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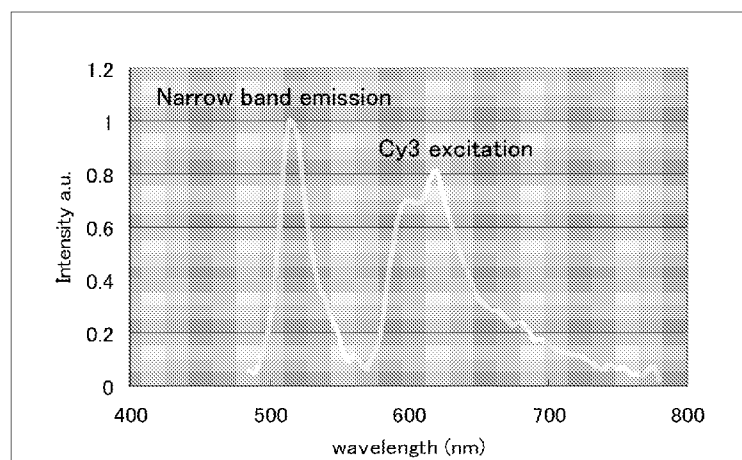
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(54) **Title:** NARROW BAND EXCITATION LIGHT SOURCE FOR FLUORESCENCE SENSING SYSTEM

Fig.5



(57) **Abstract:** A straight type sensor includes: a light source; a micro channel disposed on the light-emitting side of the light source; and a photo detector disposed on the micro channel opposite the light source. The light source is constituted by an organic light emitting diode (OLED) which includes as a dopant a boron complex derived from 2-((3,5-dimethylpyrrol-2-ylidene)(4-(do-
 decyloxy)-2,6-dimethylphenyl)methyl)-3,5-dimethylpyrrole, for example.



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Narrow Band Excitation Light Source For Fluorescence Sensing System

Technical Field

[0001] The present invention relates to a novel sensor having a simple straight-type structure which is useful in diagnosis and treatment of disease and also relates to a method of manufacturing the same.

Background Art

[0002] Conventionally, applications of the fluorescence technique require a large system such as HPLC or MALDI-MS when quantitatively analyzing glucose, albumin, and creatinine for diabetes testing, for example. Such tests have been expensive and time consuming since the samples require transport to a laboratory for analysis. Within the instrument for detecting fluorescence markers, if a splitter is used for separating light source and fluorescence emission, the system inevitably becomes large due to the orthogonal disposition in the system.

[0003] Recently, straight type optical sensors have been developed as described in WO2009/013491 A1 and WO2009/013494 A1. Although straight type optical sensors may be made compact as disclosed in the references, these types of sensors face a problem of spectral overlap between the excitation light and fluorescence emission from an analyte. To eliminate the interfering light from the light source, the above-mentioned references utilize a polarizer. However, utilizing a polarizer has drawbacks wherein the detection sensitivity inevitably becomes poor due to light absorption by the polarizer. When a broad band spectrum light source is used, it is impossible to achieve satisfactory separation between the excitation light and the fluorescence emission even with a color filter having sharp wavelength cut-off.

Disclosure of Invention

[0004] An embodiment of the present invention provides a straight type sensor comprising:

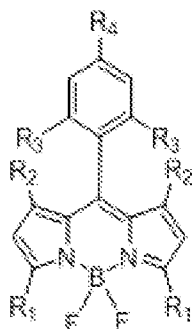
[0005] a micro channel for receiving a target therein, said micro channel having a light input side and a light output side opposite to the light input side;

[0006] a light source disposed on the light input side of the micro channel; and

[0007] a photo detector disposed on the light output side of the micro channel,

[0008] wherein the light source is constituted by a layer of an organic light-emitting diode (OLED) which comprises a boron complex represented by chemical formula 1 as a dopant in a host polymer,

[0009] Chemical Formula 1



[0010] wherein R₁ represents an alkyl group having one or two carbon atom(s), R₂ represents an alkyl group having one or two carbon atom(s), R₃ represents CH₃ or H, and R₄ represents an alkyl group or alkoxy group having 1 to 18 carbon atom(s).

[0011] By using the boron complex as a dopant, the OLED can generate fluorescence emission in a narrow band which can easily be filtered out by a color filter, for example, and separated from the excitation light from a target (substantially no spectral overlaps between the excitation light and the fluorescence emission), and the excited light can quantitatively be detected by a photo detector. Due to the narrow band emission, the above configuration can eliminate other optical devices such as a polarizer and beam splitter. The color filter can also be eliminated if light intensity is measured in relation to wavelengths. In an embodiment, the sensor can be small and portable, and can be used in combination with any suitable fluorescence marker. For example, the sensor can be used for detecting glucose, albumin, and/or creatinine, so as to detect diabetes and/or diabetic nephropathy.

[0012] For purposes of summarizing aspects of the invention and the advantages achieved over the related art, certain objects and advantages of the invention are described in this disclosure. Of course, it is to be understood that not necessarily all such objects or advantages may be achieved in accordance with any particular embodiment of the invention. Thus, for example, those skilled in the art will recognize that the invention may be embodied or carried out in a manner that achieves or optimizes one advantage or group of advantages as taught herein without necessarily achieving other objects or advantages as may be taught or suggested herein.

[0013] Further aspects, features and advantages of this invention will become apparent from the detailed description of the preferred embodiments which follow.

Brief Description of Drawings

[0014] These and other features of this invention will now be described with reference to the drawings of preferred embodiments which are intended to illustrate and not to limit the invention. The drawings are oversimplified for illustrative purposes and are not necessarily to scale.

[0015] Fig. 1 is a general view of a sensor in which a system has a light source, an analyte, and a detector.

[0016] Fig. 2 is a view of a sensor during a manufacturing process where a square bank with round holes is printed on an emissive layer with polymethyl methacrylate (PMMA) solution according to an embodiment of the present invention.

[0017] Fig. 3 is a view of a sensor during a manufacturing process where an Al cathode is deposited on a LiF layer according to an embodiment of the present invention.

