-onato) iridium**



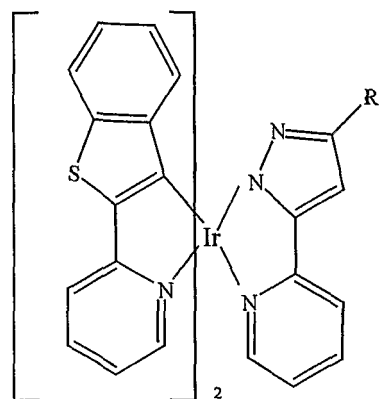
- 22 -

Tetrakis[2-benzo[b]thiophen-2-yl-pyridine-C<sup>2</sup>, N<sup>1</sup>]( $\mu$ -chloro) diiridium (1.0g, 0.77mmol), 4-*tert*-butylacetyl-3-methyl-1-phenyl-pyrazol-5-one (0.54g, 2mmol) and sodium carbonate (dried at 100°C, 0.63g, 5mmol) were refluxed under an inert atmosphere in 2-ethoxyethanol (dried and distilled over magnesium sulfate, 40mL) for 16 hours. On cooling to room temperature, an orange/red solution with a small amount of residue was observed. The solution was filtered, washed with a little ethanol and the solvent was removed under reduced pressure (10<sup>-1</sup> Torr) and elevated temperature (60°C). The crude product was dissolved in dichloromethane and initially purified by filtration through a short silica-gel pad and washing with dichloromethane (darkly coloured impurities remain on the silica-gel). Final purification was performed by flash column chromatography [chloroform:hexane (1:1, then 2:1)], discarding the first fraction and keeping the second, highly-luminescent fraction. Yield: 0.8g (59%).

### 15 Summary of bis(phenylpyridine)(pyrazolyl-pyridine) iridium complexes:



Compound F - H



Compound I

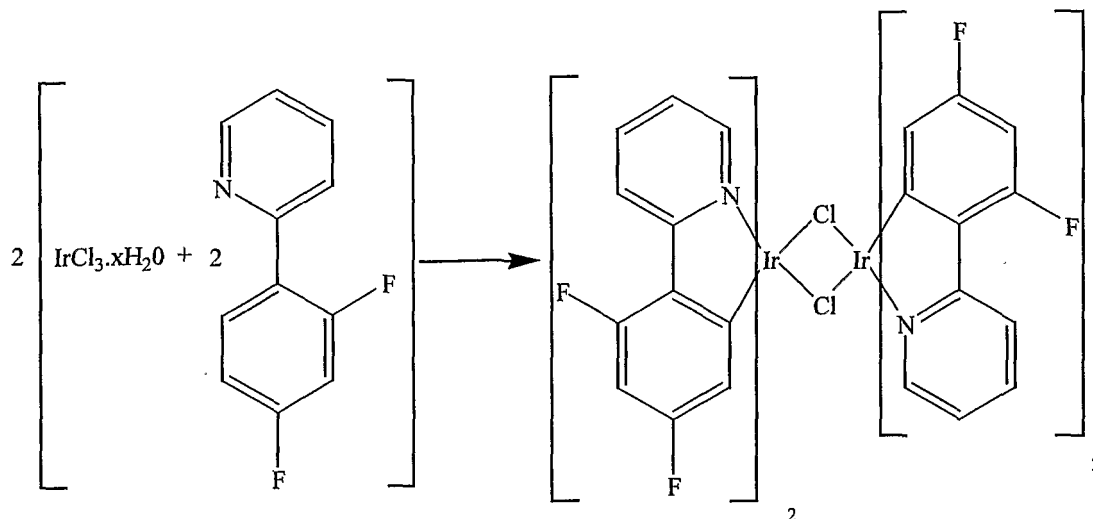
5

Cpd	R <sub>1</sub>	R <sub>2</sub>	R <sub>3</sub>	m.p./°C	PL <sub>em</sub> peak/ nm	Elemental analysis (CHN observed, found)		
F	Ph	F	F	Not observed (194 - T <sub>g</sub> )	488, 498 (solid state) 470 (DCM)	54.54	2.80	8.83
						54.05	2.73	8.56
G	CN-Ph	F	F	374 (204 - T <sub>g</sub> )	502 (solid state) 468 (DCM)	54.34	2.59	10.28
						54.02	2.36	10.19
H	tBu	F	F	266 (166 - T <sub>g</sub> )	504 (solid state) 479 (DCM)	52.84	3.39	9.06
						52.58	3.44	8.96
I	(OMe) <sub>3</sub> - Ph	Compound I		Not observed	597 (DCM)	55.95	3.49	7.59
						54.97	3.38	7.32

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- 24 -

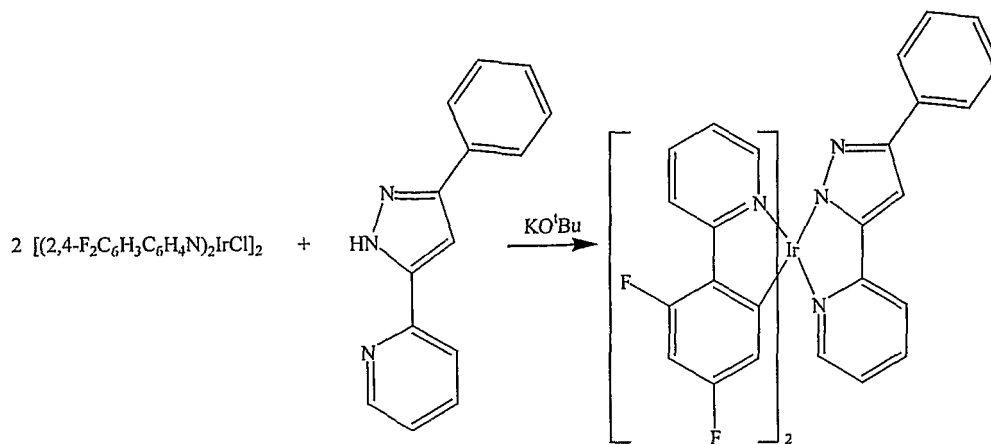
**Tetrakis[2-(2,4-difluorophenyl)pyridine-C<sup>2</sup>, N<sup>1</sup>]( $\mu$ -chloro) diiridium**



5 Iridium trichloride hydrate (2.81g, 9.4mmol) was combined with 2-(2',4'-difluorophenyl)pyridine (5.4g, 28mmol), dissolved in a mixture of 2-ethoxyethanol (70mL, dried and distilled over MgSO<sub>4</sub>, degassed) and water (20mL, degassed), and refluxed for 24 hours. The solution was cooled to room temperature and the yellow precipitate collected on a glass sinter. The precipitate was washed with ethanol (60mL, 95%), acetone (60mL), and hexane. This was dried and used without further purification. Yield (3.5g, 61%).

10

**Bis[2-(2',4'-difluorophenyl)pyridine-C<sup>2</sup>, N<sup>1</sup>] [2-(5-phenyl-2H-pyrazol-3-yl)pyridine] iridium**



- 25 -

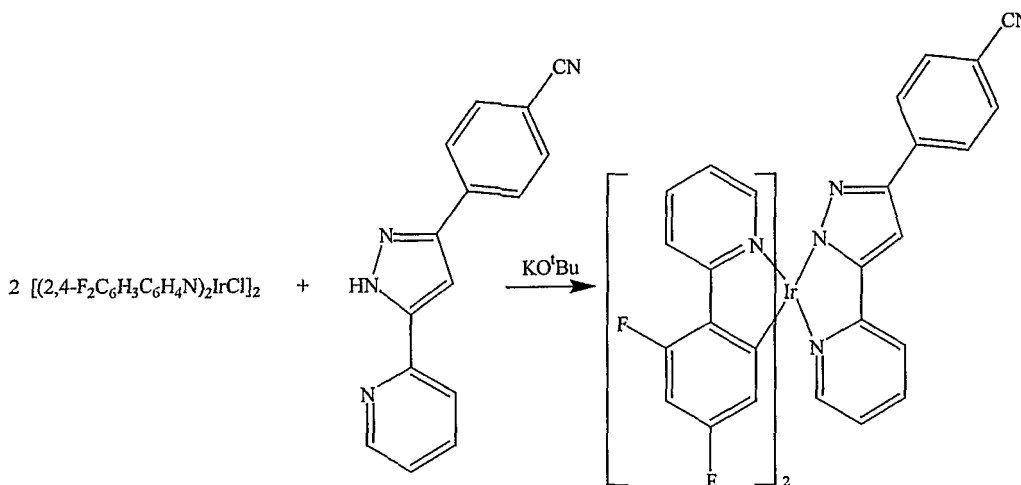
Potassium *tert*-butoxide (0.24g, 2.1mmol) and 2-(5-phenyl-2H-pyrazol-3-yl)pyridine (0.47g, 2.1mmol) were added to a 200mL Schlenk tube under an inert atmosphere. 2-Ethoxyethanol (dried and distilled over magnesium sulfate, 40mL) was added and the resultant solution stirred at ambient temperature for 10 minutes. Tetrakis[2-(2',4'-

5 difluorophenyl)-C<sup>2</sup>, N']( $\mu$ -chloro) diiridium (1.0g, 0.82mmol) was added and the mixture refluxed under an inert atmosphere for 16 hours. On cooling to room temperature, a yellow solution with a small amount of residue was observed. The solvent was removed under reduced pressure (10<sup>-1</sup> Torr) and elevated temperature (60°C). Purification was achieved on a flash silica-gel column (chloroform, then

10 chloroform:ethyl acetate 4:1). Yield: 0.9g (69%).

T<sub>g</sub> 194 °C.

**Bis[2-(2',4'-difluorophenyl)pyridine-C<sup>2</sup>, N'] {2-[5-(4-benzonitrile) -2H-pyrazol-3-yl]pyridine} iridium**



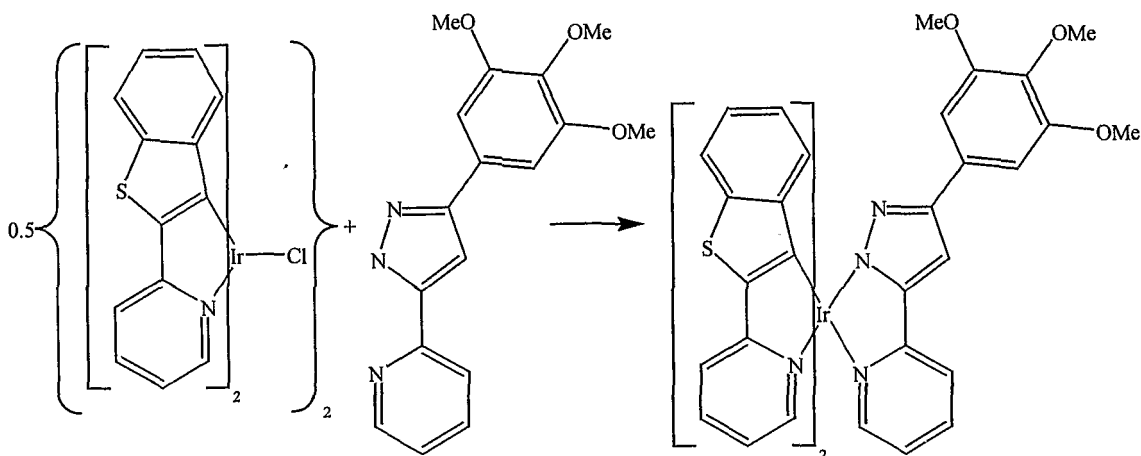
Potassium *tert*-butoxide (0.24g, 2.1mmol) and 2-[5-(4'-cyanophenyl) -2H-pyrazol-3-yl]pyridine (0.52g, 2.1mmol) were added to a 200mL Schlenk tube under an inert atmosphere. 2-Ethoxyethanol (dried and distilled over magnesium sulfate, 40mL) was

20 added and the resultant solution stirred at ambient temperature for 10 minutes. Tetrakis[2-(2',4'-difluorophenyl)-C<sup>2</sup>, N']( $\mu$ -chloro) diiridium (1.0g, 0.82mmol) was added and the mixture refluxed under an inert atmosphere for 16 hours. On cooling to

- 26 -

room temperature, a yellow solution with a small amount of residue was observed. The solvent was removed under reduced pressure ( $10^{-1}$  Torr) and elevated temperature ( $60^{\circ}\text{C}$ ). Purification was achieved on a flash silica-gel column (chloroform, then chloroform:ethyl acetate 4:1), followed by recrystallisation from methanol. Yield: 1.0g (75%). M.p.  $367^{\circ}\text{C}$ .  $T_g$   $208^{\circ}\text{C}$ .

**Bis[2-benzo[b]thiophen-2-yl-pyridine- $\text{C}^2$ ,  $\text{N}^1$ ] {2-[5-(3',4',5'-trimethoxyphenyl)-2H-pyrazol-3-yl]pyridine} iridium**



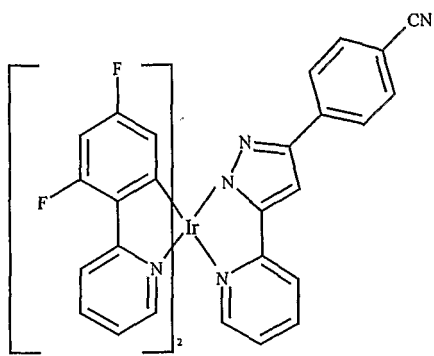
10

Potassium *tert*-butoxide (0.09g, 0.8mmol) and 2-[5-(3',4',5'-trimethoxyphenyl)-2H-pyrazol-3-yl]pyridine (0.25g, 0.8mmol) were added to a 200mL Schlenk tube under an inert atmosphere. 2-Ethoxyethanol (dried and distilled over magnesium sulfate, 30mL) was added and the resultant solution stirred at ambient temperature for 10 minutes. Tetrakis[2-benzo[b]thiophen-2-yl-pyridine- $\text{C}^2$ ,  $\text{N}^1$ ]( $\mu$ -chloro) diiridium (0.5g, 0.385mmol) was added and the mixture refluxed under an inert atmosphere for 16 hours. On cooling to room temperature, an orange/red solution with a small amount of residue was observed. The solvent was removed under reduced pressure ( $10^{-1}$  Torr) and elevated temperature ( $60^{\circ}\text{C}$ ). Purification was achieved on a flash silica-gel column (chloroform), followed by recrystallisation from ethanol. Yield: 0.6g (84%).

