

IN THE 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.

Case No. IPR2026-00129
Patent No. 12,158,250

**PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO.
12,158,250 UNDER 35 U.S.C. §§311-319 AND 37 C.F.R. §42.100 *et seq.***

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1001	U.S. Patent No. 12,158,250
1002	File History for U.S. Patent No. 12,158,250
1003	Declaration of Dr. Russell J. Holmes
1004	Curriculum Vitae of Dr. Russell J. Holmes
1005	Declaration of June Ann Munford
1006	Declaration of Rachel Garland (Elsevier)
1007	Certified Translation of Japanese Patent Application Publication No. JP 2007-277631 A (“Suzuki”)
1008	Japanese Patent Application Publication No. JP 2007-277631 A (“Suzuki”)
1009	Certified Translation of International Patent Application Publication No. WO 2008/040323 A2 (“Diekmann”)
1010	International Patent Application Publication No. WO 2008/040323 A2 (“Diekmann”)
1011	J.W. Ma et al., <i>Organic light-emitting diodes based on new n-doped electron transport layer</i> , Synthetic Metals 158 (2008) (“Ma”)
1012	U.S. Patent Application Publication No. 2005/0146267 (“Lee”)
1013	U.S. Patent No. 11,828,425 (“’425 patent”)
1014	File History for U.S. Patent No. 11,828,425
1015	File History for U.S. Patent Application No. 16/790,198
1016	File History for U.S. Patent Application No. 15/651,508
1017	File History for U.S. Patent Application No. 13/139,514
1018	Gufeng He et al., <i>Very high-efficiency and low voltage phosphorescent organic light-emitting diodes based on a p-i-n junction</i> , 95 J. Appl. Phys., 5773-5777 (2004) (“He”)
1019	Gufeng He et al., <i>High-efficiency and low-voltage p-i-n electrophosphorescent organic light-emitting diodes with double-emission layers</i> , 85 Appl. Phys. Lett. 3911-3913 (2004)
1020	Martin Pfeiffer et al., <i>Electrophosphorescent p-i-n organic light-emitting devices for very-high-efficiency flat-panel displays</i> , 22 Adv. Mater. 14 (2002)
1021	Harald Gross et al., <i>High Power Efficiencies at Record Lifetimes: NOVALED’S PIN-OLEDs</i> , FPD Yokohama 2005

Exhibit No.	Description
1022	Intentionally Left Blank
1023	V. Bulovic et al., <i>Transparent light-emitting devices</i> , 29 Nature 380 (1996)
1024	K. Walzer et al., <i>Highly Efficient Organic Devices Based on Electrically Doped Transport Layers</i> , 107 Chem. Rev. 1233-1271 (2007)
1025	L. Moro et al, <i>Process and design of a multilayer thin film encapsulation of passive matrix OLED displays</i> , Proceedings of SPIE Vol. 5214 (2004)
1026	Anna B. Chwang et al., <i>Thin film encapsulated flexible organic electroluminescent displays</i> , 83 Appl. Phys. Lett. 413-415 (2003)
1027	U.S. Patent Application Publication No. 2011/0260201 (“Klein”)
1028	Zugang Liu et al., <i>Improved electron injection in organic LED with lithium quinolate/aluminium cathode</i> , 128 Synthetic Metals 211-214 (2002)
1029	Lumtec, Liq, https://www.lumtec.com.tw/products-view.php?ID=327
1030	Lumtec, LiF, https://www.lumtec.com.tw/products-view.php?ID=371
1031	Commission on Isotopic Abundances and Atomic Weights, Barium, https://www.ciaaw.org/barium.htm
1032	Commission on Isotopic Abundances and Atomic Weights, Cesium, https://www.ciaaw.org/caesium.htm
1033	Adachi et al., <i>Confinement of charge carriers and molecular excitons within 5-nm-thick emitter layer in organic electroluminescent devices with a double heterostructure</i> , 57 Appl. Phys. Lett. 531–533 (1990)
1034	Jun Endo et al., <i>Organic Electroluminescent Devices Having Metal Complexes as Cathode Interface Layer</i> , Jpn. J. Appl. Phys. Vol. 41 (2002)
1035	Gregor Schwartz et al., <i>Reduced efficiency roll-off in high-efficiency hybrid white organic light-emitting diodes</i> , Appl. Phys. Lett. 92, 053311 (2008)
1036	Gregor Schwartz et al., <i>High efficiency white organic light emitting diodes combining fluorescent and phosphorescent emitter systems</i> , Proc. of SPIE Vol. 6192, 61920Q (2006)

Exhibit No.	Description
1037	Baldo et al., <i>Highly efficient phosphorescent emission from organic electroluminescent devices</i> , 395 Nature 151 (1998)
1038	Baldo et al., <i>Very high-efficiency green organic light-emitting devices based on electrophosphorescence</i> , 75 Appl. Phys. Lett. 4–6 (1999)
1039	Xinyou Zheng et al., <i>Efficiency improvement of organic light-emitting diodes using 8-hydroxy-quinolinato lithium as an electron injection layer</i> , Thin Solid Films 478 (2005)
1040	Sung Hoon Choi et al., <i>Improved Efficiency and Lifetime of Organic Light-Emitting Diode with Lithium-Quinolate-Doped Electron Transport Layer</i> , Jpn. J. Appl. Phys. 48 (2009)
1041	Kaushik Roy Choudhury et al., <i>LiF as an n-Dopant in Tris(8-hydroxyquinoline) Aluminum Thin Films</i> , Adv. Mater. 2008, 20, 1456–1461
1042	Christoph Schmitz et al., <i>Lithium-Quinolate Complexes as Emitter and Interface Materials in Organic Light-Emitting Diodes</i> , Chem. Mater. 2000, 12, 3012–3019
1043	Notice of Withdrawal of Plaintiffs’ Motion for Leave to File Second Amended Complaint, <i>Pictiva Displays International Ltd. v. Samsung Electronics Co., Ltd., et al.</i> , Case No. 2:23-cv-00495, Dkt. 123 (E.D. Tex. Dec. 17, 2024)
1044	Plaintiffs’ Notice that It Will Not Seek to Amend Complaint to Add U.S. Pat. No. 12,158,250, <i>Pictiva Displays International Ltd. v. Samsung Electronics Co., Ltd., et al.</i> , Case No. 2:23-cv-00532, Dkt. 27 (E.D. Tex. Dec. 17, 2024)
1045	Claim Construction Order, <i>Pictiva Displays International Ltd. v. Samsung Electronics Co., Ltd., et al.</i> , Case No. 2:23-cv-00495, Dkt. 397 (E.D. Tex. June 27, 2025)
1046	Patent Owner Response, <i>Samsung Display Co., Ltd. v. Pictiva Displays International Ltd.</i> , IPR2024-01094, Paper 19 (PTAB May 5, 2025)
1047	Institution Decision, <i>Samsung Display Co., Ltd. v. Pictiva Displays International Ltd.</i> , IPR2024-01094, Paper 11 (Jan. 23, 2025)
1048	Institution Decision, <i>Samsung Display Co., Ltd. v. Pictiva Displays International Ltd.</i> , IPR2024-01095, Paper 12 (PTAB January 23, 2025)

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Exhibit No.	Description
1049	Petition, <i>Samsung Display Co., Ltd. v. Pictiva Displays International Ltd.</i> , IPR2024-01095, Paper 1 (PTAB July 3, 2025)
1050	Petitioner's Reply, <i>Samsung Display Co., Ltd. v. Pictiva Displays International Ltd.</i> , IPR2024-01095, Paper 29 (PTAB August 11, 2025)
1051	Transcript of July 25, 2025 Deposition of Dr. P. Morgan Pattison in <i>Samsung Display Co., Ltd. v. Pictiva Displays International Ltd.</i> , IPR2024-01095

All annotations, coloring, and emphases throughout the petition have been added unless noted otherwise.

LISTING OF CLAIMS

Claim 1

[1Pre] A device comprising:

[1A] an organic light-emitting diode comprising:

[1B] an organic layer sequence,

[1C] a radiation exit area, and

[1D] an encapsulation wherein the encapsulation forms a seal of the organic layer sequence against environmental influences,

[1E] wherein the organic layer sequence and the encapsulation are disposed on a carrier,

[1F] wherein the organic layer sequence comprises at least one radiation-emitting region configured to generate electromagnetic radiation in a spectral range from infrared radiation to UV radiation during operation,

[1G] wherein the organic layer sequence comprises an electron transport layer that is n-doped; and

[1H] wherein the organic layer sequence comprises an emission layer comprising an iridium-containing compound; and

[1I] wherein the electron transport layer comprises 8-hydroxyquinolinolato-lithium.

Claim 2

[2A] The device of claim 1, wherein at least one part of the encapsulation is formed by an insulation layer, and

[2B] wherein the insulation layer comprises at least one of: resin, silicon oxide, or silicon nitride.

Claim 3

[3A] The device of claim 1, wherein the encapsulation comprises a first encapsulation layer and a second encapsulation layer,

[3B] the first and the second encapsulation layer each having a respective volume structure,

[3C] wherein the volume structure of the second encapsulation layer is independent of the volume structure of the first encapsulation layer, and

[3D] the volume structure of the second encapsulation layer has a higher amorphicity than the volume structure of the first encapsulation layer.