[0018] Fig. 4 is a view of a sensor during a manufacturing process where the sensor is sealed with a glass cap using epoxy after the process illustrated in Fig. 3 according to an embodiment of the present invention.

[0019] Fig. 5 shows spectra from Cy3 fluorescence emission and narrow band OLED excitation light obtained from an embodiment of the present invention.

[0020] Fig. 6 shows spectral transmission of Sudan II color filter.

[0021] Fig. 7 shows spectra of broad band excitation light and Cy3 fluorescence emission.

[0022] Fig. 8 shows connections to positive and negative terminals when applying voltage to the OLED according to an embodiment of the present invention.

[0023] Fig. 9 shows a cross sectional view of the OLED according to an embodiment of the present invention.

[0024] [Description of Symbols]

[0025] 1: Photo detector (PD)

[0026] 2: Micro channel

[0027] 3. Light source

[0028] 4: Emissive layer

[0029] 5: Polymethyl methacrylate (PMMA) bank array

- [0030] 6: Indium tin oxide (ITO)
- [0031] 7: Al cathode
- [0032] 8: Glass cap
- [0033] 9: Positive terminal
- [0034] 10: Negative terminal
- [0035] 11: Excitation light
- [0036] 12: Glass substrate
- [0037] 13: PEDOT layer
- [0038] 14: Lif/TPBi layer
- [0039] 16: Dessicant

Best Mode for Carrying Out the Invention

[0040] In view of the invention background described above, conventional sensors have shortcomings of being large devices or having poor detection sensitivity due to fluorescence emission being interfered with by excitation light from the light source in the straight type sensor. Therefore, there is demand for a compact instrument without compromising its data reliability. It is an aspect of the present invention to provide compactness along with good detection sensitivity in a straight-type device by utilizing a narrow band excitation light source to easily separate the excitation light from fluorescence emission of an analyte.

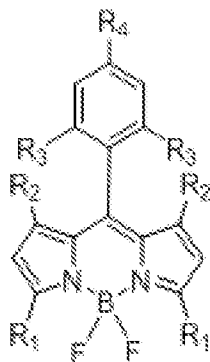
[0041] In this disclosure, "straight type" means that the geometry of a system has a light source, an analyte, and a detector aligned substantially in a straight line as illustrated in Fig. 1, rather than using a light refracting device in an orthogonal optical system. In Fig. 1, a light source 3 is attached to a micro channel 2, and a photo detector is also attached to the micro channel 2 on the side opposite to the light source 3.

[0042] The embodiments will be explained with respect to preferred embodiments which are not intended to limit the present invention. In the present disclosure where conditions and/or structures are not specified, the skilled artisan in the art can readily provide such conditions and/or structures, in view of the present disclosures, as a matter of routine experimentation.

[0043] As described above, in an embodiment, a straight type sensor comprises: (i) a micro channel for receiving a target therein, said micro channel having a light input side and a light output side opposite to the light input side; (ii) a light source disposed on the light input side of the micro channel; and (iii) a photo detector disposed on the light output side of the micro

channel, wherein the light source is constituted by a layer of an organic light-emitting diode (OLED) which comprises a boron complex represented by chemical formula 1 as a dopant in a host polymer,

[0044] Chemical Formula 1



[0045] wherein R_1 represents an alkyl group having one or two carbon atom(s), R_2 represents an alkyl group having one or two carbon atom(s), R_3 represents CH_3 or H, and R_4 represents an alkyl group or alkoxyl group. In one embodiment, R_4 represents an alkyl group or alkoxyl group having 1 to 18 carbon atom(s). In another embodiment R_4 represents an alkyl group or alkoxyl group having 10 to 14 carbon atom(s). In another embodiment R_4 represents an alkyl group or alkoxyl group having 12 carbon atoms.

[0046] In any of the foregoing embodiments, the OLED may comprise about 1% to about 15% (preferably about 3% to about 10%) by weight of the boron complex relative to the host polymer. In an embodiment, the host polymer may be poly(N-vinylcarbazole) having a molecular weight of 500,000 to 2,000,000 (e.g., 1,100,000). Also, in an embodiment, polyfluorene or conjugated host polymer for organic EL may be used as the host polymer.

[0047] A positive terminal and negative terminal may be connected to the OLED, and by applying about 9-10 V of voltage to the OLED, about 2,000 cd/m^2 of luminous intensity can be obtained in an embodiment.

[0048] In any of the foregoing embodiments, the layer of the OLED may have a thickness of 1 nm to 100 nm. In other embodiments, the layer of the OLED may have a thickness of 5 nm to 75 nm. In other embodiments, the layer of the OLED may have a thickness of 20 nm to 50 nm.

[0049] In any of the foregoing embodiments, the OLED may be printed on a substrate. Also, in an embodiment, the photo detector may be printed on a substrate. As the

photo detector, any conventional photodiode or photodetector circuit board can be used in an embodiment.

[0050] In any of the foregoing embodiments, the substrate for the OLED may comprise a patterned conductive glass substrate such as a patterned glass/ITO substrate coated with a transparent, conductive polymer film such as a coating of poly(3,4-ethylenedioxythiophene) (PEDOT), on which the OLED is disposed, and wherein a conductive material such as TPBi, LiF, and Al is disposed on the OLED on a side opposite to the side of the glass substrate. In an embodiment, a glass cap may be attached to the glass substrate to seal the OLED inside the glass cap.

[0051] In any of the foregoing embodiments, no polarizer nor beam splitter may be included.

[0052] In any of the foregoing embodiments, the OLED may generate narrow band emission, and the sensor may further comprise a color filter which substantially filters out the narrow band emission but substantially passes excited light from the target.

[0053] In any of the foregoing embodiments, the target may be a target substance with a fluorescence marker. In an embodiment, the target may be glucose, albumin, and/or creatinine. In an embodiment, the straight-type sensor may be a detector for detecting diabetes and/or diabetic nephropathy.