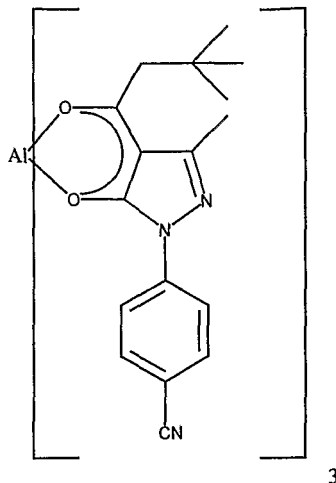
20

Electroluminescent Devices

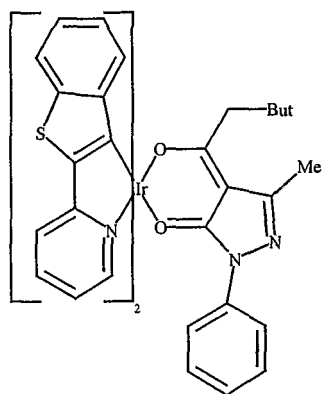
In these devices the following compounds were used:-



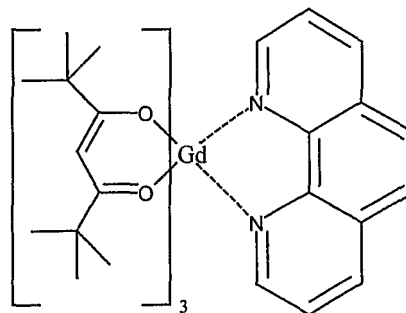
Compound F



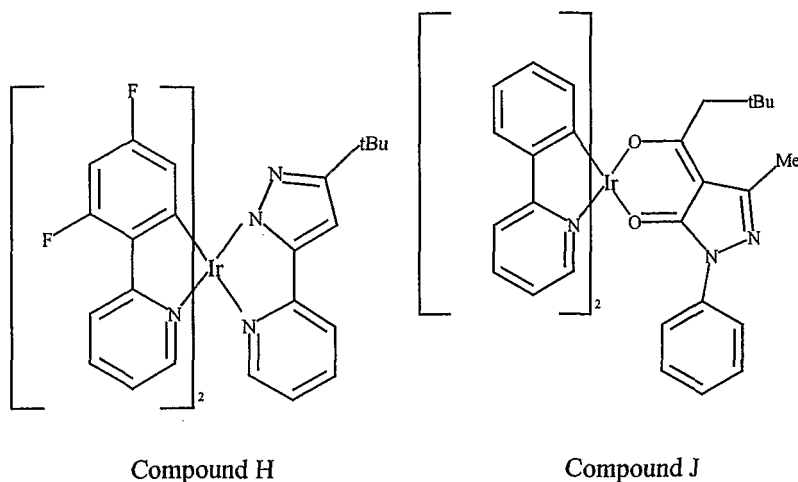
Compound G



Compound K



Compound L



### Example 1

- 5 A pre-etched ITO coated glass piece (10 x 10cm<sup>2</sup>) was used. The device was fabricated by sequentially forming on the ITO, by vacuum evaporation using a Solciet Machine, ULVAC Ltd. Chigacki, Japan the active area of each pixel was 3mm by 3mm, the layers comprised:-
- (1)ITO (165 nm)/(2)CuPc (25 nm)/(3) $\alpha$ -NPB (40 nm)/(4)TCTA : Compound F (38 :  
 10 2.1 nm)/(5)Liq (30 nm)/(6)LiF (0.5 nm)/(7)Al

The device structure is shown in fig. 1

where CuPc is a copper phthalocyanine buffer layer,  $\alpha$ -NPB is as in fig. TCTA is 4,4',4''-Tris(carbazole-9-yl)-triphenylamine, Liq is lithium quinolate and LiF is lithium fluoride.

- 15 The coated electrodes were stored in a vacuum desiccator over a molecular sieve and phosphorous pentoxide until they were loaded into a vacuum coater (Edwards, 10<sup>-6</sup> torr) and aluminium top contacts made. The devices were then kept in a vacuum desiccator until the electroluminescence studies were performed.

- 29 -

The ITO electrode was always connected to the positive terminal. The current vs. voltage studies were carried out on a computer controlled Keithly 2400 source meter.

The electroluminescent properties were measured and the results shown in fig. 9.

5

#### Example 2

An electroluminescent device was made as in Example 1 with the structure:

ITO (165 nm)/CuPc (25 nm)/ $\alpha$ -NPB (40 nm)/TCTA : Compound F (37 : 3 nm)/Compound G (3 nm)/Zr<sub>q</sub> (30 nm)/LiF (0.5 nm)/Al

10 where Zr<sub>q</sub> is zirconium quinolate.

The electroluminescent properties are shown in fig. 10.

#### Example 3

An electroluminescent device was made as in Example 1 with the structure

15 ITO (165 nm)/CuPc (25 nm)/ $\alpha$ -NPB (60 nm)/CBP : Compound J (20 : 1.3 nm)/BCP (6 nm)/Alq<sub>3</sub> (40 nm)/LiF (0.2 nm)/Al

where CBP is as in fig. 5b of the accompanying drawings where R is hydrogen.

and BCP is bathocupron.

The electroluminescent properties are shown in fig. 11.

20

#### Example 4

An electroluminescent device was made as in Example 1 with the structure

ITO (165 nm)/CuPc (25 nm)/ $\alpha$ -NPB (40 nm)/CBP : Compound J (20 : 0.6 nm)/BCP (6 nm)/Li<sub>q</sub> (40 nm)/LiF (0.5 nm)/Al.

25 The electroluminescent properties are shown in fig. 12.

Example 5

An electroluminescent device was made as in Example 1 with the structure:

ITO (165 nm)/ $\alpha$ -NPB (40 nm)/CBP : Compound J (20 : 7 nm)/BCP (10 nm)/Zr<sub>q</sub>4 (50 nm)/LiF (0.5 nm)/Al.

5 The electroluminescent properties are shown in fig. 13.

Example 6

An electroluminescent device was made as in Example 1 with the structure:

10 ITO (165 nm)/CuPc (25 nm)/ $\alpha$ -NPB (40 nm)/TCTA : Compound H (40 : 0.8 nm)/Liq (30 nm)/LiF (0.5 nm)/Al.

The electroluminescent properties are shown in fig. 14.

Example 7

An electroluminescent device was made as in Example 1 with the structure:

15 ITO (165 nm)/ $\alpha$ -NPB (40 nm)/CBP : Compound J (20 : 8.3 nm)/  
Compound L (10 nm)/Zr<sub>q</sub>4 (50 nm)/LiF (0.5 nm)/Al.

The electroluminescent properties are shown in fig. 15.

Example 8

20 An electroluminescent device was made as in Example 1 with the structure;

ITO (165 nm)/CuPc (25 nm)/ $\alpha$ -NPB (40 nm)/CBP : Compound K (35 : 5 nm)/Zr<sub>q</sub>4 (30 nm)/LiF (0.5 nm)/Al.

The electroluminescent properties are shown in fig. 16.

Example 9

An electroluminescent device was made as in Example 1 with the structure:

ITO (165 nm)/CuPc (50 nm)/  $\alpha$ -NPB (40 nm)/CBP : Compound J (20 : 6.1 nm)/Compound F (10 nm)/Zr<sub>q</sub> (50 nm)/LiF (0.5 nm)/Al.

- 5 The electroluminescent properties are shown in fig. 17.



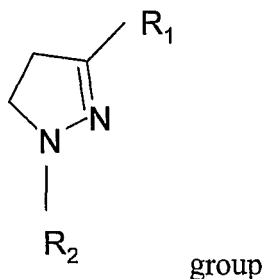
- 33 -

substituted and unsubstituted fused aromatic, heterocyclic and polycyclic ring structures and can be copolymerisable with a monomer, e.g. styrene, and where  $R_4$  and  $R_5$  can be the same or different and are selected from hydrogen, and substituted and unsubstituted hydrocarbyl groups such as substituted and unsubstituted aliphatic groups, substituted and unsubstituted aromatic, heterocyclic and polycyclic ring structures, fluorocarbons such as trifluoromethyl groups, halogens such as fluorine or thiophenyl groups;  $R_1$ ,  $R_2$  and  $R_3$  can also form substituted and unsubstituted fused aromatic, heterocyclic and polycyclic ring structures and can be copolymerisable with a monomer,  $M$  is ruthenium, rhodium, palladium, osmium, iridium or platinum and  $n+2$  is the valency of  $M$ .

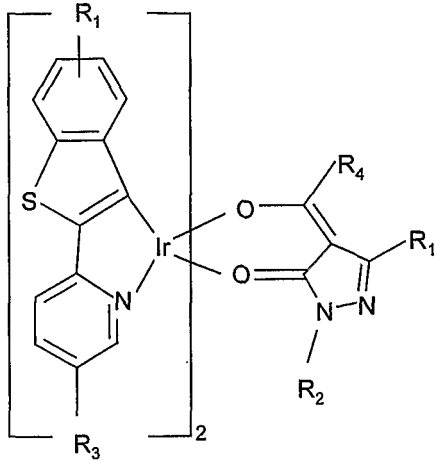
2. An electroluminescent compound as claimed in claim 1 in which  $M$  is iridium and  $n$  is 2.

3. An electroluminescent compound as claimed in claims 1 or 2 in which  $R_1$  and/or  $R_2$  and/or  $R_3$  and/or  $R_4$  and/or  $R_5$  and/or  $R_6$  include aliphatic, aromatic and heterocyclic alkoxy, aryloxy and carboxy groups, substituted and substituted phenyl, fluorophenyl, biphenyl, phenanthrene, anthracene, naphthyl and fluorene groups alkyl groups such as t-butyl, heterocyclic groups such as carbazole.

4. An electroluminescent compound as claimed in claims 1, 2 or 3 in which the compounds (I) are those in which  $R_5$  and  $R_6$  form a

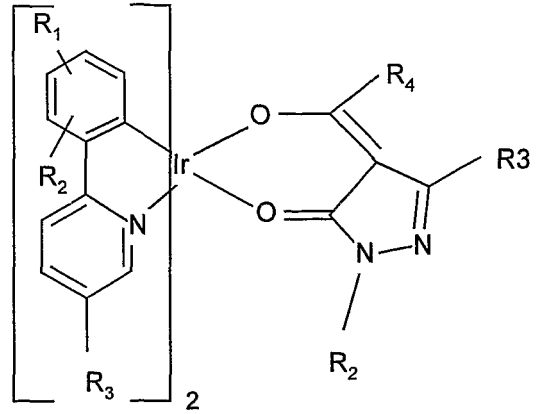


5. An electroluminescent compound as claimed in claim 4 which has the formula



(IV)

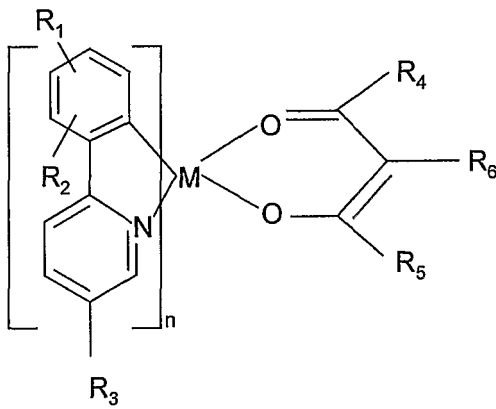
and



(V)

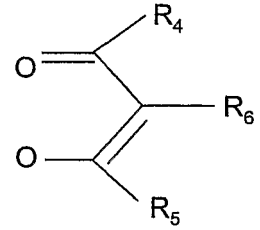
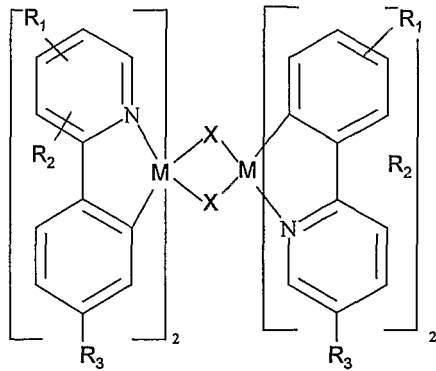
6. An electroluminescent compound as claimed in claim 5 in which R<sub>2</sub> is a phenyl or substituted phenyl group.

7. A method of making an electroluminescent compound of formula



10

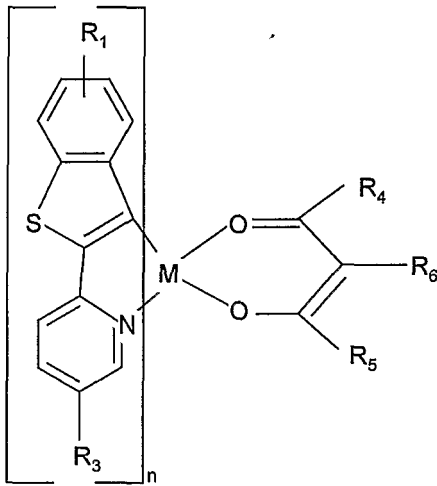
which comprises reacting a compound of formula



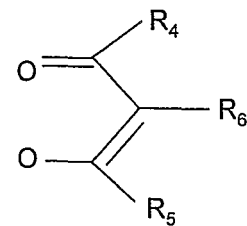
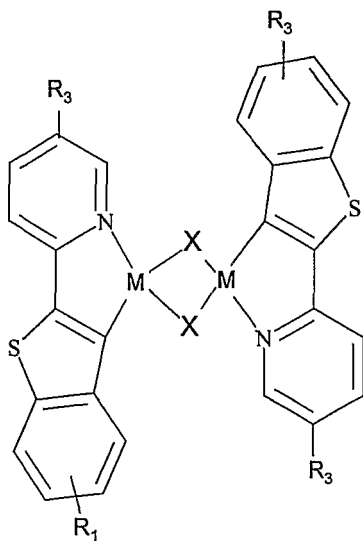
with a compound of formula

where  $R_1, R_2, R_3, R_4, R_5$  and  $R_6$  are as above,  $X$  is an anion and  $n+2$  is the valency of  $M$ .

5 8. A method of making an electroluminescent compound of formula



which comprises reacting a compound of formula

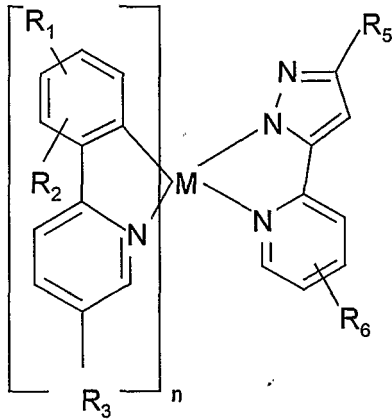


with a compound of formula

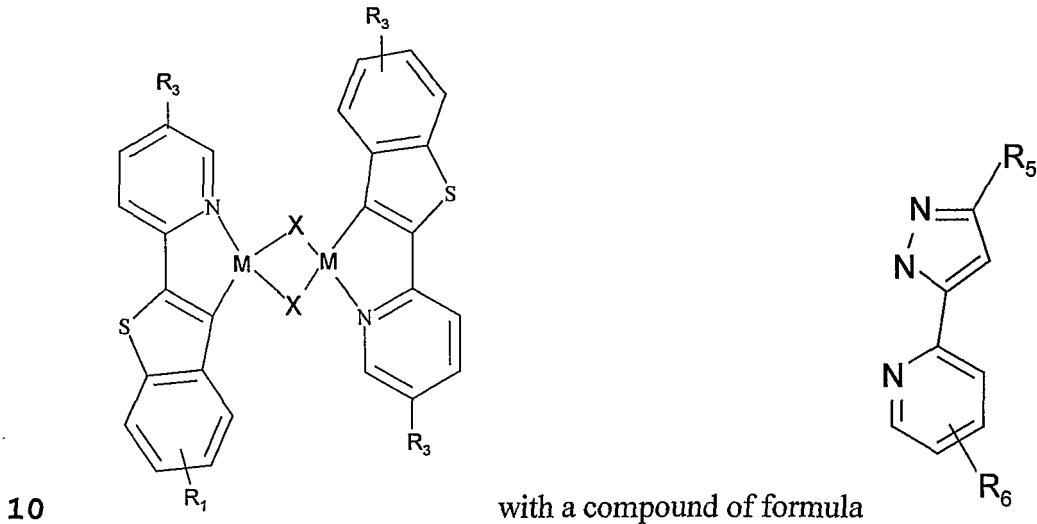
where  $R_1, R_2, R_3, R_4, R_5$  and  $R_6$  are as above,  $X$  is an anion and  $n+2$  is the valency of  $M$ .

5

9. A method of making an electroluminescent compound of formula



which comprises reacting a compound of formula



10

with a compound of formula

where  $R_1, R_2, R_3, R_4, R_5$  and  $R_6$  are as above,  $X$  is an anion and  $n+2$  is the valency of  $M$ .

10. An electroluminescent compound made by the method of any one of claims 7 to

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9.

