

**UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE PATENT TRIAL AND APPEAL BOARD**

SAMSUNG DISPLAY CO., LTD.

Petitioner,

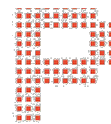
v.

PICTIVA DISPLAYS INTERNATIONAL LTD.

Patent Owner.

IPR2024-01093
U.S. Patent No. 8,723,164

October 24, 2025



pictivadisplays

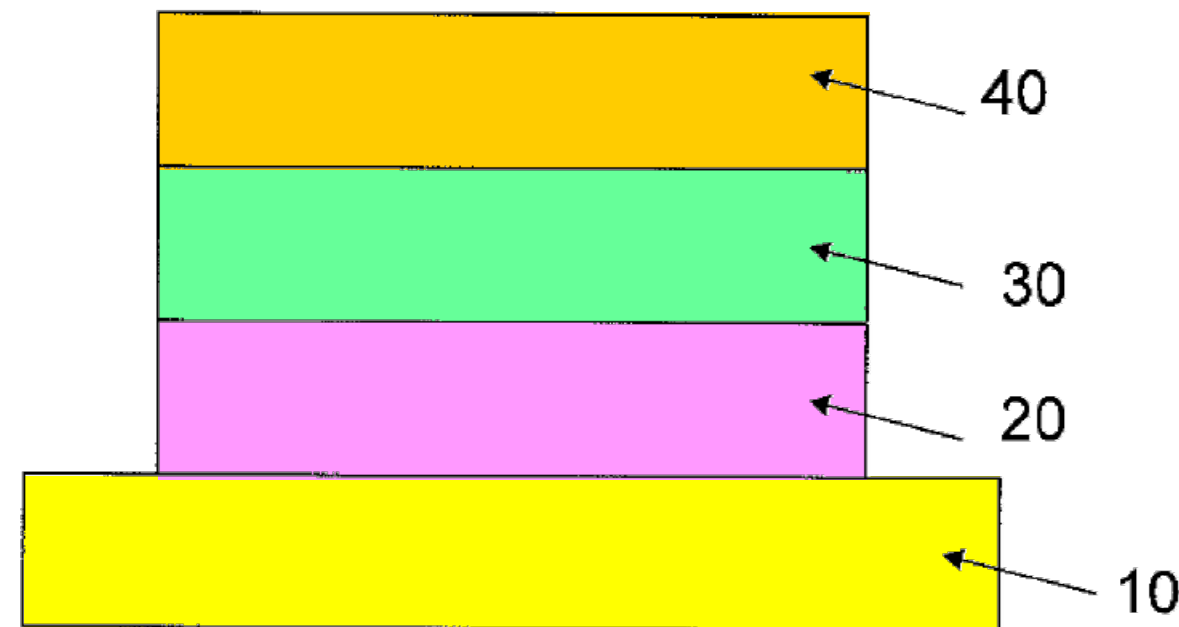
EX2034

TOPICS

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• Ground 1: Choulis	50
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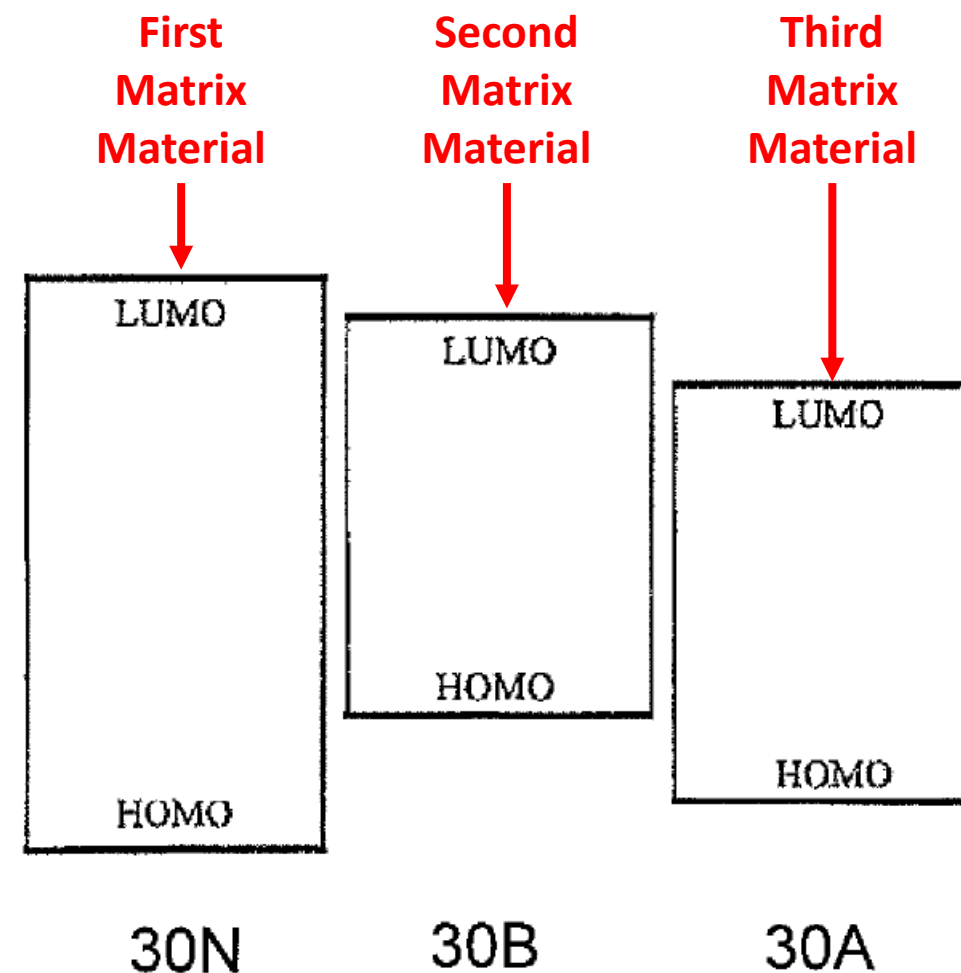
'164 Patent – Claim 1

1. An electronic device, comprising:
a substrate;
a first electrode;
at least one organic functional layer; and
a second electrode, wherein the at least one organic functional layer is located between the first electrode and the second electrode, and wherein the at least one organic functional layer has at least a first matrix material, a second matrix material, and a third matrix material, and the third matrix material has a Lowest Unoccupied Molecular Orbital (LUMO), which is energetically lower than the LUMO of the second matrix material and the LUMO of the first matrix material, and wherein the second matrix material has a Highest Occupied Molecular Orbital (HOMO), which is energetically higher than the HOMO of the first matrix material and the HOMO of the third matrix material,
wherein the organic functional layer is an emission layer and is doped with at least one emitter material.

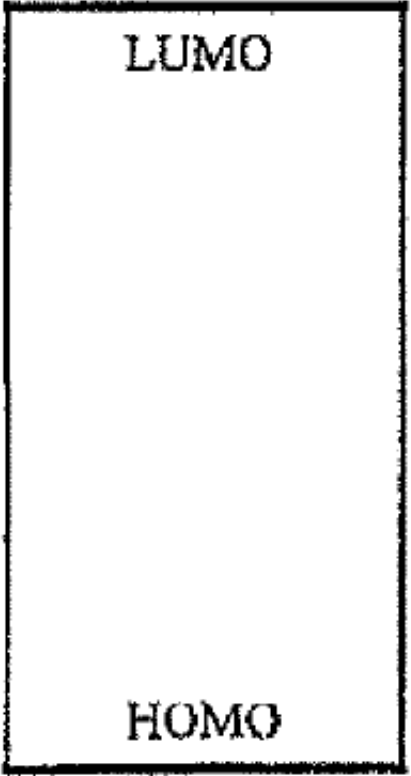
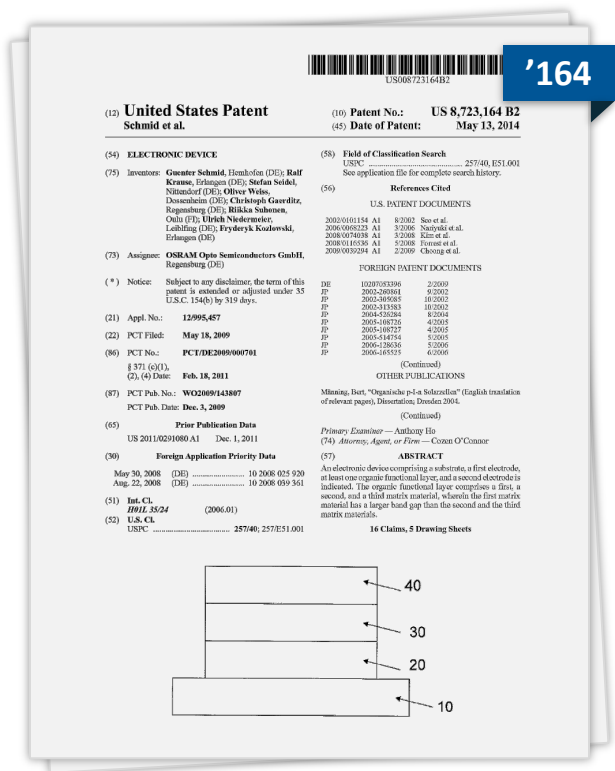


'164 Patent – Claim 1

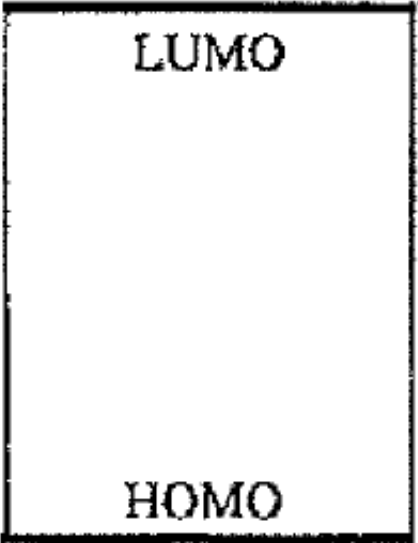
1. An electronic device, comprising:
a substrate;
a first electrode;
at least one organic functional layer; and
a second electrode, wherein the at least one organic functional layer is located between the first electrode and the second electrode, and wherein the at least one organic functional layer has at least a first matrix material, a second matrix material, and a third matrix material, and the third matrix material has a Lowest Unoccupied Molecular Orbital (LUMO), which is energetically lower than the LUMO of the second matrix material and the LUMO of the first matrix material, and wherein the second matrix material has a Highest Occupied Molecular Orbital (HOMO), which is energetically higher than the HOMO of the first matrix material and the HOMO of the third matrix material,
wherein the organic functional layer is an emission layer and is doped with at least one emitter material.



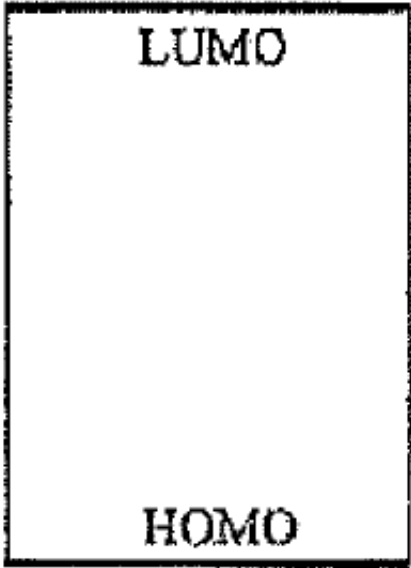
HOMO-LUMO Values



30N

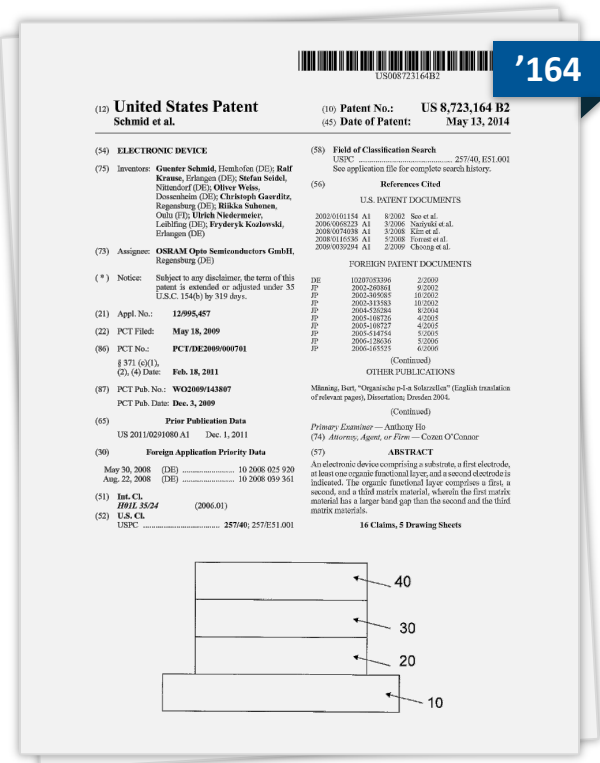


30B



30A

Hole-Electron Creation



To create a hole in the matrix, which is composed of the three matrix materials, an electron must be removed from the HOMO, for example, which is more difficult with an energetically low HOMO than with an energetically higher one. Thus, the second matrix material, which has a higher HOMO than the third matrix material, is more suitable as the hole transport material than the third matrix material. Something analogous is true for the creation of electrons in LUMOs, which is energetically favored with energetically lower LUMOs. Thus, the third matrix material, which has a lower LUMO than the second matrix material, is suitable as the electron transport material.

EX1001 (164 patent) at 2:46-57

Charge Mobility

'164

(12) **United States Patent**
Schmid et al.

(10) **Patent No.:** **US 8,723,164 B2**
(45) **Date of Patent:** **May 13, 2014**

(54) **ELECTRONIC DEVICE**

(75) **Inventors:** **Guenther Schmid**, Hombfien (DE); **Ralf Krause**, Erlangen (DE); **Stefan Seidel**, Nurnberg (DE); **Oliver Weiss**, Dossenheim (DE); **Christoph Gauditz**, Regensburg (DE); **Rikku Salonen**, Oulu (FI); **Erich Niedermeier**, Leinfelden (DE); **Tytderyk Koudewald**, Erlangen (DE)

(73) **Assignee:** **OSRAM Opto Semiconductors GmbH**, Regensburg (DE)

(*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 315 days.

(21) **Appl. No.:** **12/995,457**

(22) **PCT Filed:** **May 18, 2009**

(86) **PCT No.:** **PCT/DE2009/000751**

[371 (a)(1), (2), (4) Date: **Feb. 18, 2010**

(87) **PCT Pub. No.:** **WO2009/08090**
PCT Pub. Date: **Dec. 3, 2009**

(65) **Prior Publication:** **US 2011/0291080 A1**

(30) **Foreign Application:**
May 30, 2008 (DE)
Aug. 22, 2008 (DE)

(51) **Int. Cl.:** **H01L 35/24** (2006)

(52) **U.S. Cl.:** **USPC**

The mobility of electrons and holes can depend on the molecule distance—that is, the average distance between charge carrier-transporting molecules in the individual matrix material. Thus, the concentration of a matrix material in the

EX1001 (164 patent) at 3:17-20

Charge Balance Critical for Efficiency

'164

(12) **United States Patent**
Schmid et al.

(10) **Patent No.:** **US 8,723,164 B2**
(45) **Date of Patent:** **May 13, 2014**

(54) **ELECTRONIC DEVICE**

(75) **Inventors:** **Gunter Schmid, Hamburg (DE); Ralf Krause, Erlangen (DE); Stefan Seidel, Nurnberg (DE); Oliver Weis, Dossenheim (DE); Christoph Gaevertz, Regensburg (DE); Rikku Salonen, Oulu (FI); Ulrich Niedermeier, Leinfelden (DE); Fryderyk Kuslewski, Erlangen (DE)**

(73) **Assignee:** **OSRAM Opto Semiconductors GmbH, Regensburg (DE)**

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(21) **Appl. No.:** **12/995,457**

(22) **PCT Filed:** **May 18, 2009**

(86) **PCT No.:** **PCT/DE2009/00759**

[371 (a)(1),
(2), (4) Date: **Feb. 18, 2011**

(87) **PCT Pub. No.:** **WO2009/143897**

PCT Pub. Date: **Dec. 3, 2009**

(65) **Prior Publication Data**

US 2011/0291080 A1 **Dec. 1, 2011**

(36) **Foreign Application Priority**

May 30, 2008 (DE) **10 2008 000 759**

Aug. 22, 2008 (DE) **10 2008 000 759**

(51) **Int. Cl.** **H01L 35/24** **(2006.01)**

(52) **U.S. Cl.** **257/40**

USPC **257/40**

(58) **Field of Classification Search**

USPC **257/40, E51, 001**

See application file for complete search history.

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2009/039294 A1 **2/2009** **Choung et al.**

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JP **2002-243383** **10/2002**

which lead to light emission. In order to obtain a high efficiency of the electronic device, the ratio between electrons and “holes” which are transported in the emission layer is decisive. A nonbalanced ratio between hole and electron transport results in a low radiation efficiency of the device.

EX1001 (164 patent) at 1:25-29

Claim Construction for “Matrix Material”

“Matrix Materials” Do Not Encompass Dopants or Dispersed Agglomerations

Claim Construction of “Matrix Material”



“The Board is required to construe ‘only those terms . . . that are in controversy, and only to the extent necessary to resolve the controversy.’”

Realtime Data, LLC v. Iancu, 912 F.3d 1368, 1375 (Fed. Cir. 2019)
(quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200
F.3d 795, 803 (Fed. Cir. 1999)).