[0054] For the micro channel, a micro channel described in Japanese Patent Publication 2005-265634 may be used, for example. In an embodiment, a micro channel made of polydimethylsiloxane (PDMS) having a thickness of about 300 μm to 1 mm, and a flow path width of about 100 μm to 300 μm may be used. In the above, the flow path width can vary depending on the type of biological sample, i.e., blood or urine.

[0055] In another aspect, the disclosed embodiments include a method for detecting a fluorescence marker comprising: (a) providing any of the foregoing straight type sensors; (b) introducing a target labeled with a fluorescence marker into the micro channel; and (c) detecting the fluorescence marker with the straight-type sensor. The disclosed embodiments further include a method for detecting diabetes and/or diabetic nephropathy comprising: (A) providing any of the foregoing straight-type sensors; (B) introducing a biological sample labeled with a fluorescence marker into the micro channel; and (C) quantitatively detecting the fluorescence marker with the straight-type sensor, thereby detecting diabetes and/or diabetic nephropathy. In the above, the biological sample may include glucose, albumin, and/or creatinine.

[0056] In still another aspect, the disclosed embodiments include a method for manufacturing any of the foregoing straight-type sensors which may comprise: (I) providing a substrate for the OLED; (II) forming a layer of the OLED on the substrate by inkjet printing; (III) providing a substrate for the photo detector; (IV) forming a layer of the photo detector on the substrate by inkjet printing; (V) providing a micro channel; and (VI) assembling the OLED, the photo detector, and the micro channel. The micro channel can be attached to the light source using a transparent adhesive sheet or applying a transparent adhesive on the light source.

[0057] Embodiments of the present invention are explained below with reference to drawings. It should be noted, however, that these embodiments and drawings are not intended to limit the present invention. In the present disclosure where conditions and/or structures are not specified, the skilled artisan in the art can readily provide such conditions and/or structures, in view of the present disclosures, as a matter of routine experimentation. The numerical numbers applied in specific embodiments may be modified by a range of at least $\pm 50\%$ in other embodiments, wherein the endpoints of the ranges may be included or excluded.

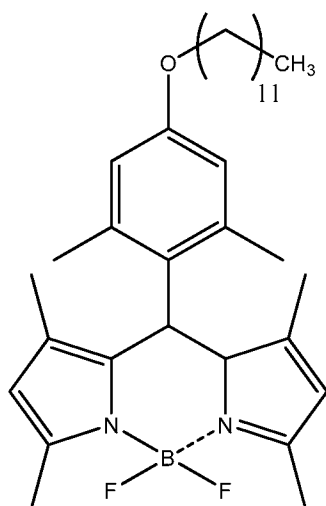
[0058] [Example 1]

[0059] First, a patterned indium tin oxide (ITO)/glass substrate (5 cm square) was cleaned with detergent, water, and isopyl alcohol (IPA) using ultrasonication, and then cleaned by UV ozone after drying.

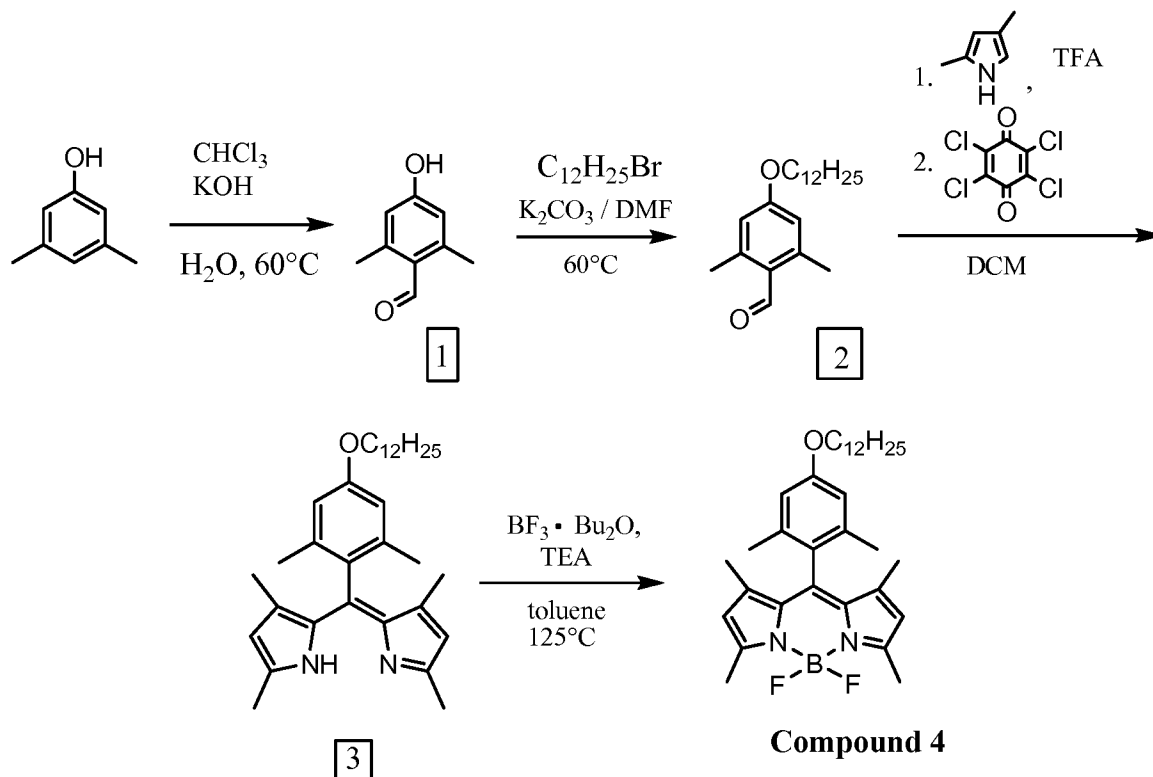
[0060] Poly(3,4-ethylenedioxythiophene) (PEDOT, AI4083) was spin-coated on the substrate at 3,000 rpm for 30 seconds and baked at 180C° for 30 minutes.