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11. An electroluminescent device which comprises (i) a first electrode (ii) a layer of an electroluminescent material of formula as claimed in any one of claims 1 to 6 or claim 10 and (iii) a second electrode.
- 5 12. An electroluminescent device as claimed in claim 11 in which there is a layer of a hole transmitting material between the first electrode and the electroluminescent layer.
- 10 13. An electroluminescent device as claimed in claim 12 in which the hole transmitting material is an aromatic amine complex.
14. An electroluminescent device as claimed in claim 12 in which the hole transmitting material is a polyaromatic amine complex.
- 15 15. An electroluminescent device as claimed in claim 12 in which the hole transmitting material is a film of a polymer selected from poly(vinylcarbazole), N,N'-diphenyl-N,N'-bis (3-methylphenyl) -1,1' -biphenyl -4,4'-diamine (TPD), polyaniline, substituted polyanilines, polythiophenes, substituted polythiophenes, polysilanes and substituted polysilanes.
- 20 16. An electroluminescent device as claimed in claim 12 in which the hole transmitting material is a film of a compound of formula (VII) or (VII) herein or as in figures 4 to 8 of the drawings.
- 25 17. An electroluminescent device as claimed in claim 12 in which the hole transmitting material is a copolymer of aniline, a copolymer of aniline with o-anisidine, m-sulphanilic acid or o-aminophenol, or o-toluidine with o-aminophenol, o-ethylaniline, o-phenylene diamine or with an amino anthracene.

- 38 -

18. An electroluminescent device as claimed in claim 12 in which the hole transmitting material is a conjugated polymer.
19. An electroluminescent device as claimed in claim 18 in which the conjugated polymer is selected from poly (p-phenylenevinylene)-PPV and copolymers including PPV, poly(2,5 dialkoxyphenylene vinylene), poly (2-methoxy-5-(2-methoxypentyloxy-1,4-phenylene vinylene), poly(2-methoxypentyloxy)-1,4-phenylenevinylene), poly(2-methoxy-5-(2-dodecyloxy-1,4-phenylenevinylene) and other poly(2,5 dialkoxyphenylenevinylenes) with at least one of the alkoxy groups being a long chain solubilising alkoxy group, poly fluorenes and oligofluorenes, polyphenylenes and oligophenylenes, polyanthracenes and oligo anthracenes, polythiophenes and oligothiophenes.
20. An electroluminescent device as claimed in any one of claims 11 to 19 in which the electroluminescent compound is mixed with the hole transmitting material.
21. An electroluminescent device as claimed in any one of claims 11 to 20 in which there is a layer of an electron transmitting material between the cathode and the electroluminescent compound layer.
22. An electroluminescent device as claimed in claim 21 in which the electron transmitting material is a metal quinolate.
23. An electroluminescent device as claimed in claim 18 in which the metal quinolate is an aluminium quinolate, zirconium quinolate or lithium quinolate.
24. An electroluminescent device as claimed in claim 21 in which the electron transmitting material is of formula  $Mx(DBM)_n$  where Mx is a metal and DBM is dibenzoyl methane and n is the valency of Mx.

25. An electroluminescent device as claimed in claim 21 in which the electron transmitting material is a cyano anthracene such as 9,10 dicyano anthracene, a polystyrene sulphonate or a compound of formulae shown in figures 2 or 3 of the drawings.
- 5
26. An electroluminescent device as claimed in any one of claims 21 to 25 in which the electron transmitting material is mixed with the electroluminescent compound.
- 10
27. An electroluminescent device as claimed in any one of claims 11 to 26 in which the first electrode is a transparent electricity conducting glass electrode.
28. An electroluminescent device as claimed in any one of claims 11 to 27 in which the second electrode is selected from aluminium, calcium, lithium, magnesium and alloys thereof and silver/magnesium alloys.
- 15

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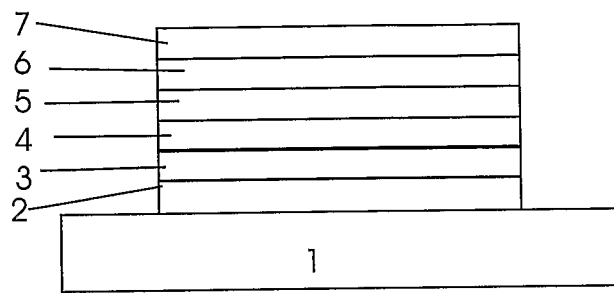
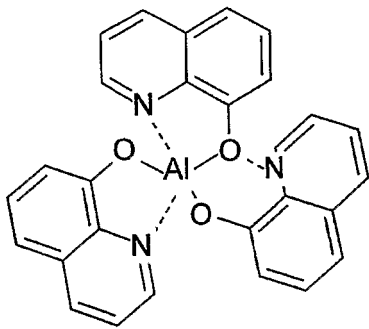
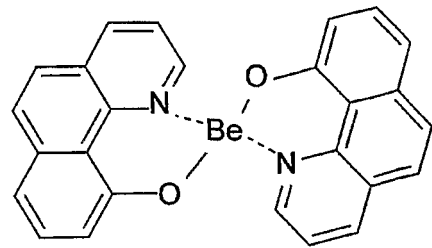


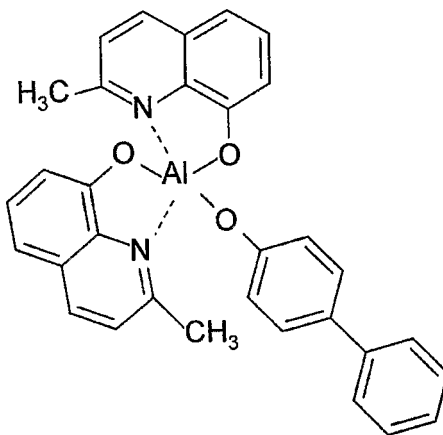
Fig. 1



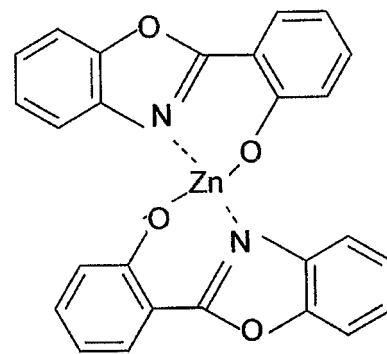
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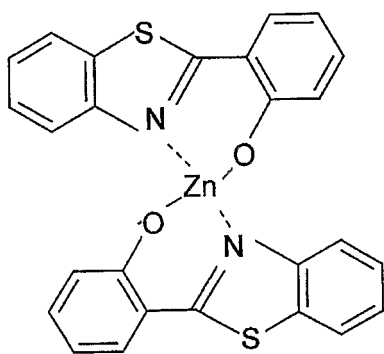
Bebq



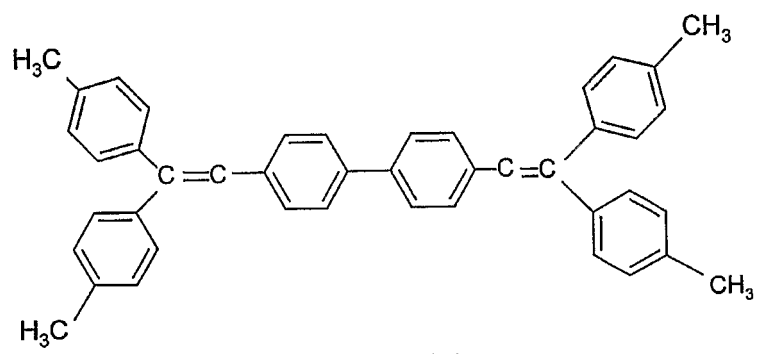
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ZnPBO



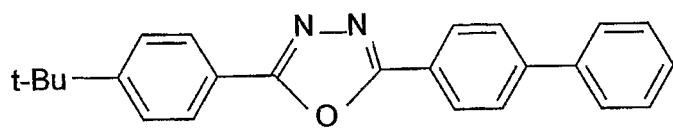
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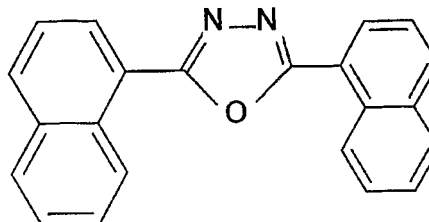
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Fig. 2

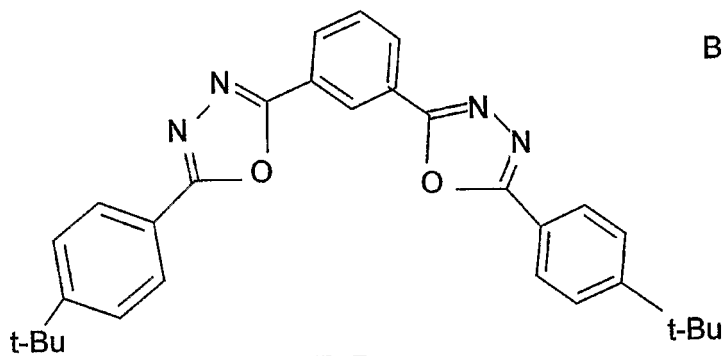
3/26



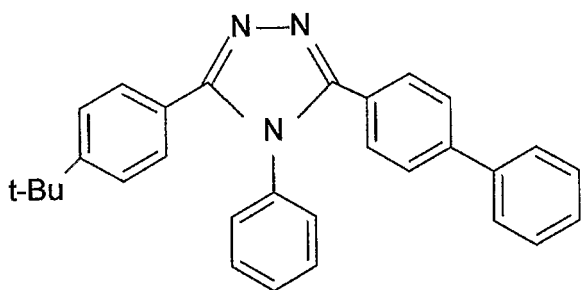
t-Bu-PBD



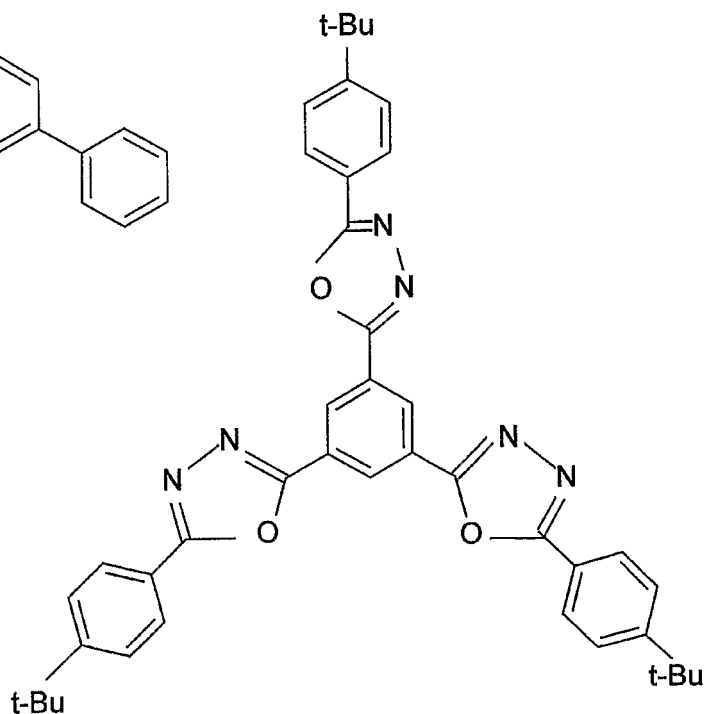
BND



OXD-7



TAZ



OXD-Star

Fig. 3

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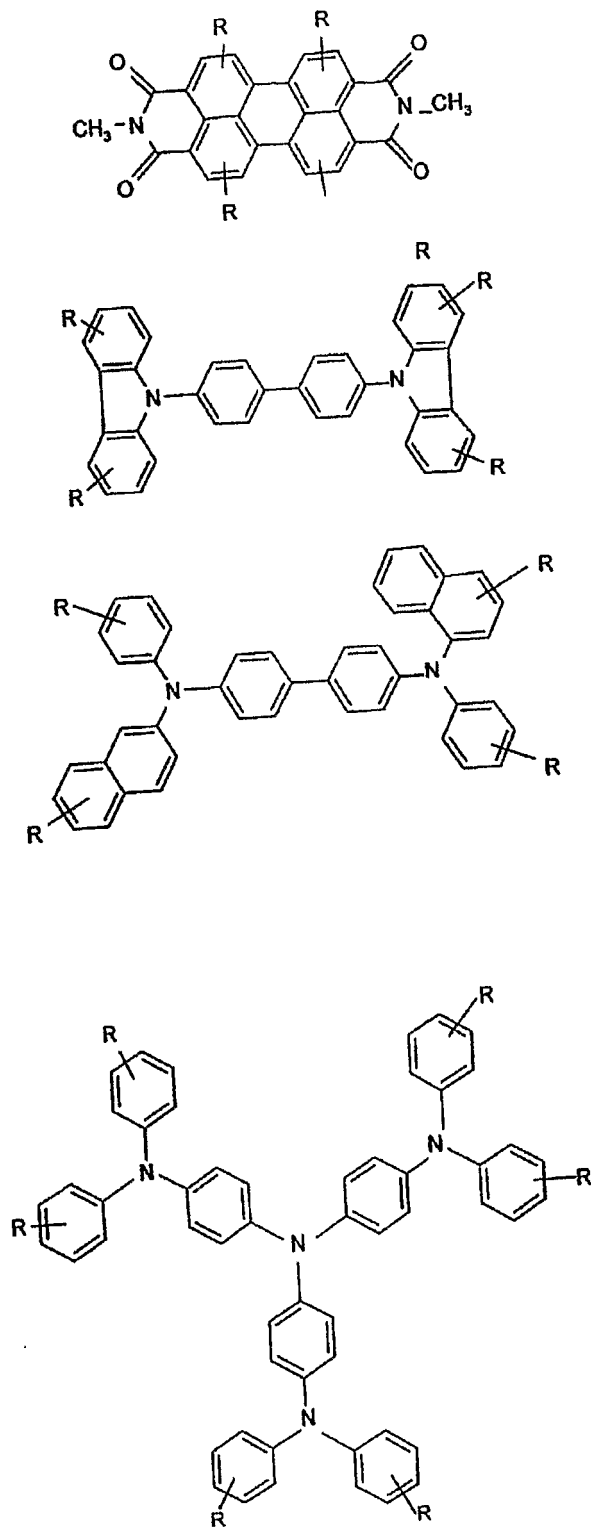