Claim 4

The device according to claim 1, wherein the organic light-emitting diode comprises a hole transport layer that is p-doped.

Claim 5

[5A] The device according to claim 1, wherein a color filter is arranged between the emission layer and the radiation exit area, and

[5B] wherein the color filter is configured to be highly transmissive for a first spectral subrange of the generated electromagnetic radiation and highly absorbent for a second spectral subrange of the generated electromagnetic radiation.

Claim 6

[6Pre] A device comprising:

[6A] an organic light-emitting diode comprising:

[6B] an organic layer sequence,

[6C] a radiation exit area, and

[6D] an encapsulation,

[6E] wherein the organic layer sequence and the encapsulation are disposed on a carrier,

[6F] wherein the organic layer sequence comprises at least one radiation-emitting region configured to generate electromagnetic radiation in a spectral range from infrared radiation to UV radiation during operation,

[6G] wherein the organic layer sequence comprises an electron transport layer that is n-doped,

[6H] wherein the organic layer sequence comprises an emission layer comprising an iridium-containing compound; and

[6J]¹ wherein the organic light-emitting layer sequence comprises a cathode having a thickness of at least 1 nm and at most 50 nm.

Claim 7

The device according to claim 6, wherein the cathode comprises one of: Silver, Magnesium, or an alloy comprising Silver and Magnesium.

Claim 8

The device according to claim 6, wherein the cathode is in direct contact with a Lithium containing layer.

Claim 9

The device according to claim 6, wherein the electron transport layer comprises 8-hydroxyquinolinolato-lithium.

Claim 10

[10Pre] A device comprising:

[10A] an organic light-emitting diode comprising:

[10B] an organic layer sequence,

[10C] a radiation exit area, and

[10D] an encapsulation,

¹ For simplicity, the petition identifies this element as [6J] (instead of [6I]) so that it has the same alphabetical identifier as [10J] in claim 10.

[10E] wherein the organic layer sequence and the encapsulation are disposed on a carrier,

[10F] wherein the organic layer sequence comprises at least one radiation-emitting region configured to generate electromagnetic radiation in a spectral range from infrared radiation to UV radiation during operation,

[10G] wherein the organic layer sequence comprises an electron transport layer that is n-doped;

[10I]² wherein the electron transport layer comprises 8-hydroxyquinolinolato-lithium; and

[10H] wherein the organic layer sequence comprises an emission layer comprising an iridium-containing compound;

[10J] wherein the organic light-emitting layer sequence comprises a cathode having a thickness of at least 1 nm and at most 50 nm;

[10K] wherein the cathode comprises one of: Silver, Magnesium, or an alloy comprising Silver and Magnesium; and

[10L] wherein the cathode is in direct contact with a Lithium containing layer.

² The petition identifies this element as [10I] (instead of [10H]) so that it has the same alphabetical identifier as element [1I] in claim 1.

Claim 11

[11Pre] A device comprising:

[11A] an organic light-emitting diode comprising:

[11B] an organic layer sequence,

[11C] a radiation exit area, and

[11D] an encapsulation,

[11E] wherein the organic layer sequence and the encapsulation are disposed on a carrier,

[11F] wherein the organic layer sequence comprises at least one radiation-emitting region configured to generate electromagnetic radiation in a spectral range from infrared radiation to UV radiation during operation,

[11G] wherein the organic layer sequence comprises an electron transport layer that is n-doped;

[11H] wherein the organic layer sequence comprises an emission layer comprising an iridium-containing compound;

[11J]³ wherein at least one part of the encapsulation is formed by an insulation layer, the insulation layer comprising at least one of: resin, silicon oxide, silicon

³ The petition identifies this element as [11J] (instead of [11I]) so that it has the same alphabetical identifier as element [16J] in claim 16.

nitride; and

[11K] wherein the encapsulation comprises a first encapsulation layer and a second encapsulation layer,

[11L] the first and the second encapsulation layer each having a respective volume structure,

[11M] wherein the volume structure of the second encapsulation layer is independent of the volume structure of the first encapsulation layer, and

[11N] the volume structure of the second encapsulation layer has a higher amorphicity than the volume structure of the first encapsulation layer.

Claim 12

The device of claim 11, wherein the electron transport layer comprises 8-hydroxyquinolinolato-lithium.

Claim 13

The device of claim 11, wherein the organic light-emitting layer sequence comprises a cathode having a thickness of at least 1 nm and at most 50 nm.

Claim 14

The device of claim 13, wherein the cathode comprises one of: Silver, Magnesium, or an alloy comprising Silver and Magnesium.

Claim 15

The device of claim 13, wherein the cathode is in direct contact with a Lithium containing layer.

Claim 16

[16Pre] A device comprising:

[16A] an organic light-emitting diode comprising:

[16B] an organic layer sequence,

[16C] a radiation exit area, and

[16D] an encapsulation,

[16E] wherein the organic layer sequence and the encapsulation are disposed on a carrier,

[16F] wherein the organic layer sequence comprises at least one radiation-emitting region configured to generate electromagnetic radiation in a spectral range from infrared radiation to UV radiation during operation,

[16G] wherein the organic layer sequence comprises an electron transport layer that is n-doped,

[16I]⁴ wherein the electron transport layer comprises 8-hydroxyquinolinolato-lithium;

[16H] wherein the organic layer sequence comprises an emission layer comprising an iridium-containing compound;

[16J] wherein at least one part of the encapsulation is formed by an insulation layer, the insulation layer comprising at least one of: resin, silicon oxide, silicon nitride;

[16K] wherein the encapsulation comprises a first encapsulation layer and a second encapsulation layer,

[16L] the first and the second encapsulation layer each having a respective volume structure,

[16M] wherein the volume structure of the second encapsulation layer is independent of the volume structure of the first encapsulation layer,

[16N] the volume structure of the second encapsulation layer has a higher amorphicity than the volume structure of the first encapsulation layer.

[16O] wherein the organic light-emitting layer sequence comprises a cathode having a thickness of at least 1 nm and at most 50 nm;

⁴ The petition identifies this element as [16I] (instead of [16H]) so that it has the same alphabetical identifier as element [1I] in claim 1.

[16P] wherein the cathode comprises one of: Silver, Magnesium, or an alloy comprising Silver and Magnesium; and

[16Q] wherein the cathode is in direct contact with a Lithium containing layer.

I. Introduction

Samsung Display Co., Ltd. (“Petitioner”) petitions for *inter partes* review (“IPR”) seeking cancellation of claims 1-16 of U.S. Patent No. 12,158,250 (Ex.1001, “’250 patent”), a continuation of U.S. Patent No. 11,828,425 (Ex.1013, “’425 patent”) under review in IPR2024-01095.

The ’250 patent relates to a device comprising an “organic light-emitting diode” (“OLED”), including an organic layer sequence comprising an n-doped electron transport layer (“ETL”) and an emission layer comprising an iridium-containing compound. Ex.1001, 1:34-45, 88:2-20. The patent describes that generated light exits through a “radiation exit area” and an “encapsulation forms a seal...against environmental influences.” *Id.*, 1:34-45.

But this OLED device described in the ’250 patent was well-known in the art. It was specifically disclosed by Suzuki (Ex.1007), which the Board relied on in instituting IPR2024-01095 for the parent ’425 patent claiming the same features at issue here. Ex.1048, 4-6, 16-21, 26. Diekmann (Ex.1009) also discloses the OLED device. The other claimed features were known to be useful in OLEDs.

All claims are thus unpatentable and should be canceled. Ex.1003, ¶¶100-351.

II. Standing, Mandatory Notices, and Fee Authorization

Grounds for Standing: Under 37 C.F.R. §42.104(a), Petitioner certifies that the ’250 patent is available for IPR and Petitioner is not barred or estopped from

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requesting an IPR challenging this patent on the grounds in this petition.

Real-Party-in-Interest: Petitioner identifies Samsung Display Co., Ltd., and Samsung Electronics Co., Ltd., and Samsung Electronics America, Inc. (“Samsung Electronics Entities”) as real-parties-in-interest.

Related Matters: In *Pictiva Displays International Ltd. v. Samsung Electronics Co., Ltd.*, 2:23-cv-00495 (E.D. Tex.), Pictiva Displays International Ltd. (“Patent Owner”) moved for leave to amend the complaint to assert the ’250 patent before it issued, but later withdrew the motion. Ex.1043. In *Pictiva Displays International Ltd. v. Samsung Electronics Co., Ltd.*, 2:24-cv-00532 (E.D. Tex.), Patent Owner sought to amend the complaint to add the ’250 patent before it issued, but withdrew its request to “amend the complaint to add a claim for infringement of [the ’250 patent].” Ex.1044. Thus, the ’250 patent has never been asserted in the -00495 and -00532 cases, or in any other case.

The Board is reviewing the parent ’425 patent in IPR2024-01095. In 2:23-cv-00495, the jury found that defendants had not proven by clear and convincing evidence that claim 2 of the ’425 patent is invalid based on prior art grounds not presented in this petition.