Claim Terms Can Be Defined *By Implication*



“[T]he ***specification is the single best guide*** to the meaning of a disputed term, and that ***the specification acts as a dictionary*** when it expressly defines terms used in the claims or ***when it defines terms by implication.***”

Phillips v. AWH Corp., 415 F.3d 1303, 1320-21 (Fed. Cir. 2005)
(internal citations omitted)

Claim Terms Can Be Defined By Repeated and Consistent Usage



“Thus, when a patentee uses a claim term throughout the entire patent specification, in a manner consistent with only a single meaning, ***he has defined that term ‘by implication’.***”

Bell Atl. Network Servs., Inc. v. Covad Communications Group, Inc.,
262 F.3d 1258, 1271 (Fed. Cir. 2001)

“[A] claim term may be clearly redefined without an explicit statement of redefinition” and “[e]ven when guidance is not provided in explicit definitional format, ***the specification may define claim terms by implication*** such that the meaning may be found in or ascertained by a reading of the patent documents.”

Trustees of Columbia University in City of New York v. Symantec Corp.,
811 F.3d 1359, 1364 (Fed. Cir. 2016)

The '164 Patent Universally Distinguishes Matrix Materials From Dopants

'164

(12) **United States Patent**
Schmid et al.

(10) Patent No.: **US 8,723,164 B2**
(45) Date of Patent: **May 13, 2014**

(54) **ELECTRONIC DEVICE**

(75) Inventors: **Guenther Schmid, Hombfien (DE); Ralf Krause, Erlangen (DE); Stefan Seidel, Nurnberg (DE); Oliver Weiss, Dossenheim (DE); Christoph Gaevertz, Regensburg (DE); Rikku Salonen, Oulu (FI); Ulrich Niedermeier, Leiflitz (DE); Fryderyk Kuculewski, Erlangen (DE)**

(73) Assignee: **OSRAM Opto Semiconductors GmbH, Regensburg (DE)**

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(21) Appl. No.: **12/995,457**

(22) PCT Filed: **May 18, 2009**

(86) PCT No.: **PCT/DE2009/009761**

[371 (a)(1), (2), (4) Date: **Feb. 18, 2011**

(87) PCT Pub. No.: **WO2009/143897**
PCT Pub. Date: **Dec. 3, 2009**

(65) **Prior Publication Data**
US 2011/0291080 A1 Dec. 1, 2011

(30) **Foreign Application Priority Data**
May 30, 2008 (DE) 10 2008 025 920
Aug. 22, 2008 (DE) 10 2008 039 361

(51) **Int. Cl.** **H01L 35/24** (2006.01)

(52) **U.S. Cl.** **257/40; 257/E51.001**

(58) **Field of Classification Search**
USPC: 257/40, E51.001
See application file for complete search history.

(56) **References Cited**
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Primary Examiner — Anthony Ho
(74) **Attorney, Agent, or Firm — Cozen O'Connor**

(57) **ABSTRACT**
An electronic device comprising a substrate, a first electrode, at least one organic functional layer, and a second electrode is disclosed. The organic functional layer comprises a first, a second, and a third matrix material, wherein the first matrix material has a larger band gap than the second and the third matrix materials.

16 Claims, 5 Drawing Sheets



production of the electronic device. Four evaporation sources **50** are applied on a holder **51**, for example, from which **matrix materials and/or doping substances** can be evaporated onto the deposition substrate **60**. In order to be able to determine

EX1001 (164 patent) at 7:12-15

the deposition substrate **60**. In order to be able to determine the individual concentration of **the matrix material and/or the doping substances** precisely, the evaporation rate is measured

EX1001 (164 patent) at 7:15-17

The '164 Patent Universally Distinguishes Matrix Materials From Dopants

'164

(12) **United States Patent**
Schmid et al.

(10) **Patent No.:** **US 8,723,164 B2**
(45) **Date of Patent:** **May 13, 2014**

(54) **ELECTRONIC DEVICE**

(75) **Inventors:** **Guenther Schmid, Hombfien (DE); Ralf Krause, Erlangen (DE); Stefan Seidel, Nurnberg (DE); Oliver Weis, Dossenheim (DE); Christoph Gauditz, Regensburg (DE); Rikku Salonen, Oulu (FI); Ulrich Niederwieser, Leinfelden (DE); Fryderyk Kucielak, Erlangen (DE)**

(73) **Assignee:** **OSRAM Opto Semiconductors GmbH, Regensburg (DE)**

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(22) **PCT Filed:** **May 18, 2009**

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[371 (a)(1),
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(87) **PCT Pub. No.:** **WO2009/143897**
PCT Pub. Date: **Dec. 3, 2009**

(65) **Prior Publication Data**
US 2011/0291080 A1 Dec. 1, 2011

(30) **Foreign Application Priority Data**
May 30, 2008 (DE) 10 2008 025 920
Aug. 22, 2008 (DE) 10 2008 039 361

(51) **Int. Cl.**
H01L 35/24 (2006.01)

(52) **U.S. Cl.**
USPC 257/40; 257/E51.001

(58) **Field of Classification Search**
USPC 257/40; E51.001
See application file for complete search history.

(56) **References Cited**
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2008/016385 A1 5/2008 Tsvet et al.
2009/039294 A1 2/2009 Choong et al.

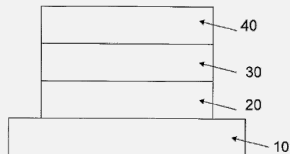
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Primary Examiner—Anthony Ho
(74) **Attorney, Agent, or Firm**—Conner O'Connor

(57) **ABSTRACT**
An electronic device comprising a substrate, a first electrode, at least one organic functional layer, and a second electrode is disclosed. The organic functional layer comprises a first, a second, and a third matrix material, wherein the first matrix material has a larger band gap than the second and the third matrix materials.

16 Claims, 5 Drawing Sheets



layers. Emission layers thereby have a matrix material, which is doped with emitter molecules. In the emission layer, exci-

EX1001 (164 patent) at 1:22-23

device, for example, an OLED. The emission layer 30 can have a first, a second, and a third matrix material and be doped with an emitter material.

EX1001 (164 patent) at 6:14-16

By not doping with emitter materials, it is possible to produce transport, intermediate, and blocking layers.

EX1001 (164 patent) at 4:15-16

Doping/Doped Refers to a Dopant

Dr. Holmes
Expert Witness

SAMSUNG

When the verb "dope," "to dope," for example, or "doping" is used, is it your understanding that that the subject of that verb would be a dopant?

A So I just want to make sure I understand what you're asking. So you're saying when the term "doping" is used, is the subject a dopant?

Q Yes.

A Yes, when the term "doping" is used, the subject would certainly would then be a dopant.

EX2033 (Holmes Dep. Tr.) at 75:7-16

Dr. Holmes Agrees There is a Distinction in the '164 Patent

Dr. Holmes
Expert Witness

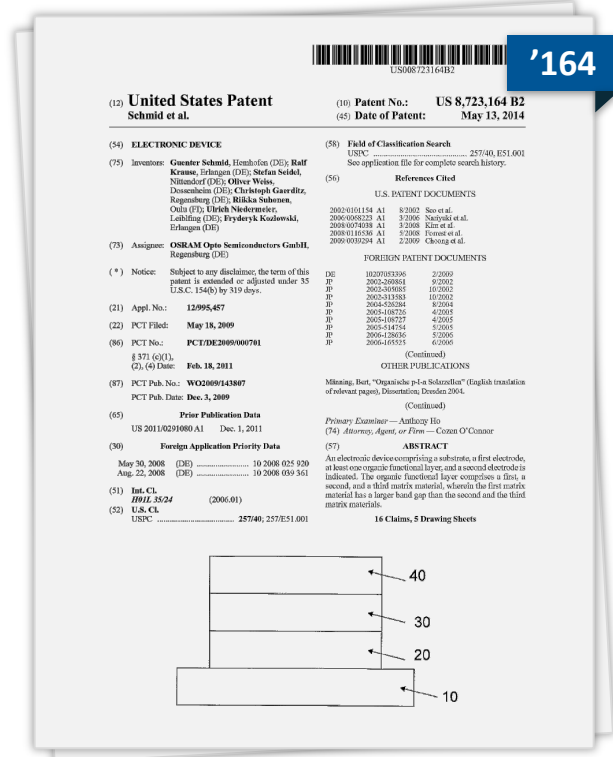
SAMSUNG

Q In fact, it always distinguishes emitter material from matrix materials, correct?

A In the embodiment that is shown in the '164, there's a distinction between the matrix materials used and the emitter material.

EX2020 (Holmes Dep. Tr.) at 298:18-22

The '164 Patent Universally Distinguishes Matrix Materials From Dopants



The matrix cannot be selected arbitrarily for phosphorescent emitters because of chemical compatibility. The red emitter iridium (III) bis(2-methyldibenzo[f,h]quinoxaline) acetylacetonate) is only efficient in an **NBP matrix**. NPB, however, is a hole transport material. If on the anode side, there is also another emitter layer, then this is not sufficiently supplied with electrons. **By doping in an electron transport material, for example, BCP,** the relative transport characteristics can be adjusted. The fine coordination of the transport characteristics takes place with UGH4.

EX1001 (164 patent) at 8:56-65

BCP Doped Into an NPB Matrix

Dr. Sims Confirmed Column 8 of '164 Describes BCP as a Dopant in an NPB Matrix

Dr. Sims
Expert Witness



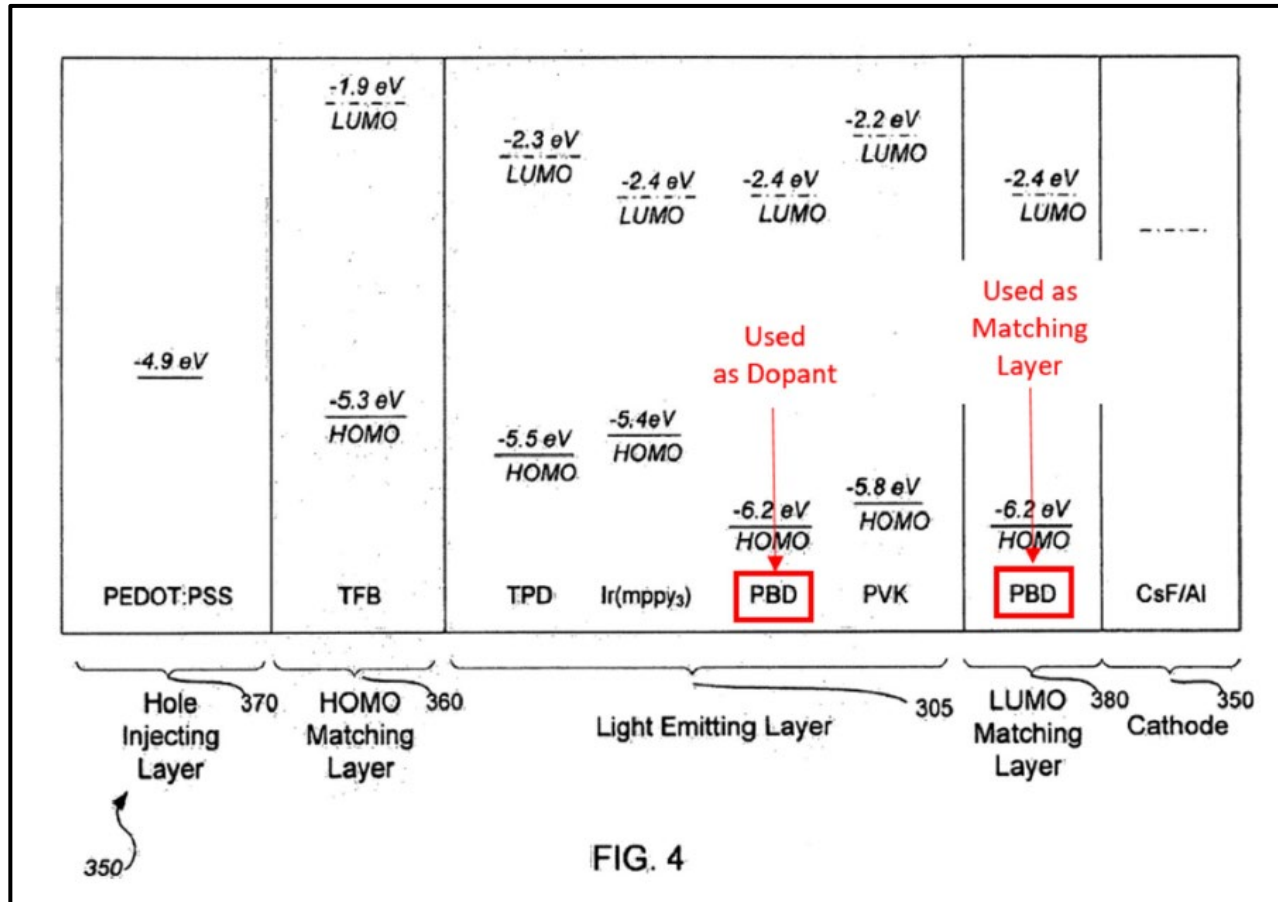
pictiva displays

Q. Okay. So here, the BCP is described as being doped into the NPB matrix?

A. Uh-huh.

EX1043 (Sims Dep. Tr.) at 89:13-15

Petitioner Conflates Composition With Usage



EX1004 (Choulis), FIG. 4

The PBD is used as a moiety in the light emitting layer rather than as a thin matching layer, as above. PBD is also used as a LUMO matching layer (or interfacial layer) between the light emitting layer 305 and a cathode 350. The cathode 350,

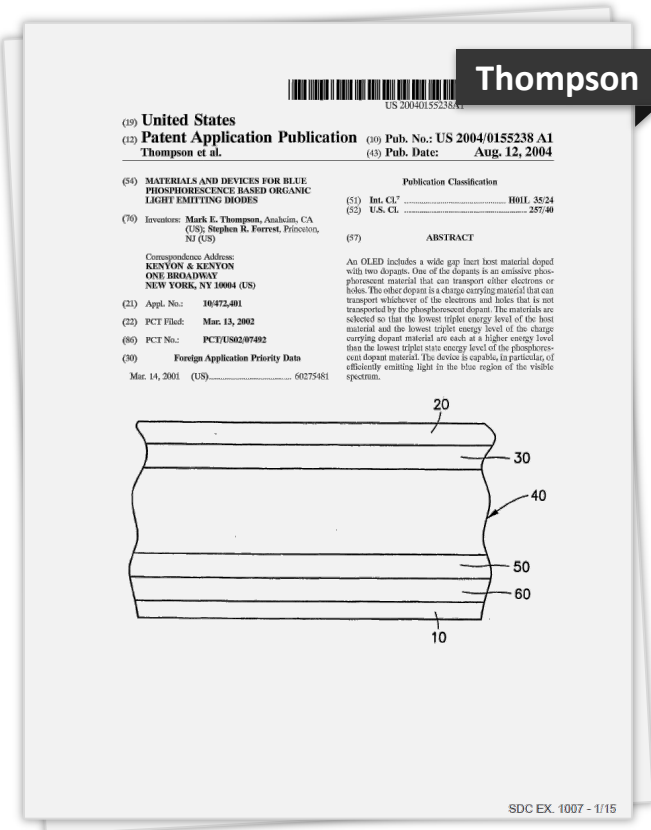
EX1004 (Choulis) at [0031]

Claim Construction for “Matrix Material”

“Matrix Materials” Do Not Encompass Dopants or Dispersed Agglomerations

Extrinsic Evidence

Thompson (Ground 4) Distinguishes Between Matrix Materials and Dopants



all, inefficiently from the matrix material, and not from the phosphorescent dopant material. Accordingly, there is great

electrophosphorescent devices. The HOMO energy levels of the phosphorescent dopants are typically higher in energy than those of the matrix materials into which they are doped.

charge carrying dopant material, wherein the emissive material is dispersed in the host matrix together with the charge carrying dopant material.

polystyrene acted as an inert matrix in which the dopants were supported. Although this device produced light in the

EX1007 (Thompson) at [0006], [0023], [0025], [0057]

OLED Manufacturers Distinguish Matrix Materials from Dopants

'129

United States Patent
Hofmann et al.

(10) Patent No.: US 7,911,129 B2
(45) Date of Patent: Mar. 22, 2011

(54) ARRANGEMENT FOR AN ORGANIC
PIN-TYPE LIGHT-EMITTING DIODE AND
METHOD FOR MANUFACTURING

(75) Inventors: Michael Hofmann, Dresden (DE); Jan
Birnstock, Dresden (DE); Jan
Biedewitz-Nunoth, Dresden (DE);
Angus Werner, Dresden (DE); Martin
Pfeiffer, Dresden (DE); Rensaro
Harske, Dresden (DE)

(73) Assignee: Novaled AG, Dresden (DE)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 459 days.

(21) Appl. No.: 11/279,514
(22) Filed: Apr. 12, 2006

(65) Prior Publication Data
US 2006/0250076 A1 Nov. 9, 2006

(30) Foreign Application Priority Data
Apr. 13, 2005 (EP) 05008105

(51) Int. Cl.
H01L 33/14 (2006.01)
H01L 51/50 (2006.01)

(52) U.S. Cl. 313/504; 313/505; 313/506; 445/24;
445/25; 429/499

(58) Field of Classification Search 313/501-512
See application file for complete search history.

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ics Letters, vol. 51, No. 12 Sep. 21, 1987 pp. 913-991.
(Continued)

Primary Examiner—Nimishkumar D Patel
Assistant Examiner—Tracie Green
(74) Attorney, Agent, or Firm—Sutterland, Aßhoff &
Beckmann, LLP

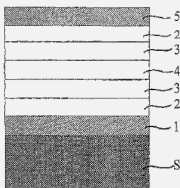
(57) ABSTRACT
The invention relates to an arrangement for an organic pin-
type light-emitting diode with an electrode and a counter-
electrode and a stack with organic layers between the elec-
trode and the counter-electrode, where the stack with the
organic layers comprises an emission layer comprising a k
(k=1, 2, 3, . . .) organic matrix materials, a doped charge
carrier transport layer, which is arranged between the elec-
trode and the emission layer, and one block layer, which is
arranged between one of the doped charge carrier transport
layers and the emission layer. The organic layers of the stack
are formed by means of n (n=3 to 4) organic matrix materials,
where the n organic matrix materials comprise the k organic
matrix materials of the emission layer. The stack with the
organic layers can also be executed in a block-layer-free
manner, where then the emission layer and the doped charge
carrier transport layer are formed from an organic matrix
material. Furthermore, a method for manufacturing such
arrangements is stated.