Fig. 4

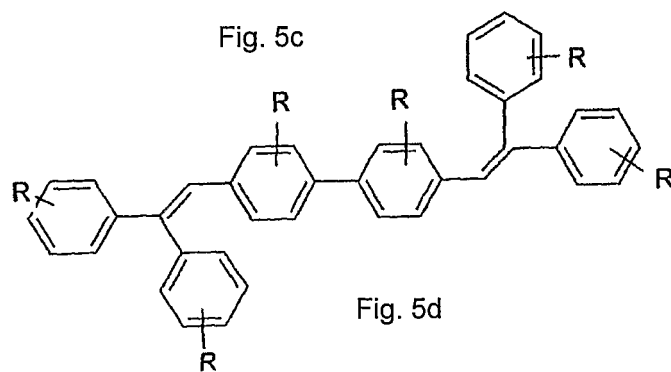
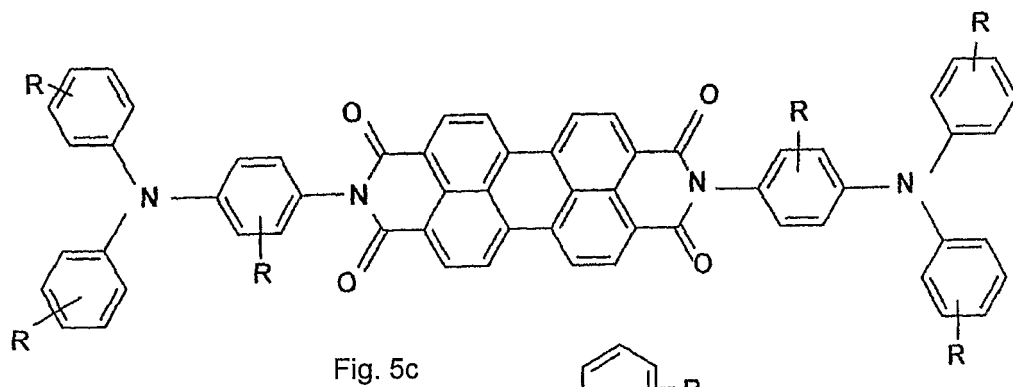
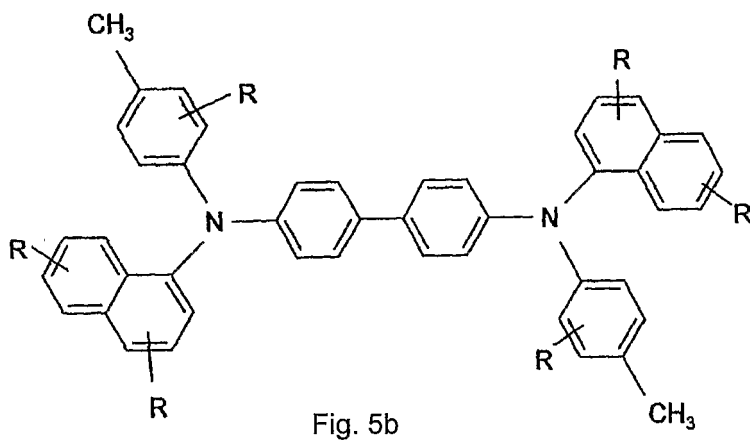
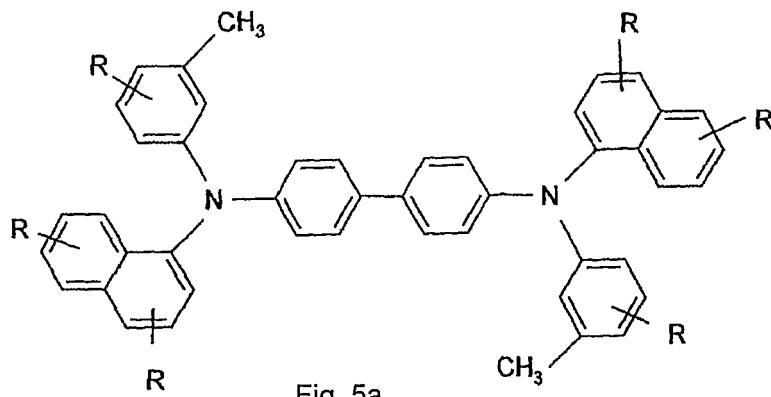
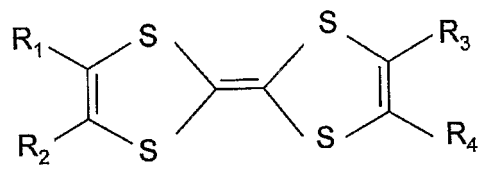
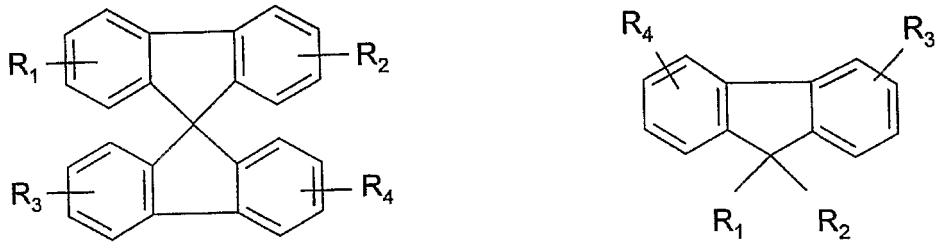


Fig. 5

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or

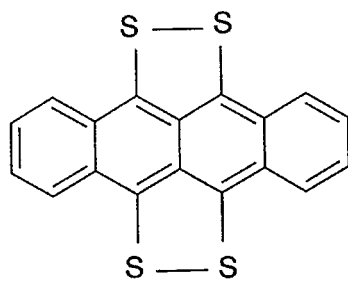
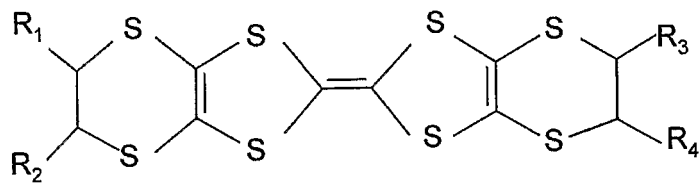


Fig. 6

7/26

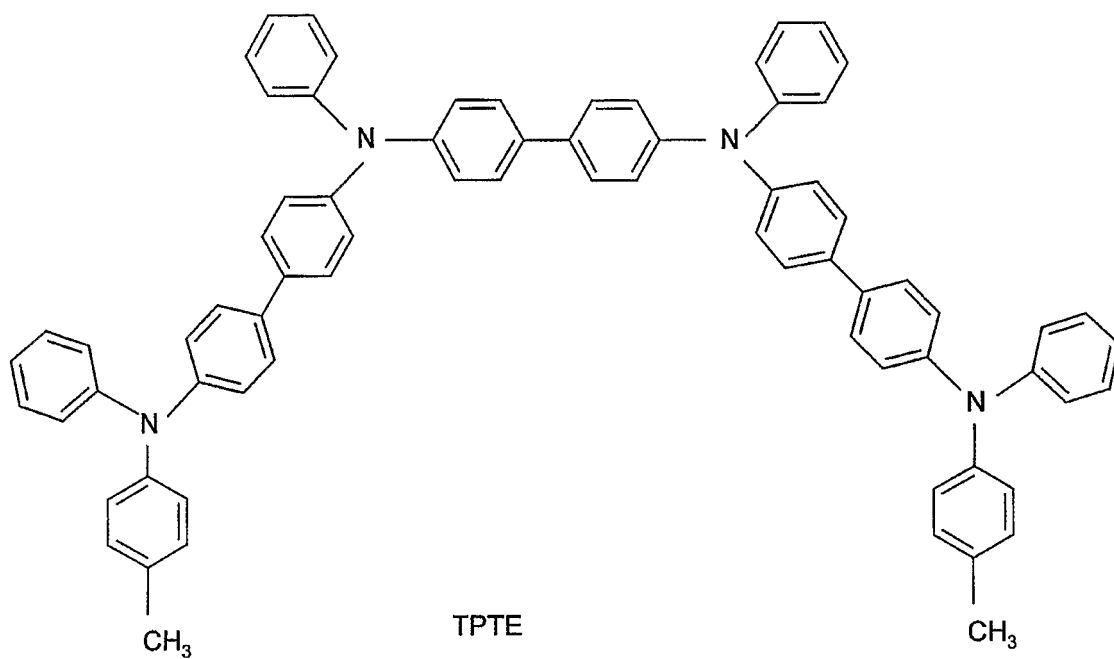
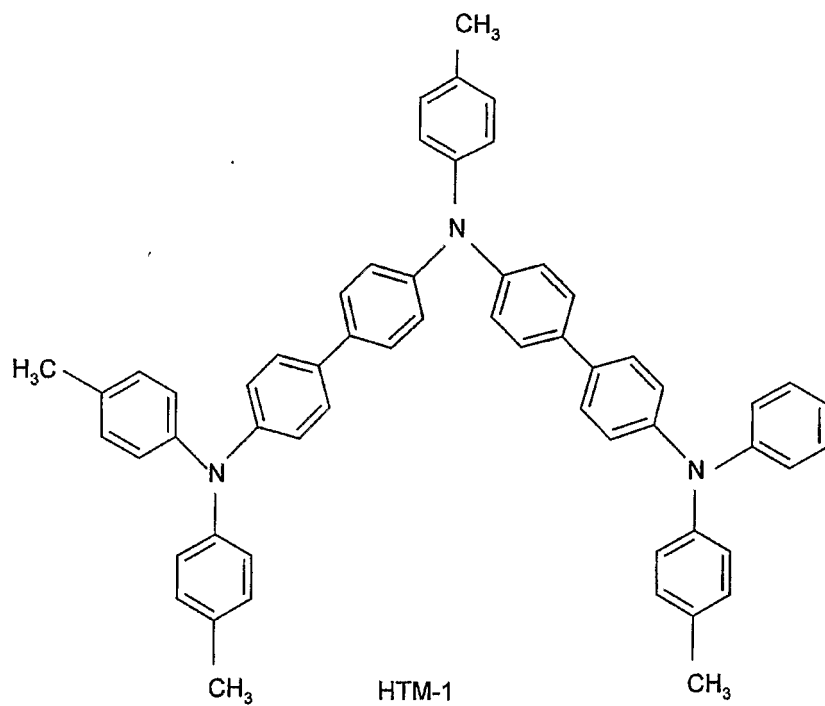
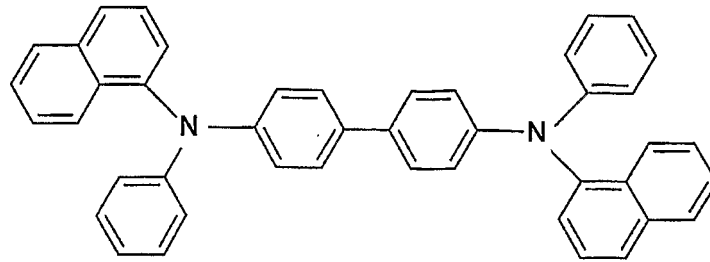
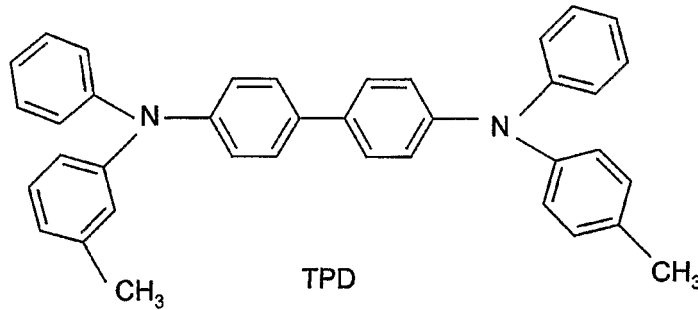


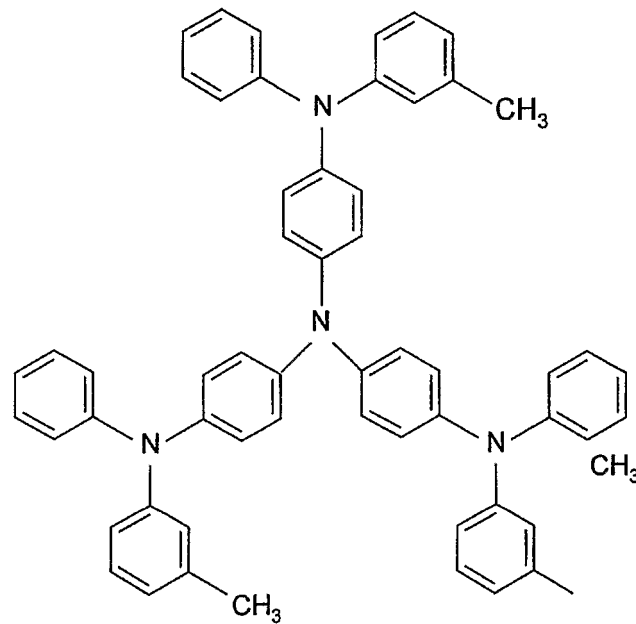
Fig. 7



$\alpha$ -NPB



TPD



mTADATA

Fig. 8

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ITO (165 nm)/CuPc (25 nm)/ $\alpha$ -NPB (40 nm)/TCTA : Compound A (38 : 2.1 nm)/Liq (30 nm)/LiF (0.5 nm)/Al

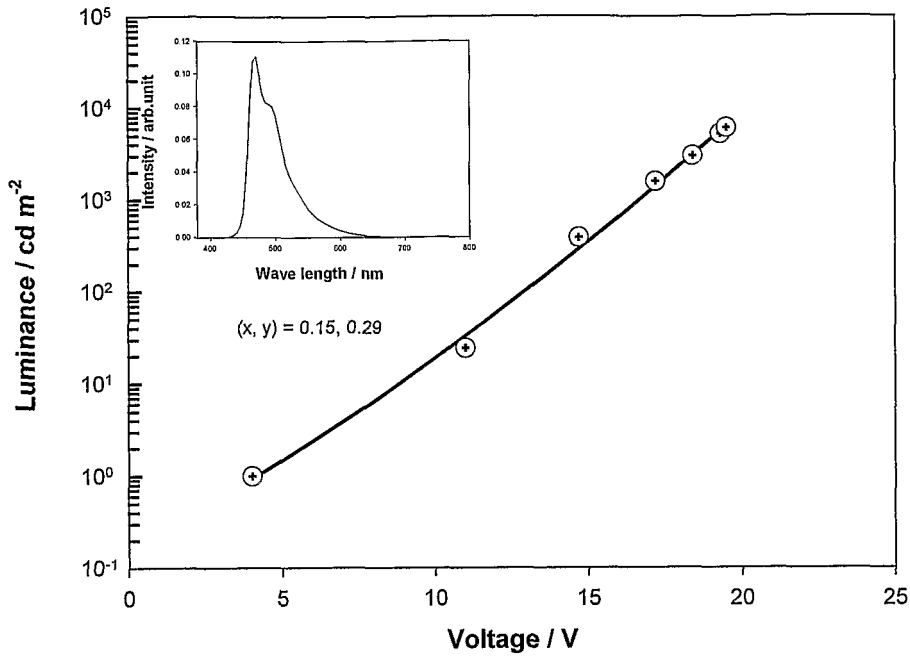


Fig. 9a

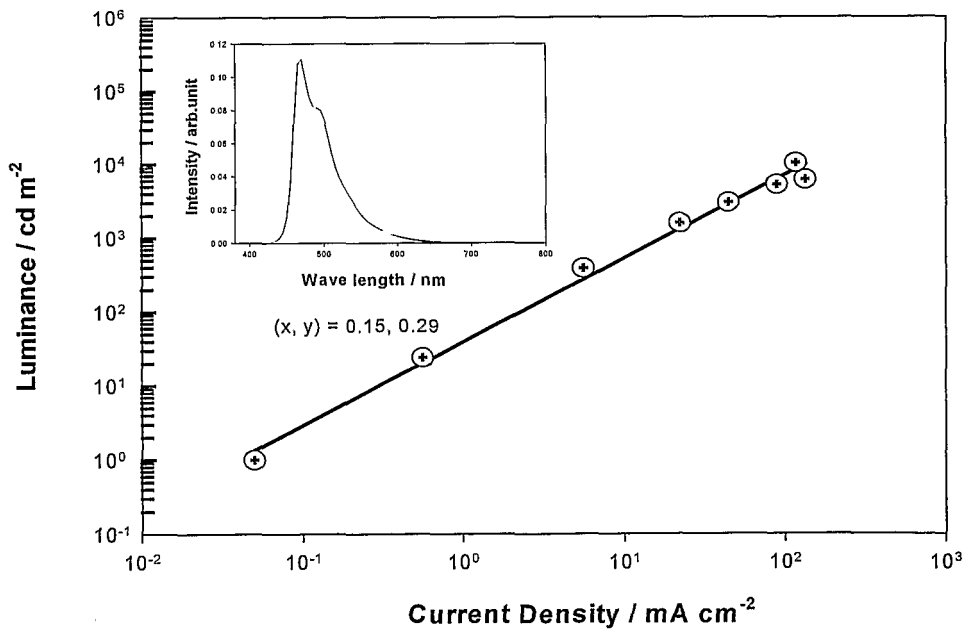


Fig. 9b

10/26

ITO (165 nm)/CuPc (25 nm)/ $\alpha$ -NPB (40 nm)/TCTA : Compound A (38 : 2.1 nm)/Liq (30 nm)/LiF (0.5 nm)/Al