Lead and Back-Up Counsel: Petitioner designates Scott C. Weidenfeller (Reg. No. 54,531, sweidenfeller@cov.com) as lead counsel, and David A. Garr (Reg. No. 74,932, dgarr@cov.com) as back-up counsel, of Covington & Burling

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LLP, One CityCenter, 850 Tenth Street, NW, Washington, DC 20001 (postal and hand delivery), telephone: 202-662-6000, facsimile: 202-662-6291.

Service Information: Service information is provided in the designation of counsel above. Petitioner consents to service via e-mail at SDC-Pictiva-IPR@cov.com.

Fee Authorization: The Office is authorized to charge all fees due for this proceeding to Deposit Account No. 60-3160.

III. Summary of Challenge

Petitioner requests cancellation of claims 1-16 as set forth below.

Ground	References	Basis	Claims
1	Suzuki, Ma	§103	1-2, 4-5, 8-10
2	Suzuki	§§102, 103	6-8
3	Suzuki, Ma, Lee	§103	3, 11-12, 15-16
4	Suzuki, Lee	§103	11, 13-15
5	Diekmann, Ma	§103	1-2, 4-5, 8-10
6	Diekmann	§§102, 103	6-8
7	Diekmann, Ma, Lee	§103	3, 12, 15-16
8	Diekmann, Lee	§103	11, 13-15

The application issued as the '250 patent was filed on October 23, 2023, and claims priority to a foreign application filed on December 11, 2008. Petitioner's challenge is based on the following references, which are prior art under 35 U.S.C.

§102 (pre-AIA)¹:

Exhibit	Reference	Date(s)	Availability as Prior Art
Ex.1007 (certified translation) and Ex.1008 (Suzuki)	Japanese Patent Application Publication No. 2007-277631	Published Oct. 25, 2007	§§102(a), 102(b)
Ex.1009 (certified translation) and Ex.1010 (Diekmann)	International Patent Application Publication No. WO 2008/040323	Filed Sep. 26, 2007 Published Apr. 10, 2008	§§102(a), 102(b)
Ex.1011 (Ma)	Ma, et al. “Organic light-emitting diodes based on new n-doped electron transport layer,” 158 <i>Synthetic Metals</i> 810-814 (2008)	Published Aug. 29, 2008	§§102(a), 102(b)
Ex.1012 (Lee)	U.S. Patent Application Publication No. 2005/0146267	Filed Dec. 8, 2004 Published Jul. 7, 2005	§§102(a), 102(b), 102(e)

IV. The '250 Patent

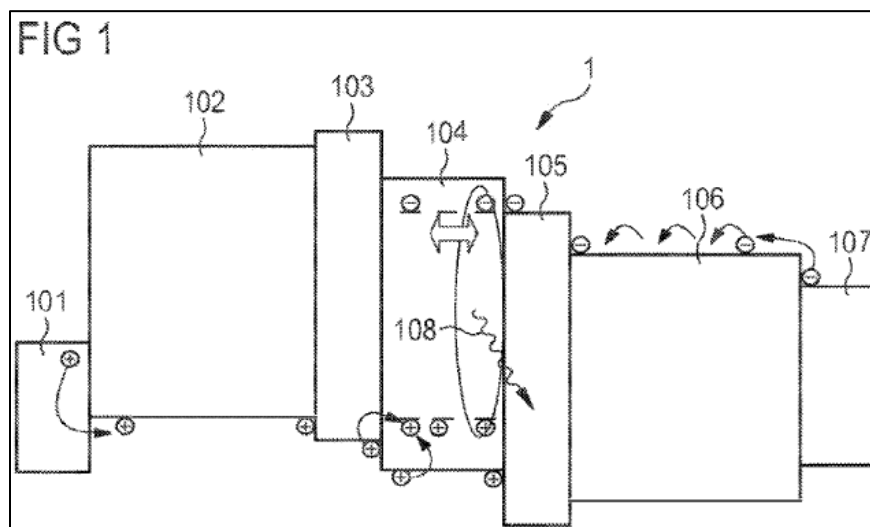
A. Overview

The '250 patent relates to a device comprising an “organic light-emitting diode.” Ex.1001, Abstract. The patent describes “an organic light-emitting diode

¹ During prosecution, Applicant did not indicate that the application was subject to the AIA, and the Examiner examined it under pre-AIA provisions. Ex.1002, 6, 228, 297, 357, 502.

comprising an organic layer sequence, a radiation exit area and an encapsulation,” where the organic layer sequence “generates electromagnetic radiation in the spectral range from infrared radiation to UV radiation.” *Id.*, 1:34-42.

Figure 1 shows an “organic light-emitting diode 1” comprising “first electrode 101” as an anode, and “hole transport layer 102 adjoin[ing] the first electrode 101” for “transport[ing] the positive charge carriers toward the radiation-emitting region 104 of the organic light-emitting diode 1.” Ex.1001, 24:42-49. The OLED includes a radiation-emitting region 104 that “[d]uring the operation of the organic light-emitting diode 1, [generates] electromagnetic radiation.” *Id.*, 24:55-57. The electron transport layer 106 “transports negative charge carriers—electrons—from the second electrode 107, embodied as a cathode, to the radiation-emitting region 104.” *Id.*, 25:1-4. According to the patent, the ETL 106 “comprise[s], for example, a matrix material that is...n-doped.” *Id.*, 25:5-9.



Id., Fig. 1.

The patent lists various materials that could be used for the ETL 106, including “8-hydroxyquinolinolato-lithium (Liq).” Ex.1001, 26:44-47. The patent, however, does not state or suggest that using Liq was an inventive feature of its OLED device; nor does it mention any known problems with using Liq that it purports to solve. *Id.*

B. Prosecution History

The Examiner did not substantively address the Suzuki, Ma, Lee, and Diekmann-based grounds in this petition.

The '250 patent is a continuation of Application No. 18/098,326 (issued as the '425 patent), which is a continuation of Application No. 16/790,198, which is a continuation of Application No. 15/651,508, which is a continuation of Application No. 13/139,514 (“’514 Application”), filed as PCT Application PCT/DE2009/001741. Ex.1001, Cover.

Applicant preliminarily amended the claims to cancel claims 1-21 and introduce claims 22-37. Ex.1002, 245-52. The Examiner rejected claims 22-37 on nonstatutory-double-patenting grounds over the '425 patent. Ex.1002, 295-304. Applicant responded by filing a terminal disclaimer. Ex.1002, 309-12, 315-23.

On July 19, 2024, the Examiner accepted the terminal disclaimer and mailed a notice of allowance. Ex.1002, 353-62. Nearly two months after the notice of

allowance was issued, on September 13, 2024, Applicant submitted an information disclosure statement (“IDS”) listing over 30 documents—including Suzuki, Diekmann, Ma, and Lee—identified in the IPR2024-01095 petition. Ex.1002, 364-69.

The Examiner did not explicitly discuss any references in the IDS. Ex.1002, 491-97, 503. On October 17, 2024, the Examiner mailed a notice of allowance, stating that the reasons for allowance were “provided in the previous office action mailed on July 19, 2024.” Ex.1002, 503. Although the “previous office action” was issued before Applicant’s submission of the IDS, the Examiner did not discuss the newly-disclosed references in the second notice of allowance. Ex.1002, 498-505. The Examiner thus did not discuss the grounds presented in this petition.

V. Level of Ordinary Skill in the Art

A person of ordinary skill in the art (“POSITA”) at the time of the alleged invention of the ’250 patent would have had a Bachelor’s degree in chemistry, physics, or a comparable field of study, and at least three years of research or industrial experience with organic optoelectronic light-emitting devices. An individual with additional education could have less research or industrial experience and vice versa. In instituting IPR2024-01095, the Board adopted this uncontested definition. Ex.1048, 15-16. Ex.1003 (Holmes Decl.), ¶¶67-70.

VI. Claim Construction

For this proceeding, Petitioner does not believe any specialized constructions are necessary. The Board need not explicitly construe the terms discussed below because it would be unnecessary to resolve any controversy.

A. “Electromagnetic radiation in a spectral range from infrared radiation to UV radiation”

In district court litigation of the parent ’425 patent, Patent Owner argued this term means “electromagnetic radiation having a spectrum of wavelengths that fall anywhere within the spectral range from a wavelength in the infrared radiation range to a wavelength in the UV radiation.” Ex.1045, 47-48. The court construed the term as “electromagnetic radiation with one or more wavelengths in a spectral range anywhere between the lowest frequency of the UV spectrum and the highest frequency of the IR spectrum.” Ex.1045, 48.

There, Samsung Electronics Entities proposed this term means “electromagnetic radiation in a spectral range that includes the full spectrum from infrared radiation to UV radiation.” Ex.1045, 47. In IPR2024-01095, Petitioner argues that this term encompasses the prior art’s “white light” and is also met by the district court’s construction. Ex.1049, 23-24, 55-56; Ex.1050, 26-27. Indeed, in examining the ’514 Application, Examiner *expressly* determined that Diekmann discloses “generat[ing] electromagnetic radiation in the spectral range from infrared radiation to UV radiation during operation.” Ex.1017, 1407.

