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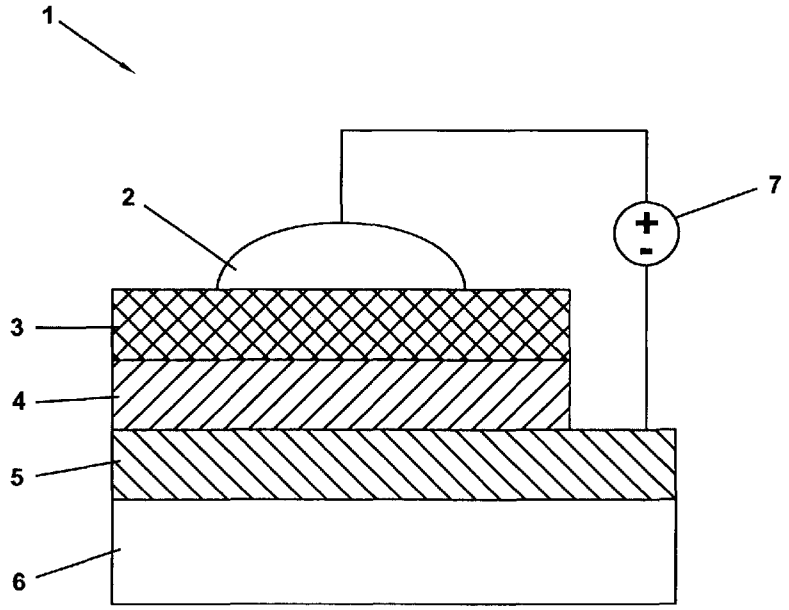
(54) Title: METHODS FOR PRODUCING ELECTROLUMINESCENT DEVICES BY SCREEN PRINTING



(57) Abstract: The present invention includes methods for fabrication polymer light emitting devices (1) by screen-printing. These light emitting devices use silver paste as the top electrode (2), eliminating the use of evaporated low work function metal. This is made possible by the presence of a buffer layer such as the sulfonated polyaniline layer in the structure of SCALE devices. These devices allow a very inexpensive and fast means to form stable top electrodes for large-scale polymer light emitting device fabrication.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

METHODS FOR PRODUCING ELECTROLUMINESCENT DEVICES BY SCREEN PRINTING

This application claims the benefit of U.S. Provisional Application Serial No. 60/308,276, filed on July 27, 2001, which is incorporated herein by reference.

The present invention arose through work supported in part by Office of Naval Research. The United States Government may have certain rights to this invention under 35 U.S.C. Section 200 et seq.

Technical Field of the Invention

This invention relates to light-emitting devices driven by an electric field and which are commonly referred to as electroluminescent devices.

Background of the Invention

Conjugated polymers have proven to be excellent candidates for low cost large area display applications, due to unique properties such as electroluminescence (EL), solution processibility, band gap tunability and mechanical flexibility. A major advantage of the conjugated polymer light emitting devices (LEDs) is their potential capability of using web based roll-to-roll processing. If realized, the manufacturing cost of polymer LEDs for large area applications may be significantly reduced. In the past few years, polymer LEDs have made remarkable progress toward commercialization, though the effort is mainly focused on small-area applications.

Typical single layer polymer LEDs are constructed by sandwiching a thin layer of luminescent conjugated polymer between two electrodes, an anode and a cathode, where at least one of the electrodes is either transparent or semi-transparent. In some multilayer devices, charge injection and transport layers may be incorporated to improve the device performance. For selected multilayer devices, electrons and holes combine at the interfaces to form exciplexes that emit light of a different color than either of the polymers comprising the interface. When a high electric field is applied between the electrodes in these devices, electrons are injected from the cathode and holes injected from the anode into the polymer layers. The injected charges recombine and decay radiatively to emit light. The double charge injection mechanism of such polymer LEDs requires matching of the cathode (anode) work function to the corresponding LUMO (HOMO) level of the polymer with which the electrode is in contact, in order to achieve efficient charge injection. Indium-tin-oxide (ITO) is widely used as the anode material for polymer LEDs because it is conductive, transparent and has a relatively high work function that is close to the HOMO level of many conjugated polymers. Because most conjugated polymers have relatively low electron affinity, however, they require metals with low work functions as the cathode material to achieve efficient electron injection. Low work function metals are generally oxygen reactive, leading to which are usually unstable. Devices with low work function cathodes may even degrade during storage.

In a typical polymer LED, the polymer layers are formed by spin-casting or other similar techniques, such as dip-coating, that are more suitable for large area processing. The cathode, on the other hand, is almost exclusively formed by vacuum

deposition techniques such as thermal evaporation or sputtering of low work function metals or alloys. These vacuum deposition techniques are expensive, slow, and not well suited for large area processing.

It is thus an object of the present invention to provide a method of fabrication that provides a fast, inexpensive means of fabricating polymer light emitting devices suitable for large area applications.

Although described with respect to the field of light-emitting devices driven by an electric field, it will be appreciated that similar advantages of fast, inexpensive fabrication, as well as other advantages, may obtain in other applications of the present invention. Such advantages may become apparent to one of ordinary skill in the art in light of the present disclosure or through practice of the invention.