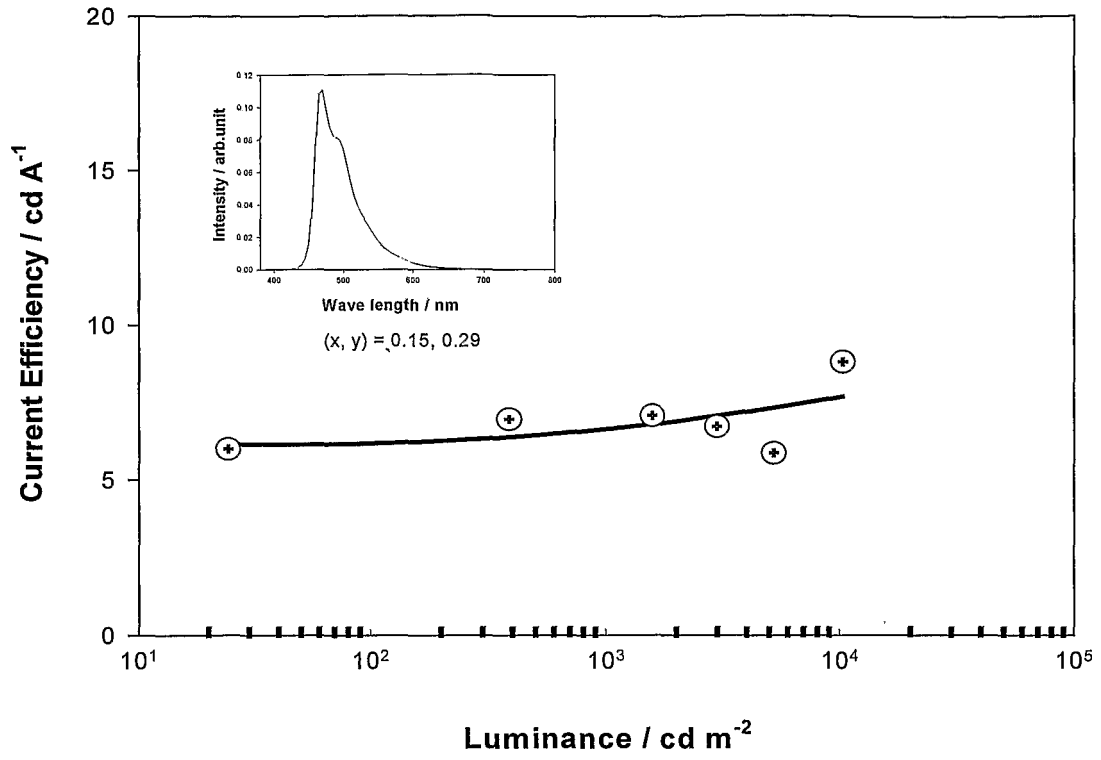


Fig. 9c

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ITO (165 nm)/CuPc (25 nm)/ $\alpha$ -NPB (40 nm)/TCTA : Compound F (37 : 3 nm)/Compound B (3 nm)/Zr<sub>q</sub>4 (30 nm)/LiF (0.5 nm)/Al

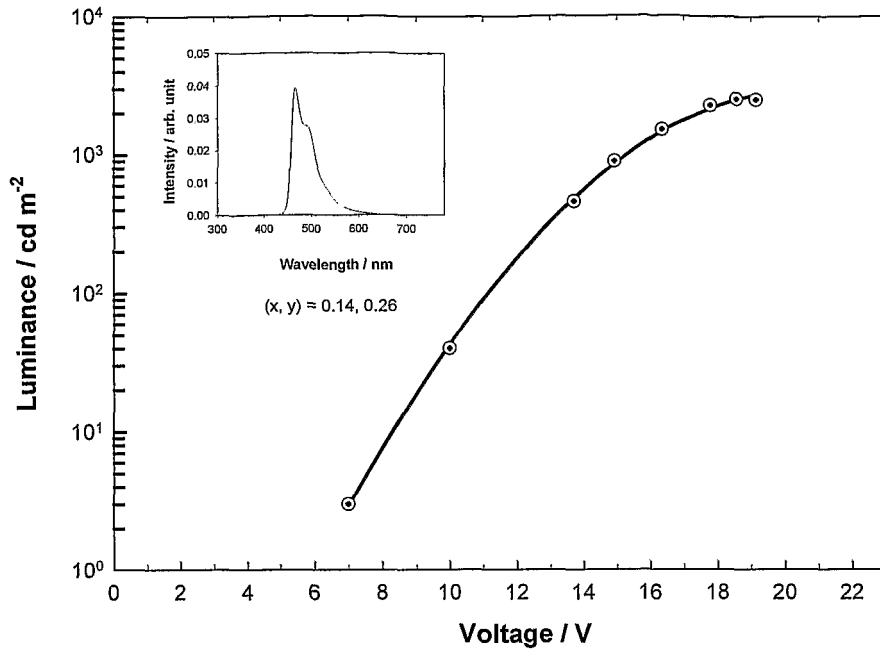


Fig. 10a

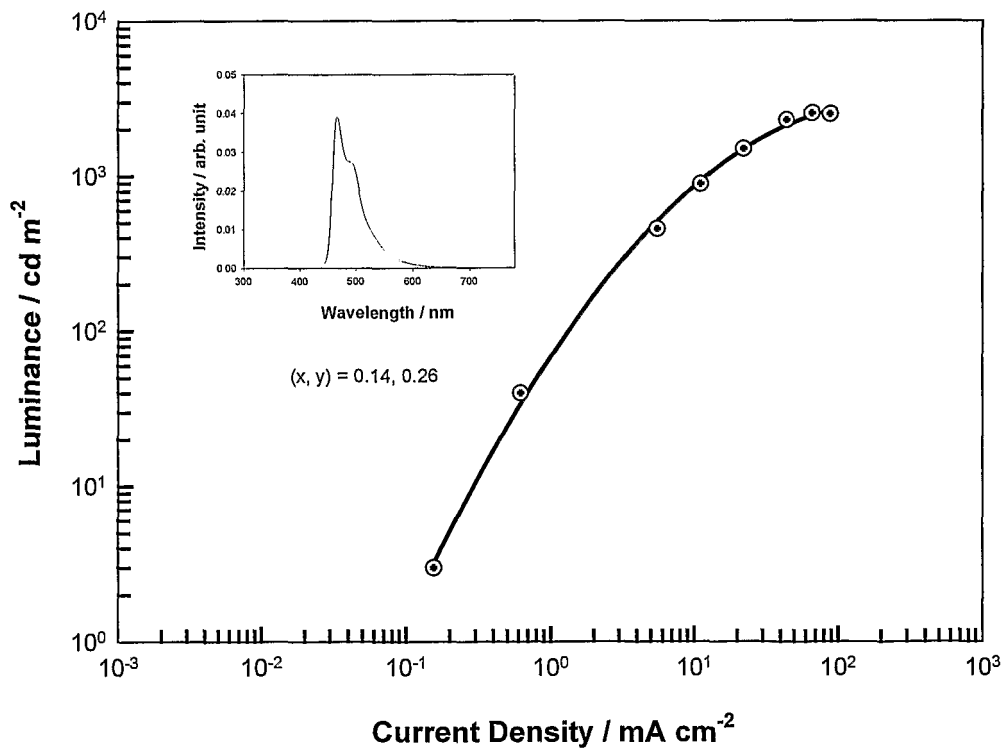


Fig. 10b

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ITO (165 nm)/CuPc (25 nm)/□-NPB (40 nm)/TCTA : Compound F (37 : 3 nm)/Compound B (3 nm)/Zr<sub>q</sub>4 (30 nm)/LiF (0.5 nm)/Al

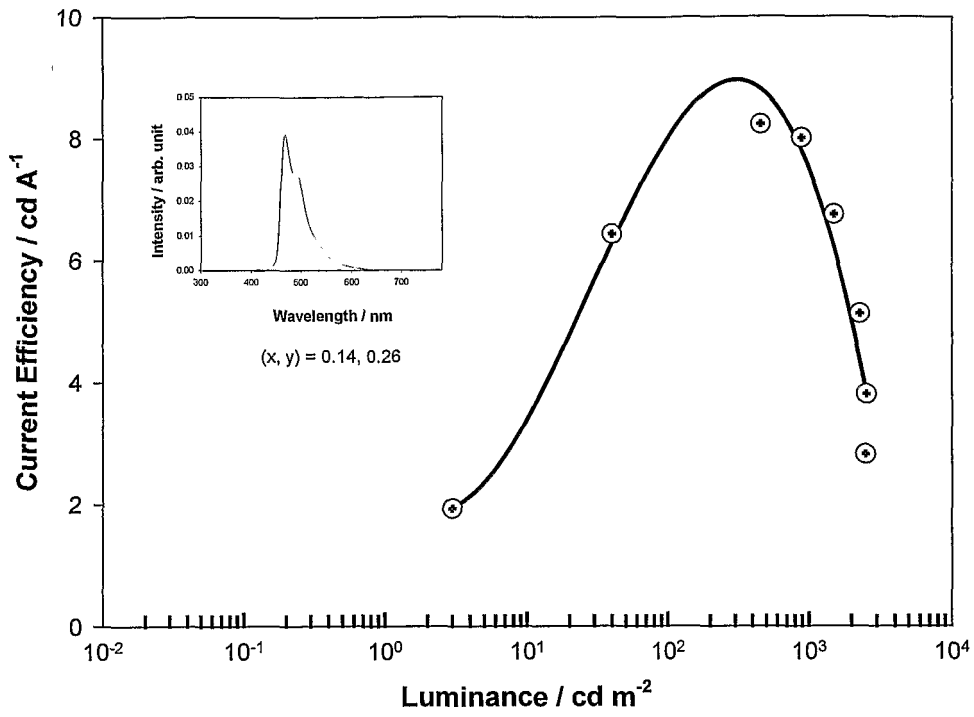


Fig. 10c

ITO (165 nm)/CuPc (25 nm)/ $\alpha$ -NPB (60 nm)/CBP : Compound D (20 : 1.3 nm)/BCP (6 nm)/Alq<sub>3</sub> (40 nm)/LiF (0.2

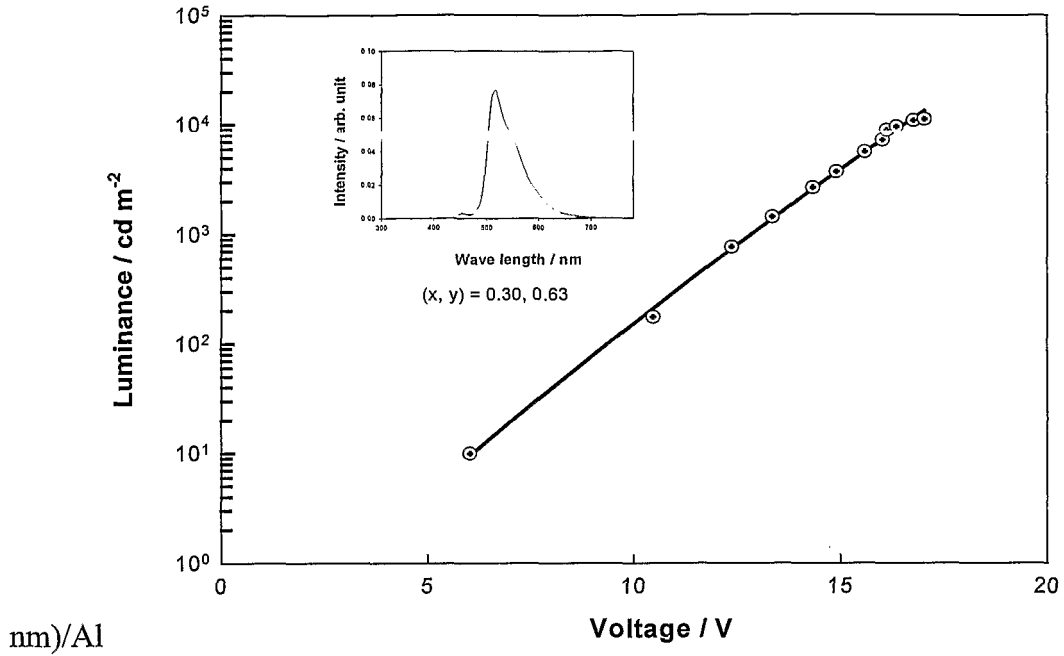


Fig. 11a

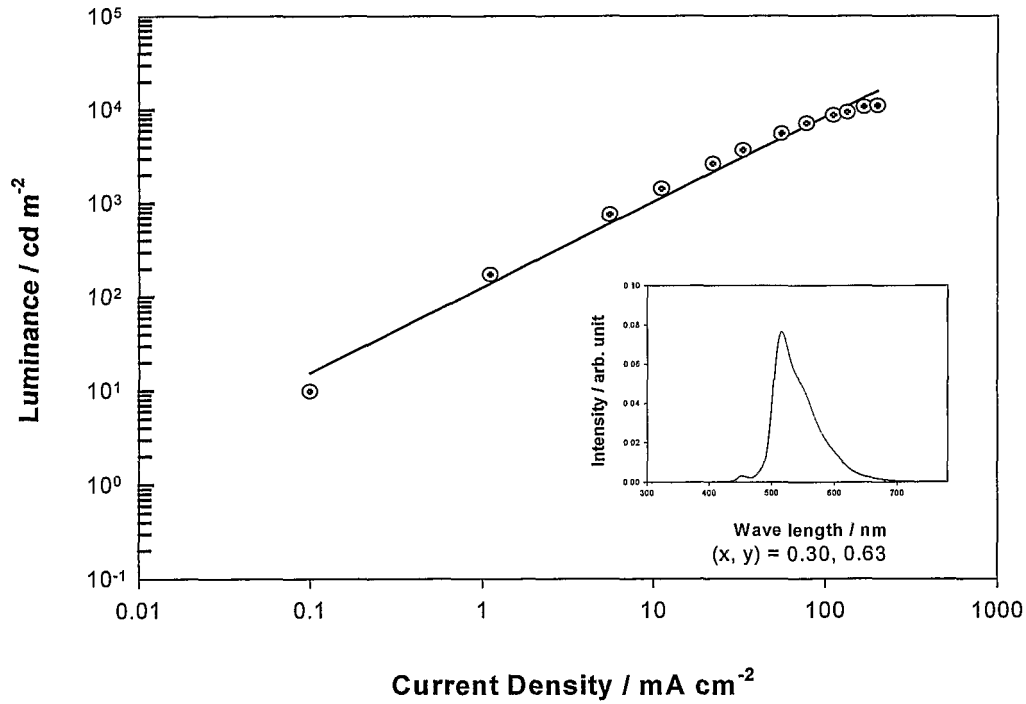


Fig. 11b

ITO (165 nm)/CuPc (25 nm)/ $\alpha$ -NPB (60 nm)/CBP : Compound J (20 : 1.3 nm)/BCP (6 nm)/Alq<sub>3</sub> (40 nm)/LiF (0.2 nm)/Al