[0061] For preparing an emissive layer solution, 15 mg of poly(N-vinylcarbazole), (Mw=1,100,000, Aldrich) (PVK), 6 mg of 2-(4-biphenyl)-5-(4-tert-butylphenyl)-1,3,4-oxadiazole (PBD, sublimation purified), and 0.56 mg of a boron complex shown in chemical formula 2 as a dopant were mixed in 5.4 mL of dichlorobenzene (anhydrous grade) in a glovebox at an oxygen level of less than 0.1 ppm. This solution was then placed into an inkjet cartridge (Dimatix, LCP grade) and printed on a 3 x 4 cm area of the substrate to form an emissive layer of 20 nm thickness. Molecular weight of PVK may be between about 500,000 and 2,000,000, preferably close to 1,100,000. As an alternative to PVK, other polymer such as polyfluorene or conjugated polymer for organic electro luminescence (OEL) may be used, for example.

[0062] Chemical Formula 2



[0063] The boron complex shown in chemical formula 2 was synthesized as follows:



[0064] 1. **Synthesis of 2, 6-dimethyl-4-hydroxybenzaldehyde (1):** 3, 5-dimethylphenol (186g, 1.52mol) and potassium hydroxide (156g, 2.78mol) were added to water (600mL). The subsequent mixture was heated to about 60°C. Chloroform (242mL, 1.36mol) was slowly added over 10 hours at about 60°C. The mixture was stirred overnight at about 60°C. After cooling, the mixture was poured into dilute sulfuric acid solution (60mL concentrated

H₂SO₄ in 1L H₂O). A yellow precipitate formed and was filtered. The resulting solids were washed with chloroform. After drying, 18g of material was isolated; HNMR shows minor impurities; 8% yield.

[0065] 2. Synthesis of 4-(dodecyloxy)-2,6-dimethylbenzaldehyde (2): A mixture of 2, 6-dimethyl-4-hydroxybenzaldehyde (1) (5.00g, 33.3mmol), 1-bromododecane (9.14g, 36.7mmol), and potassium carbonate (5.07g, 36.7mmol) was degassed in dimethylformamide (anhydrous, 40mL) for about 30 minutes. The mixture was heated to about 60°C overnight under argon. After cooling, DMF was removed under vacuum. The mixture was then dissolved in methylene chloride and loaded onto silica gel. A flash column (gradient of 1 to 10% ethyl acetate in hexanes) gave 8.33g of (2); 78% yield; pure by HNMR.

[0066] 3. Synthesis of 2-((3,5-dimethylpyrrol-2-ylidene)(4-(dodecyloxy)-2,6-dimethylphenyl)methyl)-3,5-dimethylpyrrole (3): A mixture of 4-(dodecyloxy)-2,6-dimethylbenzaldehyde (2) (7.0g, 22mmol) and 2, 4-dimethylpyrrole (4.17g, 43.8mmol) was degassed in methylene chloride (anhydrous, 50mL) for about 20 minutes. Trifluoroacetic acid (1 drop) was added, and the mixture was stirred overnight under argon at room temperature. Chloranil (5.95g, 24.2mmol) was added; solution turned to dark brown. Mixture was then stirred at room temperature for about 4 hours. After reaction, the mixture was diluted with methylene chloride, and washed with water and brine. The organic layer was collected, dried over sodium sulfate, and loaded onto silica gel. A flash column (gradient of 2 to 17% ethyl acetate in hexanes) and recrystallization from methylene chloride/methanol gave 6.23g of material; 58% yield; pure by HNMR.

[0067] 4. Synthesis of Boron Complex (Compound 4): A mixture of 2-((3,5-dimethylpyrrol-2-ylidene)(4-(dodecyloxy)-2,6-dimethylphenyl)methyl)-3,5-dimethylpyrrole (3) (1.00g, 2.05mmol) and triethylamine (2.07g, 2.05mmol) was degassed in toluene (anhydrous, 12mL). Boron trifluoride-dibutylether complex (3.25g, 16.4mmol) was added, and the mixture was heated to reflux (125°C) under argon for about 60 minutes. After cooling, the mixture was poured into a saturated sodium bicarbonate solution (150mL); the product extracted using methylene chloride. Organic layer was collected, dried over sodium sulfate, and loaded onto silica gel. A flash column (gradient of 10 to 50% methylene chloride in hexanes) and recrystallization from methylene chloride/methanol gave 812 mg of product; 74% yield; pure by HNMR.

[0068] A skilled artisan would synthesize a boron complex other than the above based on the processes disclosed in this disclosure, as a matter of routine experimentation.

[0069] Next, 50 mg of polymethyl methacrylate (PMMA, $M_w = 120,000$) was dissolved in 5 g of nitromethane. A square bank with round holes (3 mm diameter) in array was then printed on the emissive layer with the PMMA solution using an inkjet printer in a glovebox as shown in Fig. 2, wherein the PMMA bank array 5 was formed on the emissive layer 4 which was seen through the holes as viewed from above. In Fig. 2, as explained above, the ITO 6 was formed on the glass substrate 12, and the PEDOT layer 13 was formed thereon as shown in a cross sectional view, Fig. 9.

[0070] 1,3,5-Tris(N-phenylbenzimidazol-2-yl)benzene (TPBi, 30 nm), LiF (0.8 nm), and Al (150 nm) were then deposited on the PMMA bank array by a vacuum deposition device in a glovebox as shown in Fig. 3 (this is also shown in Fig. 9, where the LiF/TPBi layer 14 and the Al layer (cathode) 7 were formed). Lastly, the OLED was sealed with glass cap 8 using epoxy as shown in Fig. 4 (See also Fig. 9 for the cross sectional view).

[0071] A micro channel through which a sample solution flows was disposed on the light-emitting side of the OLED. A photo detector was then disposed on the micro channel opposite the OLED to form a straight-type sensor as shown in Fig. 1. The OLED and the photo detector may be disposed on the micro channel either using a transparent adhesive or directly printing thereon, for example.