21 Claims, 7 Drawing Sheets

Assignee: **Novaled AG, Dresden (DE)**

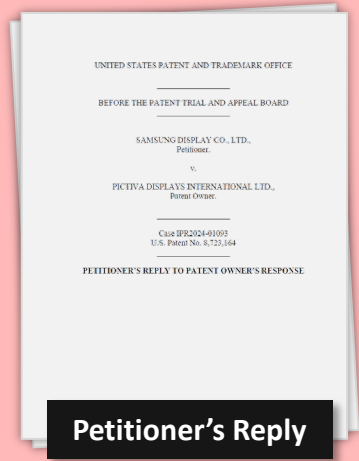
An organic **matrix material** in the sense of the invention is every organic host material to which further materials such as **dopants or emitter substances**, typically in the molar concentrations 1:100 000 to 5:1, **can be admixed (doping)**. Further-

EX2024 (US7,911,129) (Novaled) at 4:24-27



Pictiva EX2024 p. 1
Samsung v Pictiva
EX2024-01093

The Parties Agree That the Term “Host” is Consistent With “Matrix Material”



SAMSUNG

The use of the term “host” material in certain references for “matrix” material aligns with the ’164 patent’s use of “matrix material” to encompass host materials.

Dr. Holmes Has Never Seen Prior Art Literature Describe a Host as a Dopant

Dr. Holmes
Expert Witness

SAMSUNG

Q Right. I understand co-hosts were described in the literature in your opinion.

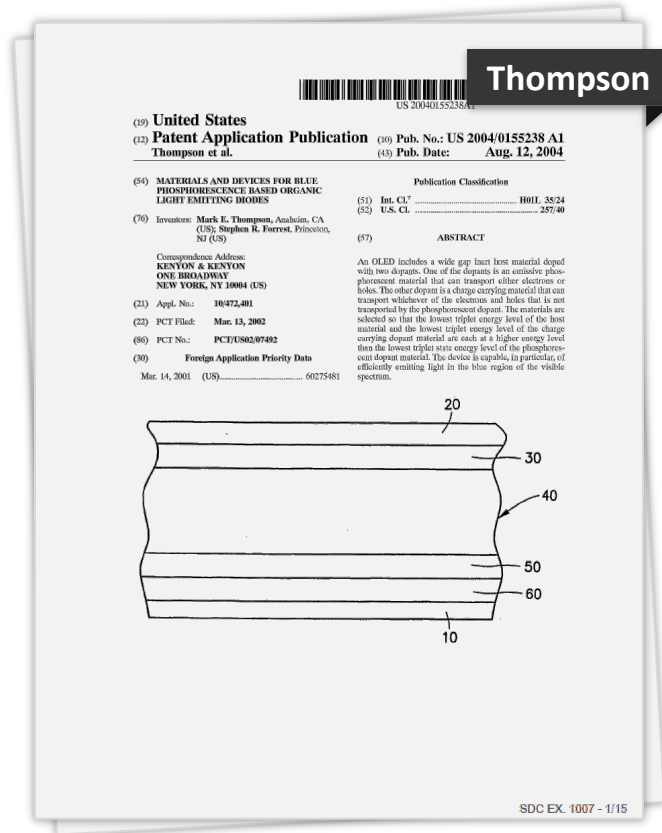
But none of those co-host systems were describing a host or co-host as being a dopant; right?

A So, again, what I can say with certainty is that the exhibits I have here that are prior art do not describe them as a dopant.

But whether there's other prior work that might use that terminology in the context of a mixed host OLED, I can't say with certainty that there is not.

EX2033 (Holmes Dep. Tr.) at 86:8-19

Thompson Demonstrates The Importance of Honoring What a Reference Says About Material Usage



[0025] Thus, one of the distinctive features of the present invention is that the charge carrying materials that are typically used as the predominant component, if not sole component, for the hole transporting layer or the electron transporting layer in a conventional OLED, may be used in the present invention as the charge carrying dopant material in an inert matrix. An additional feature of the present

EX1007 (Thompson) at [0025]

Li Is Not Extrinsic Evidence and Does Not Reflect General Usage of the Term “Host” at the Time of the ’164 Patent

2020



Cite this: *J. Mater. Chem. C*, 2020, 8, 3438

Pure-blue fluorescent organic light-emitting diodes by co-doping a supplementary host material into a light-emitting layer as an electron transport ladder

Zhenzhen Li, Liang Zhou, * Ruixia Wu, Qi Zhu, Weidong Sun, Shuaibing Li and Hongjie Zhang 

EX1033 (Li) at 1

Claim Construction for “Matrix Material”

District Court & Petitioner: “Matrix Materials” are “Part of the Same Matrix”

Petitioner's New Claim Construction (from District Court)

Petition



VI. CLAIM CONSTRUCTION

Petitioner does not believe that any specialized constructions are necessary for this petition.

Petition at 12

District Court



“matrix material”
(’164 Patent, Claim 1–6, 10, 13–16)

“The first, second, and third matrix materials are different materials and are part of the same matrix”

EX1030 (District Court Claim Construction Order) at 50

Reply



The term “matrix” in “matrix material” indicates that the material is part of the same matrix. *See, e.g.,* Ex.1001, 4:24-26, 2:46-47, Ex.1030, 33, 50.

Reply at 4; see also EX1044 (Holmes Decl.) at ¶ 7 (same).

Petitioner's Understanding of "Matrix"

Dr. Holmes
Expert Witness
SAMSUNG

Pictiva's Construction	Samsung's Construction
"matrix material": plain and ordinary meaning, i.e., a material that forms a continuous phase	matrix: "a continuous phase of the mixture of matrix materials" matrix material: "The first, second, and third matrix materials are different materials and are part of the same matrix"

EX1030 (District Court Claim Construction Order) at 32

Q Do you generally agree with Samsung's construction of matrix, just the term "matrix" as presented here on Page 32?

A Yes, I do.

EX2033 (Holmes Dep. Tr.) at 60:9-12

Experts Agree That Dopants Are Added to an Existing Host Structure

Dr. Sims
Expert Witness



pictiva displays

Q. Okay. And when someone says "doping a component into a matrix," does that usually imply that the matrix already exists and the -- and the dopant is then added to it?

MR. BYUN: Objection; leading.

THE WITNESS: I mean, it definitely -- I mean, I think in most cases, that's how you would interpret that, yes. I mean -- yeah.

EX1043 (Sims Dep. Tr.) at 90:14-21

A. A dopant is a material that is housed in a matrix.

EX1043 (Sims Dep. Tr.) at 40:9-10

Experts Agree That Dopants Are Added to an Existing Host Structure

Dr. Holmes
Expert Witness

SAMSUNG

“The term “dopant” merely refers to a component that has been added to a film or functional layer.”

EX1044 (Holmes Decl.) at ¶ 6

Experts Agree That Dopants Are Added to an Existing Host Structure

Dr. Kymissis
Expert Witness

SAMSUNG

understood that these materials are doped into the light emitting layer.⁵⁴⁰ In OLED design, “doping” refers to the intentional introduction of a foreign material (or impurity) into a host at low concentrations to modify its electronic or optical properties. This is a well-known concept that a skilled practitioner in the field would recognize. Emission layers often use a guest–host system where the host material forms the bulk of the emission layer and the guest (emitter) material is added in small amounts. This doping approach enables efficient energy transfer

EX2031 (Kymissis Report) at ¶ 814

Experts Agree That Dopants Are Added to an Existing Host Structure

Dr. Schubert
Expert Witness

SAMSUNG

140. Second, the presence of dopant/guest molecules changes the electronic structure around the matrix molecules. This affects the overlap between molecular orbitals in the transport

EX2016 (Schubert Decl.) at ¶ 140

Embedded Materials Are Not “Part of” the Matrix

Dr. Sims
Expert Witness



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A. Yeah. But, normally, a matrix is a surrounding medium, which implies something is being embedded in it.

EX1043 (Sims Dep. Tr.) at 36:7-9

35. In the context of the '164 patent, a “matrix material” refers to a material in a more or less continuous phase into which other materials can be embedded. This is not only consistent with the general meaning of the term, but directly follows from the fact that the second and third matrix materials are responsible respectively for hole and electron transport, which a POSITA would understand to have sufficiently short molecular distances to facilitate electron and hole hopping. For example, in some of the embodiments, I note that the first

EX2019 (Sims Decl.) at ¶ 35

matrix (BioSci) More or less continuous matter in which something is embedded, eg the non-cellulosic substances of

EX2013 (Cambridge Dictionary of Science and Technology) at 3

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

Pictiva slide, p. 34

Embedded Materials Are Not “Part of” the Matrix

Dr. Schubert
Expert Witness

SAMSUNG

matrix. To be effective, a matrix needs to be in a continuous phase to not only encourage the efficient transport of electrons and holes through, *e.g.*, the electron transporting material and hole transporting material in the matrix, but to also ensure the desired distribution and stable housing of the emitter material. Given that the claimed matrix is composed of a “mixture of matrix materials,” the mixture needs to form a continuous phase. That is, the multiple matrix materials would together form a mixed matrix—a connected structure that holds, *e.g.*, the emitter material.

EX2016 (Schubert Decl.) at ¶ 129

Dr. Holmes Does Not Dispute that Embedded Materials Are Not “Part of” the Matrix

Dr. Holmes
Expert Witness

SAMSUNG

“And I don't want to offer further off-the-cuff opinions on "embed" versus "part of" as a matter here because it's not something I've considered in detail.”

EX2033 (Holmes Dep. Tr.) at 71:23-72:1

Q Okay. So is it fair to say that you are not prepared to render an opinion on whether there is a distinction between embedding something in a matrix versus something being part of a matrix?

A That is not something I'm willing to offer a new opinion on right now in terms of further detail on those terms.

EX2033 (Holmes Dep. Tr.) at 72:6-12

Dr. Holmes' Other Testimony Suggests Embedded Materials Are Not "Part of" the Matrix

Dr. Holmes
Expert Witness

SAMSUNG

And for something to be a matrix, it should have continuous character, not be discontinuous in this way, and so the distinction

EX2020 (Holmes Dep. Tr.) at 273:3-5

Q In this film, as drawn here in this cartoon, 3C and 3B are not continuous, correct?

A That's because they're matrix materials, not a matrix themselves.

EX2020 (Holmes Dep. Tr.) at 96:5-8

Claim Construction for “Matrix Material”

“Matrix Materials” Do Not Encompass Dispersed Agglomerations

Matrix Materials Do Not Encompass Dispersed Agglomerations

Dr. Sims
Expert Witness



pictiva displays

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matrix (BioSci) More or less continuous matter in which something is embedded, eg the non-cellulosic substances of

EX2013 (Cambridge Dictionary of Science and Technology) at 3

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

Dispersed Agglomerations Are Structurally the Same as Dopants/Guest Materials

Dr. Sims
Expert Witness



pictivadisplays

119. I note that the mixture of materials 3A, 3D and 3E does not form a continuous phase in the emission layer; instead, the only non-dispersed phase is formed by host material (blue shaded areas) with materials 3D and 3E embedded therein at discrete locations like “islands in a sea.” Indeed, given that materials 3D and 3E, like the emitters, are dispersed in host 3A with no other materials embedded in them, materials 3D and 3E would be regarded as having the same structural nature as the emitter materials—they are all dopants, not matrix

EX2019 (Sims Decl.) at ¶ 119

Matrix Materials Do Not Encompass Dispersed Agglomerations

Dr. Schubert
Expert Witness

SAMSUNG

matrix. To be effective, a matrix needs to be in a continuous phase to not only encourage the efficient transport of electrons and holes through, *e.g.*, the electron transporting material and hole transporting material in the matrix, but to also ensure the desired distribution and stable housing of the emitter material. Given that the claimed matrix is composed of a “mixture of matrix materials,” the mixture needs to form a continuous phase. That is, the multiple matrix materials would together form a mixed matrix—a connected structure that holds, *e.g.*, the emitter material.

EX2016 (Schubert Decl.) at ¶ 129

Dr. Schubert: Sugiura's "Agglomerations" Are Not A Matrix

Dr. Schubert
Expert Witness

SAMSUNG

Q. Does the figure show a continuous phase of the mixture of 3A, 3B, and 3C?

MS. BAILY: Object to the form.

THE WITNESS: If these little circles contain only one matrix material, then I would say that this is not a matrix because it does not include a continuous phase of matrix materials. But rather agglomerations of materials as expressed by the circle features or circular features.

EX2018 (Schubert Dep. Tr.) at 114:13-21

Petitioner’s Understanding of “Matrix”

Dr. Holmes
Expert Witness
SAMSUNG

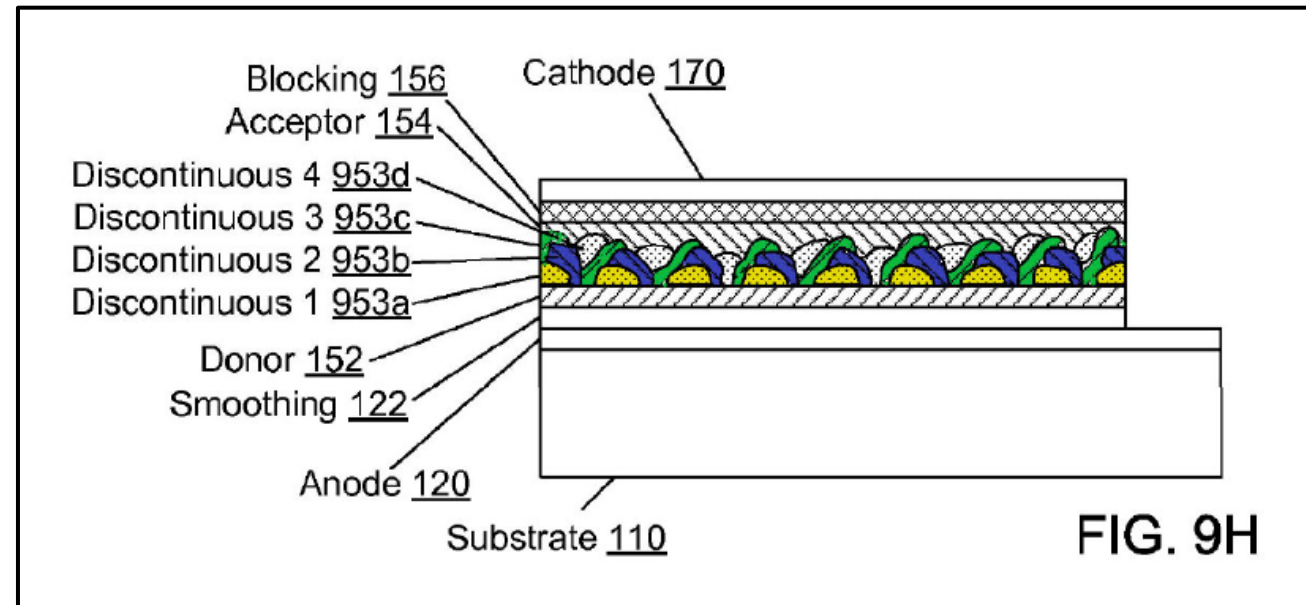
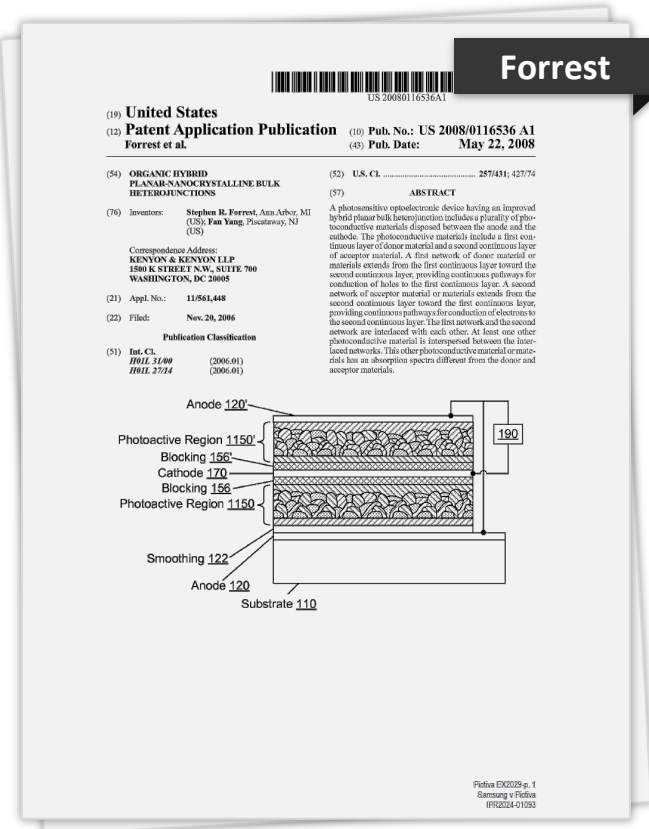
Pictiva’s Construction	Samsung’s Construction
“matrix material”: plain and ordinary meaning, i.e., a material that forms a continuous phase	matrix: “a continuous phase of the mixture of matrix materials” matrix material: “The first, second, and third matrix materials are different materials and are part of the same matrix”

EX1030 (District Court Claim Construction Order) at [32](#)

Q Do you generally agree with Samsung's construction of matrix, just the term "matrix" as presented here on Page 32? A Yes, I do.

EX2033 (Holmes Dep. Tr.) at 60:9-12

Forrest Discloses Vertically Continuous Layers, Not Agglomerations



EX2029 (Forrest) at FIG. 9H

form a first continuous layer, depositing at least three discontinuous layers of photoconductive material directly over the first continuous layer, material of each discontinuous layer being in direct contact with material of at least one adjacent discontinuous layer, portions of an underlying layer or layers

EX2029 (Forrest) at [0026]

Forrest Discloses Vertically Continuous Layers, Not Agglomerations

United States
Patent Application Publication
Forrest et al.