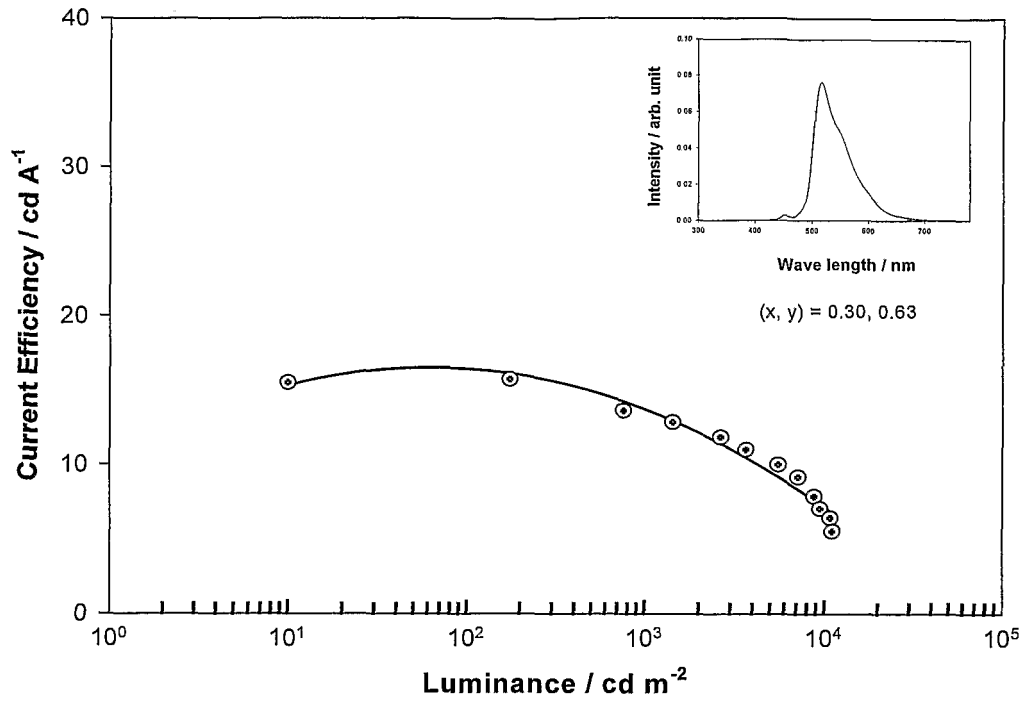


Fig. 11c

15/26

ITO (165 nm)/CuPc (25 nm)/ $\alpha$ -NPB (40 nm)/CBP : Compound D (20 : 0.6 nm)/BCP (6 nm)/Liq (40 nm)/LiF (0.5 nm)/Al

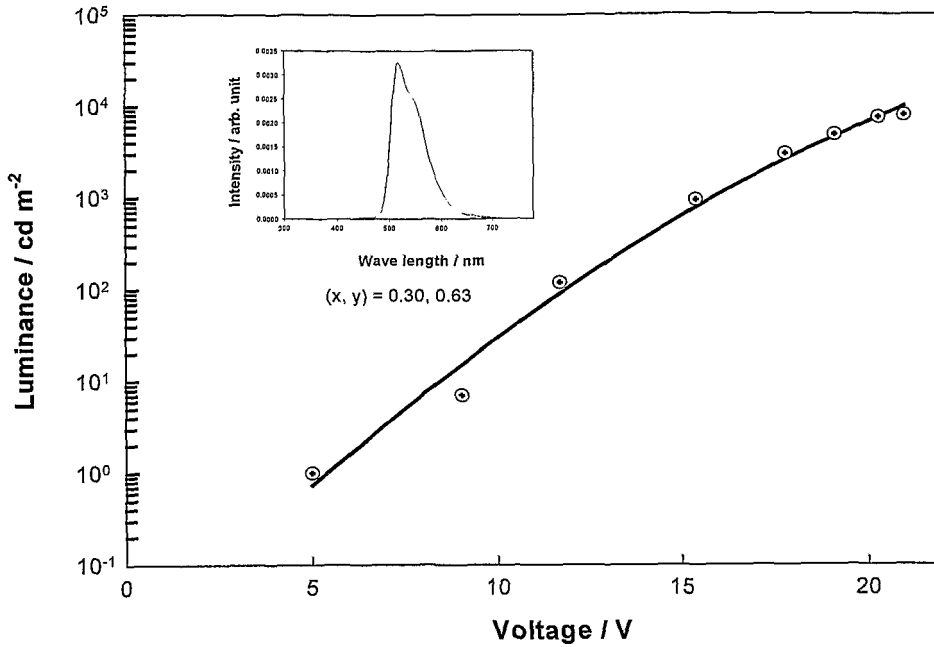


Fig. 12a

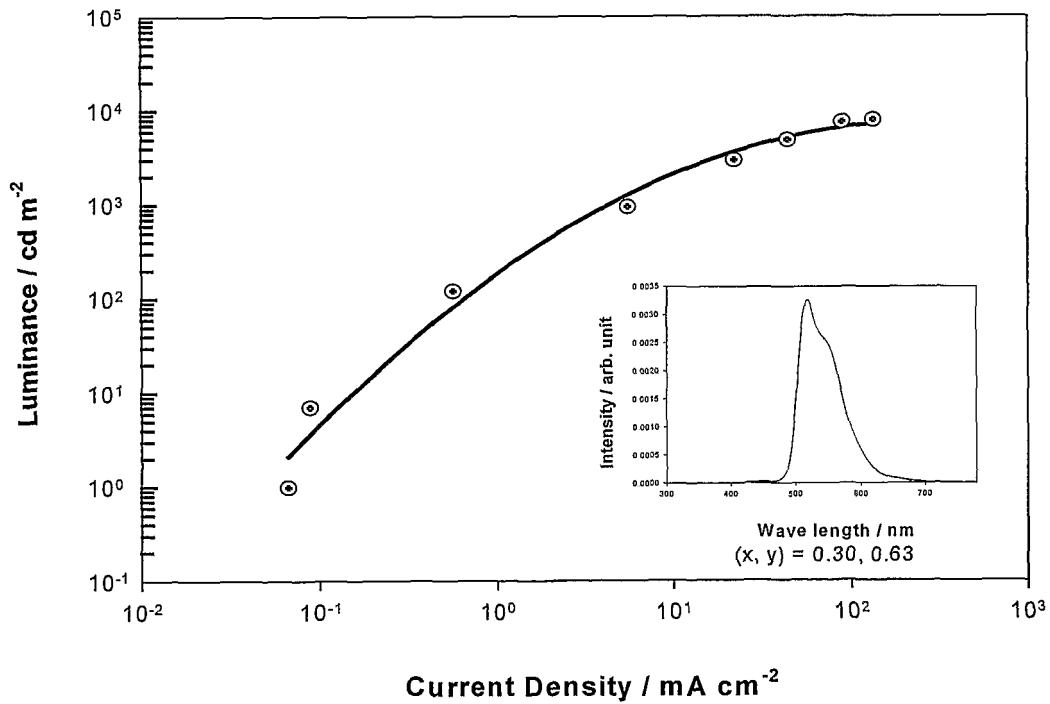


Fig. 12b

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ITO (165 nm)/CuPc (25 nm)/ $\alpha$ -NPB (40 nm)/CBP : Compound D (20 : 0.6 nm)/BCP (6 nm)/Liq (40 nm)/LiF (0.5 nm)/Al

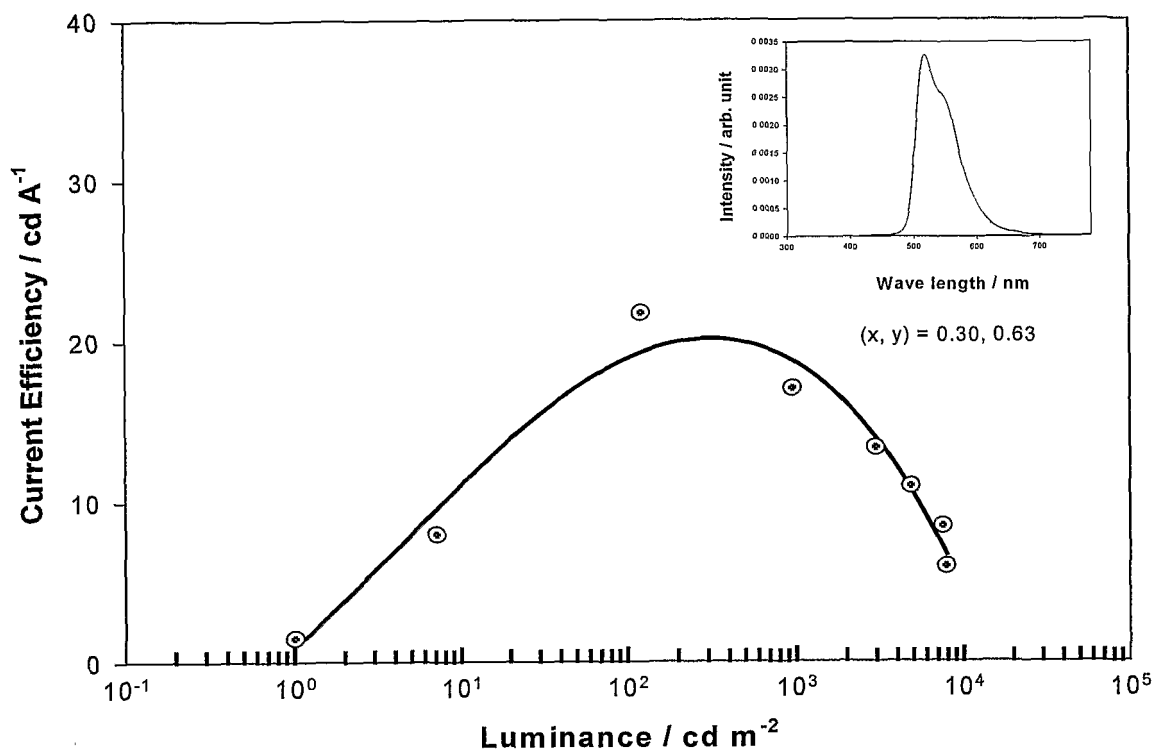


Fig. 12c

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ITO (165 nm)/ $\alpha$ -NPB (40 nm)/CBP : Compound D (20 : 7 nm)/BCP (10 nm)/Zr<sub>q</sub>4 (50 nm)/LiF (0.5 nm)/Al

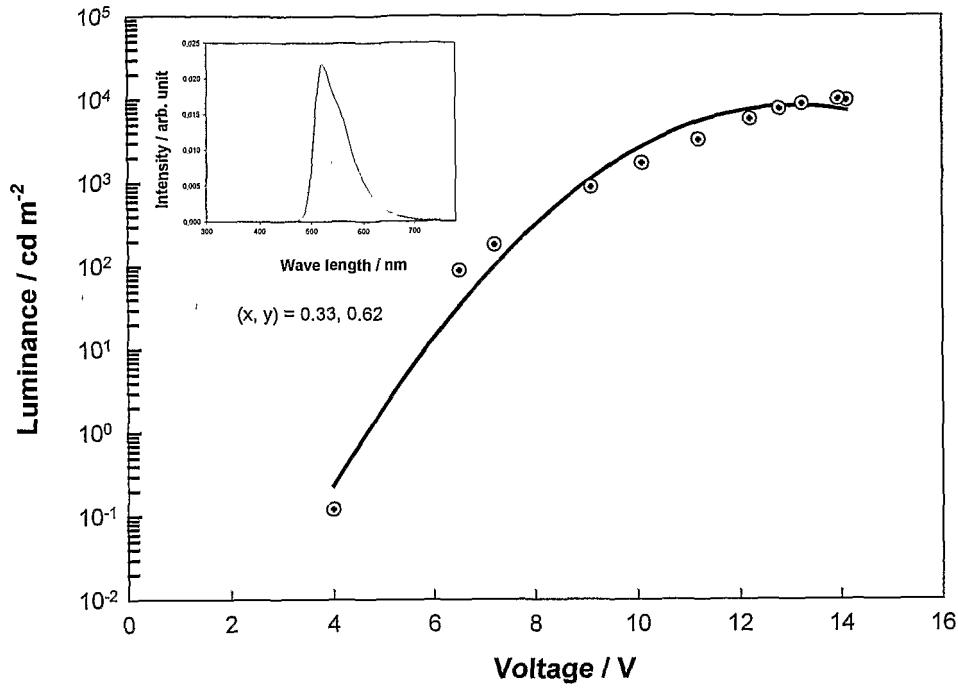


Fig. 13a

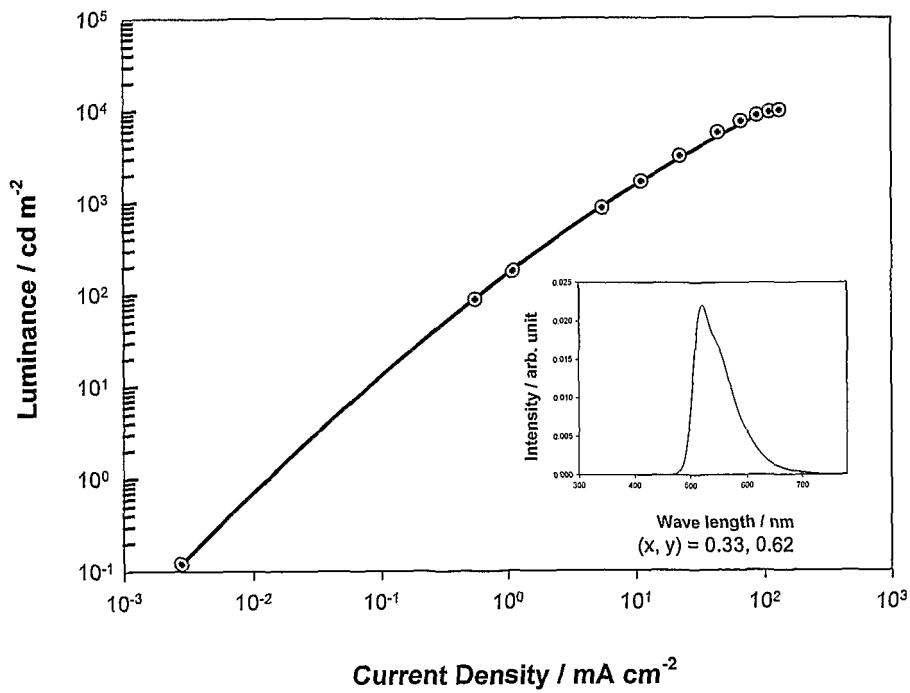


Fig. 13b

18/26

ITO (165 nm)/ $\alpha$ -NPB (40 nm)/CBP : Compound D (20 : 7 nm)/BCP (10 nm)/Zr<sub>q</sub>4 (50 nm)/LiF (0.5 nm)/Al

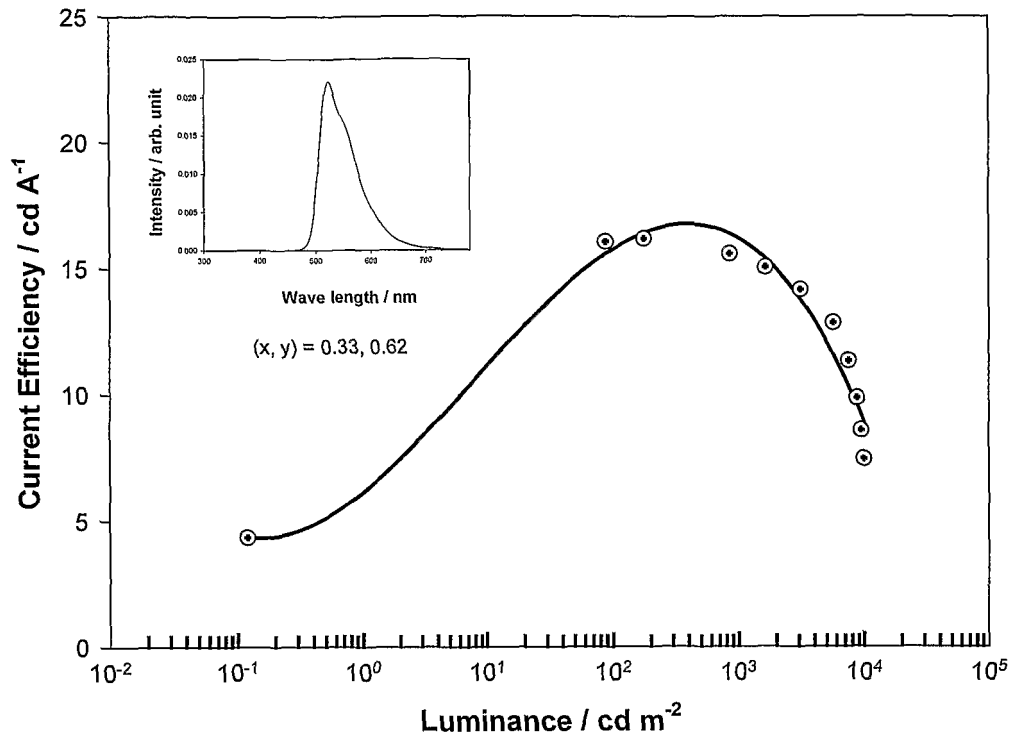


Fig. 13c

19/26

ITO (165 nm)/CuPc (25 nm)/ $\alpha$ -NPB (40 nm)/TCTA : Compound C (40 : 0.8 nm)/Liq (30 nm)/LiF (0.5 nm)/Al