To the extent the above constructions differ, Petitioner does not take a position for purposes of this proceeding. The Board need not resolve any conflict between the proposals because the prior art (Suzuki, Diekmann) teaches “white light” encompassed by this term regardless of the construction, as explained for element [1F/6F/10F]. *First*, the prior art OLEDs emit white light including visible light with wavelengths “fall[ing] anywhere within the spectral range from a wavelength in the infrared...to a wavelength in the UV” and “in a spectral range anywhere between the lowest frequency of the UV spectrum and the highest frequency of the IR spectrum” under Patent Owner’s and the district court’s constructions.

Second, the “white light” emission disclosed by the prior art covers the full spectrum from infrared-to-UV and is “radiation in a spectral range from infrared radiation to UV radiation” as discussed by the Board’s Institution Decision in IPR2024-01095. Ex.1048, 16-19; Suzuki, [0319] (“any desired light emission color,” including “[w]hite light”); Diekmann, 40-41, 44, 66, 70, 76, 91, 122, 157 (using “white light” emitters and generating “ultraviolet to infrared spectra range”); Ex.1017, 1407. Indeed, in IPR2024-01095, Patent Owner’s expert admitted that “white light” meets the claimed “spectral range from infrared radiation to UV radiation.” Ex.1051, 76:1-14.

Accordingly, a POSITA would have appreciated that this term encompasses white light that covers the full infrared-to-UV spectrum, or at a minimum, a

wavelength falling anywhere between the lowest frequency of the UV spectrum and the highest frequency of the IR spectrum, as taught by the prior art (Suzuki, Diekmann).

B. “Volume structure”

During prosecution of the '514 Application (the '250 patent's predecessor), Applicant explained the meaning of “volume structure,” which appears in claims 3, 11, and 16 of the '250 patent. Applicant argued that “volume structure” is “a term of art to a [POSITA],” and it is distinct from “surface structure”:

[I]n solids there is a well-ordered molecular, atomic or ionic arrangement. Part of the atoms or molecules of the solid are ordered at the surface of the solid and is called surface structure. Part of the atoms or molecules of the solid are ordered inside the solid, wherein every atom or molecule has neighbors. This part is called a “volume structure.”

Ex.1017, 1386-87; *id.*, 1240-42, 1313-14.

Applicant argued that “the term ‘volume structure’ was chosen to comprise any structure ranging from polycrystalline to polyamorphous,” and “examples of volume structures” include “crystalline, partly crystalline and/or polycrystalline or completely amorphous.” Ex.1017, 1241, 1313-14, 1386-87.

Thus, the term “volume structure” encompasses the part of the atoms or molecules inside a solid and its examples include crystalline to completely

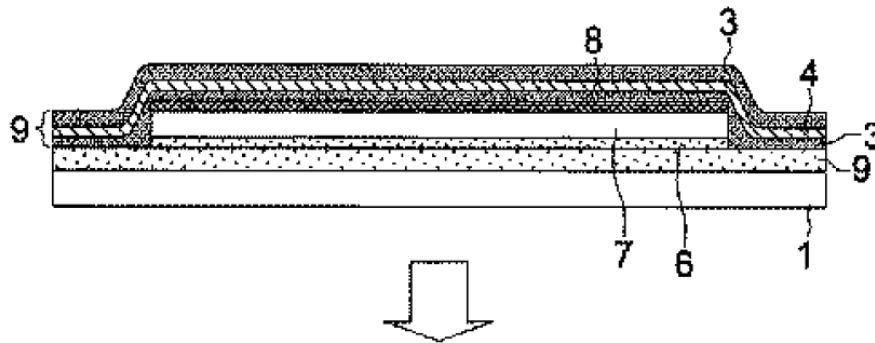
amorphous structures. The Board need not explicitly construe the term because the prior art (e.g., Lee) teaches the structure described by Applicant.

VII. Overview of Prior Art

A. Suzuki

Suzuki relates to an “organic electroluminescent device” using an encapsulation, Suzuki, [0001], as shown, for example, in Figure 9:

【図9】

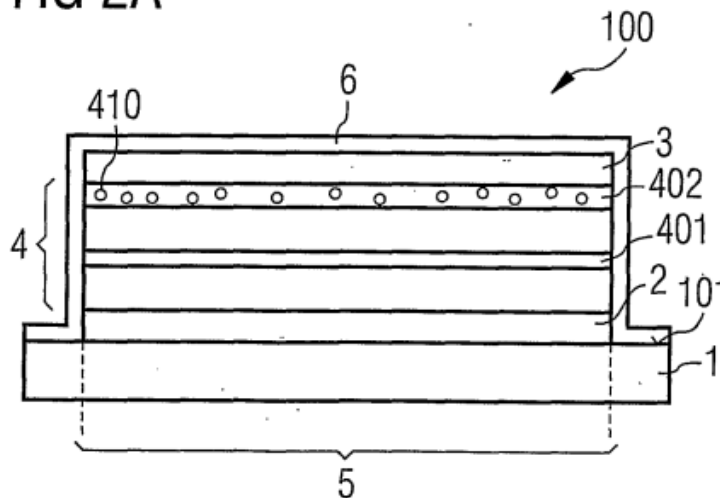


Id., Fig. 9. Suzuki’s OLED devices have a resin substrate material 1, gas barrier thin film laminate 9, anode 6, organic layer 7 including “a hole transport layer, a light emission layer, [and] an electron transport layer,” cathode 8, and another gas barrier thin film laminate 9 as an encapsulation. *Id.*, [0274]. Suzuki discloses that the “electron transport layer” is of “*high n nature doped*.” *Id.*, [0333]. Suzuki’s devices generate “white light” and use iridium in the emission layer. Suzuki, [0319], [0299]-[0300], [0303], [0348], [0369]-[0370], [0374]. Ex.1003, ¶¶85-88.

B. Diekmann

Diekmann “relates to an organic lighting device and lighting equipment with such a lighting device,” Diekmann, 1, as Figure 2A illustrates:

FIG 2A



Diekmann, Fig. 2A. This device comprises a substrate 1 having a surface 101, to which a first electrode 2 is applied. Organic layer stack 4 that includes “at least one layer 401 suitable for generating light” is arranged on the first electrode, and a second electrode 3 is arranged on the organic layer stack. *Id.*, 91. In this example, the first electrode is the anode and the second electrode is the cathode. *Id.* The organic layer stack “has a doped layer 402 with a dopant 410.” *Id.* The device has a thin-film encapsulation 6 that is “applied directly to the second electrode.” *Id.*, 92. Ex.1003, ¶¶88-91.

The substrate, the first electrode, the organic material in the organic layer stack, the second electrode, and the thin-film encapsulation, are all designed to be “transparent to visible light.” *Id.*, 92, 94. Ex.1003, ¶92.

C. Ma

Ma reports the benefits of n-doping an ETL with “8-hydroxy-quinolinato lithium (Liq)” to improve efficiency and performance of OLEDs. Ma, 810-14. Ma examines the “conductivity of carrier transport layers with different doping concentration” and concludes that a “doping concentration of the Liq” in the ETL results in increased current density, reduced driving voltage, and improved electron transport ability. *Id.*, 813. Ma attributes the improved power efficiency to “the improved conductivity of the transport layers and the efficient charge balance in the emission zone.” *Id.*, Abstract. Ex.1003, ¶96.

1. Public Accessibility

Ma was publicly available since August 29, 2008, and at least by December 2, 2008, before the earliest possible priority date of the ’250 patent (i.e., December 11, 2008). Ex.1005 (Munford Decl.), ¶¶11-63; Ex.1006 (Garland Decl.), ¶¶6-11.

The publisher (Elsevier) made Ma available online on August 29, 2008, as shown in its cover. Ma, 810; Ex.1005, ¶¶10-30, 63; Ex.1006, ¶¶9-11; *Hulu, LLC v. Sound View Innovations, LLC*, IPR2018-01039, Paper 29, at 17-18 (Dec. 20, 2019) (precedential) (“[T]he indicia on the face of a reference, such as printed dates and

stamps, are considered as part of the totality of the evidence.”). Ma was published in *Synthetic Metals*, a well-known journal, by Elsevier, a well-established publisher, and was readily accessible once being published online. Ex.1003, ¶¶94-95; Ex.1005, ¶¶11-63. Wayback Machine archives, including the “Articles in Press Listing” of the Elsevier ScienceDirect webpage, demonstrate Ma was publicly available online as of August 29, 2008, and at least by December 2, 2008. Ex.1005, ¶¶10-30, 63; *Analog Devices, Inc. v. Xilinx, Inc.*, IPR2020-01606, Paper 63, at 7-8 (PTAB Apr. 20, 2022) (“[A]rchived...webpages...captured at various times by the Wayback Machine[] are...inherently reliable.”). The public had access to Ma, such as through the ScienceDirect website, when Ma was published online on August 29, 2008. Ma remained online through at least December 2, 2008, as shown by the Wayback Machine archives, and to present.² Ex.1005, ¶¶31-63.