[0072] To evaluate the sensor prepared as described above, Cy3 fluorescent dye dissolved in dimethylsulfoxide (Cy3-DMSO, red fluorescent dye) was channeled through the micro channel and irradiated by the OLED to excite. A positive terminal 9 and a negative terminal 10 were connected to the OLED as shown in Fig. 8. The positive terminal may be connected to either right or left side of the ITO layer in an embodiment. Applying about 9-10 V of voltage to the OLED may give about $2,000 \text{ cd/m}^2$ of luminous intensity in an embodiment.

[0073] The Cy3 fluorescence emission was then detected by the photo detector. The results shown in Fig. 5 indicate suitable separation between the Cy3 fluorescence emission and narrow band OLED excitation light. The spectrum of the Cy3 fluorescence emission has substantially no interference with the narrow band OLED excitation light. Extraction of only Cy3 fluorescence emission can now easily be achieved by employing a commercially available color filter or any other suitable color filters. An example of applicable color filters is Sudan II and its spectral transmittance is shown in Fig. 6. The skilled artisan would understand that any suitable dye other than Cy3 (such as fluorescein, phycoerythrin, other cyanine dyes (e.g., CY5), allophycocyanine, Texas Red, peridenin chlorophyll, cyanine, 6-carboxyfluorescein (6-FAM), 2',7'-dimethoxy-4',5'-dichloro-6-carboxyrhodamine (JOE), N,N,N',N'-tetramethyl-e-

carboxyrhodamine (TAMRA), 2',4',1,4,-tetrachlorofluorescein (TET), and 2'-chloro-7'-phenyl-1,4-dichloro-6-carboxyfluorescein (VIC), or a combination thereof, provided that the peak emission of the excited light is effectively different from that of the narrow band OLED excitation light) can be used in a similar manner for the purpose of detection using the OLED, and also would understand that any suitable color filter material other than Sudan II (other azo pigments, e.g., Sudan III, Sudan IV, Oil Red O) can be used in a similar manner for the purpose of effectively blocking transmittance of the narrow band OLED emission and effectively transmitting the fluorescent emission so as to make the fluorescent emission detectable. The detectable labels such as Cy3 can be selected based on affinity to the target substance to be finally detected (e.g., either proteins/peptides or nucleotides or other substances), its detectable peak emission when excited with the narrow band OLED light (preferably, the peak emission is effectively different from that of the narrow band OLED light), the light absorption/transmittance range of color filter (preferably, the color filter effectively blocks the transmittance of the narrow band OLED emission but effectively transmits the fluorescent emission of the label), and sensitivity of the light emission analyzer/detector.

[0074] [Comparative Example 1]

[0075] As a comparative study, the above evaluation was repeated using broad band excitation light instead of narrow band excitation light while the other conditions remained the same. The results from this comparative study are shown in Fig. 7. It is clear that suitable separation for optical analysis cannot be obtained when broad band excitation light is used. Broad band excitation light interferes with the Cy3 fluorescence emission.

[0076] According to the above disclosure, suitable separation and miniaturization of the sensor can be obtained simultaneously by employing narrow band excitation light. These are great advantages to optical diagnostic tools for developing more compact systems and more reliable detection.

[0077] It will be understood by those of skill in the art that numerous and various modifications can be made without departing from the spirit of the present invention. Therefore, it should be clearly understood that the forms of the present invention are illustrative only and are not intended to limit the scope of the present invention.

Industrial Application

[0078] The disclosed embodiments of the compounds can be used as a dopant in an organic light-emitting diode (OLED) light source for detecting diabetes and/or diabetic

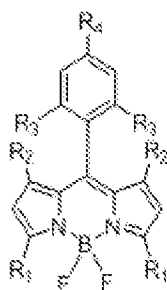
nephropathy by testing a biological sample with a straight-type sensor using the OLED. In the detection of diabetes and/or diabetic nephropathy, glucose, albumin, and/or creatinine are quantitatively analyzed for diabetes and/or diabetic nephropathy testing.

[0079] In the disclosed embodiments, there are substantially no spectral overlaps between the excitation light and the fluorescence emission, and thus, no optical devices such as a polarizer or a beam splitter for eliminating the excitation light from the fluorescence emission are required. Further, if the fluorescence emission peak is analyzed with a computerized data system, a color filter can also be eliminated. Because of this simple structure, a compact sensor may be obtained, which leads to low-cost tests that are available over the counter via point of care instruments for use in a doctor's office or even a portable system without compromising data reliability.

[0080] A color filter may also be used for eliminating the excitation light. In this embodiment, the electric current detected by the photo detector is directly proportional to the amount of analyte in the sample and may be evaluated without processing the data. Therefore, this sensor does not require a computer data system for analyzing the results, and thus an even more portable sensor may be obtained.

CLAIMS

1. A straight type sensor comprising:
 - a micro channel for receiving a target therein, said micro channel having a light input side and a light output side opposite to the light input side;
 - a light source disposed on the light input side of the micro channel; and
 - a photo detector disposed on the light output side of the micro channel,
 wherein the light source is constituted by a layer of an organic light emitting diode (OLED) which comprises a boron complex represented by the following general formula as a dopant in a host polymer,



- wherein R₁ represents an alkyl group having one or two carbon atom(s), R₂ represents an alkyl group having one or two carbon atom(s), R₃ represents CH₃ or H, and R₄ represents an alkyl group or alkoxy group having 1 to 18 carbon atom(s).
2. The straight type sensor according to Claim 1, wherein the OLED comprises 1-15% by weight of the boron complex relative to the host polymer.
 3. The straight type sensor according to Claim 2, wherein the OLED comprises 3-10% by weight of the boron complex relative to the host polymer.
 4. The straight type sensor according to any of Claims 1 to 3, wherein the host polymer is poly(N-vinylcarbazole) having a molecular weight of 500,000 to 2,000,000.
 5. The straight type sensor according to any of Claims 1 to 4, wherein the layer of the OLED has a thickness of 1 nm to 100 nm.
 6. The straight type sensor according to any of Claims 1 to 5, wherein the OLED is printed on a substrate.
 7. The straight type sensor according to any of Claims 1 to 6, wherein the photo detector is printed on a substrate.