(10) Pub. No.: US 2008/0116536 A1
(45) Pub. Date: May 22, 2008

(54) ORGANIC HYBRID
PLANAR-NANO-CRYSTALLINE BULK
HETEROJUNCTIONS

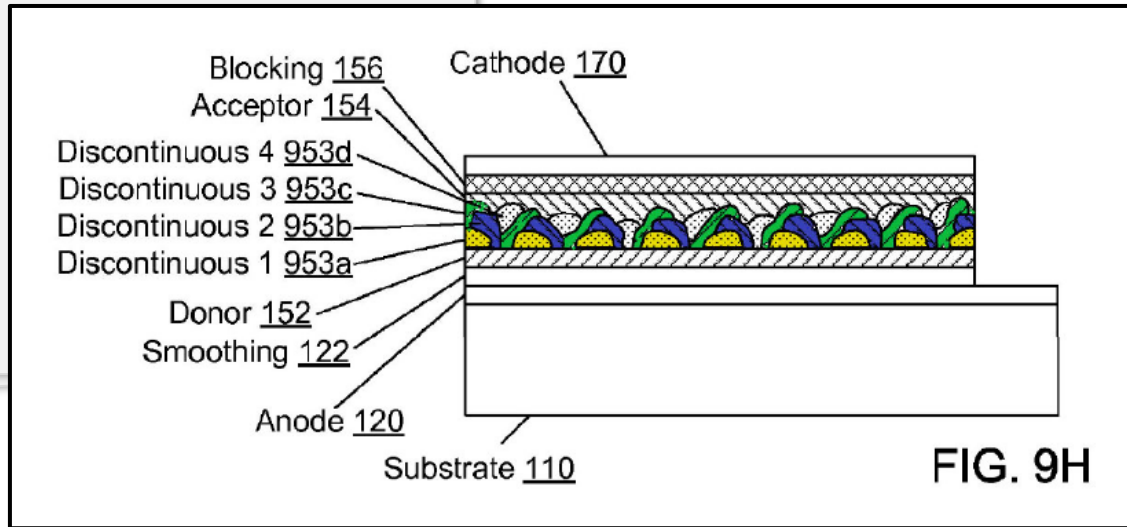
(57) ABSTRACT
A photoemitter epitaxial device having an improved hybrid planar bulk heterojunction includes a plurality of photoconductive materials disposed between the anode and the cathode. The photoconductive materials include a first continuous layer of donor material and a second continuous layer of acceptor material. A first network of donor material or materials extends from the first continuous layer toward the second continuous layer, providing continuous pathways for conduction of holes to the first continuous layer. A second network of acceptor material or materials extends from the second continuous layer toward the first continuous layer, providing continuous pathways for conduction of electrons to the second continuous layer. The first network and the second network are interlaced with each other. At least one other photoconductive material is interspersed between the interlaced networks. This other photoconductive material or materials has an absorption spectra different from the donor and acceptor materials.

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(21) Appl. No.: 11/561,448
(22) Filed: Nov. 26, 2006

Publication Classification
(51) Int. Cl. H01L 31/00 (2006.01)
H01L 27/14 (2006.01)

Forrest



EX2029 (Forrest) at FIG. 9H

[0035] Preferably, there are a plurality of discontinuous layers composed of a donor material or materials forming conductive pathways with the continuous donor layer, and there are a plurality of discontinuous layers composed of an acceptor material or materials forming conductive pathways with the continuous acceptor layer.

EX2029 (Forrest) at [0035]

152, providing electrically conductive pathways for dissociated holes from layer 953c to the anode 120 in the finished device.

EX2029 (Forrest) at [0081]

continuous acceptor layer 154, providing electrically conductive pathways for dissociated electrons from layer 953b to the cathode in the finished device. In FIG. 9G, an exciton block-

EX2029 (Forrest) at [0082]

Forrest Discloses Vertically Continuous Layers, Not Agglomerations

Dr. Sims
Expert Witness



pictiva displays

63. Based on Forrest’s description above and figures, a POSITA would recognize that although the discontinuous layers in Forrest may be horizontally discontinuous with gaps filled by subsequent layers, the layers are at least vertically continuous. This is evidence from the fact that Forrest describes the presence of conductive pathways through the respective discontinuous layers, which would not be the case if Forrest’s discontinuous layers were implemented using dispersed agglomerations. Therefore, Forrest does not disclose or suggest that a “matrix material” can encompass dispersed agglomerations.

EX2019 (Sims Decl.) at ¶ 63.

Claim Construction for “Matrix Material”

The Term “Matrix” Should Be Construed Consistently

The Term “Matrix” in “Matrix Material” Should Have the Same Meaning Throughout



“[W]hatever interpretation we assign should encompass both uses because the same word appearing in the same claim should be interpreted consistently.”

Digital Biometrics, Inc. v. Identix, Inc., 149 F.3d 1335, 1345 (Fed. Cir. 1998)

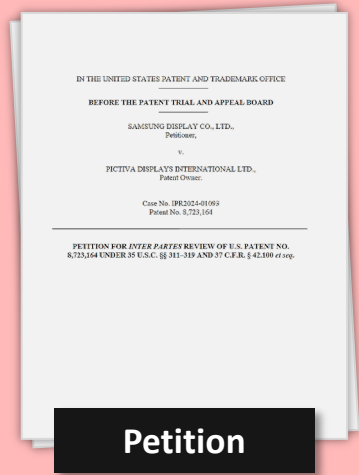
“A word or phrase used consistently throughout a claim should be interpreted consistently.”

Phonometrics, Inc. v. Northern Telecom Inc., 133 F.3d 1459, 1464 (Fed. Cir. 1998)

“[T]he principle that the same phrase in different claims of the same patent should have the same meaning is a strong one”

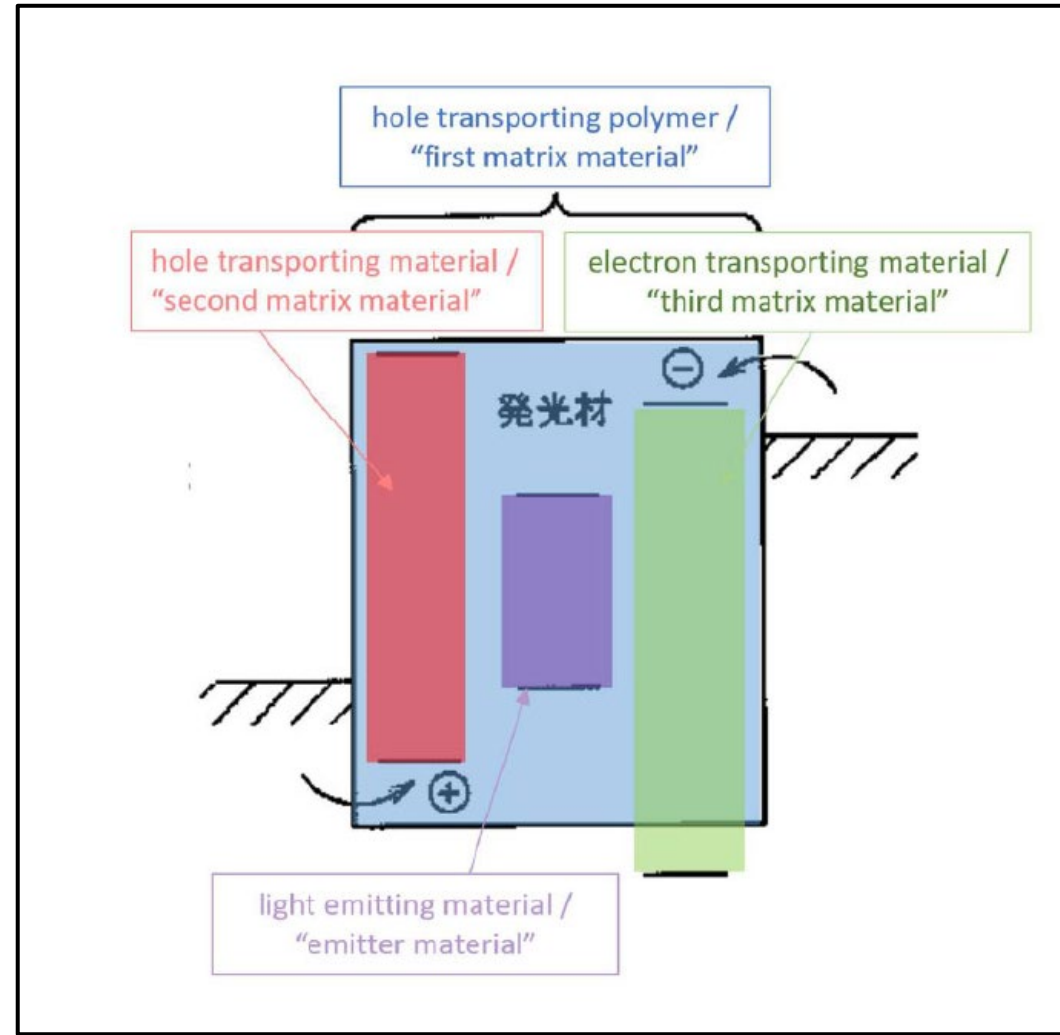
In re Varma, 816 F. 3d 1352, 1363 (Fed. Cir. 2016)

Materials That Are “Part of the Matrix” Versus Embedded in a Matrix



Petition

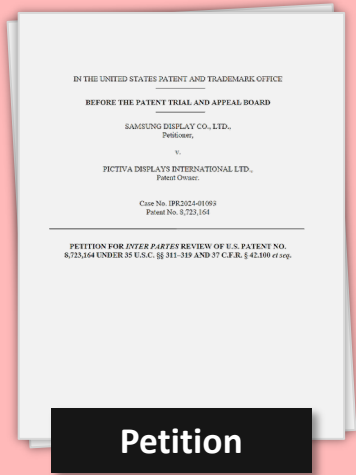
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Pet. 54-55 (annotating Sugiura, FIG. 8).

Ground 1: Choulis

Ground 1 (Claim 1) Is Based on Anticipation Only



SAMSUNG

Choulis anticipates all of the elements of claims 1-8 and 10-16 of the '164 patent, as discussed below. Ex.1003, ¶¶72-159. Moreover, to the extent there is any question whether Choulis anticipates any element of claims 1-8 and 10-16 of the '164 patent, the element or claim would have been obvious based on Choulis for substantially similar reasons. Ex.1003, ¶¶72-166. That is, to the extent any limitation is not disclosed by Choulis, it would have been strongly suggested to a POSITA for the same reasons discussed in Ground I below for that limitation. *See also Realtime Data, LLC v. Iancu*, 912 F.3d 1368, 1373 (Fed. Cir. 2019) (“It is well settled that a disclosure that anticipates under § 102 also renders the claim invalid under § 103, for anticipation is the epitome of obviousness.” (cleaned up). Further, given the

Petition at 19-20.

Ground 1 (Claim 1) Is Based on Anticipation Only

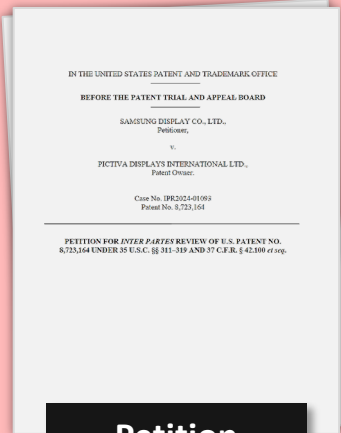
Dr. Holmes
Expert Witness
SAMSUNG

Q Okay. So for ground 1, claim number 1, you only proceed on anticipation under Choulis, correct?

A That's right. I am only arguing anticipation.

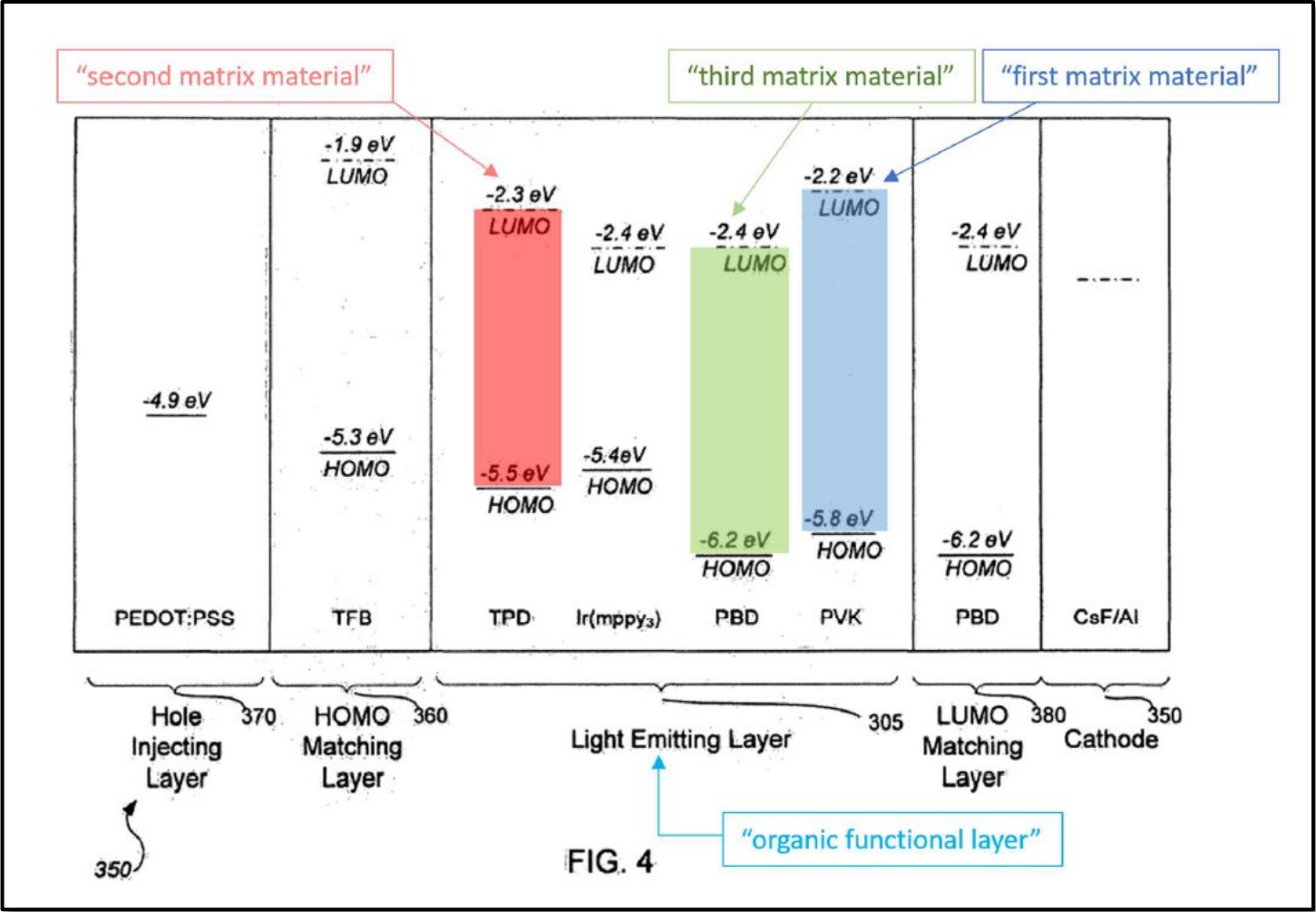
EX2020 (Holmes Dep. Tr.) at 167:5-9

Ground 1 Requires Choulis' Dopants to Be Matrix Materials



Petition

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Petition at 25 (annotating Choulis, FIG. 4)

Choulis' Discloses a PVK Host Into Which TPD and PBD Are Doped

Choulis

(10) United States
(12) Patent Application Publication
Choulis et al.
(10) Pub. No.: US 2007/0069636 A1
(43) Pub. Date: Mar. 29, 2007

(54) ORGANIC ELECTROPHOSPHORESCENCE DEVICE

(76) Inventors: Stelios A. Choulis, San Jose, CA (US);
Matthew Mathai, Santa Clara, CA (US);
Vi-Ea Chung, San Jose, CA (US);
Franky Su, Gainesville, FL (US)

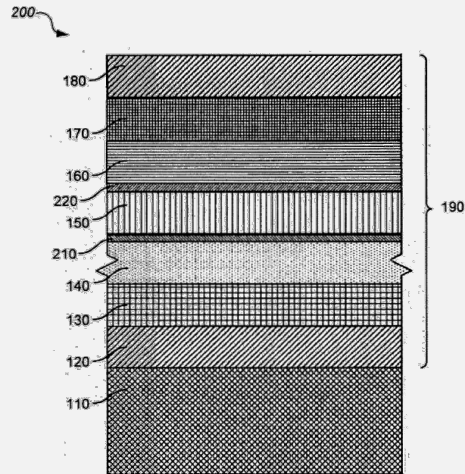
Correspondence Address:
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PO BOX 1022
MINNEAPOLIS, MN 55440-1022 (US)

(21) Appl. No.: 11/238,888
(22) Filed: Sep. 28, 2005

(51) Int. Cl. 2006.01
(52) U.S. Cl. 313/504

(57) ABSTRACT

Techniques are described for forming an organic light emitting diode device with improved device efficiency. Materials having at least one energy level that is similar to those of a phosphorescent light emitting material in the diode are incorporated into the device to directly inject holes or electrons to the light emitting material.



SDC EX. 1004 - 1/14

[0030] Referring to FIG. 4, organic moieties (which can include functional groups or whole molecules) can be mixed in with the light emitting layer 305 and a matching layer can be used to improve efficiencies of injecting of holes into the light emitting layer. The light emitting layer 305 includes a host material 310, poly(9-vinylcarbazole) (PVK), a light emitting material 320, (Ir(mppy)₃), a first organic moiety 330, triphenyldiamine (TPD) and a second organic moiety 335, PBD. The HOMO and LUMO energy levels of PVK

layer does not include a host. In some embodiments, the light emitting layer includes materials that are insulated matrices, that is, the host does not have transport properties,

[0032] As noted herein, the light emitting layer can be co-doped with organic moieties, that is, matching material.