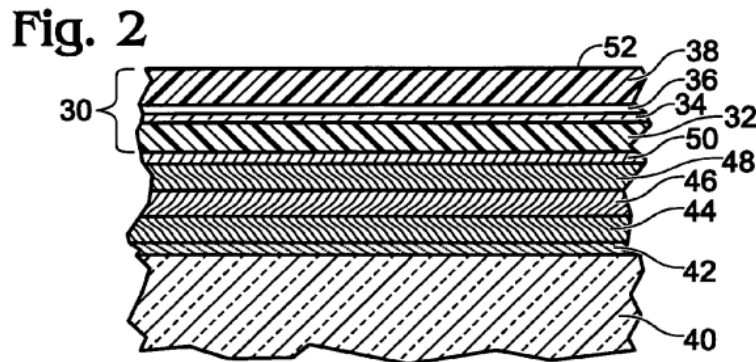
Accordingly, Ma was “disseminated or otherwise made available to the extent that persons interested and ordinarily skilled in the subject matter or art, exercising reasonable diligence, [could] locate it” before December 11, 2008. *In re Wyer*, 655 F.2d 221, 210 (CCPA 1981); MPEP §2128.I. Indeed, the Board previously instituted

² In IPR2024-01094, Patent Owner conceded that Ma was available online at least by December 1, 2008. Ex.1046, 34 (showing “Indexed 2008-12-01”).

trials based on Ma's August 29, 2008, publication date. Ex.1047, 13-19; Ex.1048, 6, 25.

D. Lee

Lee relates to an OLED device "having a barrier for protection against environmental degradation" as shown below. Lee, [0002].



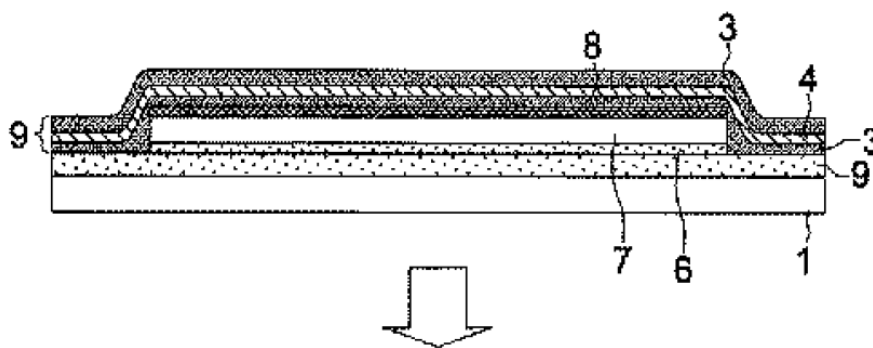
Id., Fig 2. Lee's OLED layers are formed on a substrate 40 and include "a transparent anode 42, an organic hole transport layer 44, an organic light emitting layer 46, an organic electron transport layer 48, and a cathode 50." Lee, [0022]; Ex.1003, ¶98.

Lee teaches using a multi-layered encapsulation such as polymer layers 32 and 38 sandwiching an inorganic barrier layer 34 and with different amorphicity (e.g., "semi-crystalline parylene-based polymer," "highly crystalline parylene-based polymer"). Lee, [0021]-[0024]. Lee explains its encapsulation prevents "propagation of defects" within its layers and improves blocking "water vapor and oxygen permeation into the OLED" to achieve better lifetime. *Id.*, [0020]. Ex.1003, ¶99.

ii. [1A/6A/10A] an organic light-emitting diode comprising:

Suzuki discloses this element. Suzuki discloses OLEDs. Suzuki, [0274]-[0279], [0287]. For example, Suzuki discloses an “organic EL device” shown below:

【図9】

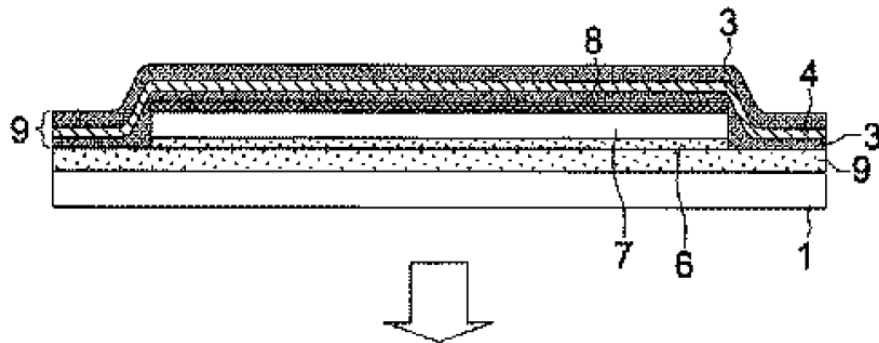


Id., Fig. 9; *id.*, Fig. 10, [0274]-[0279], [0286]. Ex.1003, ¶¶103-05.

iii. [1B/6B/10B] an organic layer sequence,

Suzuki discloses this element. Suzuki discloses OLEDs including “an organic EL element comprising an anode, a light emission layer[,], an organic layer, and a cathode.” Suzuki, [0274]. Suzuki describes that the “organic EL element” of its OLEDs has an anode 6, “an organic layer (comprising a hole transport layer, a light emission layer, an electron transport layer, and the like),” and a cathode 8. *Id.*; *id.*, [0275]-[0279], [0287]. Suzuki thus discloses an organic layer sequence including the anode, and “organic layer” comprising multiple organic layers, and cathode:

【図9】

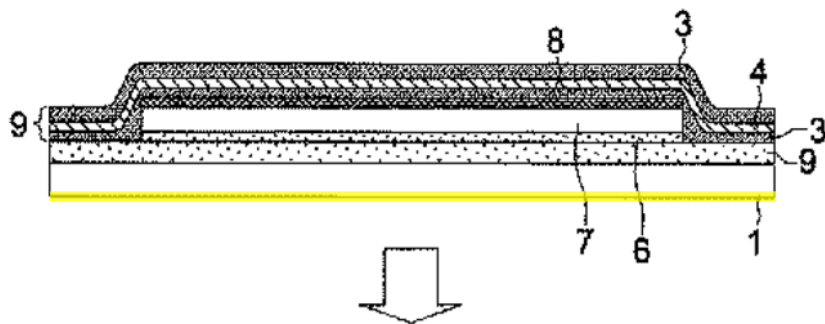


Suzuki, Fig. 9, Fig. 10. Ex.1003, ¶¶106-07.

iv. [1C/6C/10C] a radiation exit area, and

Suzuki discloses this element. As an example, Suzuki describes that light generated by the OLEDs may exit from the bottom after passing through the resin substrate material 1. Suzuki, [0274]. For instance, a radiation exit area is highlighted yellow below:

【図9】



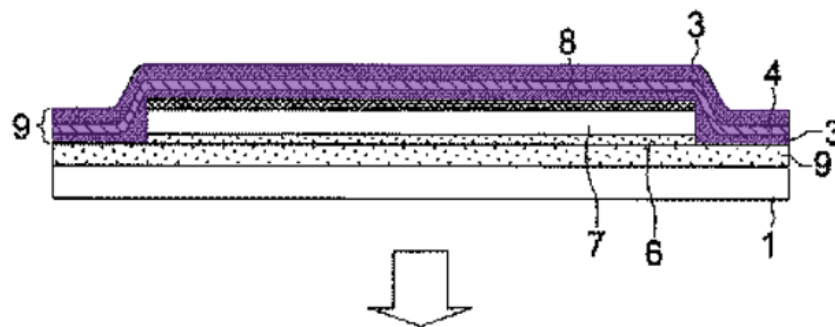
Suzuki, Fig. 9, Fig. 10, [0274]-[0279]. A POSITA would have understood that the surface of any OLED component below the substrate where light exits is a radiation exit area. Ex.1003, ¶¶108-09.

v. [1D/6D/10D] an encapsulation [wherein the encapsulation forms a seal of the organic layer sequence against environmental influences],³

Suzuki discloses this element. Suzuki's OLEDs include an encapsulation of "gas barrier thin film laminate 9" (purple below) including a "buffer film 3," "barrier film 4," another "buffer film 3," and silicon oxide film. Suzuki, [0274]-[0279], Figs. 9-10. The "gas barrier thin film laminate 9" forms a seal for the organic EL element and protects its layers against influences such as moisture and leads to a "sealed organic electroluminescent device." Suzuki, [0067], [0273]-[0274]. Suzuki explains the laminate, including buffer and barrier films, forms a seal and protects the organic layer from environmental influences because, for instance, the "barrier film" has "low gas and moisture vapor permeability" and laminating films provide good "gas barrier performance." *Id.*, [0067], [0416].

³ Bracketed text appears only in [1D].

【図9】

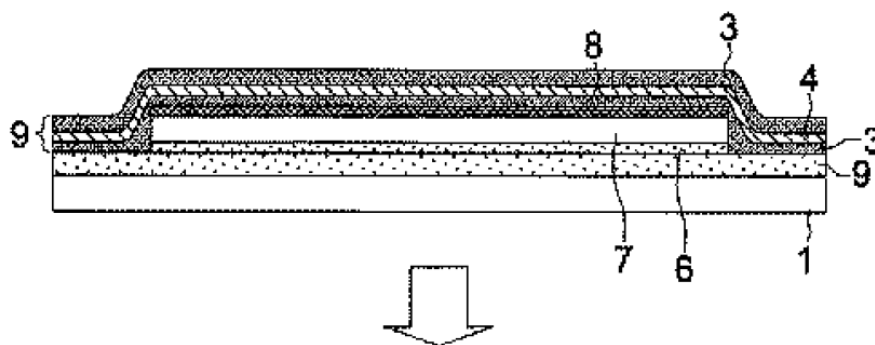


Suzuki, Fig. 9. Ex.1003, ¶¶110-12.