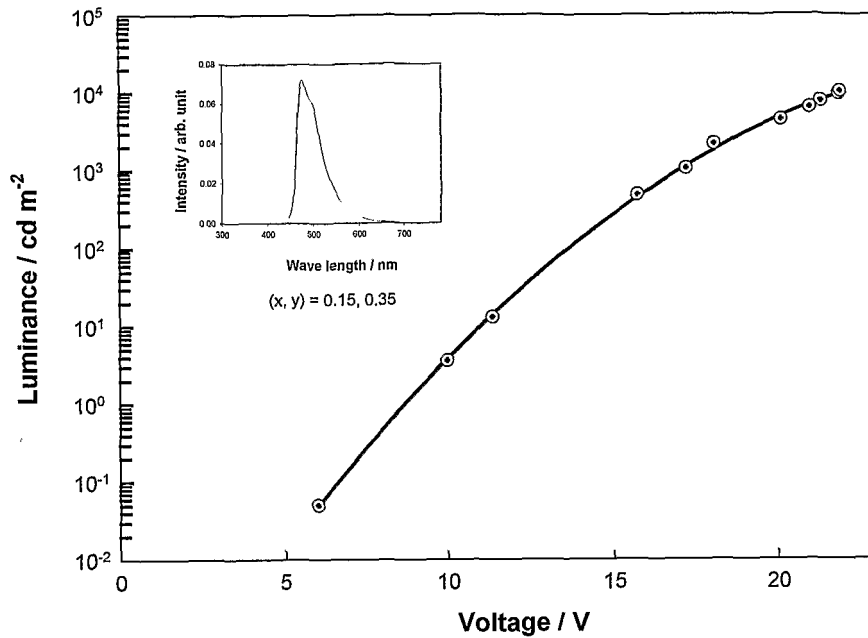


Fig. 14a

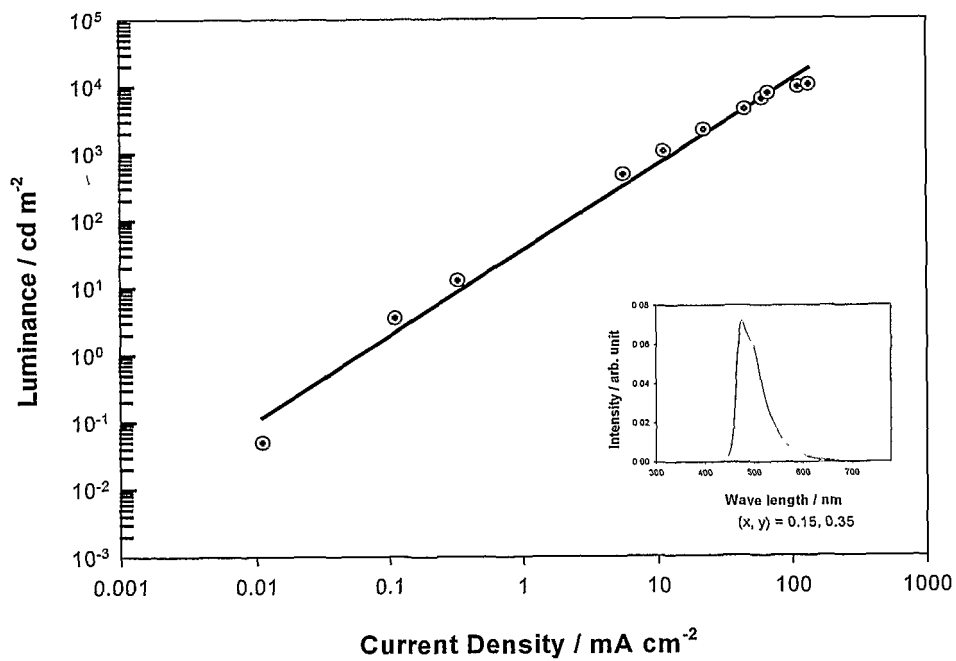


Fig. 14b

20/26

ITO (165 nm)/CuPc (25 nm)/ $\alpha$ -NPB (40 nm)/TCTA : Compound C (40 : 0.8 nm)/Liq (30 nm)/LiF (0.5 nm)/Al

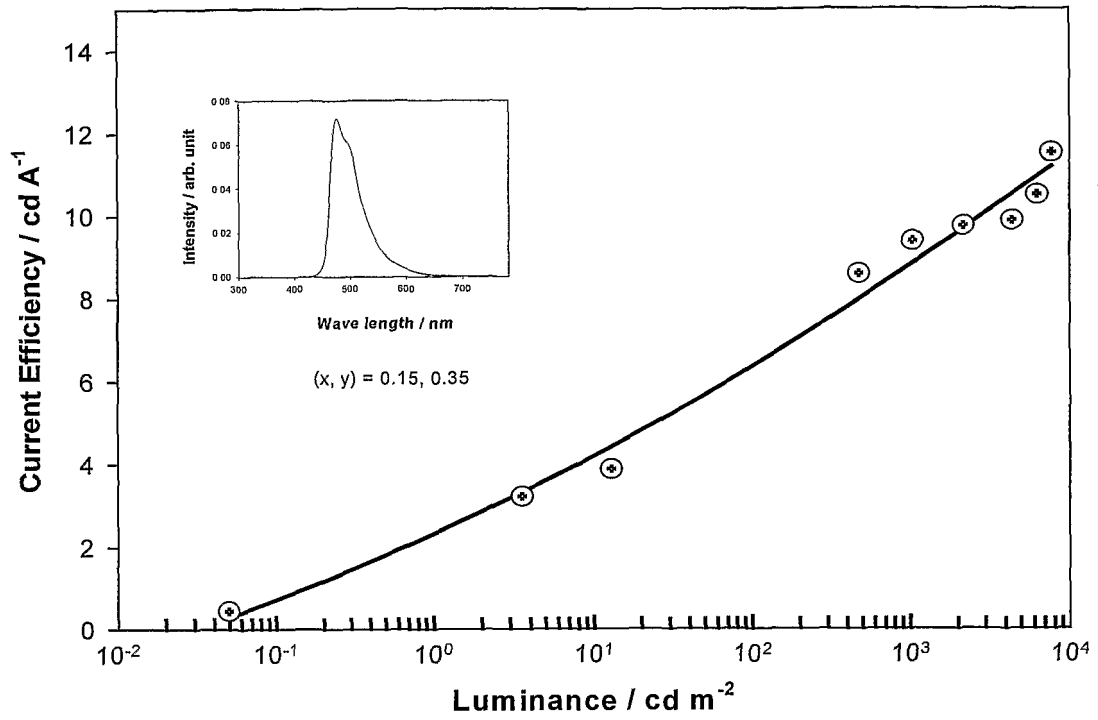


Fig. 14c

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ITO (165 nm)/ $\alpha$ -NPB (40 nm)/CBP : Compound D (20 : 8.3 nm)/  
Compound F (10 nm)/Zr<sub>q</sub> (50 nm)/LiF (0.5 nm)/Al

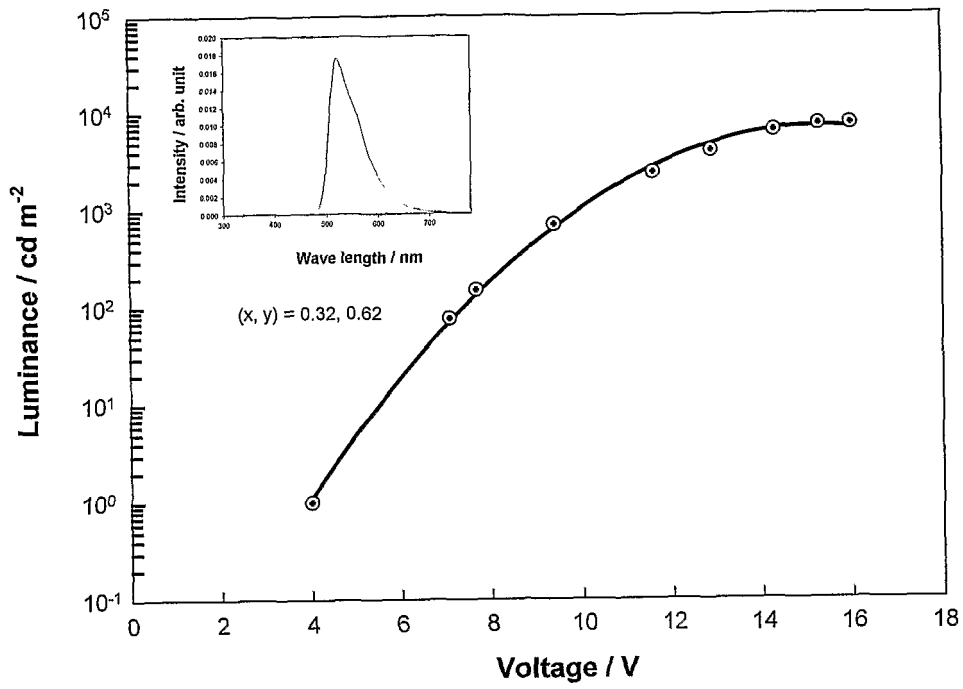


Fig. 15a

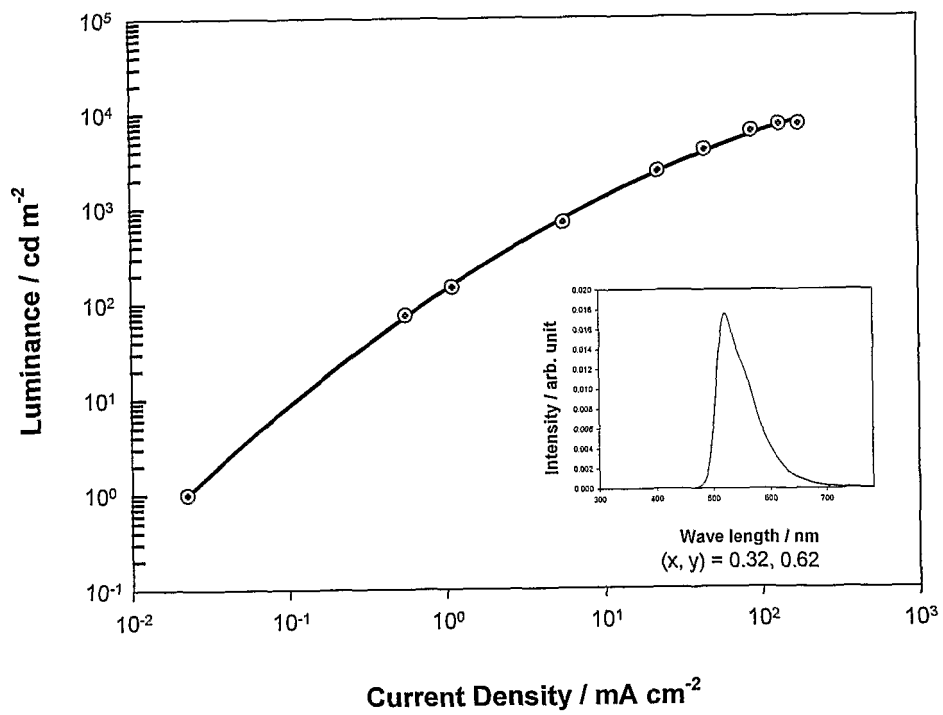


Fig. 15b

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ITO (165 nm)/ $\alpha$ -NPB (40 nm)/CBP : Compound D (20 : 8.3 nm)/  
Compound F (10 nm)/Zr<sub>q</sub>4 (50 nm)/LiF (0.5 nm)/Al

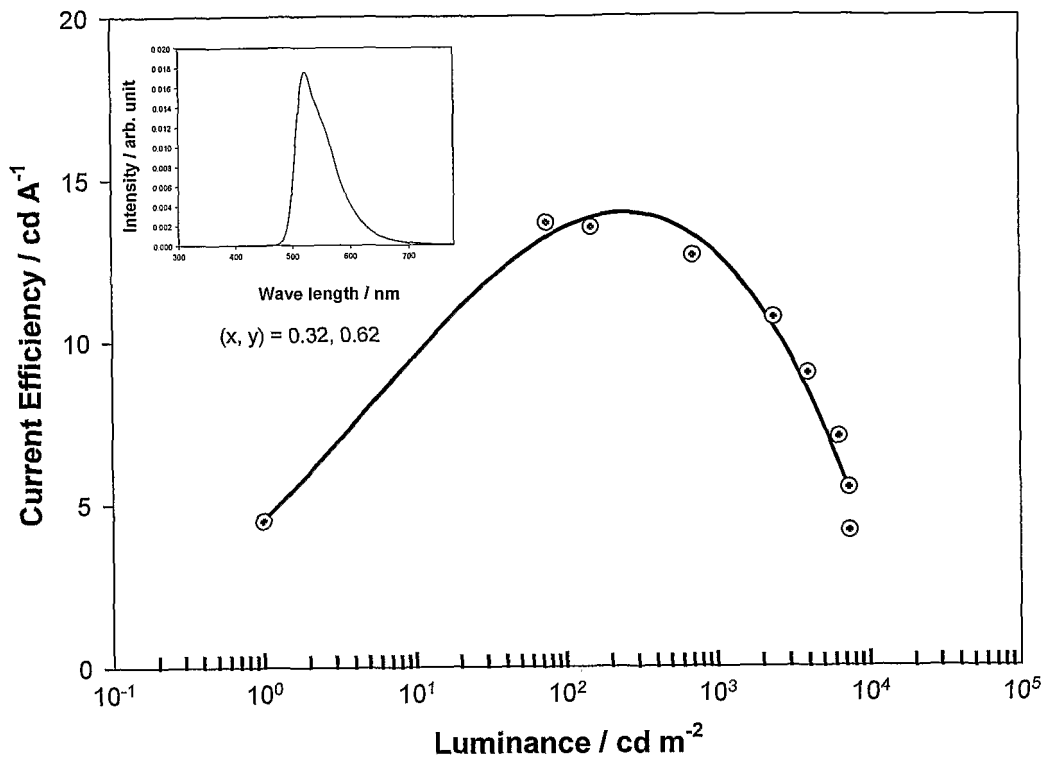


Fig. 15c

23/26

ITO (165 nm)/CuPc (25 nm)/ $\alpha$ -NPB (40 nm)/CBP : Compound E (35 : 5 nm)/Zr<sub>q</sub>4 (30 nm)/LiF (0.5 nm)/Al