8. The straight type sensor according to any of Claims 1 to 7, wherein the substrate for the OLED comprises a patterned conductive glass substrate coated with a transparent, conductive polymer film, on which the OLED is disposed, and wherein a conductive material is disposed on the OLED on a side opposite to the side of the glass substrate.

9. The straight type sensor according to Claim 8, wherein a glass cap is attached to the glass substrate to seal the OLED inside the glass cap.

10. The straight type sensor according to any of Claims 1 to 9, wherein no polarizer nor beam splitter is included.

11. The straight type sensor according to any of Claims 1 to 10, wherein the OLED generates narrow band emission, and the sensor further comprises a color filter which substantially filters out the narrow band emission but substantially passes excited light from the target.

12. The straight type sensor according to any of Claims 1 to 11, wherein the target is a target substance with a fluorescence marker.

13. The straight type sensor according to any of Claims 1 to 12, wherein the target is glucose, albumin, and/or creatinine.

14. The straight type sensor according to any of Claims 1 to 13, which is a detector for detecting diabetes and/or diabetic nephropathy.

15. A method for detecting a fluorescence marker comprising:
providing the straight type sensor of any of Claims 1 to 14;
introducing a target labeled with a fluorescence marker into the micro channel;
and
detecting the fluorescence marker with the straight type sensor.

16. A method for detecting diabetes and/or diabetic nephropathy comprising:
providing the straight type sensor of any of Claims 1 to 14;
introducing a biological sample labeled with a fluorescence marker into the micro channel; and
quantitatively detecting the fluorescence marker with the straight type sensor, thereby detecting diabetes and/or diabetic nephropathy.

17. The method according to Claim 16, wherein the biological sample includes glucose, albumin, and/or creatinine.

18. A method for manufacturing the straight type sensor according to any of Claims 1 to 14, comprising:

providing a substrate for the OLED;
forming a layer of the OLED on the substrate by inkjet printing;
providing a substrate for the photo detector;
forming a layer of the photo detector on the substrate by inkjet printing;
providing a micro channel; and
assembling the OLED, the photo detector, and the micro channel.