- vi. [1E/6E/10E] wherein the organic layer sequence and the encapsulation are disposed on a carrier,

Suzuki discloses this element. Suzuki discloses that the organic EL element with the anode 6, organic layer 7, and cathode 8 as well as the gas barrier thin film laminate 9 are disposed on a carrier, a “resin substrate material 1”:

【図9】

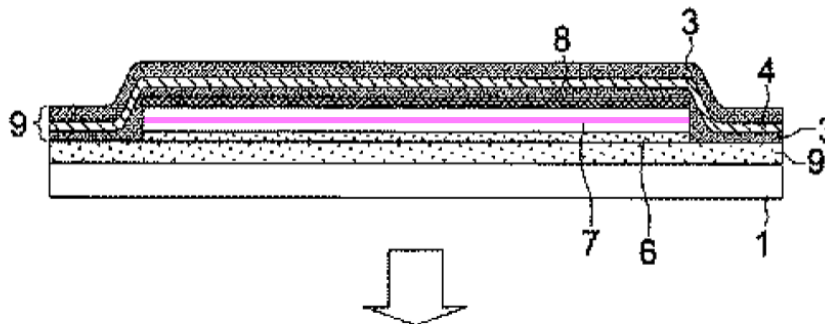


Suzuki, Fig. 9, [0121], [0274]; Fig. 10, [0275]-[0279]. Ex.1003, ¶¶113-14.

- vii. **[1F/6F/10F] wherein the organic layer sequence comprises at least one radiation-emitting region configured to generate electromagnetic radiation in a spectral range from infrared radiation to UV radiation during operation,**

Suzuki discloses this element. Suzuki's organic layer 7 of the organic EL element (including the anode 6, organic layer 7, and cathode 8) includes "a light emission layer" containing a radiation-emitting region (e.g. pink below) that emits light. Suzuki, [0274]-[0279].

【図9】



Suzuki, Fig. 9, Fig. 10. The emission layer of organic layer 7 "emits light by recombination of electrons and holes..., and the portion that emits light may be within the light emission layer, or at the interface between the light emission layer and an adjacent layer." Suzuki, [0299]. Ex.1003, ¶¶115-17.

Suzuki discloses that the radiation-emitting region of the organic layer 7 generates "white light" in a range from infrared to UV. Suzuki explains that its OLED devices emit "white light" to cover such a full spectral range, including

visible wavelengths, and describes using various “light emission hosts” “used in combination” and that “by using a plurality of dopant compounds, it is possible to mix different light emissions, thereby obtaining any desired light emission color.” Suzuki, [0316]-[0319], [0369]-[0370]. Suzuki describes that “[w]hite light emission is possible by adjusting the type and doping amount of phosphorescent compounds, and can be applied to illumination and backlighting.” *Id.*, [0316]-[0319], [0348], [0369]-[0370]. Based on the full spectral range of emission, Suzuki explains using the OLEDs for backlights, full-color displays, or using the white light to provide desired colors. Suzuki, [0336], [0348], [0373]-[0374]. Ex.1003, ¶¶117-19.

Indeed, in IPR2024-01095, Patent Owner’s expert admitted that “white light” meets the claimed “spectral range from infrared radiation to UV radiation.” Ex.1051, 76:1-14. This is consistent with a POSITA’s understanding based on usage in the art. Diekmann, 40-41, 44, 66, 70, 76, 91, 122, 157 (describing OLEDs providing “white light” to provide a radiation in an “ultraviolet to infrared spectral range”). And the Board found that Suzuki teaches this element when instituting IPR2024-01095. Ex.1048, 16-19. Ex.1003, ¶121.

Moreover, Suzuki discloses using films in its OLEDs to have “a [uniform] light absorption rate of 0.1% or less” in the “380-800 nm” range covering some infrared and UV radiation. Suzuki, [0096], [0118]. Indeed, Suzuki describes near-infrared and near-UV radiation around 400 and 700 nm, respectively. Suzuki, [0264]

(describing visible light in “the range of 400-700 nm”). A POSITA would have understood that Suzuki’s white light has radiation from infrared to UV, including visible light, because Suzuki teaches having little or no absorption in the “380-800 nm” range for its films to improve the emitted-light transmission with wavelengths covering that range. Ex.1003, ¶120.

Accordingly, and for the reasons in §VI.A, Suzuki discloses “radiation in a spectral range from infrared radiation to UV radiation” encompassing the full spectrum from infrared-to-UV, and at a minimum, visible light. Ex.1003, ¶¶115-23.

viii. [1G/6G/10G] wherein the organic layer sequence comprises an electron transport layer that is n-doped[; and]

Suzuki discloses this element, or teaches it alone or in combination with Ma. Suzuki’s organic EL element with organic layer 7 includes “an electron transport layer,” and Suzuki explains that the “electron transport layer comprises a material having the function of transporting electrons.” Suzuki, [0274], [0283], [0286]-[0287], [0329]-[0333]. Suzuki discloses using “an electron transport layer with a *high n nature doped* with impurities” and lists publications including examples of this doped ETL. Suzuki, [0333]. A POSITA would have understood that this disclosure refers to an ETL that is n-doped as the exemplary publications cited by Suzuki explicitly disclose n-doped ETLs. For example, He (discussed in [0333] of Suzuki) discloses the use of an “*n*-doped electron transport layer.” Ex.1018,

Abstract, p.5773. He discloses that use of the “*n*-doped electron transport layer” (in the “*p-i-n*” device) increases OLED performance with higher current and luminescence and low operating voltage. Ex.1018, 5774-75, Fig. 3. A POSITA thus would have understood Suzuki’s disclosure of using “an electron transport layer with a high *n* nature doped with impurities” refers to an *n*-doped ETL, particularly given Suzuki’s reference to examples (such as He) that explicitly disclose *n*-doped ETLs and their benefits. Ex.1018, 5773-5774; Ex.1048, 19-21 (“Suzuki teaches an *n*-doped transport layer.”). Ex.1003, ¶124.

Even had Suzuki not disclosed this element, it would have been obvious to use an *n*-doped ETL in Suzuki’s OLEDs from Suzuki’s and Ma’s teachings. A POSITA would have been motivated to include an *n*-doped ETL in Suzuki’s OLEDs. As explained above, Suzuki teaches using “a high *n* nature doped” ETL and cites exemplary publications using an “*n*-doped electron transport layer” and discussing its benefits. Suzuki, [0333]; Ex.1018. Advantages of *n*-doped ETLs were well-known. Ex. 1024, 1254-55; Ex.1018, Abstract; Ex.1020 (Pfeiffer); Ex.1021; Diekmann, 10, 91, 119. A POSITA would have been motivated to include an *n*-doped ETL to promote transport of electrons from the cathode and improve electron injection and transport to the light-emitting region. Ma, 812-14 (describing “significant enhancement in the device performance” due to the “improved transport conductivity” of “*n*-doped ETL”). Further, *n*-doping Suzuki’s ETL would be nothing

more than applying a known technique to a known structure to improve it in a similar way. Ex.1003, ¶¶125-26; 35-38. A POSITA would have reasonably expected success, as n-doped ETLs were widely used at the time in OLEDs for this reason, and implementing such a feature would have been a straightforward, routine modification to Suzuki's ETL as shown in numerous prior art "[e]xamples." Suzuki, [0333]; Ma, 812-14; Ex.1018; Ex.1020; Ex.1021; Diekmann, 10, 91, 119; *see* §VIII.A.1.x. Ex.1003, ¶127.

ix. [1H/6H/10H] wherein the organic layer sequence comprises an emission layer comprising an iridium-containing compound; and

Suzuki discloses this element. Suzuki's organic EL element with organic layer 7 includes a "light emission layer." Suzuki, [0274]-[0279], [0287], [0299]. Suzuki discloses that the light emission layer "contains a host compound and a dopant compound" "for even higher light emission efficiency." *Id.*, [0300]. Suzuki discloses that its OLEDs include "iridium compounds" for its phosphorescent dopants. *Id.*, [0301]-[0303]. Suzuki explains the use of such iridium compounds were well-known in the art. *Id.*, [0303]-[0304], [0307]-[0308]. Suzuki describes an exemplary method for using emissive layers with iridium compounds. *Id.*, [0409]. Ex.1048, 16-19. Ex.1003, ¶¶128-30.

x. [11/10I] wherein the electron transport layer comprises 8-hydroxyquinolinolato-lithium.

Suzuki in view of Ma renders obvious this element. As explained in §VIII.A.1.viii, Suzuki (alone or in combination with Ma) teaches an n-doped ETL. It would have been obvious to a POSITA to use 8-hydroxyquinolinolato-lithium (“Liq”) as the dopant in Suzuki’s n-doped ETL as taught by Ma. Ma discloses an OLED with an ETL n-doped with Liq and teaches its benefits. Ma, Abstract, 810-14. Ex.1003, ¶¶131-35.