Summary of the Invention

The present invention includes electroluminescent polymer devices and electroluminescent polymer systems. The present invention also includes machines and instruments using those aspects of the invention. Included in the present invention are methods for the fabrication of such devices by screen printing. The methods of the present invention may be applied using procedures and protocols known and used in the arts to which they pertain. The methods of the present invention may be used to manufacture unipolar LED devices, bipolar SCALE devcies and bipolar two-color SCALE devices. The present invention may be used to upgrade, repair, or retrofit existing machines or instruments using those aspects of the invention, using methods and components used in the art.

Method for preparing a layered composite

In broadest terms, the method of the present invention for preparing a layered composite capable of forming a light-emitting device comprises the steps of: (1) obtaining a substrate material comprising a layer of an electrode material; (2) forming an emitting layer on the substrate material, the emitting layer capable of functioning as a light-emitting layer in a light-emitting device; and (3) applying a conductive paste material to the emitting layer, such as silver paste, the conductive paste material comprising a layer of an electrode material. The emitting layer may also be coated with an appropriate buffer layer prior to application of said conductive paste material, such as a layer of an appropriate semiconducting or conducting polymer.

The conductive paste material may applied by a technique such as painting, spraying, or screen-printing. The substrate material may consist of a material such as flexible ITO-coated PET or ITO-coated glass, thus the substrate may be either flexible or rigid. The substrate material may also be substantially impermeable to either oxygen or water. The emitting layer may be selected from the group consisting of light emitting molecules, oligomers, polymers, their derivatives and blends thereof. Further the emittng layer may itself be comprised of multiple layers. In the case of a multi-layered emitting layer, each sub-layer of the multi-layerd emitting layer may be separately chosen from light emitting molecules, oligomers and polymers. The semiconducting and conducting polymers may be selected from the group consisting of polyanilines, polythiophenes, polypyrroles, their derivatives, their copolymers and blends thereof.

The electrodes of the present invention may be patterned, such as for pixelation.

Examples of conductive pastes that may be used in the present invention include: silver paste, gold paste, graphite paste, carbon paste or other particulate conductors dispersed in a medium allowing it to be applied by printing or screen printing technologies.

Examples of light emitting molecules that may be used in the emitting layer include: tris(8-quinolinolato)aluminum, bis(2-(2-hydroxyphenyl)pyridinato)beryllium, anthracene, tris(2-phenylpyridine)iridium doped in a host of 4,4'-N,N'-dicarbazol-biphenyl, their derivatives and blends thereof.

Examples of light emitting oligomers that may be used in the emitting layer include: oligo(phenylenevinylene)s, sexithiophene, oligo(thiophene)s, oligo(pyridine)s, their derivatives and blends thereof.

Examples of light emitting polymers that may be used in the emitting layer include: poly(arylene vinylene)s, poly(phenylene)s, poly(fluorene)s, poly(vinyl carbazole), poly(pyridine), poly(pyridyl vinylene), poly(phenylene vinylene pyridyl vinylene), their derivatives, their copolymers and blends thereof.

Layered composite

Also included in the present invention is, in broadest terms, a layered composite capable of forming a light-emitting device comprising: (1) a substrate material comprising a layer of an electrode material; (2) an emitting layer formed on the substrate material, the emitting layer capable of functioning as a light-emitting layer in a light-emitting device; and (3) a conductive paste material such as silver

paste applied to the emitting layer, the conductive paste material comprising a layer of an electrode material. The layered composite may additionally comprise an appropriate buffer layer between the emitting layer and the conductive paste material. The buffer layer may be selected from the group consisting of semiconducting and conducting polymers.

The conductive paste material of the layered composite may be applied by a technique such as painting, spraying, or screen-printing. The substrate material may be selected from the group consisting of flexible ITO-coated PET and ITO-coated glass. The substrate material may also be substantially impermeable to either oxygen or water. The emitting layer may be selected from the group consisting of light emitting molecules, oligomers and polymers, their derivatives, coplymers and blends such as PPV, PPyVPV, PTP and poly(flourene)s. The semiconducting and conducting polymers may be selected from the group consisting of polyanilines, polypyrroles or blends of PPyVPV and PTP.

The electrodes of the present invention may be patterned, such as for pixelation.

Examples of conductive pastes that may be used in the present invention include: silver paste, gold paste, graphite paste, carbon paste or other particulate conductors dispersed in a medium allowing it to be applied by printing or screen printing technologies.

Examples of light emitting molecules that may be used in the emitting layer include: tris(8-quinolinolato)aluminum, bis(2-(2-hydroxyphenyl)pyridinato)beryllium, anthracene, tris(2-phenylpyridine)iridium doped in a host of 4,4'-N,N'-dicarbazol-biphenyl, their derivatives and blends thereof.

Examples of light emitting oligomers that may be used in the emitting layer include: oligo(phenylenevinylene)s, sexithiophene, oligo(thiophene)s, oligo(pyridine)s, their derivatives and blends thereof.