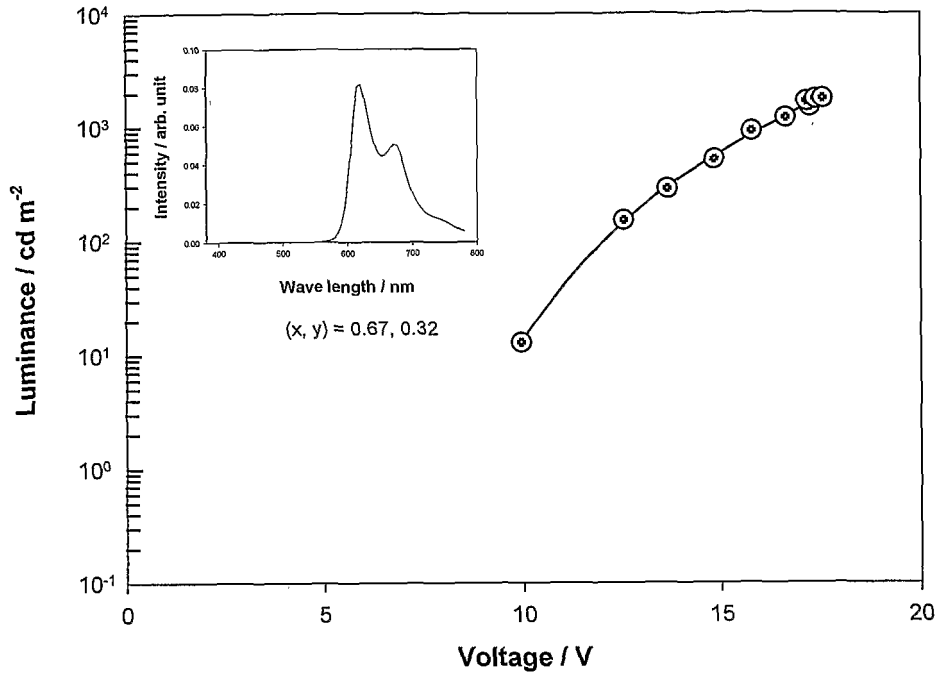


Fig. 16a

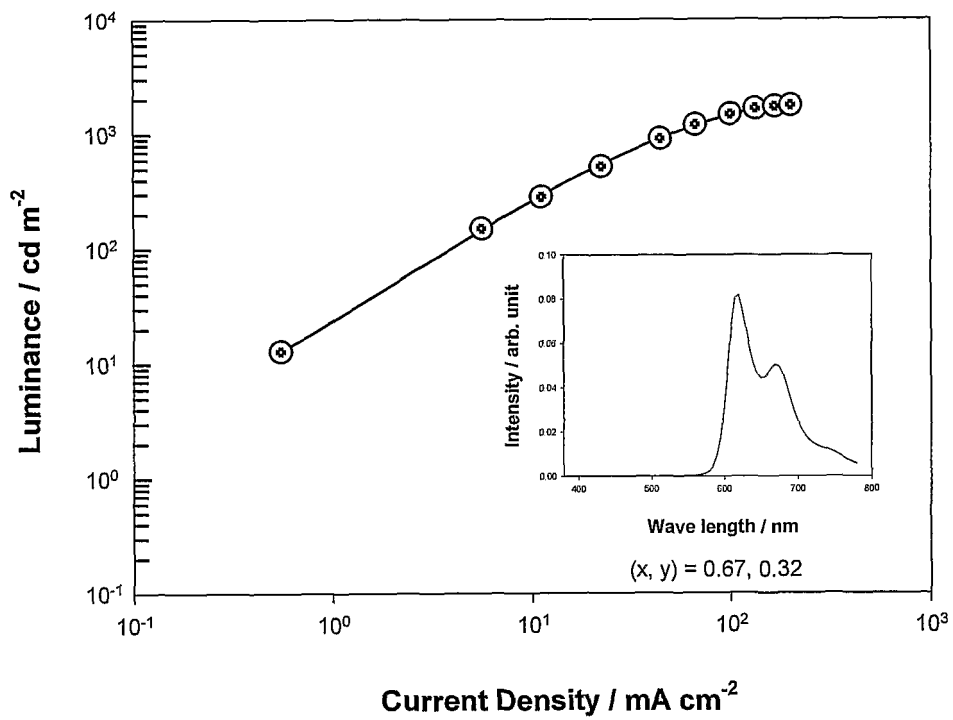


Fig. 16b

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ITO (165 nm)/CuPc (25 nm)/  $\alpha$ -NPB (40 nm)/CBP : Compound E (35 : 5 nm)/Zr<sub>q</sub>4 (30 nm)/LiF (0.5 nm)/Al

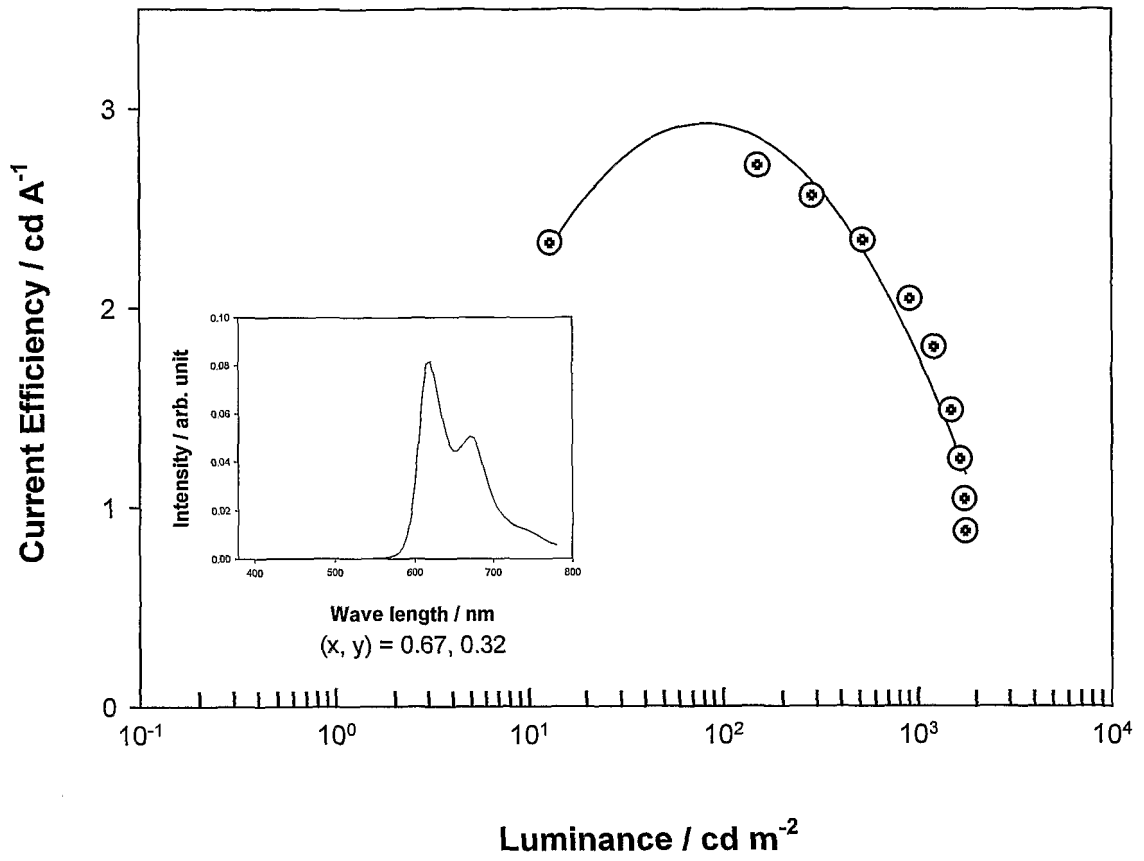


Fig. 16c

ITO (165 nm)/CuPc (50 nm)/  $\alpha$ -NPB (40 nm)/CBP : Compound D (20 : 6.1 nm)/Compound F (10 nm)/Zr<sub>q</sub> (50 nm)/LiF (0.5 nm)/Al

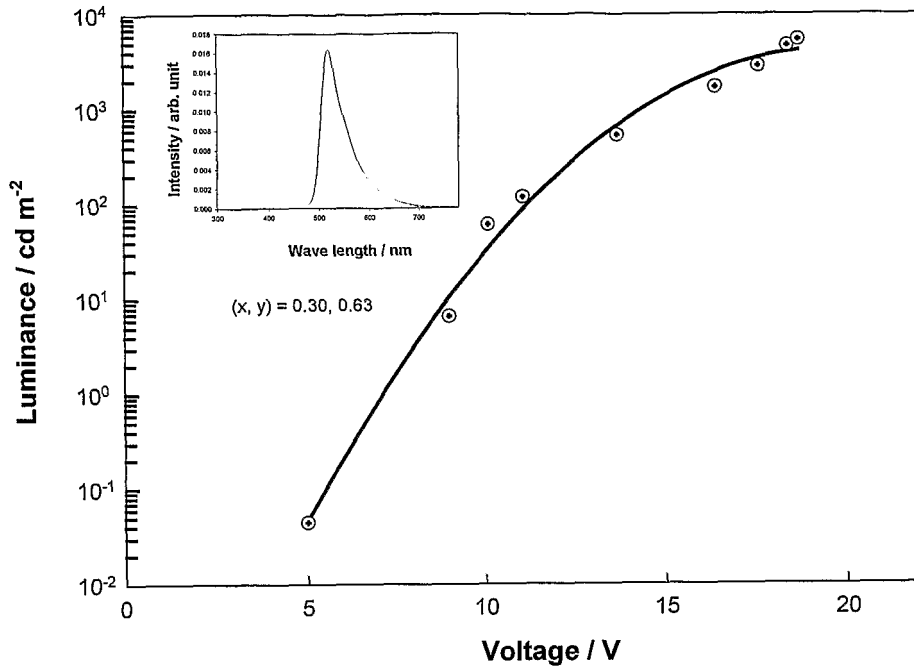


Fig. 17a

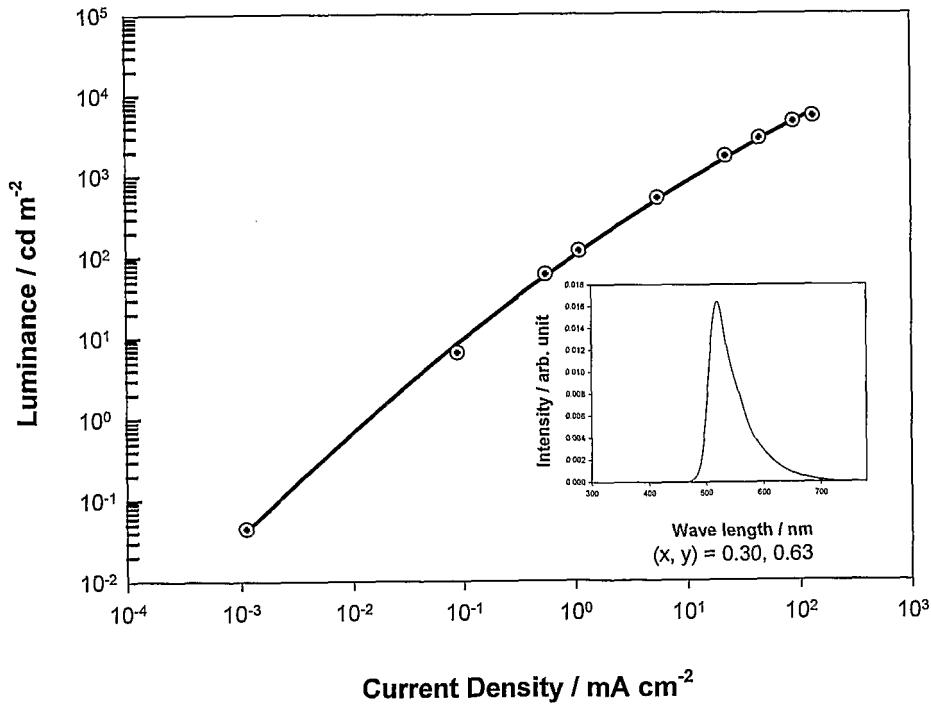


Fig. 17b

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ITO (165 nm)/CuPc (50 nm)/  $\alpha$ -NPB (40 nm)/CBP : Compound D (20 : 6.1 nm)/Compound F (10 nm)/Zr<sub>q</sub> (50 nm)/LiF (0.5 nm)/Al

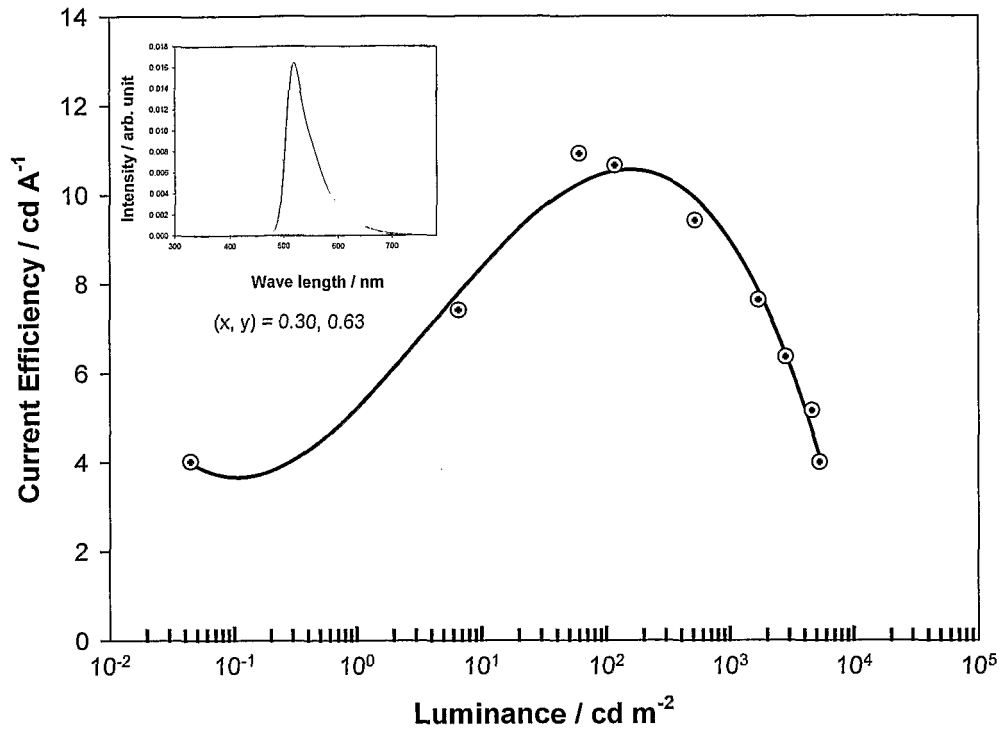


Fig. 17c

专利名称(译)	电致发光材料和器件		
公开(公告)号	<a href="#">EP1723213A2</a>	公开(公告)日	2006-11-22
申请号	EP2005708271	申请日	2005-02-10
[标]申请(专利权)人(译)	OLED - T有限公司		
申请(专利权)人(译)	OLED-T有限公司		
当前申请(专利权)人(译)	MERCK PATENT GMBH		
[标]发明人	KATHIRGAMANATHAN POOPATHY PRICE RICHARD GANESHAMURUGAN SUBRAMANIAM PARAMASWARA GNANAMOLY KUMARAVARL MUTTULINGHAM PARTHEEPAN ARUMUGAM SELVARANJAN SELVADURAI ANTIPAN LARA JUAN SURENDRAKUMAR SIVAGNANASUNDRAM		
发明人	KATHIRGAMANATHAN, POOPATHY PRICE, RICHARD GANESHAMURUGAN, SUBRAMANIAM PARAMASWARA, GNANAMOLY KUMARAVARL, MUTTULINGHAM PARTHEEPAN, ARUMUGAM SELVARANJAN, SELVADURAI ANTIPAN-LARA, JUAN SURENDRAKUMAR, SIVAGNANASUNDRAM		
IPC分类号	C09K11/06 H01L51/30 H01L51/00 H01L51/50		
CPC分类号	H01L51/5016 H01L51/0085 Y10S428/917		
代理机构(译)	LUCAS , BRIAN RONALD		
优先权	2004003322 2004-02-14 GB		
外部链接	<a href="#">Espacenet</a>		

摘要(译)

新型铱络合物是电致发光的。