A POSITA would have been motivated to use an Liq-doped ETL in Suzuki’s OLED to obtain the benefits provided by Liq doping of the ETL in improving OLED performance. As Ma explains, “there has been a considerable interest in developing OLEDs with high efficiency.” Ma, 810. To “lower driving voltage and enhance power efficiency, it is critical to enhance the carrier injection from the electrode to the transporting layer and to increase the transport conductivity.” *Id.* Ma teaches that a “doping concentration of the Liq” in the ETL results in increased current density and reduced driving voltage. *Id.*, 811-14. As an example, Ma teaches doping “Liq to Bphen can improve the electron transport ability of the co-deposited layer.” *Id.*, 813. Liq-doped ETLs were known to have these benefits. Ex. 1034, L800, L802; Ex. 1050, 062101-1. Ex.1003, ¶¶132-35. Like Ma, Suzuki contemplates n-doping for “efficient carrier injection” and “highly conductive” ETLs, Ex.1018, Abstract (cited in Suzuki,

[0333]), so a POSITA would have recognized that Liq is an advantageous dopant for Suzuki's ETL. Ex.1003, ¶¶136, 41.

Doping with large molecules like Liq was known to be beneficial. Diekmann, 10 (explaining that “doping advantageously increases the conductivity of the doped organic layer” and the “dopant preferably has a low diffusion constant...as is usually the case with large atoms or molecules”); Ex.1003, ¶¶137-39. A POSITA thus would have been motivated to use Liq, as Liq increases ETL conductivity, has good electron injection and transport properties, and has a larger molecular weight suitable for use as an n-dopant. Suzuki, [0333]; Ma, 813-14; Diekmann, 10, 91, 119; *see* Ex.1051, 187:19-188:7; Ex.1028, 211, 212-14; *compare* Ex.1029 with Ex.1030-Ex.1032. Ex.1003, ¶141.

Further, Liq was known to be more stable when used to n-dope an ETL, compared to n-dopants contemplated by Suzuki, like cesium. Ex.1039, 252; Ex.1003, ¶140. As discussed below in §VIII.C.1.x, Liq was known to have further benefits in processing and EL characteristics over other known n-dopants, including LiF. *See* Ex.1003, ¶140; Ex.1039, 253; Ex.1028, 212-13; Ex.1034, L802, Figs. 4-5.

Combining Suzuki and Ma would have merely amounted to applying a known technique (Ma's Liq-doping the ETL) to improve similar OLEDs (Suzuki's devices with n-doped ETLs) in the same way. Ex.1003, ¶142. Suzuki recognizes that it was desirable to use an n-doped ETL in its OLED devices as in Ma. Suzuki, [0333]

(citing Ex.1018); Ma, 810-14. The prior art has examples of n-doped ETLs in OLEDs with an emissive layer including an iridium-containing compound (Ir(ppy)₃), based on the same type of ETL and emissive layer taught by Ma and Suzuki, respectively. Ex.1003, ¶142. It was well-known that n-doping the ETL would lead to improved OLED performance. *Id.*; Ma, 813-14; Diekmann, 10, 91, 119; Ex.1051, 187:19-188:7. Liq was an art-recognized n-dopant for the ETL, known for facilitating electron transport and injection, and interchangeable with other n-dopants. Ma, 813; Ex.1034, L800. Ex.1003, ¶¶46-48, 142, 49-52.

A POSITA would have reasonably expected success in using an Liq-doped ETL in Suzuki's OLEDs, particularly as Suzuki already contemplates an n-doped ETL. Suzuki, [0333]. Using an Liq-doped ETL merely involves using a different dopant, which would have been a routine matter within a POSITA's ability. Ex.1003, ¶¶49-52, 143. Particularly so because Suzuki has blocking layers to address potential dopant diffusion. Ex.1003, ¶¶144, 42-43, 37. It was well-known that elements in Ma's devices were applicable to the type of OLEDs disclosed in Suzuki. For instance, He, cited in Suzuki, shows an example of an n-doped ETL in a phosphorescent OLED using the same ETL and emissive material taught by Ma and Suzuki, respectively. Ex.1018, Abstract, 5773-76 (n-doping Bphen ETL (like in Ma) in OLED with Ir(ppy)₃ in emissive layer (like in Suzuki)); Ma, 810-14; Suzuki, [0303]-[0304], [0307]-[0308], [0333], [0409]. Conductivity-doped phosphorescent

OLEDs were well-known, and a POSITA would have reasonably expected success in using Liq-doped ETL in Suzuki's Ir-based OLED devices. Ex.1003, ¶¶142-46.

Further, a POSITA would have reasonably expected success in applying the same known dopant to different ETL materials (and vice versa) in different OLEDs. Ex.1003, ¶147. It was well-known that applying Liq as a dopant to ETL materials such as BPhen (Ma's ETL) and Alq₃ (identified as ETL in Suzuki) improved OLED performance. Ma, 810-14; Suzuki, [0329]-[0333] (explaining "any conventionally known compounds" can be used as ETL for its OLED devices); Ex.1034, L800-L802. It was within a POSITA's skill to determine appropriate materials and doping concentrations. Ex.1003, ¶¶148-49. Moreover, a POSITA would have applied teachings concerning electron and hole transport layers from fluorescent OLEDs to phosphorescent OLEDs. Fluorescent and phosphorescent OLEDs using the same n-dopants for their ETLs were known, as were OLEDs having both fluorescent and phosphorescent emitters in the same stack sharing the same layers. Ex.1024, 1254-55; Ex.1035, 053311-1, Fig. 1; Ex.1036, 61920Q-1-61920Q-2, Fig. 1. POSITAs would naturally have applied n-dopants with favorable performance in fluorescent OLEDs (Ma) to n-doped phosphorescent OLEDs (Suzuki) with a reasonable expectation of success with the known benefits of an Liq-doped ETL. Ex.1003, ¶¶150-51.

- xi. [6J/10J] wherein the organic light-emitting layer sequence comprises a cathode having a thickness of at least 1 nm and at most 50 nm;**

Suzuki discloses or suggests this element. Suzuki's organic light-emitting layer sequence includes a "cathode." Suzuki, [0274]-[0290]. Suzuki discloses "so that the emitted light can pass through," "the cathode of the organic EL element is transparent or semi-transparent for improved luminance of the emitted light." Suzuki, [0288]. Suzuki discloses that "a transparent or semi-transparent cathode can be fabricated by fabricating a film...to 1-20 nm thick for the cathode." Suzuki, [0289]. Ex.1003, ¶¶152-53.

Suzuki's range of the cathode thickness of 1-20 nm for a transparent or semi-transparent cathode is within the claimed range. The '250 patent does not disclose any part of its claimed range as critical to the claimed invention; the '250 patent merely describes the 1-50 nm range as an example thickness for a transparent metal layer. Ex.1001, 3:8-11. While Suzuki mentions the cathode thickness can generally be in the range of 10 nm to 5 μ m, Suzuki specifically discloses using a 1-20 nm thick cathode which is transparent or semi-transparent. Suzuki, [0288]-[0289]. Accordingly, Suzuki discloses cathode thicknesses anticipating (by being within and overlapping with) the claimed 1-50 nm range. Ex.1003, ¶154.

Even had Suzuki not disclosed this element, it would have been obvious to a POSITA to use a cathode thickness in the 1-50 nm range in Suzuki's OLEDs. Suzuki

teaches the benefits of using a transparent electrode to improve luminance, specifically a transparent or semi-transparent cathode that is “1-20 nm thick.” Suzuki, [0288]-[0290]. The use of thin cathodes was well-known for OLEDs at the time, and it was well-known that using a cathode with a thickness in the 1-50 nm range to be transparent or semi-transparent would improve transmission of emitted light. Suzuki, [0289]; Diekmann, 92 (using a transparent cathode with a 30 nm silver layer); Ex.1023, 29. A POSITA would have been motivated to use a cathode with a thickness between 1-50 nm in Suzuki to achieve improved light output, and would have reasonably expected success in applying a 1-50 nm thick cathode because such a cathode (e.g., made of magnesium, silver, or Mg/Ag alloy) was well-known to improve luminescence due to its transparency. Suzuki, [0288]-[0290]; Diekmann, 92; Ex.1023, 29. Ex.1003, ¶¶26, 155-56.

xii. [10K] wherein the cathode comprises one of: Silver, Magnesium, or an alloy comprising Silver and Magnesium; and

Suzuki discloses this element. Suzuki discloses that its OLEDs use “magnesium” or “magnesium/silver mixtures” (i.e., a magnesium and silver alloy) for the cathode. Suzuki, [0288]-[0290]. Ex.1003, ¶¶157-58.

xiii. [10L] wherein the cathode is in direct contact with a Lithium containing layer.

Suzuki/Ma combination satisfies this element. As an example, Suzuki discloses OLEDs with the cathode directly contacting an ETL in the following order:

“anode / hole transport layer / light emission layer / hole blocking layer / *electron transport layer* / *cathode*.” Suzuki, [0287]; *id.*, [0274]. The ETL is the layer immediately following the cathode, and thus in direct contact with it. Suzuki, [0287]. Ex.1003, ¶159.