EX1004 (Choulis) at [0030], [0044], [0032]

Choulis Expressly Distinguishes Different PBD Usages

Choulis

(19) United States
(12) Patent Application Publication
Choulis et al. (10) Pub. No.: US 2007/0069636 A1
(43) Pub. Date: Mar. 29, 2007

(54) ORGANIC ELECTROPHOSPHORESCENCE
DEVICE

Publication Classification

(76) Inventors: Stefan A. Choulis, San Jose, CA (US);
Matthew Mathai, Santa Clara, CA
(US); Yi-Ea Chung, San Jose, CA
(US); Franky Su, Gainesville, FL (US)

(51) Int. Cl.
H05B 33/00 (2006.01)
(52) U.S. Cl.
313/504

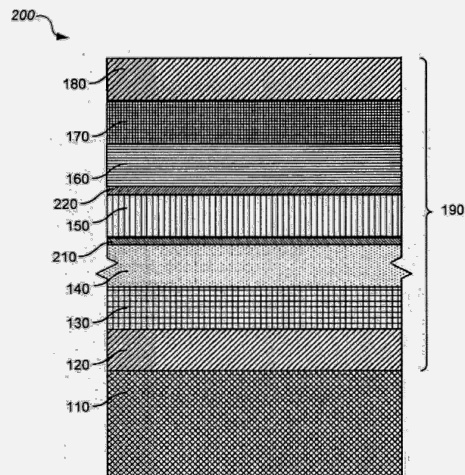
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SDC EX. 1004 - 1/14

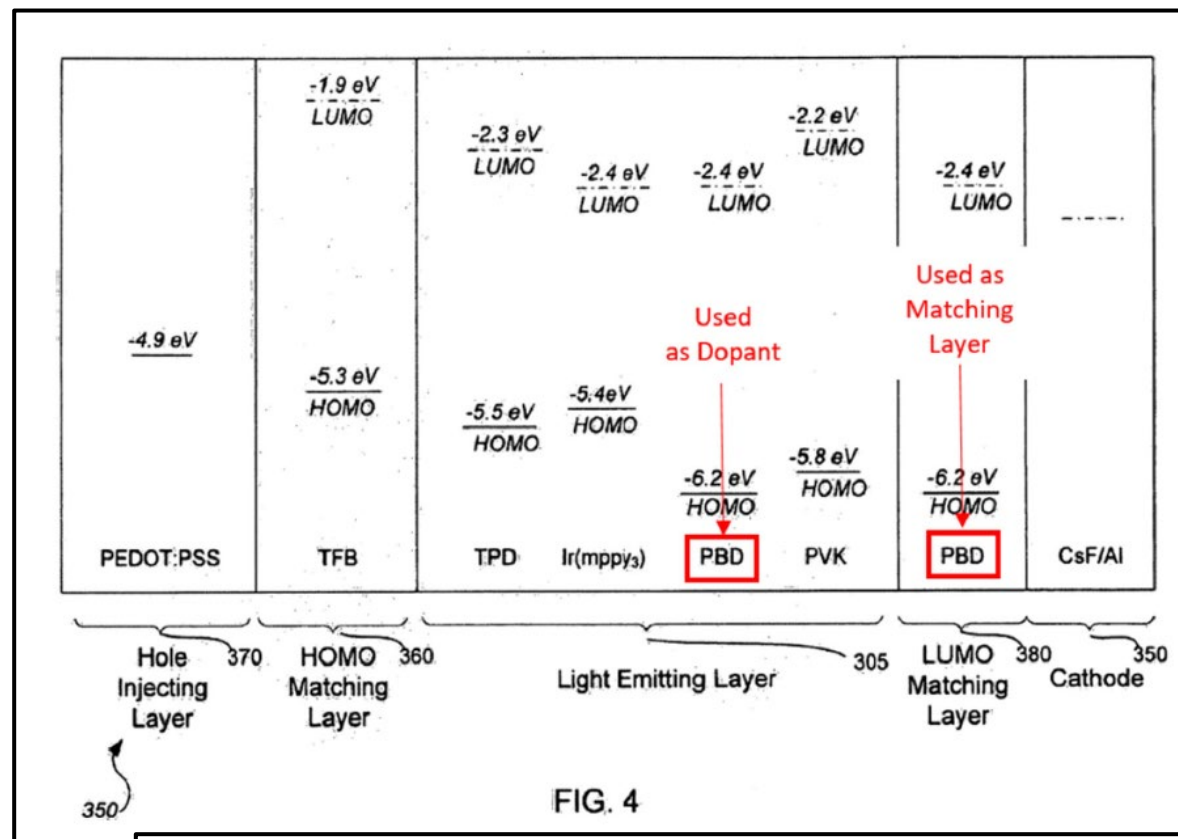


FIG. 4

The PBD is used as a moiety in the light emitting layer rather than as a thin matching layer, as above. PBD is also used as a LUMO matching layer (or interfacial layer) between the light emitting layer 305 and a cathode 350. The cathode 350,

EX1004 (Choulis) at FIG. 4, [0031]

Choulis Uses the Same Formulation as Yang

papers (EX1017). It is readily apparent that Choulis used one of Yang’s “optimized” test composition for its emission layer:

Choulis (EX1004)	Yang and Neher (EX1017)
[0054] (“The light emitting layer includes 61% PVK, 24% PBD, 9% TPD and <u>6% Ir(mppy)₃</u> .”).	EX1017, 2478, Figure 3 caption (“... a device containing PVK (0.61) + PDB (0.24) + <u>Ir(mppy)₃ (0.06)</u> + TPD (0.09)....”); EX1017, 2478 (“Figure 3 shows the current density-brightness-voltage properties of a device with ~ <u>6 wt% Ir(mppy)₃</u> and 9 wt% TPD”).

EX2019 (Sims Decl.) at ¶ 70.

Dr. Sims
Expert Witness



Yang: TPD Is Not, and Should Not Be Used as a Host in Choulis

TABLE I. Performances of PVK:PBD based single-layer devices with $\sim 6\%$ Ir(mppy)₃ and different TPD concentrations.

TPD concentration	Peak luminous efficiency	Voltages at 10 ² , 10 ³ , 10 ⁴ cd/m ²	PCE at 1000 cd/m ²	Brightness at 10 V
0%	23.7 cd/A	5.0 V, 6.9 V, > 10 V	10.5 lm/W	8920 cd/m ²
6%	35.5 cd/A	4.4 V, 5.9 V, 8.8 V	17.6 lm/W	17 900 cd/m ²
9%	38.1 cd/A	4.3 V, 5.8 V, 8.6 V	19.8 lm/W	18 600 cd/m ²
12.5%	37.1 cd/A	4.2 V, 5.6 V, 8.4 V	19.8 lm/W	21 400 cd/m ²
19%	27.6 cd/A	4.1 V, 5.4 V, 8.2 V	15.2 lm/W	22 100 cd/m ²

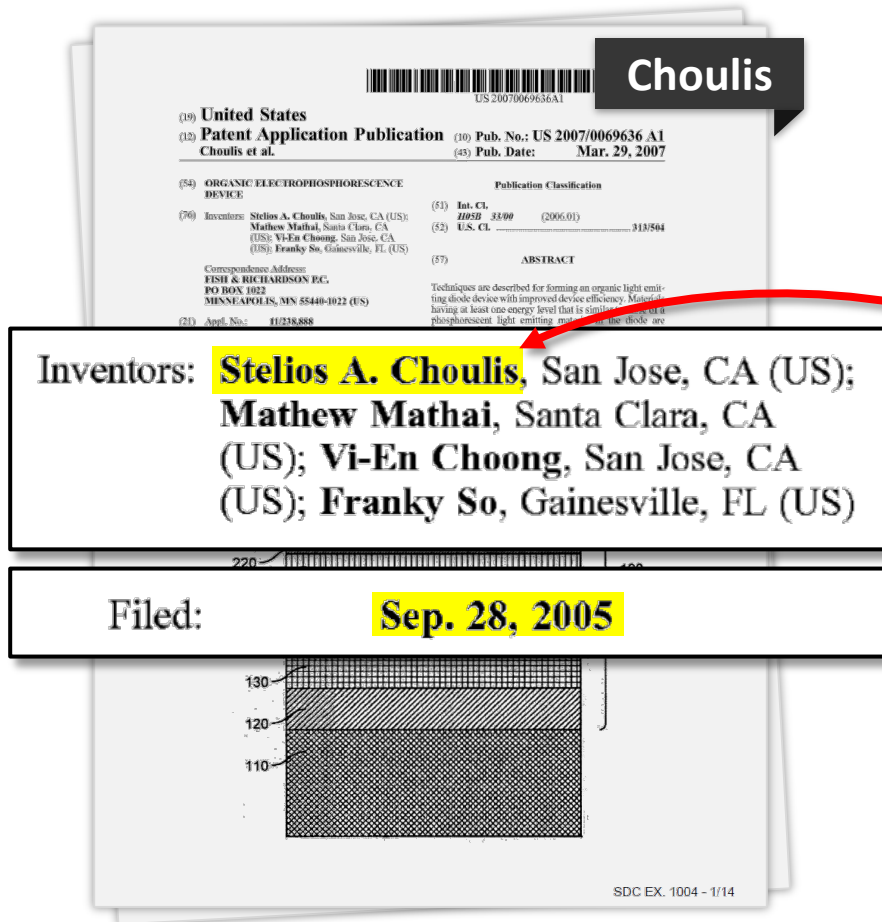
EX1017 (Yang) at 2477

13 wt%, indicating that a large concentration of TPD disturbs the balance of carrier injection and transport.

doped into a PVK:PBD host.³⁰ We, therefore, expect that co-doping with hole-transporting moieties such as TPD may be a general scheme to improve the efficiency of PVK:PBD based devices.

EX1017 (Yang) at 2478

Choulis' Other Publications Confirm PVK Is the Host Into Which TPD and PBD Are Doped



EX1004

Highly efficient organic electroluminescent device with modified cathode

Stelios A. Choulis,^{a)} Mathew K. Mathai, Vi-En Choong, and Franky So^{b)}
Osram Opto Semiconductors, Inc., San Jose, California 95134

(Received 6 December 2005; accepted 4 April 2006; published online 17 May 2006)

One of the key parameters for high efficiency organic electrophosphorescent light emitting diodes is charge injection into the phosphorescence compound. By introducing a hybrid device architecture, and incorporating electron and hole interfacial layers with lowest unoccupied molecular orbital and highest occupied molecular orbital levels similar to that of the phosphorescence compound, on the cathode and the anode side of the device, respectively, charge injection properties were improved. A green electrophosphorescence device with luminous efficacy of 50 lm/W at luminance efficiency reaching 55 cd/A was demonstrated. © 2006 American Institute of Physics.

[DOI: 10.1063/1.2204840]

EX1022

Choulis' Other Publications Confirm PVK Is a Host Into Which TPD and PBD Are Doped

Highly efficient organic electroluminescent device with modified cathode

Stelios A. Choulis,^{2d} Mathew K. Mathai, Vi-En Choong, and Franky So^{2b}
Oxram Opto Semiconductors, Inc., San Jose, California 95134

(Received 6 December 2005; accepted 4 April 2006; published online 17 May 2006)

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[DOI: 10.1063/1.2204840]

The ability of organic phosphorescence emitters to achieve emission from both singlet and triplet excited states has opened the possibility to develop highly efficient organic light emitting diodes (OLEDs) for flat panel displays and solid state lighting applications.¹ The field of organic electronics is divided in two broad categories: thermally deposited small molecules (low molecular weight materials) and solution processed polymer based OLEDs. Of the two, the small molecule technology is the more mature, and has produced high efficiencies up to 77 lm/W for green phosphorescence based OLEDs (PHOLEDs).² This particular device structure consists of several stacked layers, each one optimized to perform functions including charge confinement, electron and hole injection/transport/blocking, and exciton recombination.³ However, such complicated structures do increase fabrication complexity,^{3,4} and may not be suitable for low cost, high volume manufacturing. Thus, there remains interest in investigating solution processed OLEDs as these fabrication techniques are more scalable and have better potential for low cost high volume processing.

However, to achieve the same kind of efficiencies, solution processed approaches will also have to incorporate phosphorescent emitters in place of existing fluorescent emitters while keeping simple device architectures. Although incorporation of phosphorescence emitters into conjugated polymers has been reported to improve device performance for red PHOLEDs, efficiency values are still much lower than those obtained for small molecule based devices. The problem is more severe for blue and green emissions due to luminescence quenching effects caused by the low triplet energy level of the conjugated polymers.⁵ Thus, to minimize quenching effects, large band-gap host materials with higher triplet energy than that of the phosphorescence dye are needed.

Recent work have used nonconjugated polymers, such as poly(*N*-vinylcarbazole) (PVK), as the large band-gap host. This host is then molecularly doped with *N,N'*-diphenyl-*N,N'*-bis(3-methylphenyl) - [1,1-biphenyl]-4,4'-diamine (TPD), 2-(4-biphenyl)-5-(4-*tert*-butylphenyl)-1,3,4-oxadiazole (PBD), and tris(2-(4-tolyl)phenylpyridine)iridium Ir(mppy)₃, components that serves the purpose of carrier transport and emission. With this composition, a single layer green emitting polymer based PHOLED with luminous efficacy (or power efficiency) of 24 lm/watt at luminance (or current) efficiencies exceeding 30 cd/A was achieved.⁶ The PVK polymer is particularly

phenylpyridine)iridium Ir(mppy)₃, components that serves the purpose of carrier transport and emission. With this composition, a single layer green emitting polymer based PHOLED with luminous efficacy (or power efficiency) of 24 lm/watt at luminance (or current) efficiencies exceeding 30 cd/A was achieved.⁶ The PVK polymer is particularly suitable for a host since it can ensure the confinement of the triplet excited state in the Ir(mppy)₃ guest phosphorescence molecule, and thus prevent luminescence quenching.⁷ In this type of device, good charge balance within the phosphorescence light emitting layer (LEP) has been achieved.^{8,9}

We have recently reported further improvement on the performance of molecular doped PHOLEDs by incorporation of a solution processed interfacial layer, based on poly(9,9-dioctyl-fluorene-co-3,4-(4-biphenyl)-diphenylamine) (TFB) between 3,4-polyethylene di-*o*-methylphenylene-poly(styrene sulfonate) (PEDOT:PSS) and the LEP.¹⁰ Devices with the TFB interfacial layer show luminous efficacy of 41 lm/W at efficiencies reaching 50 cd/A,¹⁰ exceeding the 31 lm/W reported for a small molecule PHOLED, using 4,4'-*N,N'*-dicarbazole-biphenyl the small molecule derivative of PVK as a host and the same emitter.¹¹

In this letter we demonstrate that further improvement in the device performance was achieved by improving the electron injection properties. This was achieved with a modified cathode. The cathode now consists of interfacial layer specially chosen to enhance electron injection. With this modified cathode, the efficiency of the PHOLED is further enhanced by 25%.

Details about the materials, standard device preparation, and characterization have been published elsewhere.^{10,12} In the present study TFB and PBD were used as hole and electron injecting interfacial layers, respectively. The TFB layer was spin coated inside the glovebox onto the PEDOT:PSS buffer layer from toluene solution and baked at 130 °C for 10 min in a nitrogen environment. Under these conditions an interlayer thickness of around 10 nm was obtained. To achieve the interfacial layer and prevent mixing of the TFB layer with the active organic layer we introduced a washing step using toluene on the TFB layer. This results to a TFB polymer based interfacial layer with a thickness of ≤ 3 nm. Full details for the improvement on the hole injection properties for organic electronic devices by incorporation of a TFB interfacial layer have been published previously.^{10,13}

^{2d}Author to whom correspondence should be addressed; present electronic mail: stelios.choulis@oxram.com

^{2b}Present address: Department of Materials Science and Engineering, University of Florida, Gainesville, FL 32611-6400.

Recent work have used nonconjugated polymers, such as poly(*N*-vinylcarbazole) (PVK), as the large band-gap host. This host is then molecularly doped with *N,N'*-diphenyl-*N,N'*-(bis(3-methylphenyl)) - [1,1-biphenyl]-4,4'-diamine (TPD), 2-(4-biphenyl)-5-(4-*tert*-butylphenyl)-1,3,4-oxadiazole (PBD), and tris(2-(4-tolyl)phenylpyridine)iridium Ir(mppy)₃, components that serves the purpose of carrier transport and emission. With this composition, a single layer green emitting polymer based PHOLED with luminous efficacy (or power efficiency) of 24 lm/watt at luminance (or current) efficiencies exceeding 30 cd/A was achieved.⁶ The PVK polymer is particularly

⁶X. H. Yang and D. Neher, Appl. Phys. Lett. **84**, 2476 (2004).

EX1022 (Choulis paper) at 203502-1

Ground 2: Choulis + Yong (Claim 9)

Claim 9: Concentration Gradient

'164

(12) **United States Patent**
Schmid et al.

(10) Patent No.: **US 8,723,164 B2**
(45) Date of Patent: **May 13, 2014**

(54) **ELECTRONIC DEVICE**

(75) Inventors: **Guenther Schmid**, Hombfien (DE); **Ralf Krause**, Erlangen (DE); **Stefan Seidel**, Nurnberg (DE); **Oliver Weiss**, Dossenheim (DE); **Christoph Gauditz**, Regensburg (DE); **Rikku Salonen**, Oulu (FI); **Ulrich Niedermeier**, Leinfelden (DE); **Wladyslaw Kucukowski**, Erlangen (DE)

(73) Assignee: **OSRAM Opto Semiconductors GmbH**, Regensburg (DE)

(*) Notice: Subject to any disclaimer, the term patent is extended or adjusted in U.S.C. 154(b) by 315 days.