Examples of light emitting polymers that may be used in the emitting layer include: poly(arylene vinylene)s, poly(phenylene)s, poly(fluorene)s, poly(vinyl carbazole), poly(pyridine), poly(pyridyl vinylene), poly(phenylene vinylene pyridyl vinylene), their derivatives, their copolymers and blends thereof.

Brief Description of the Drawings

Figure 1 shows repeat units of the materials of the present invention: (a) poly(pyridyl vinylene phenylene vinylene) (PPyVPV); (b) poly(thienylene phenylene) (PTP); (c) sulfonated polyaniline (SPAN).

Figure 2 is a side elevational view of a polymer light-emitting device using silver paste as the top electrode in accordance with one embodiment of the present invention.

Figure 3 shows the current-voltage and luminance-voltage characteristics for the ITO/PPyVPV:PTP/silver paste device of the present invention.

Figure 4 shows a variation of the EL intensity (solid line) with time of a ITO/PPyVPV:PTP/silver paste device of the present invention.

Detailed Description of the Preferred Embodiments

In accordance with the foregoing summary, the following present a detailed description of the preferred embodiment of the invention that is currently considered to be the best mode.

The present invention presents a method for the fabrication of working light-emitting devices using silver paste as the cathode. This may be made possible by the presence of a buffer layer comprised of a semiconducting polymer (such as the emeraldine base form of polyaniline) or a conducting polymer, such as sulfonated polyaniline (SPAN). To eliminate the use of low work function metals, one may either use polymers with high electron affinities or modify the charge injection characteristics at the polymer/electrode interfaces.

Along these lines, a preferred embodiment of the present invention utilizes pyridine containing conjugated polymers and copolymers (which have higher electron affinities than their phenyl analogs) as the emitting materials and novel device configurations such as symmetrically configured AC light-emitting (SCALE) devices. These devices may modify the charge injection and/or transport characteristics such that their operations are insensitive to the electrode materials used. As a consequence, more stable metals such as Al or Au may be used as electrodes.

Using the novel structure of SCALE devices with a structure of substrate/ITO/emitting layer/SPAN, the top electrode may be formed simply by painting the silver paste over the SPAN layer. This may allow a very inexpensive and fast means to form a stable top electrode. When high resolution is needed, the electrode may be formed by screen printing techniques. Unlike the vacuum

deposition techniques, the screen printing technique is compatible with web based processing on flexible substrate for low cost, large quantity production.

In a preferred embodiment, a copolymer of poly(pyridyl vinylene) and poly(phenylene vinylene) derivative, poly(pyridyl vinylene phenylene vinylene) (PPyVPV), and a copolymer of polythiophene and polyphenylene derivative, poly(thienylene phenylene) (PTP), may be used as the emitting materials. Blends of PPyVPV and PTP may be successfully used as active layers in SCALE devices, particularly color variable bipolar/AC light emitting devices. SPAN is a water-soluble self-doped conducting polymer with a conductivity of about 0.01 S/cm. Figure 1 shows the chemical structures of PPyVPV, PTP and SPAN. The device structure **1** is shown schematically in Figure 2. The PPyVPV:PTP (3:2 weight ratio) blend layer **4** may be formed by spin-casting at about 2000 rpm from trichloroethylene or xylenes solution (total concentration of about 10 mg/ml) onto a pre-cleaned patterned ITO **5** coated glass or flexible PET substrate **6**. The SPAN layer **3** may be subsequently spin coated over the emitting layer **4** from an aqueous solution (50 mg/ml). In pixilated displays, in order to minimize the probability of cross-talk, a blend of SPAN and poly(vinyl alcohol) (PVA) (1: 1 weight ratio) may be used to reduce the lateral conductance between the pixels. The top electrode **2** may be deposited simply by applying a silver paste, such as SPI #5063, on top of the SPAN layer **3**. Care may be taken to avoid solvent penetration into the polymer layers. A driving voltage source **7** may then be connected to the anode **6** and cathode **3** layers.

In an second embodiment, blend layer **4** may be comprised of multiple sub-layers of molecules, oligomers and polymers. In such an embodiment, the electron

transport layers would be closer to the cathode while the hole transport layers would be closer to the anode. Suitable electron transport layer materials may be comprised of polymeric or molecular materials. Preferred polymeric electron transport layer materials include: poly(pyridine) and poly(oxadiazole)s. Preferred molecular electron transport layer materials include: tris(8-quinolinolato)aluminum nad 2-(4'-biphenyl)-5-(4"-tert-butylphenyl)-1,3,4-oxadiazole. Similarly, suitable hole transport materials may be comprised of polymeric or molecular materials. Preferred polymeric hole transport layer materials include: poly(vinyl carbazole) and poly(arylene vinylene)s. Preferred hole transport layer materials include: aromatic diamines and starburst polyamines.

Electroluminescence may be measured using a fluorometer. The current-voltage (I-V) characteristics may be measured simultaneously with EL output while dc voltages are continuously applied. A computer may record the I-V-EL data, and quantum efficiency and brightness calculated. All device-testing procedures may be performed in air on as-made devices without any encapsulation.