Fig.1

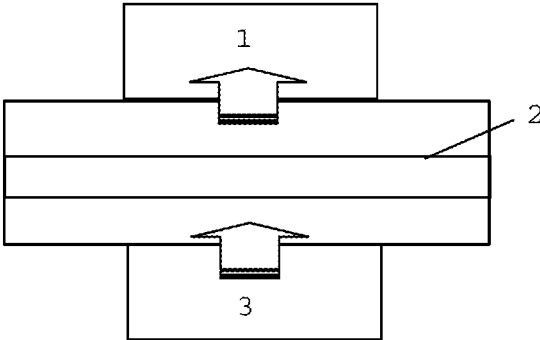


Fig.2

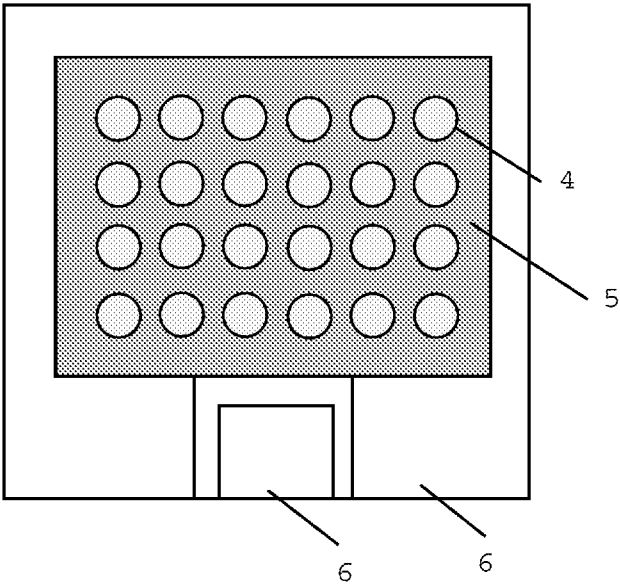


Fig.3

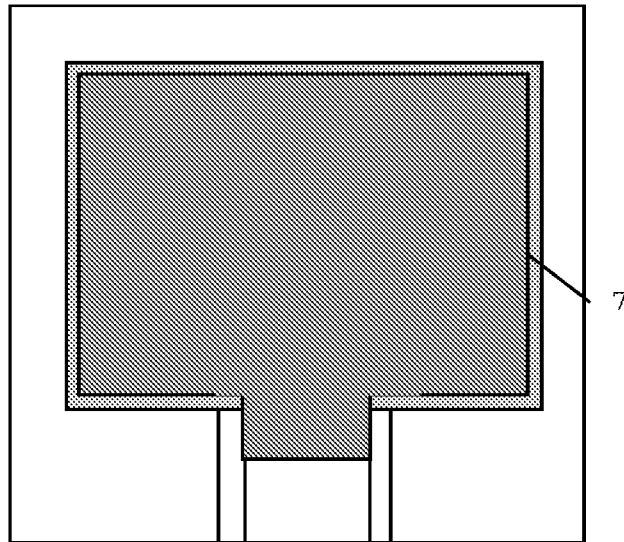


Fig.4

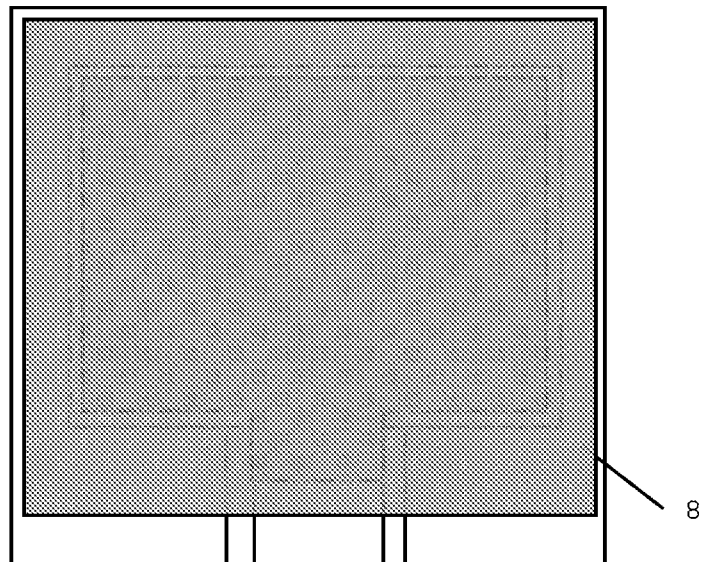


Fig.5

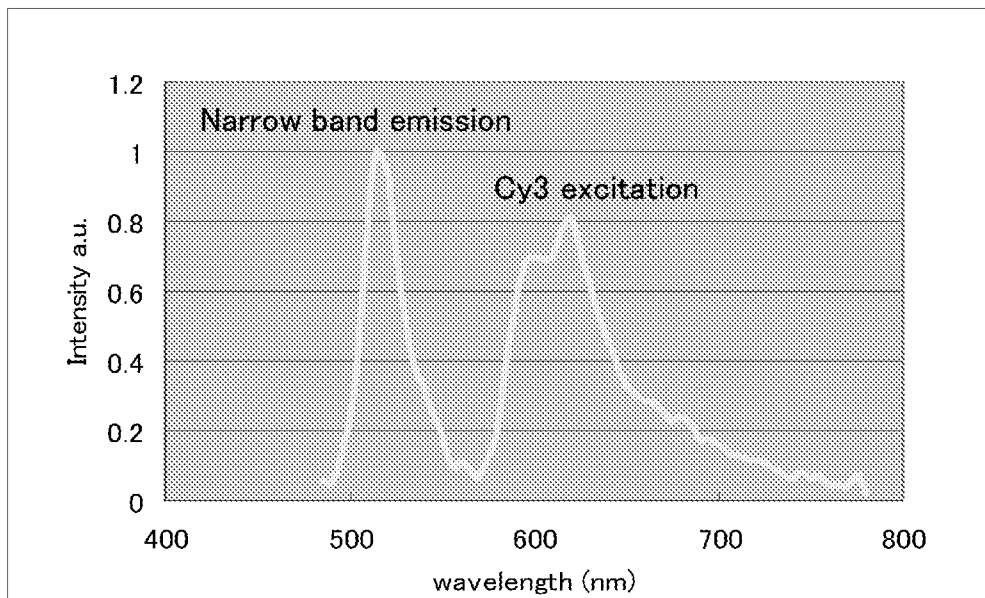
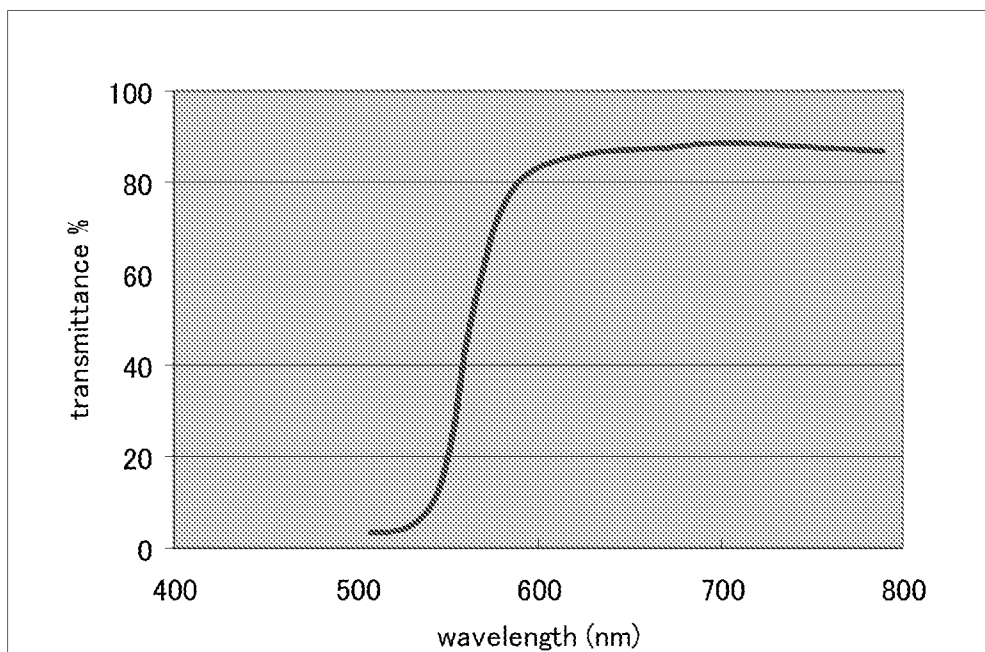