(21) Appl. No.: **12/995,457**

(22) PCT Filed: **May 18, 2009**

(86) PCT No.: **PCT/DE2009/009781**
[371 (a)(1),
(2), (4) Date: **Feb. 18, 2011**

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PCT Pub. Date: **Dec. 3, 2009**

(65) **Prior Publication Data**
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(36) **Foreign Application Priority Data**
May 30, 2008 (DE) 10 2008 0
Aug. 22, 2008 (DE) 10 2008 0

(51) **Int. Cl.** **H01L 35/24** (2006.01)

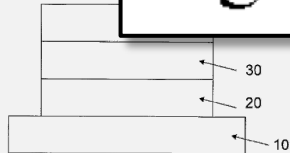
(52) **U.S. Cl.** 257/40; 257/E
USPC

(58) **Field of Classification Search**
USPC
See application file for complete search history.

(56) **References Cited**
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2009/039294 A1 2/2009 Cheong et al.

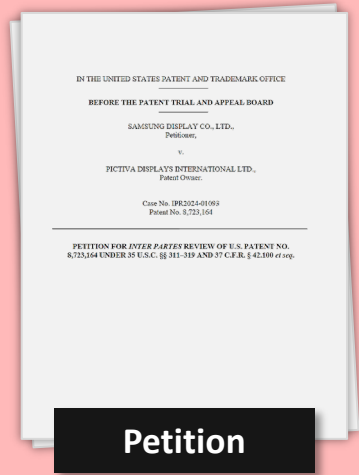
FOREIGN PATENT DOCUMENTS

9. The electronic device according claim 1, wherein the concentration of the emitter material in the emission layer has a gradient.



EX1001, claim 9

Petitioner's Alleged Motivation to Combine



SAMSUNG

It would have been obvious to a POSITA to dope the emission layer in the device disclosed in Choulis such that “the concentration of the emitter material in the emission layer has a gradient.” Ex.1003, ¶164. A POSITA would have been motivated to use a gradient for the emitter concentration in the emission layer to achieve the advantages discussed in Yong, including improving the device’s luminescence efficiency and stability. Ex.1003, ¶164.

Petition at 50

Yong's Principle is to Match the Emitter Gradient to the Transport Materials' Gradient

From Background Section

electrons are minority carriers. In the light emitting layer of phosphorescent devices, the concentration distribution of electrons shows a non-linear decreasing trend along the direction from the electron transporting layer to the hole transporting layer. Therefore, uniformly doped phosphorescent devices can only emit light from dyes located in the emitting region, and their luminescence efficiency and brightness are limited to a certain extent.

EX1009 (Yong) at 10/33

From “Contents of the Invention”

In OLEDs, the concentration distribution of electrons generally decreases nonlinearly from the electron transporting layer to the hole transporting layer. The gradient distribution of the doping concentration of phosphorescent dyes in the organic light emitting layer in the host material in the above technical solution is to make the distribution trend of phosphorescent dyes in the host material conform to the distribution trend of electrons in the host material, and such concentration distribution expands the luminescent region of the device, improves the utilization rate of phosphorescent dyes, and is also conducive to the combination of electrons and holes to form excitons.

EX1009 (Yong) at 10/33

Yong

[01] China National Intellectual Property Administration

10109 5314



[32] Invention Patent Publication Description

[34] Application No.: 200410089258.4

10109 5312

10109 5314

[43] Publication date: February 16, 2005

[31] Publication No.: CN 1382073A

[21] Application Date: July 16, 2004

[22] Application No.: 200410089258.4

[30] Priority

[52] February 27, 2004 [53] CN [31] 20041004408.4

[74] Applicant: Tsinghua University

Address: Room 205A, Tsinghua University Engineering

Museum, Tsinghua Garden, Haidian District,

Beijing 100084 China

Co-applicant: Beijing Vision Technology Co., Ltd.

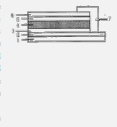
[72] Inventors: Qiao Yong, Lai Gang, Wang Li-shao

5 pages of claims, 22 pages of description, and 4
pages of figures

[54] Invention Name: A phosphorescent organic light emitting device and the preparation method thereof

[57] Abstract

The present invention relates to a phosphorescent organic light emitting device and the preparation method thereof. The device comprises a transparent substrate, an anode layer, an organic functional layer, and a cathode layer, wherein the organic functional layer comprises an organic light emitting layer, selective of one or more layers of hole injection layer, hole transporting layer, electron transporting layer, and electron injection layer; the organic light emitting layer comprises a host material and a phosphorescent dye, and the doping concentration of the phosphorescent dye gradually increases or decreases along the direction from the anode layer to the cathode layer with the increase of the thickness of the organic light emitting layer, forming a concentration with gradient doping. In the organic light emitting layer of the device, phosphorescent dyes are doped into the host material in a gradient doping manner, expanding the luminescent region of the device, improving the utilization rate of the phosphorescent dyes, and facilitating the combination of electrons and holes to form excitons, thereby improving the device's luminescence efficiency and brightness, improving its stability, and overcoming the disadvantages of low luminescence efficiency and poor stability under high current.



Choulis' Transport Materials Do Not Have Concentration Gradients

Dr. Sims
Expert Witness



pictiva displays

109. Yong's invention was specifically designed to address the non-linear decrease in electron concentrations from ETL to HTL, as described above.

EX1009, 10. Because there is no reason to believe that Choulis's specific device experiences any such concentration gradient of electrons from the ETL side to the HTL side, a POSITA would not have been motivated to complicate Choulis with addition steps to include a concentration gradient like Yong where the problem solved by Yong's concentration gradient does not exist in the first place.

EX2019 (Sims Decl.) at ¶109.

Dr. Holmes Confirmed That Choulis Does Not Have Transport Gradients

Dr. Holmes
Expert Witness

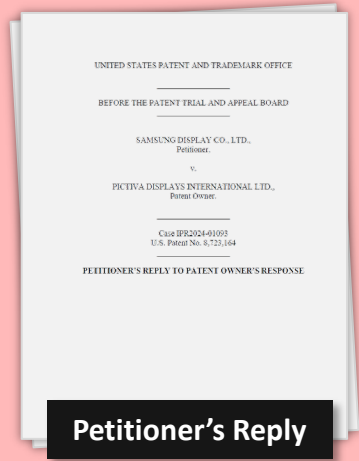
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THE WITNESS: So Choulis doesn't explicitly have a concentration gradient for their hole and electron transport materials in the embodiment I'm looking at.

EX2033 (Holmes Dep. Tr.) at 126:7-10

Yong Would Match Choulis' Uniform Transport Materials With a Uniform Emitter

Petitioner Failed to Establish a Reasonable Expectation of Success



SAMSUNG

First, as discussed above in Section III.D, Choulis discloses evaporation coating as a viable method, and a POSITA would understand that PVK can be deposited using this technique. *Second*, OLEDs utilizing solution-processed layers with a gradient in the emitter composition were well established in the field. Ex.1044, ¶¶54-55

Petitioner's Reply at 19.

Petitioner Failed to Establish a Reasonable Expectation of Success

Dr. Holmes
Expert Witness

SAMSUNG

Q Yong uses an evaporative process,
correct?

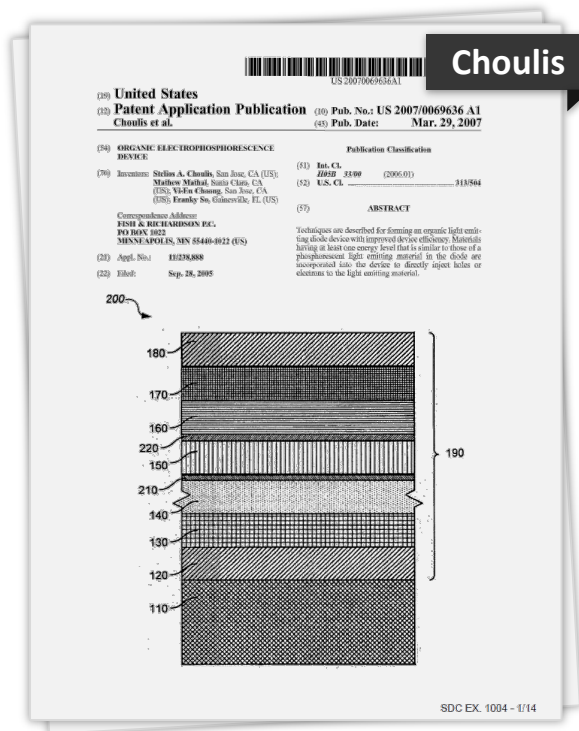
A That's correct.

Q You are not contending that a
solution-based process will yield a concentration
gradient of the emitter material; is that right?

A No. I'm using Yong with evaporation.

EX2020 (Holmes Dep. Tr.) at 172:2-8

A POSITA in Possession of Choulis Would Not Evaporate PVK



[0044] The light emitting layer can include a host material. The hole material can be PVK, as described above, which is a non-conjugated polymer having mostly hole transporting properties. The host can be also a electron, hole or bipolar

residing in the light emitting layer. Unlike polymeric materials that are applied as solutions or suspensions, small-molecule light emitting materials are preferably deposited through evaporation, sublimation, or organic vapor phase deposition methods. There are also small molecule materials

[0048] Polymer organic layers can be applied to the substrate using a variety of techniques, such as ink-jet printing an organic solution or by spin-coating. Alternatively, if small molecule materials are used instead of polymers, the layers can be deposited through evaporation, sublimation, organic

EX1004 (Choulis) at [0044], [0043], [0048]

Dr. Holmes Confirmed That He Did Not Propose to Replace PVK With a Small Molecule for Claim 9

Dr. Holmes
Expert Witness

SAMSUNG

Q Can you point me to where you propose to replace PVK with a small molecule?

A In claim 9?

Q For claim number 9, yeah.

A I didn't say that I did.

EX2020 (Holmes Dep. Tr.) at 172:2-8

Djobo Does Not Motivate the Combination or Establish a Reasonable Expectation of Success in Achieving the Claimed Invention

Dr. Sims
Expert Witness



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[0044], [0048]. Regarding evaporating PVK, Djobo demonstrates that evaporation of PVK leads to decomposition, and there is no demonstration that the resulting material would have the same HOMO/LUMO levels as PVK or that the decomposed materials would provide acceptable performance. EX1023, Abstract (“When PVK is deposited by classical thermal evaporation there is a shortening effect of the chain length”).

EX2019 (Sims Decl.) at ¶ 100

Dr. Holmes Confirmed That Evaporated PVK Degrades Into a Different Mixture Having a Different Emission Spectrum

Dr. Holmes
Expert Witness

SAMSUNG

Is it your understanding that PVK would experience some decomposition during the evaporative process?

MR. BYUN: Objection to form.

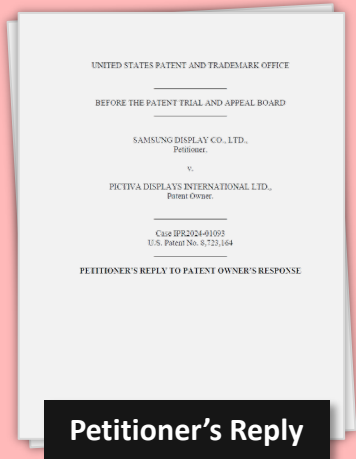
THE WITNESS: So, again, as I noted, the prior work would suggest that the spectrum is consistent with a mixture of PVK and vinylcarbazole, which would suggest there could be some degradation.

EX2033 (Holmes Dep. Tr.) at 28:11-18

And so generally when you're processing an OLED, you don't want decomposition. In fact, that would be not typically the goal.

EX2033 (Holmes Dep. Tr.) at 23:17-19

Petitioner's Reply Evidence Confirms That A POSITA Would Not Attempt to Evaporate PVK



SAMSUNG

layer.¹⁶ In all these structures, the PEDT/PSS layer and the PVK layer were prepared by spin coating and the thicknesses

EX1039 (Chang) at 575

for flat-panel display applications.^{1,2} The capability of solution processing of polymers leads to manufacturing advantage for large-area coating. However, it is difficult to inte-

EX1040 (Wu) at 794

Dr. Holmes' Testimony Confirms That PVK Should Not Be Evaporated

Dr. Holmes
Expert Witness

SAMSUNG

Q Dr. Holmes, are you aware of anyone who used evaporated PVK to make a phosphorescent OLED prior to the '164 patent?

A I'm not aware of a work that uses evaporated PVK in a phosphorescent OLED.

Q Are you aware of anyone who used evaporated PVK to make a phosphorescent OLED after the '164 patent?

MR. BYUN: Objection, form.

THE WITNESS: Again, not off the top of my head, I'm not aware of a paper since then that have applied PVK in a phosphorescent OLED.

BY MR. LINDSAY:

Q And that's even today?

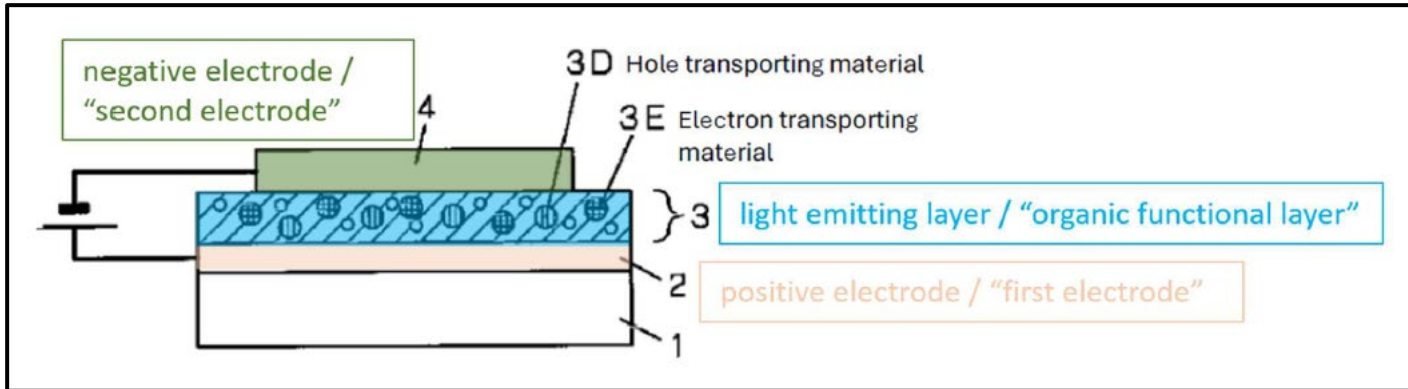
A Yes, since then, yes.

EX2033 (Holmes Dep. Tr.) at 46:2-16

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

Ground 3: Sugiura

Ground 3 Requires Sugiura's Dispersed Agglomerations to be Matrix Materials



Petition at 54 (annotated Sugiura, FIG. 4)

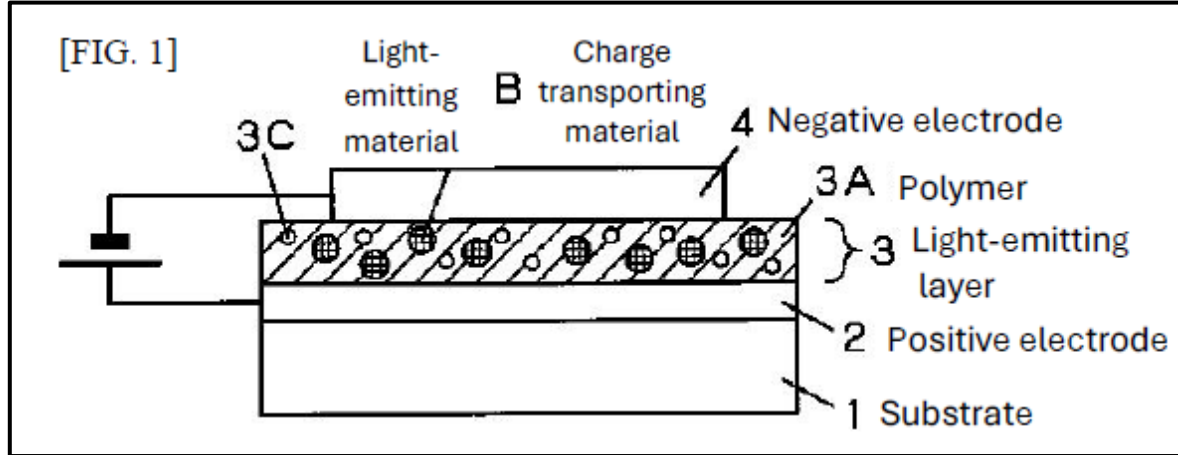
Example 1. For the light-emitting layer 3, PVK was used for the polymer 3A, N,N'-diphenyl-N,N'-bis(3-methylphenyl)-1,1'-biphenyl-4,4'-diamine (TPD) was used for the hole transporting material 3D, Alq₃ was used for the electron transporting material 3E, and Nile Red was used for the light-

EX1006 (Sugiura) at [0062]

Sugiura, [0062] (emphasis added) (referring to Figure 4 above). Here, polymer PVK is the claimed "first matrix material," the hole transport material TPD is the claimed "second matrix material," and the electron transport material Alq₃ is the claimed "third matrix material." Ex.1003, ¶179.