Figure 3 shows the current-voltage and luminance-voltage characteristics of a device configured as in Figure 2. The devices have typical turn on voltages of about 4-8 V depending upon film thickness. The devices may generate light under either polarity of driving voltage with different colors of light being emitted, red under forward bias (ITO positive) and green under reverse bias. Internal device efficiencies of about 0.1% photons/electron may be achieved for unoptimized devices. An EL spectra under forward and reverse bias are shown in the inset of Figure 3. The colors of this device may be rapidly switched when the device is driven by an AC

source. Figure 4 shows a variation of the EL intensity with time (i.e. solid curve) when the device is driven by a 0.1 Hz sinusoidal voltage source (i.e., dotted curve).

The role of the SPAN layer in color variable SCALE devices with printable electrodes may be three-fold. First, as an acidic redox polymer it may serve as the protonation agent to protonate the PPyVPV layer producing red light. Second, being a self-doped conducting polymer, it may serve as the contacting agent (buffer layer) connecting the emitting layer and the silver paste top electrodes. Third, it may serve as a protecting agent to separate the emitting layer from direct contact with the silver paste top electrode, especially when SPAN is blended with PVA.

It may be noted that without a buffer layer such as the SPAN layer, it may be difficult to fabricate any working devices when the conducting paste is in direct contact with the emitting layer. With the presence of the SPAN layer, the performance of the devices whose top electrodes are formed simply by painting a silver paste over the SPAN layer may be comparable to those whose top electrodes are formed by conventional thermal evaporation of Al. This opens the opportunity to form top electrodes for light emitting devices using screen-printing and other deposition techniques when a suitable buffer layer such as SPAN, emeraldine base, or other conducting or semiconducting polymers can be placed between the top light emitting or charge transporting layers and the printed electrodes. Screen-printing is a well-established low cost technique that may be suitable for large area processing. Unlike the vacuum deposition techniques, when a flexible substrate is used the screen printing technique may be compatible with web based processing for low cost, large quantity production of polymer light emitting devices.

The preferred embodiments herein disclosed are not intended to be exhaustive or to unnecessarily limit the scope of the invention. The preferred embodiments were chosen and described in order to explain the principles of the present invention so that others skilled in the art may practice the invention. Having shown and described preferred embodiments of the present invention, it will be within the ability of one of ordinary skill in the art to make alterations or modifications to the present invention, such as through the substitution of equivalent materials or structural arrangements, or through the use of equivalent process steps, so as to be able to practice the present invention without departing from its spirit as reflected in the appended claims, the text and teaching of which are hereby incorporated by reference herein. It is the intention, therefore, to limit the invention only as indicated by the scope of the claims and equivalents thereof.

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The foregoing references are hereby incorporated herein by reference.

What is claimed is:

Method for preparing a layered composite

1. A method for preparing a layered composite capable of forming a light-emitting device, said method comprising the steps:
   (a) obtaining a substrate material, said substrate material comprising a layer of an electrode material;
   (b) forming at least one emitting layer on said substrate material, said at least one emitting layer capable of functioning as a light-emitting layer in a light-emitting device; and
   (c) applying a conductive paste material to said emitting layer, said conductive paste material comprising a layer of an electrode material.
2. A method according to claim 1 additionally comprising the step of coating at least one said emitting layer with an appropriate buffer layer prior to application of said conductive paste material.
3. A method according to claim 2 wherein said buffer layer is selected from the group consisting of semiconducting and conducting polymers.
4. A method according to claim 3 wherein said semiconducting and conducting polymers are selectred from among the group consisting of polyanilines, polythiophenes, polypyrroles, their derivitives, their copolymers, and blends thereof.
5. A method according to claim 1 wherein said conductive paste material is applied by a technique selected from the group consisting of painting, spraying, and screen-printing.

6. A method according to claim 1 wherein said substrate material is selected from the group consisting of flexible ITO-coated PET and ITO-coated glass.
7. A method according to claim 1 wherein at least one of said at least one emitting layer comprises a light emitting molecule selected from the group consisting of tris(8-quinolinolato)aluminum, bis(2-(2-hydroxyphenyl)pyridinato)beryllium, anthracene, tris(2-phenylpyridine)iridium doped in a host 4,4'-N,N'-dicarbazol-biphenyl, their derivatives and blends thereof.
8. A method according to claim 1 wherein at least one of said at least one emitting layer comprises a light emitting oligomer selected from the group consisting of oligo(phenylenevinylene)s, sexithiophene, oligo(thiophene)s, oligo(pyridine)s, their derivatives and blends thereof.
9. A method according to claim 1 wherein at least one of said at least one emitting layer comprises a light emitting polymer selected from the group consisting of poly(arylene vinylene)s, poly(phenylene)s, poly(fluorene)s, poly(vinyl carbazole), poly(pyridine), poly(pyridyl vinylene), poly(phenylene vinylene pyridyl vinylene), their derivatives, their copolymers and blends thereof.
10. A method according to claim 3 wherein said buffer layer comprises a material selected from the group consisting of polyanilines, polythiophenes, polypyrroles, their derivatives, copolymers and blends thereof.
11. A method according to claim 8 wherein said light emitting polymer is selected from the group consisting of blends of PPyVPV and PTP.
12. A method according to claim 1 wherein said substrate material is substantially impermeable to either oxygen or water.