Fig.6



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Fig.7

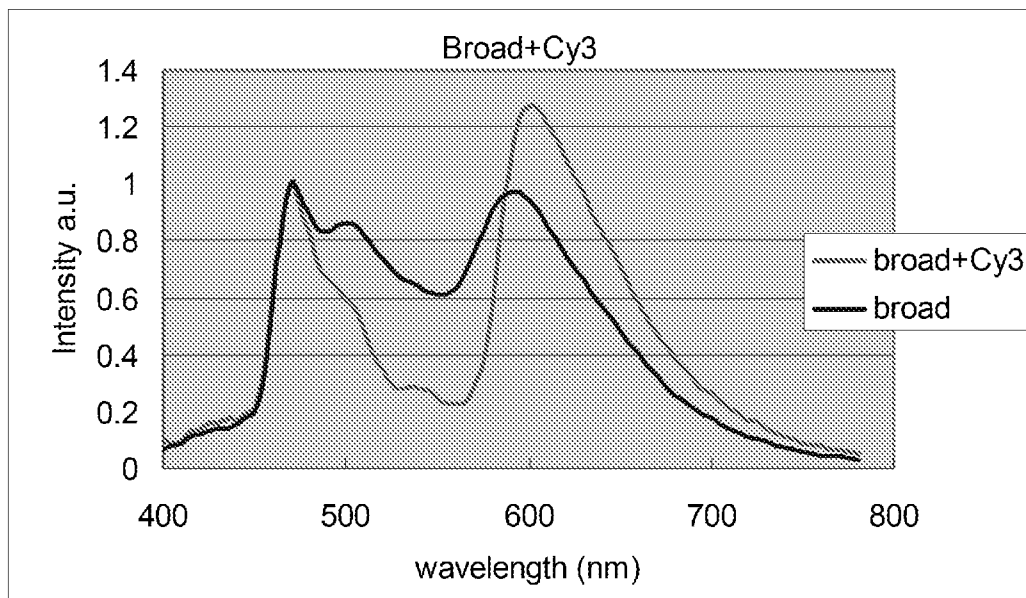


Fig.8

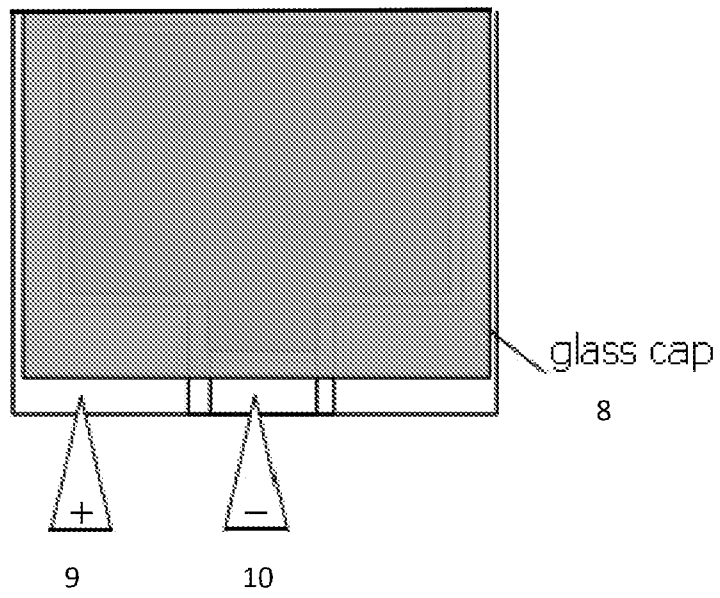
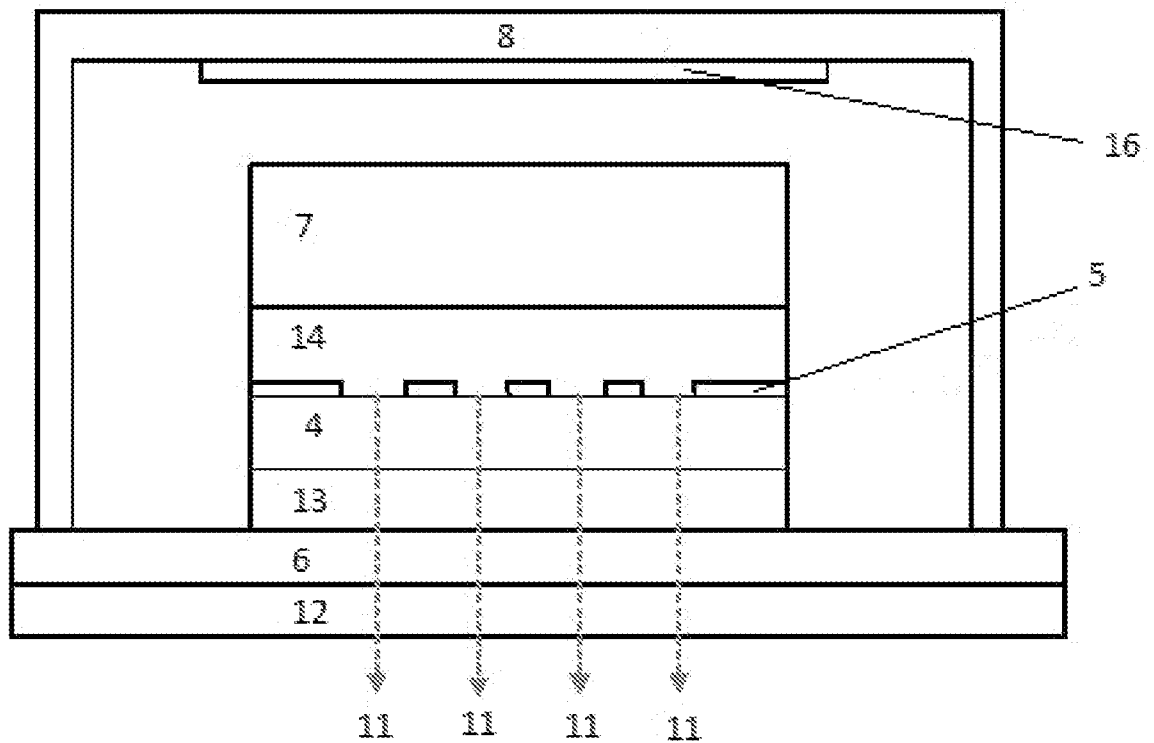


Fig. 9



INTERNATIONAL SEARCH REPORT

International application No
PCT/US2009/059873

A. CLASSIFICATION OF SUBJECT MATTER

INV. C09K11/06 G01N21/64 H05B33/14 H01L51/00
ADD.

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)

C09K G01N H05B H01L

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	paragraphs [0012], [0016], [0041] - [0046], [0048] - [0052], [0062], [0075] - [0077], [0080], [0087], [0088], [0090] - [0093] claims 1,2,5,14,15,19,21 figures 1,1a ----- -/--	2-14



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

15 June 2010

Date of mailing of the international search report

05/07/2010

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Ziegler, Jan

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2009/059873

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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International application No

PCT/US2009/059873

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