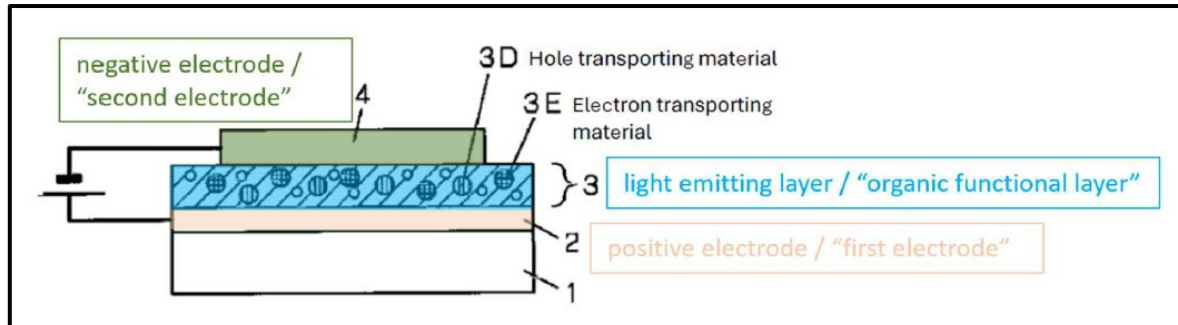
Petition at 55

Sugiura's PVK Polymer 3A Is the Host Material For Sugiura's Dispersed Agglomerations



[0041] The light-emitting layer includes a charge transporting material 3B, a light-emitting material 3C, and a polymer 3A for dispersing these. For the polymer material, charge transporting

EX1006 (Sugiura) at [0041]



[0062] (Example 8) An organic light-emitting device having the configuration in FIG. 4 was fabricated and evaluated. The substrate 1, the positive electrode 2, and the negative electrode 4 had the same configuration and thickness as in Example 1. For the light-emitting layer 3, PVK was used for the polymer 3A, N,N'-diphenyl-N,N'-bis(3-methylphenyl)-

EX1006 (Sugiura) at [0062]

Petition at 54 (annotated Sugiura, FIG. 4)

3D and 3E are "islands" dispersed in polymer 3A with no interconnections

Sugiura's Dispersed Agglomerations are Embedded in the Host Polymer 3A

Dr. Sims
Expert Witness



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119. I note that the mixture of materials 3A, 3D and 3E does not form a continuous phase in the emission layer; instead, the only non-dispersed phase is formed by host material (blue shaded areas) with materials 3D and 3E embedded therein at discrete locations like “islands in a sea.” Indeed, given that materials 3D and 3E, like the emitters, are dispersed in host 3A with no other materials embedded in them, materials 3D and 3E would be regarded as having the same structural nature as the emitter materials—they are all dopants, not matrix

EX2019 (Sims Decl.) at ¶ 119

Dr. Schubert: Sugiura's "Agglomerations" Are Not A Matrix

Dr. Schubert
Expert Witness

SAMSUNG

Q. Does the figure show a continuous phase of the mixture of 3A, 3B, and 3C?

MS. BAILY: Object to the form.

THE WITNESS: If these little circles contain only one matrix material, then I would say that this is not a matrix because it does not include a continuous phase of matrix materials. But rather agglomerations of materials as expressed by the circle features or circular features.

EX2018 (Schubert Dep. Tr.) at 114:13-21

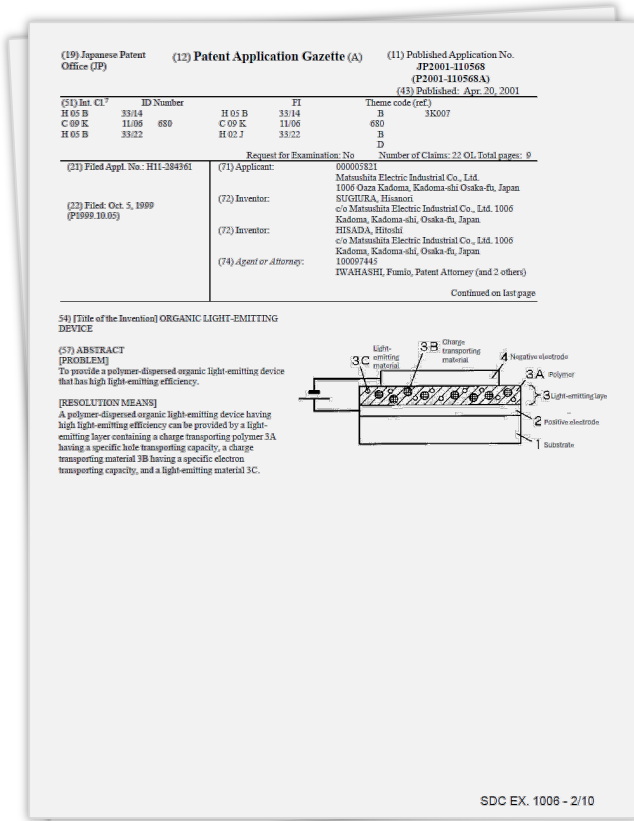
Sugiura's Example 8/Fig. 4 is Expressly Spin-Coated

[0062] (Example 8) An organic light-emitting device having the configuration in FIG. 4 was fabricated and evaluated. The

...

The light-emitting layer was formed by dissolving 300 mg of PVK, 180 mg of Alq₃, 240 mg of TPD, and 0.6 mg of Nile Red in 50 mL of a 1:1 mixed solvent of toluene and chloroform, stirring the solution for one day, then spin-coating the solution onto the ITO-affixed glass substrate in the same manner as in Example 1. The film thickness of the

EX1006 (Sugiura) at ¶ [0062]



SDC EX. 1006 - 2/10

Choulis/Sugiura Spin-Coating is Unlikely to Achieve a Fine Mixture

Dr. Sims
Expert Witness



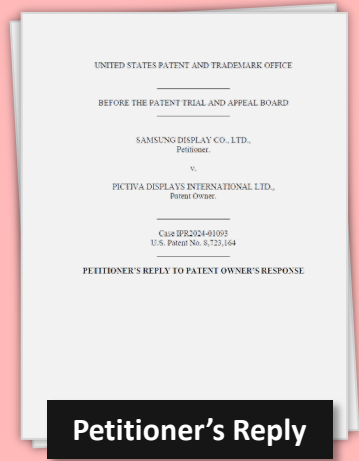
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They do mention spin coating, and spin coating is a process which is very turbulent, and when you have lots of different materials with different vapor pressures inside solvent, each of these materials will crash out at different rates.

So it is really hard to get a fine mixture, and by reading this, I can see they've made an attempt, but I really doubt they would have been able to get the granularity that you can get with an evaporative process; hence, I think that the -- they were probably aware of this, and that's why they drew the schematic the way they did.

EX1043 (Sims Dep. Tr.) at 65:6-17

Sugiura's Weight % Ratio Does Not Support Petitioner's Challenge



SAMSUNG

Moreover, Sugiura's hole and electron transport materials are not dispersed agglomerations. Ex.1044, ¶59. PO overlooks Sugiura's explicit teaching that PVK (an exemplary "first matrix material"), Alq₃ (an exemplary "third matrix material"), TPD (an exemplary "second matrix material"), and Nile Red (an exemplary "emitter material") can be mixed in a ratio of 100:60:80:0.2.¹⁰ Ex.1006, [0062]. A POSITA

Petitioner's Reply at 20.

5.4 eV. The mixing ratio of each material was:
PVK:Alq₃:TPD:Nile Red = 100:60:80:0.2 (weight ratio).

EX1006 (Sugiura) at [0062]

Sugiura's Weight % Ratio Does Not Support Petitioner's Challenge

Dr. Sims
Expert Witness



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THE WITNESS: It is difficult to say, but, you know, they've given the weight ratio here, which is not really the critical thing. We need to know what the equivalent molar ratio is for this. But I

EX1043 (Sims Dep. Tr.) at 66:3-6

Sugiura's Weight % Ratio Does Not Support Petitioner's Challenge

Dr. Holmes
Expert Witness

SAMSUNG

Q So again, the mol ratio would be substantially different than the weight ratio that Sugiura lists; right?

THE WITNESS: I don't disagree. The molecular weight difference is significant.

EX2033 (Holmes Dep. Tr.) at 152:5-11

Dr. Holmes Opinions Are Not Based on Sugiura's Weight % Ratio

59. Moreover, Sugiura's hole and electron transport materials are not dispersed agglomerations. Dr. Sims overlooks Sugiura's explicit instruction that PVK

EX1044 (Holmes Decl.) at ¶ 59

Q Okay. But the first sentence of your Paragraph 59 is drawing a conclusion about Sugiura's hole and electron transport materials as not being dispersed agglomerations; right?

A Yes.

Q Is that opinion what you're supporting with a citation to Sugiura's weight ratio for Example 8?

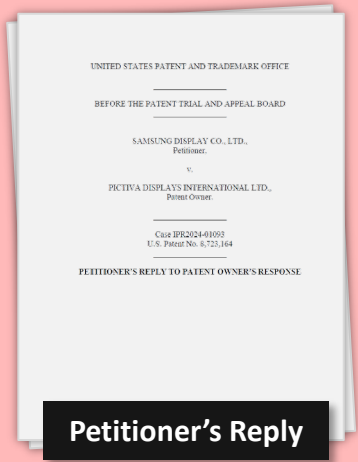
A No, because the -- again, the concentration is not -- or the weight ratio is not something that I need to invoke to define what the matrix materials are in the blend.

EX2033 (Holmes Dep. Tr.) at 136:7-18

Dr. Holmes
Expert Witness

SAMSUNG

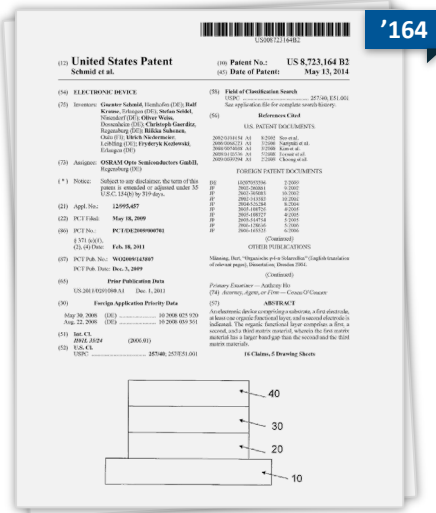
Charge Transport Materials Are Not Necessarily “Matrix Materials”



SAMSUNG

¶57. The '164 patent explicitly describes a hole transport material and an electron transport material, such as those identified by Sugiura, as matrix materials. Ex.1001, cls. 5-6, 5:34-37.

Petitioner's Reply at 20.



The device can have, for example, mCP (m-bis(N-carbazolylbenzene)), as the first matrix material in an organic functional layer; as a second matrix material, which can be a hole transport material, TCTA (9H-carbazole, 9,9',9''-(1,3,5-benzenetriyl)tris-(9Cl)); and as a third matrix material, which can be an electron transport material, for example, TPBi (1,3,5-

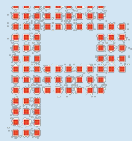
EX1001 (164 patent) at 5:32-37

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

Pictiva slide, p. 85

Charge Transport Materials Are Not Necessarily “Matrix Materials”

Dr. Sims
Expert Witness

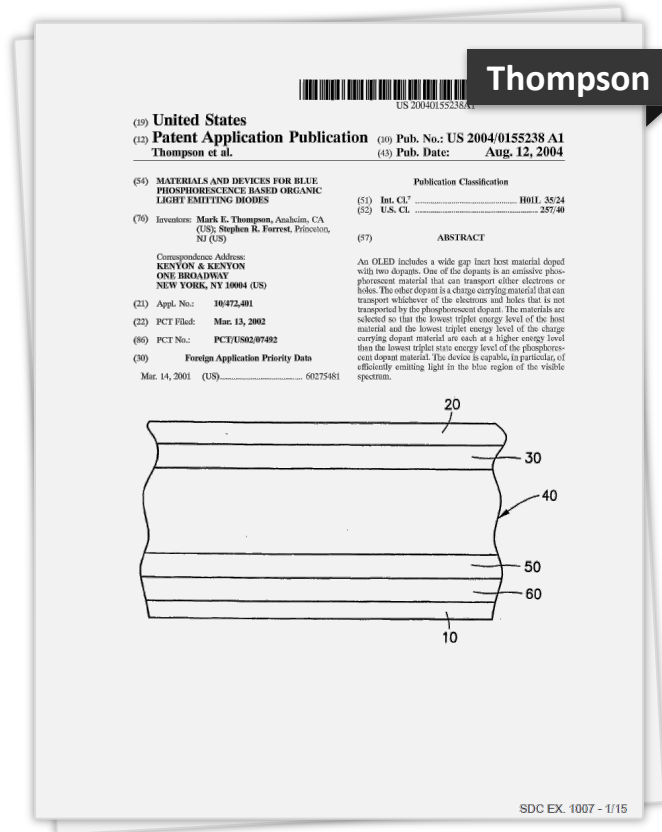


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131. I also note that the '164 patent discloses emitter materials with a HOMO energy level higher than the matrix materials. *See* EX1001, col. 7, table 1 (emitter rubrene has a HOMO level of -5.5eV, higher than the three matrix materials mCP, TCTA and TPBi), 4:44-54 (HOMO of emitter higher than those of the first, second and third matrix materials), Fig. 2 (emitter materials 30E's HOMO level above those of the matrix materials 30N, 30A and 30B). This means that the emitter materials disclosed in the '164 patent would also be expected to transport holes, but were never characterized as matrix materials. *See* EX1001, 8:27-30; *see also* EX2020, 299:20-300:7; EX1017 (Yang) at 2477 (Ir(mppy)₃ “participates in charge transport,” but never described as a host”). *See* EX1007, [0023] (expecting

EX2019 (Sims Decl.) at ¶131

Thompson: Charge Carrying Materials Can Be Dopants

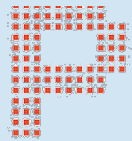


[0025] Thus, one of the distinctive features of the present invention is that the charge carrying materials that are typically used as the predominant component, if not sole component, for the hole transporting layer or the electron transporting layer in a conventional OLED, may be used in the present invention as the charge carrying dopant material in an inert matrix. An additional feature of the present

EX1007 (Thompson) at [0025]

Sugiura's Matrix Box Confirms Sugiura's Hole/Electron Transport Materials Are Not Part of the Matrix

Dr. Sims
Expert Witness



pictiva displays

Q. Okay. And what is shown in Figure 8?

A. Well, it is showing -- there's a box and that -- the top and bottom lines confining that box are denoting the HOMO and LUMO level of PVK.

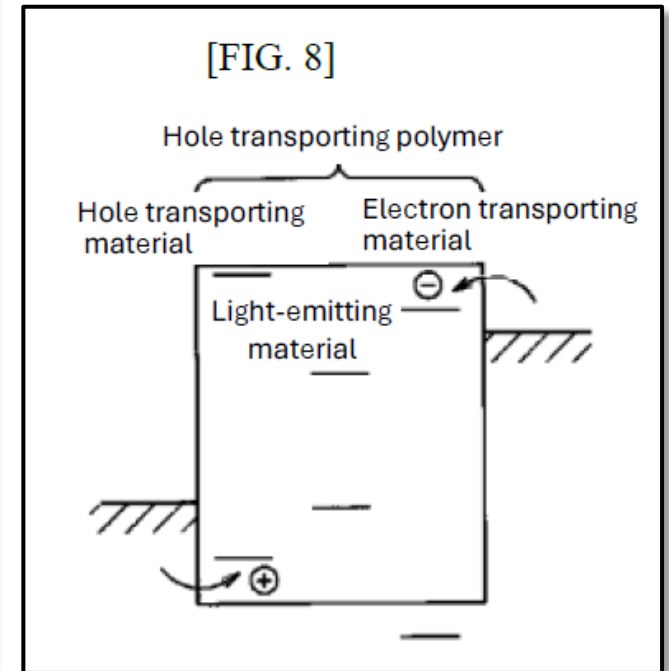
So that's the matrix, the overall matrix. And then within that, you see some other energy levels, again, HOMO and LUMO levels, of constituent molecules; in this case, electron transport, hole transport, and emitter material that are doped into the PVK, which is the overall host matrix material.

Q. Okay. And what is the significance of the box?

A. It's -- it's a matrix.

Q. Okay. So it is a conventional way to show this is a matrix?

A. Yeah. I've seen this quite a lot --

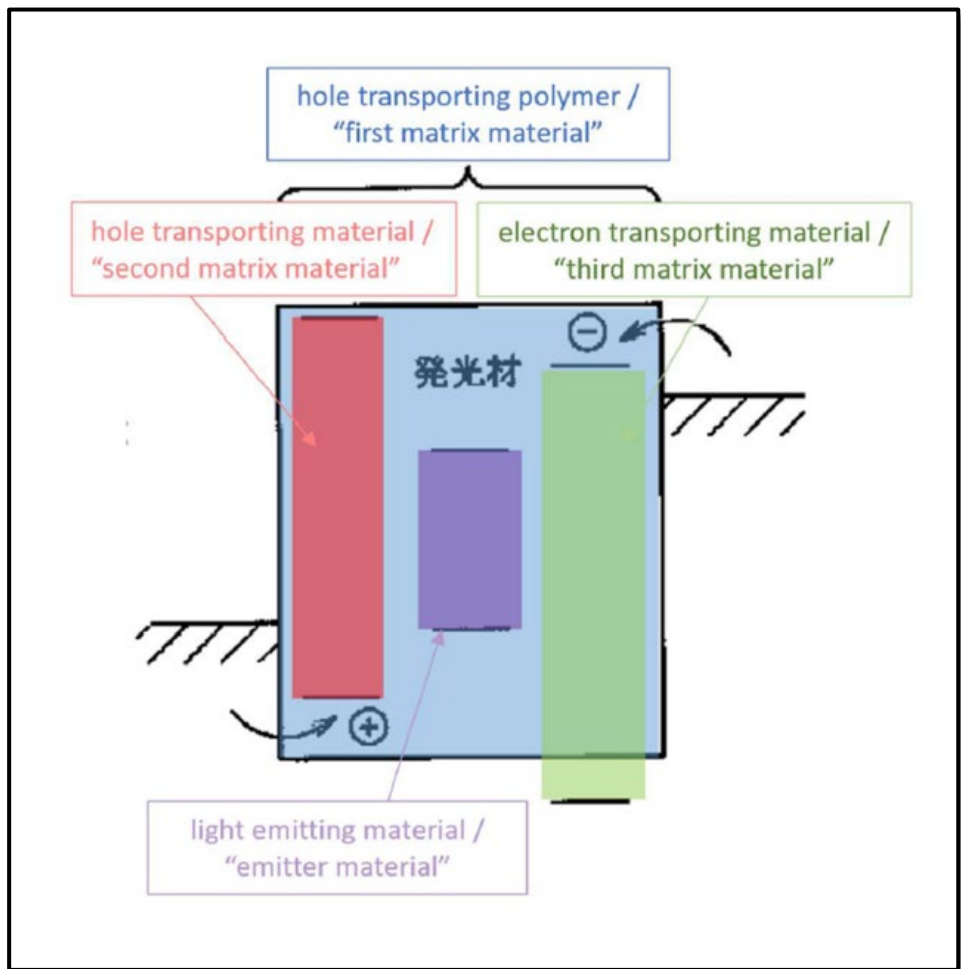


EX1006 (Sugiura) at Fig. 8

EX1043 (Sims Dep. Tr.) at 98:5-24

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

The Prior Art's Matrix Boxes Confirm Sugiura's Hole/Electron Transport Materials Are Not Part of the Matrix



EX1003 (Holmes Decl.) at ¶180 (annotation of Sugiura, Fig. 8).