13. A method according to claim 1 wherein said conductive paste material is selected from the group consisting of silver paste, gold paste, graphite paste, and carbon paste.

14. A method according to claim 1 wherein said at least one emitting layer is comprised of alternating layers of electron transport material and hole transport material.

15. A method according to claim 13 wherein said electron transport material is selected from the group consisting of: poly(pyridine), poly(oxadiazole)s, tris(8-quinolinolato)aluminum and 2-(4'-biphenyl)-5-(4"-tert-butylphenyl)-1,3,,4-oxadiazole.

16. A method accoridng to claim 13 wherein said hole transport material is selected from the group consisting of: poly(vinyl carbazole), poly(arylene vinylene), aromatic diamines and starburst polyamines.

17. A method according to claim 1 wherein said light-emitting device is a unipolar LED device.

18. A method according to claim 1 wherein said light-emitting device is a bipolar SCALE device.

19. A method according to claim 1 wherein said light-emitting device is a bipolar two-color SCALE device.

20. A method according to claim 1 wherein said substrate is flexible.

21. A method according to claim 1 wherein said substrate is rigid.

Layered composite

22. A layered composite capable of forming a light-emitting device, said layered composite comprising:
    (a) a substrate material, said substrate material comprising a layer of an electrode material;
    (b) at least one emitting layer formed on said substrate material, said at least one emitting layer capable of functioning as a light-emitting layer in a light-emitting device; and
    (c) a conductive paste material applied to said emitting layer, said conductive paste material comprising a layer of an electrode material.
23. A layered composite according to claim 21 additionally comprising an appropriate buffer layer applied between said at least one emitting layer and said conductive paste material.
24. A layered composite according to claim 22 wherein said buffer layer is selected from the group consisting of semiconducting and conducting polymers.
25. A method according to claim 24 wherein said semiconducting and conducting polymers are selectred from among the group consisting of polyanilines, polythiophenes, polypyrroles, their derivitives, their copolymers, and blends thereof.
26. A layered composite according to claim 21 wherein said substrate material is selected from the group consisting of flexible ITO-coated PET and ITO-coated glass.
27. A layered composite according to claim 21 wherein at least one of said at least one emitting layer comprises a light emitting molecule selected from the group consisting of tris(8-quinolinolato)aluminum, bis(2-(2-

hydroxyphenyl)pyridinato)beryllium, anthracene, tris(2-phenylpyridine)iridium doped in a host 4,4'-N,N'-dicarbazol-biphenyl, their derivatives and blends thereof.

28. A layered composite according to claim 21 wherein at least one of said at least one emitting layer comprises a light emitting oligomer selected from the group consisting of oligo(phenylenevinylene)s, sexithiophene, oligo(thiophene)s, oligo(pyridine)s, their derivatives and blends thereof.

29. A layered composite according to claim 21 wherein at least one of said at least one emitting layer comprises a light emitting polymer selected from the group consisting of poly(arylene vinylene)s, poly(phenylene)s, poly(fluorene)s, poly(vinyl carbazole), poly(pyridine), poly(pyridyl vinylene), poly(phenylene vinylene pyridyl vinylene), their derivatives, their copolymers and blends thereof.

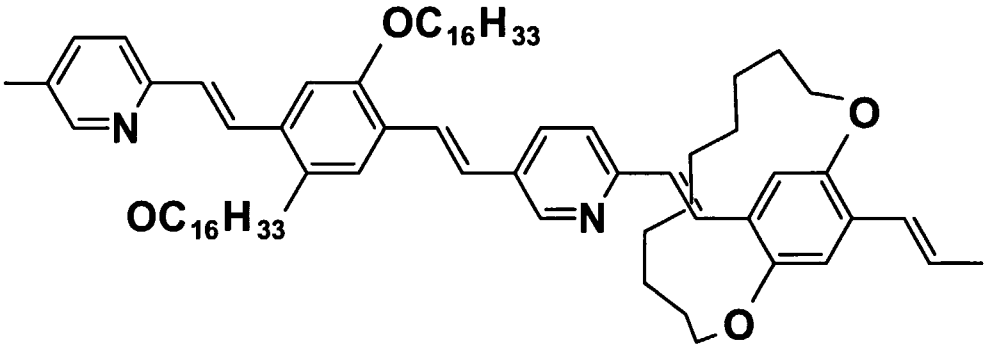
30. A layered composite according to claim ?? wherein said buffer layer is selected from the group consisting of polyanilines, polythiophenes, polypyrroles, their derivatives, copolymers and blends thereof.

31. A layered composite according to claim 21 wherein said at least one emitting layer is selected from the group consisting of blends of PPyVPV and PTP.

32. A layered composite according to claim 21 wherein said substrate material is substantially impermeable to either oxygen or water.