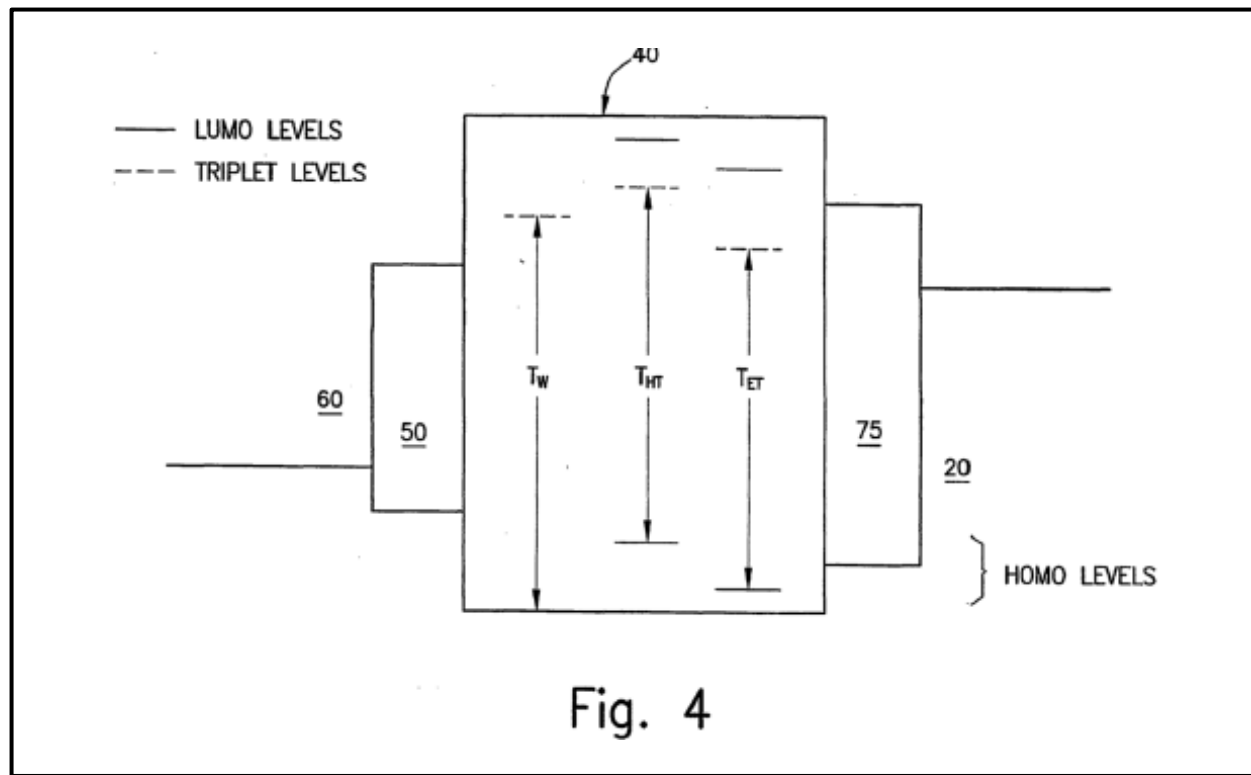


Fig. 4

[0035] In one embodiment, the wide gap host material layer 40, also referred to as matrix material, has triplet state

EX1007 (Thompson) at Fig. 4, [0035].

Ground 4: Thompson

Claims 15 & 16 Also Require Three “Matrix Materials”

'164

(12) **United States Patent**
Schmid et al.

(10) **Patent No.:** US 8,723,164 B2
(45) **Date of Patent:** May 13, 2014

(54) **ELECTRONIC DEVICE**

(75) **Inventors:** Guenter Schmid, Hombfien (DE); Ralf Krause, Erlangen (DE); Stefan Seidel, Nurnberg (DE); Oliver Weiss, Dossenheim (DE); Christoph Gauditz, Regensburg (DE); Rikku Salonen, Oulu (FI); Ulrich Niedermeier, Leinfelden (DE); Fryderyk Kuczkowski, Erlangen (DE)

(73) **Assignee:** OSRAM Opto Semiconductors GmbH, Regensburg (DE)

(*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 315 days.

(21) **Appl. No.:** 12/995,457

(22) **PCT Filed:** May 18, 2009

(86) **PCT No.:** PCT/DE2009/009761

[371 (c)(1), (2), (4) Date: Feb. 18, 2011

(87) **PCT Pub. No.:** WO2009/143897
PCT Pub. Date: Dec. 3, 2009

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May 30, 2008 (DE) 10 2008 025 920
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(52) **U.S. Cl.** 257/40; 257/E51.001

(58) **Field of Classification Search**
USPC 257/40; E51.001
See application file for complete search history.

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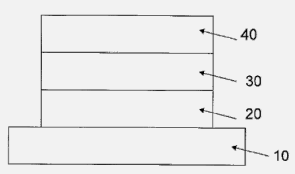
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(57) **ABSTRACT**
An electronic device comprising a substrate, a first electrode, at least one organic functional layer, and a second electrode is disclosed. The organic functional layer comprises a first, a second, and a third matrix material, wherein the first matrix material has a larger band gap than the second and the third matrix materials.

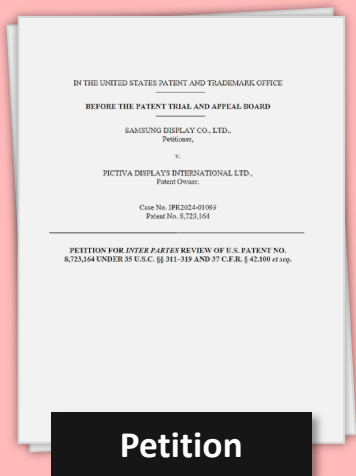
16 Claims, 5 Drawing Sheets

second electrode, and wherein the at least one organic functional layer has at least a first matrix material, a second matrix material, and a third matrix material, and



EX1001 (164 patent) at 10:24-26, 47-49

Ground 4 Reads Thomas' Dopants (incl. Emitter) on the "Matrix Materials"



Petition

SAMSUNG

f. Element 15[e]: wherein the at least one organic functional layer has at least a first matrix material, a second matrix material, and a third matrix material and

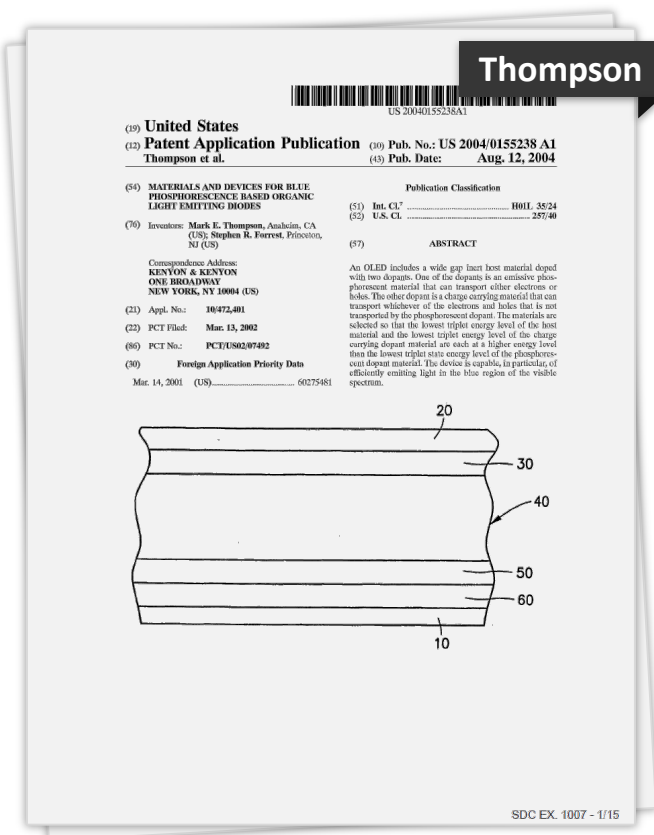
Thompson discloses this element. Ex.1003, ¶¶232-235. The invention in

Thompson is directed to:

[A]n OLED, and to methods of preparing the same, in which the he emissive layer comprises a wide gap host material doped with both a charge carrying dopant material and a phosphorescent dopant material. The charge carrying dopant material is capable of transporting a hole or an electron, and the phosphorescent dopant material is capable of transporting a charge opposite to the charge carried by the charge carrying dopant material. Each dopant material, thus, carries charge, though of opposite polarity. The charge carrying phosphorescent

Petition at 72 (citing Thomas at [0008]) (Petitioner's emphasis included)

Thompson Distinguishes Between Matrix Materials and Dopants



all, inefficiently from the matrix material, and not from the phosphorescent dopant material. Accordingly, there is great

EX1007 (Thompson) at [0006]

electrophosphorescent devices. The HOMO energy levels of the phosphorescent dopants are typically higher in energy than those of the matrix materials into which they are doped.

EX1007 (Thompson) at [0023]

charge carrying dopant material, wherein the emissive material is dispersed in the host matrix together with the charge carrying dopant material.

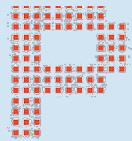
EX1007 (Thompson) at [0025]

polystyrene acted as an inert matrix in which the dopants were supported. Although this device produced light in the

EX1007 (Thompson) at [0057]

Charge Transport Materials Are Not Necessarily “Matrix Materials”

Dr. Sims
Expert Witness



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131. I also note that the '164 patent discloses emitter materials with a HOMO energy level higher than the matrix materials. *See* EX1001, col. 7, table 1 (emitter rubrene has a HOMO level of -5.5eV, higher than the three matrix materials mCP, TCTA and TPBi), 4:44-54 (HOMO of emitter higher than those of the first, second and third matrix materials), Fig. 2 (emitter materials 30E's HOMO level above those of the matrix materials 30N, 30A and 30B). This means that the emitter materials disclosed in the '164 patent would also be expected to transport holes, but were never characterized as matrix materials. *See* EX1001, 8:27-30; *see also* EX2020, 299:20-300:7; EX1017 (Yang) at 2477 (Ir(mppy)₃ “participates in charge transport,” but never described as a host”). *See* EX1007, [0023] (expecting

EX2019 (Sims Decl.) at ¶131

Optional Slides For Discussion

Solution-Based Processing Does Not Reliably Form “Matrix Materials”

The Invention of '164 Patent is Based on Evaporation Technology

'164

(12) United States Patent
Schmid et al.

(10) Patent No.: US 8,723,164 B2
(45) Date of Patent: May 13, 2014

(54) ELECTRONIC DEVICE

(75) Inventors: Guenter Schmid, Homborn (DE); Ralf Krane, Erlangen (DE); Stefan Seidel, Nittenorf (DE); Oliver Weiss, Dossenheim (DE); Christoph Gauditz, Regensburg (DE); Rikku Salonen, Oulu (FI); Ulrich Niedermeier, Leiflitz (DE); Fryderyk Kozlowski, Erlangen (DE)

(73) Assignee: OSRAM Opto Semiconductors GmbH, Regensburg (DE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 315 days.

(21) Appl. No.: 12/995,457

(22) PCT Filed: May 18, 2009

(86) PCT No.: PCT/DE2009/007501

[371] (a)(1), (2), (4) Date: Feb. 18, 2011

(87) PCT Pub. No.: WO2009/143897

PCT Pub. Date: Dec. 3, 2009

(65) Prior Publication Data

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(58) Field of Classification

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(74) Attorney, Agent, or F

(57) AB

An electronic device comp

at least one organic function

indicated. The organic fun

second, not a third matrix

material has a larger band

matrix materials.

16 Claims.

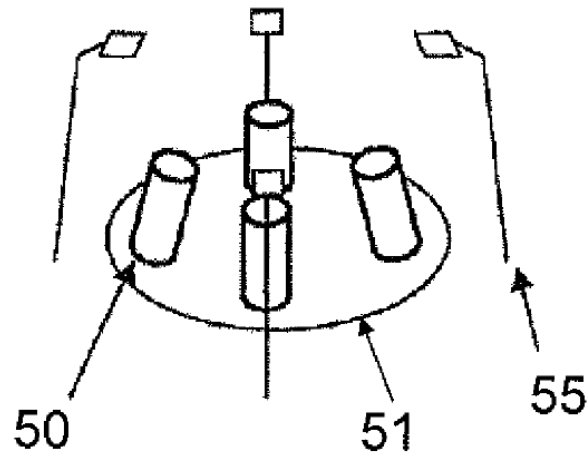


FIG. 5 shows the schematic side view of a structure for the production of the electronic device. Four evaporation sources 50 are applied on a holder 51, for example, from which matrix materials and/or doping substances can be evaporated onto the deposition substrate 60. In order to be able to determine the individual concentration of the matrix material and/or the doping substances precisely, the evaporation rate is measured and adjusted via layer thickness monitors 55. The layer thickness monitors can be, for example, oscillator quartzes.

EX1001 (164 patent) at 7:11-20

EX1001 (164 patent) at FIG. 5

The Invention of '164 Patent is Based on Evaporation Technology

Dr. Sims
Expert Witness



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74. In contrast, the '164 patent uses an evaporative method to obtain the mixture of the three matrix materials and the emitter because it reliably provides a fine intermolecular mixing of the materials as needed and is compatible with more small molecule OLED materials. The degree of mobility fine tuning can thus be controlled to a much higher degree to prevent phase separation within a matrix.

EX2019 (Sims Decl.) at ¶ 74.

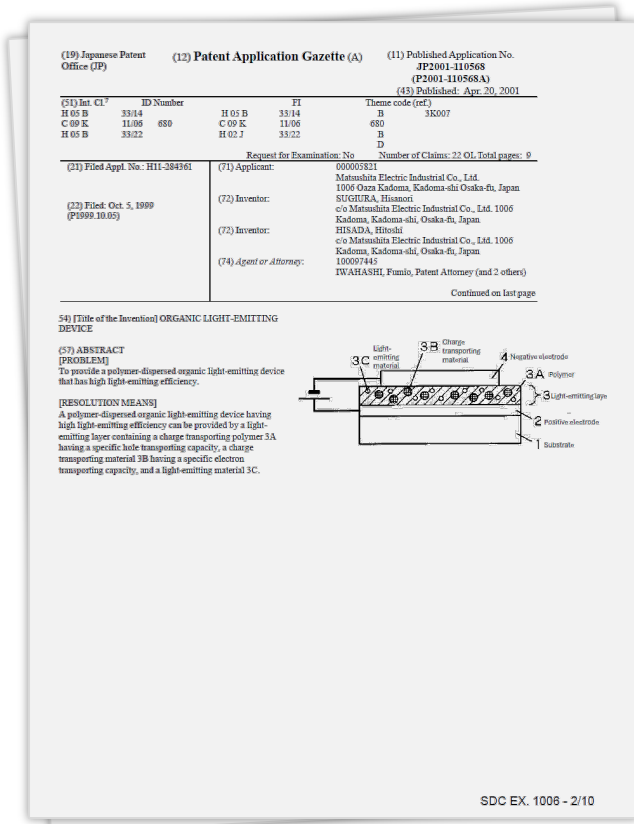
Sugiura's Example 8/Fig. 4 is Expressly Spin-Coated

[0062] (Example 8) An organic light-emitting device having the configuration in FIG. 4 was fabricated and evaluated. The

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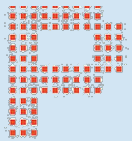
The light-emitting layer was formed by dissolving 300 mg of PVK, 180 mg of Alq₃, 240 mg of TPD, and 0.6 mg of Nile Red in 50 mL of a 1:1 mixed solvent of toluene and chloroform, stirring the solution for one day, then spin-coating the solution onto the ITO-affixed glass substrate in the same manner as in Example 1. The film thickness of the

EX1006 (Sugiura) at ¶ [0062]



Choulis/Sugiura Spin-Coating Unlikely to Achieve Fine Mixture

Dr. Sims
Expert Witness



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They do mention spin coating, and spin coating is a process which is very turbulent, and when you have lots of different materials with different vapor pressures inside solvent, each of these materials will crash out at different rates.

So it is really hard to get a fine mixture, and by reading this, I can see they've made an attempt, but I really doubt they would have been able to get the granularity that you can get with an evaporative process; hence, I think that the -- they were probably aware of this, and that's why they drew the schematic the way they did.

EX1043 (Sims Dep. Tr.) at 65:6-17

Substituting PMMA for PVK: Claims 2, 4, 15, and 16

No Motivation to Substitute PMMA for PVK in Choulis

Petitioner nevertheless argues that a POSITA would have used PMMA because they allegedly “would have understood that the host material, which serves as a matrix in which guest materials are dispersed, preferably would have a wide energy gap so as not to interfere with the charge transport of the second and third matrix materials.” Pet., 31 (citing EX1004, [0031], [0041]). However, if PVK participates in hole transport, then substituting in PMMA that does not participate in hole transport would “upset the hole and electron balance” in the emissive layer, “affect hole-charge recombination,” and “degrade the performance of the resulting OLED system” (EX2019, ¶80); but if PVK already does not participate in hole transport, then it already is not interfering with charge transport and there would be no benefit to substitute in PMMA. That is, in either case, Petitioner’s reasoning for replacing PVK with PMMA fails.