33. A layered composite according to claim 21 wherein said conductive paste material is selcted form the group consisting of silver paste, gold paste, graphitepaste and carbon paste.

(a)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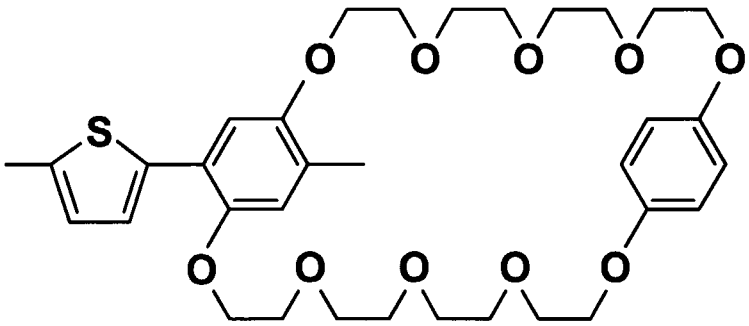
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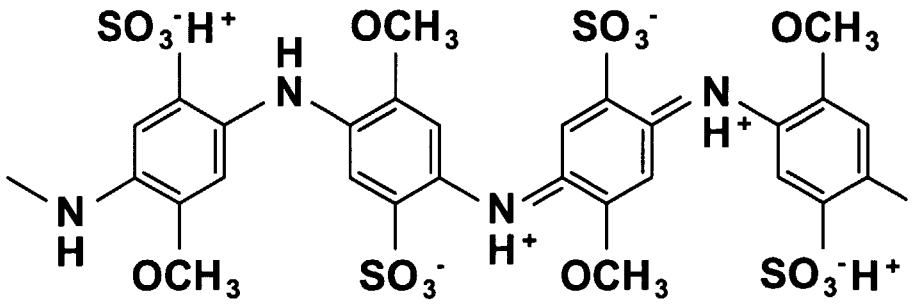
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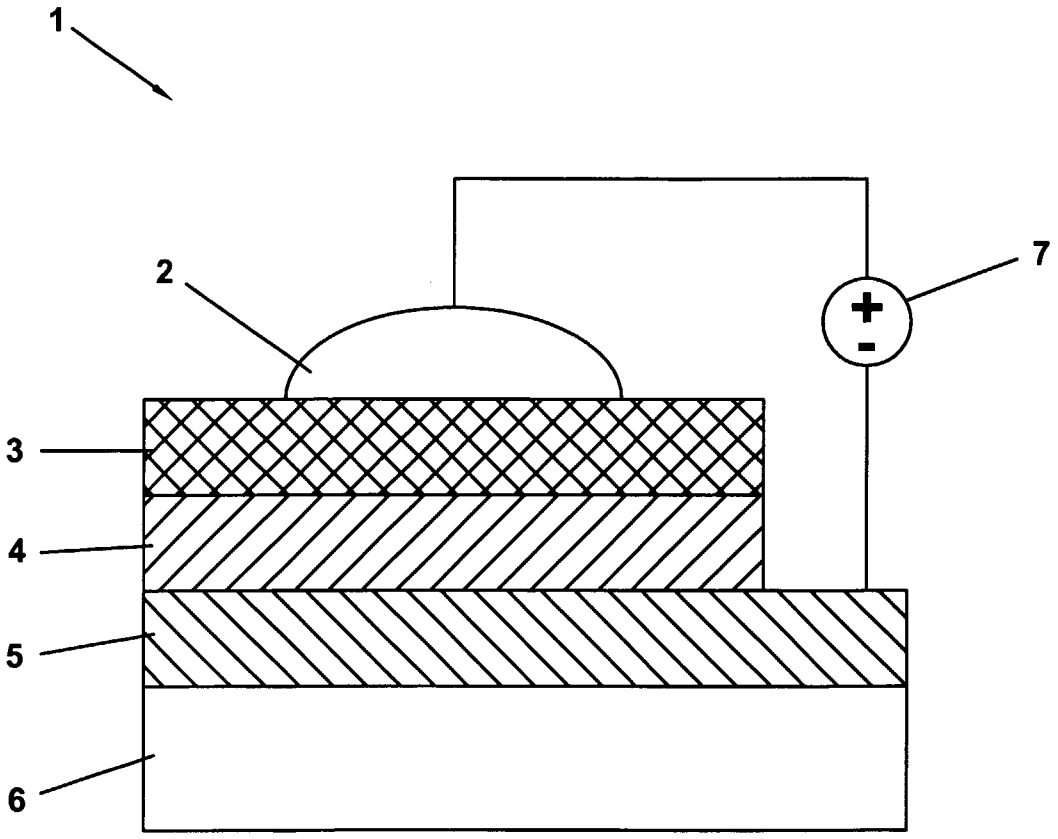
FIG. 1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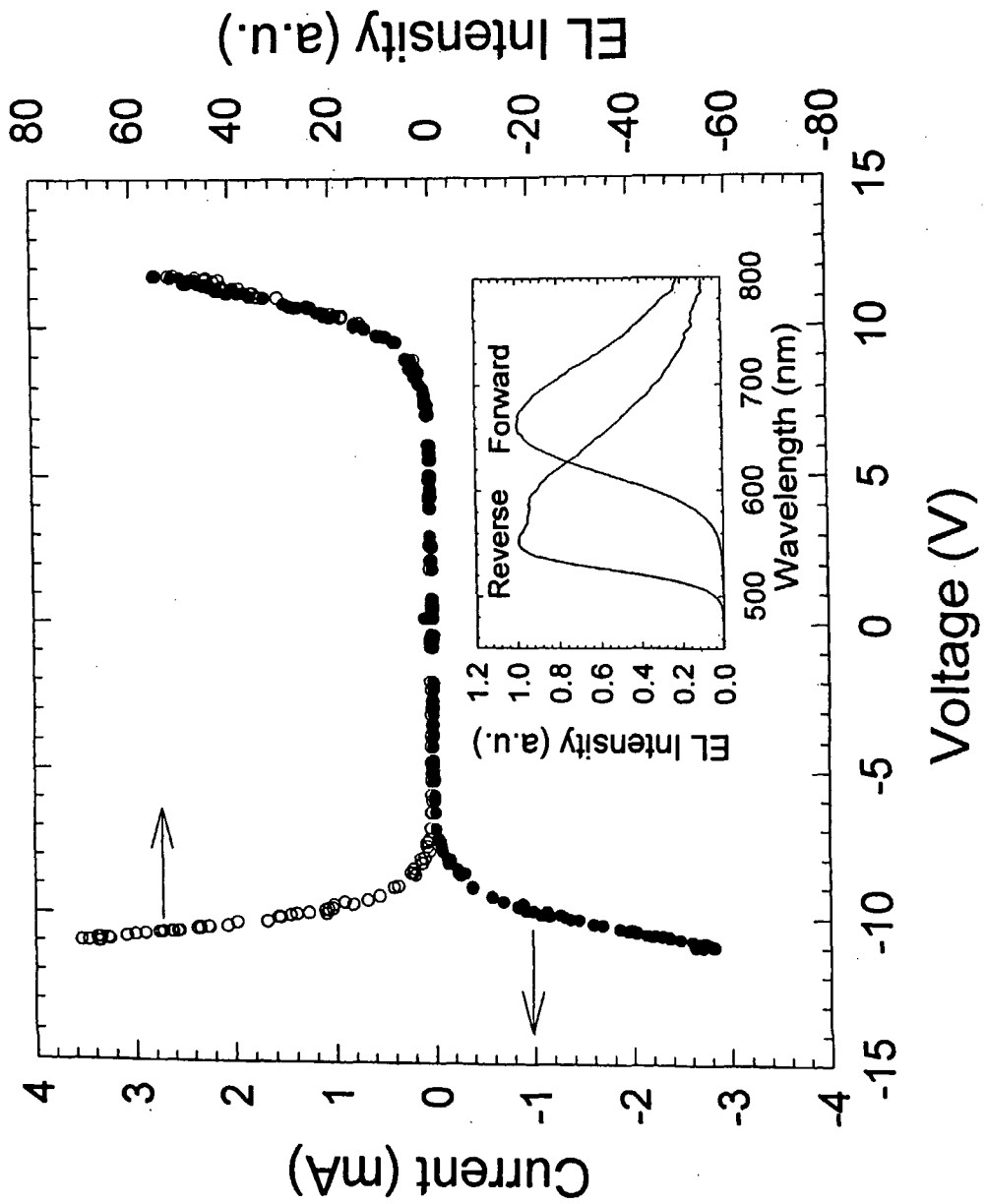
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0.0
EL Intensity (a.u.)

FIG. 3

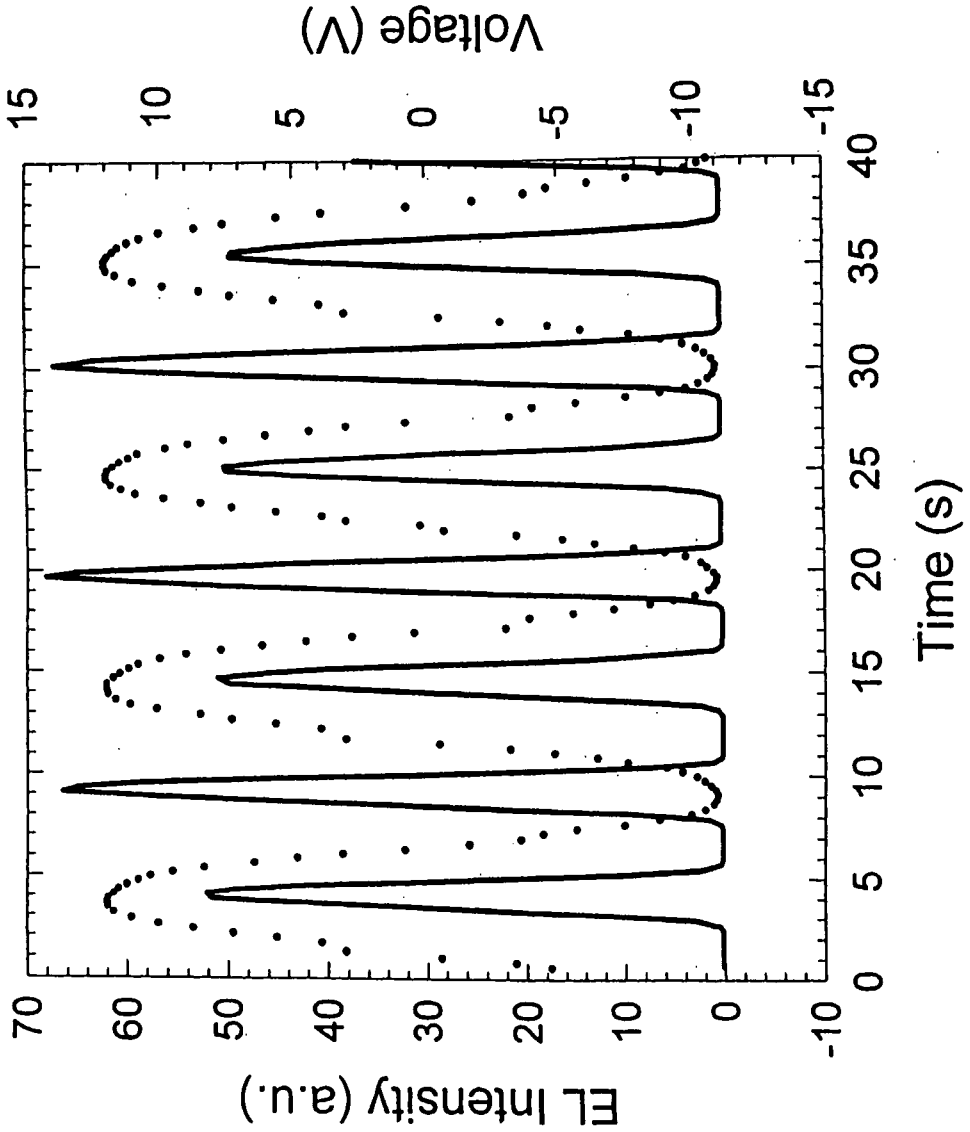
Voltage (V)
15
10
5
0
-5
-10
-15
EL Intensity (a.u.)
70
60
50
40
30
20
10
0
-10
Time (s)
0
5
10
15
20
25
30
35
40

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US02/20965

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : H01L 35/24, 51/40; H01J 63/04
US CL : 257/40; 313/504, 506; 428/917; 438/99

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)
U.S. : 257/40; 313/504, 506; 428/917; 438/99

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6,235,414 B1 (EPSTEIN et al) 22 May 2001 (22.05.2001), column 3, lines 4-23.	1-21
Y,P	US 2002/0017857 A1 (HASHIMOTO et al) 14 February 2002 (14.02.2002), page 4, paragraph 76.	1-21
A	US 5,604,398 A (ZYUNG et al) 18 February 1997 (18.02.1997), the whole document.	1-33
A,P	US 6,368,732 B1 (JIN et al) 09 April 2002 (09.04.2002), the whole document.	1-33
A,P	US 2002/0057052 A1 (KOBAYASHI) 16 May 2002 (16.05.2202), the whole document.	1-33

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"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	Date of mailing of the international search report
16 December 2002 (16.12.2002)	23 DEC 2002
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer ANETA CIELEWICZ Telephone No. (703) 308-4918

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US02/20965

Box I Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claim Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claim Nos.: 30
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
Claim 30 depends from two question marks, "??".

3. ☐ Claim Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of Item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

专利名称(译)	通过丝网印刷生产电致发光器件的方法		
公开(公告)号	EP1419536A1	公开(公告)日	2004-05-19
申请号	EP2002746822	申请日	2002-07-01
[标]申请(专利权)人(译)	俄亥俄州立大学		
申请(专利权)人(译)	俄亥俄州立大学		
当前申请(专利权)人(译)	俄亥俄州立大学		
[标]发明人	EPSTEIN ARTHUR J WANG YUNZHANG		
发明人	EPSTEIN, ARTHUR, J. WANG, YUNZHANG		
IPC分类号	H05B33/10 H01L51/00 H01L51/30 H01L51/40 H01L51/50 H01L51/52 H05B33/26 H01L35/24 H01J63/04		
CPC分类号	H01L51/5221 H01L51/0004 H01L51/0034 H01L51/0035 H01L51/0036 H01L51/0038 H01L51/0039 H01L51/0043 H01L51/005 H01L51/0081 H01L51/5036 H01L51/5048 H01L51/5092 H01L51/52		
优先权	60/308276 2001-07-27 US		
外部链接	Espacenet		

摘要(译)

本发明包括通过丝网印刷制造聚合物发光器件（1）的方法。这些发光器件使用银膏作为顶部电极（2），从而消除了使用蒸发的低功函数金属。这可以通过在SCALE装置的结构中存在诸如磺化聚苯胺层的缓冲层来实现。这些器件允许非常便宜和快速的方法来形成用于大规模聚合物发光器件制造的稳定顶部电极。