Moreover, as explained in §VIII.A.x, it would have been obvious to use Liq in Suzuki’s n-doped ETL as taught by Ma. In this Suzuki/Ma system, the cathode is in direct contact with a Li containing layer—the Liq-doped ETL—as Suzuki describes that the cathode is in direct contact with the ETL in its exemplary OLEDs. Suzuki, [0287]. Ex.1003, ¶160.

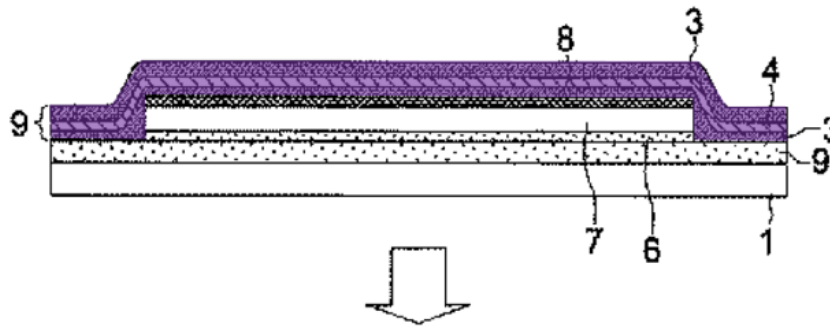
2. Claim 2

i. [2A] The device of claim 1, wherein at least one part of the encapsulation is formed by an insulation layer, and

Suzuki discloses this element. Suzuki’s OLEDs include an encapsulation, “gas barrier thin film laminate 9,” comprising a “buffer film 3,” “a barrier film 4,” another “buffer film 3,” and “silicon oxide” film, for example, as illustrated in Figure 9 below. Suzuki, [0274]-[0279]. Suzuki describes a barrier film as “a dense film...comprising a ceramic composition with low or no carbon content and having at least Si and O atoms” and a buffer film as “a film with a high content of carbon atoms with Si, O, and C atoms.” Suzuki, [0117]; *id.*, [0068]-[0069]. It was well-known that silicon oxide and ceramic materials including silicon and oxygen are insulation materials. Suzuki, [0222] (explaining ceramic provides electrical

insulation), [0398] (showing SiO₂ barrier film, a known electrical insulator). A POSITA would have understood that film layers in Suzuki's encapsulation electrically insulate the cathode and anode from each other, for instance, as depicted below, or otherwise the sides of the electrodes would be short-circuited. Thus, Suzuki's encapsulation has insulation layers including buffer films, barrier film, and silicon oxide film. Ex.1003, ¶¶161-64.

【図9】



Suzuki, Fig. 9.

ii. **[2B] wherein the insulation layer comprises at least one of: resin, silicon oxide, or silicon nitride.**

Suzuki discloses or suggests this element. As explained for element [2A], Suzuki's encapsulation has insulation layers including buffer films, barrier film, and silicon oxide film. Suzuki, [0222], [0274]-[0279], [0398]. Suzuki discloses using barrier and buffer films made from "at least one of *silicon oxide*, silicon oxide nitride, and *silicon nitride*." Suzuki, [0068]-[0069]. Ex.1003, ¶165.

Using an insulation layer including resin, silicon oxide, or silicon nitride would have been obvious to a POSITA. Suzuki, [0068]-[0069]; Diekmann, 15. A POSITA would have been motivated to use these materials for Suzuki's encapsulation as they were well-known, and given Suzuki's disclosure of silicon oxide and silicon nitride. A POSITA would have known it to be beneficial to use resin, silicon oxide, or silicon nitride, well-known insulating materials. A POSITA would have reasonably expected success in doing so as a routine modification to Suzuki's encapsulation. Ex.1003, ¶166.

3. Claim 4: The device according to claim 1, wherein the organic light-emitting diode comprises a hole transport layer that is p-doped.

Suzuki discloses this element, or suggests it alone or in combination with Ma. Suzuki's OLEDs include a "hole transport layer" ("HTL"). Suzuki, [0274], [0283], [0287], [0322]-[0328]. Suzuki specifies that "a hole transport layer with a *high p nature doped* with impurities can also be used" and lists publications as examples of this HTL. Suzuki, [0328]. A POSITA would have understood that "a hole transport layer with a high p nature doped with impurities" refers to an HTL that is p-doped, particularly as the exemplary publications cited by Suzuki explicitly disclose p-doped HTLs. Suzuki, [0328] (citing Ex.1018). Ex.1003, ¶167.

Even had Suzuki not disclosed this element, it would have been obvious to p-dope the HTL as taught by Suzuki and Ma. Using p-doped HTLs was well-known

and, in particular, it was known that using a p-doped HTL improved current and power efficiencies of OLEDs. Ex.1018 (cited by Suzuki); Ma, 810-14 (disclosing enhanced device performance attributed to “p-doped HTL”); Diekmann, 4-5, 92. A POSITA would have been motivated to use a p-doped HTL in Suzuki to improve OLED performance. Ma, 810-14; Diekmann, 4-5, 92. Ma teaches that “p-doping of HTL” “enhance[s] hole injection and lower driving voltages in OLEDs” (Ma, 810), and it was well-known that p-doping HTL results in “better hole injection from the anode into the organic layer stack” (Diekmann, 10). Numerous materials (e.g., 4,4′,4′′-tris(3-methylphenylphenylamono) triphenylamine (“m-MTDATA”)) were known as compounds useful to be p-doped to improve transport of holes from the anode to the emissive layer. Ma, 810-14; Diekmann, 4-5; Ex.1018; Ex.1020. Ex.1003, ¶¶168-69.

A POSITA would have recognized it beneficial to use a p-doped HTL together with an n-doped ETL in the “*p-i-n*” configuration which Suzuki and Ma teach and was well-known. Suzuki, [0328], [0333]; Ma, 810-14; Ex.1020; Ex.1021; §VIII.a.1.viii. A POSITA would have understood, as recognized by Ma and Suzuki, that an OLED including an p-doped HTL and n-doped ETL provides substantial flexibility to tune electron/hole currents to optimize charge balance, benefiting efficiency and lifetime. Ma, 810-14; Ex.1018, Abstract (cited by Suzuki, [0333]); Ex.1019, 3911-12; Ex.1021, 5-14. Ex.1003, ¶170.

A POSITA would have reasonably expected success in using a p-doped HTL in Suzuki's OLED. Suzuki already contemplates both an n-doped ETL and a p-doped HTL, and functional "*p-i-n*" OLEDs with both n-doped and p-doped transport layers were well-known in the art. Ma, 810-14; Ex.1018; Ex.1019, Ex.1021. Ex.1003, ¶¶171-72.

4. Claim 5

- i. [5A] The device according to claim 1, wherein a color filter is arranged between the emission layer and the radiation exit area, and**

Suzuki discloses or suggests this element. Suzuki discloses using a "color filter" to convert the color of light generated from the emission layer in its OLEDs. Suzuki, [0336] ("A color filter[...]or the like may also be used, and a color conversion filter that converts the color emitted from the organic EL element to multicolor using phosphors may also be used."). Suzuki teaches that "one emission color, e.g., white emission light, can be made into BGR using a color filter to create a full-color display" and "it is possible to convert the organic EL light emission color to other colors using color conversion filters to achieve full color." Suzuki, [0348], [0373]. A POSITA would have understood that for the color filter to have this effect it is placed between the emission layer and the radiation exit area (i.e., the light must be generated, pass through the color filter, and then exit the OLED as colored light). Ex.1003, ¶173.

Even had Suzuki not disclosed this element, it would have been obvious to use a color filter arranged between the emission layer and radiation exit area in view of Suzuki's teachings. A POSITA would have been motivated to use such a color filter because Suzuki teaches adjusting the color of light using color filters to convert light generated by the emission layer to adjust its OLEDs' output color. Suzuki, [0336], [0348], [0373]. Indeed, the use of color filters placed between the emission layer and radiation exit area to convert the color of light was well-known. Diekmann, 37-38, 40, 128-33, Figs. 35-37. A POSITA would have reasonably expected success using such color filters in Suzuki's OLEDs because it would have been a straightforward, routine modification to Suzuki known to be operational. Suzuki, [0336], [0348], [0373]; Diekmann, 37-38, 40, 128-33, Figs. 35-37. Ex.1003, ¶¶174-75.

- ii. **[5B] wherein the color filter is configured to be highly transmissive for a first spectral subrange of the generated electromagnetic radiation and highly absorbent for a second spectral subrange of the generated electromagnetic radiation.**

Suzuki discloses or suggests this element. Suzuki discloses that color filters are highly transmissive for a particular wavelength range and are highly absorbent for wavelengths falling outside of that range. Suzuki explains that "any combination of...light emitting materials can be selected, combined and whitened to *match the wavelength range corresponding to the color filter (CF) characteristics.*" Suzuki,

[0373]. A POSITA would have understood Suzuki's explanation to mean that light wavelength matching the color of the filter is highly transmissive while wavelength outside the color characteristic of the filter is highly absorbent to achieve the color filter function. Suzuki, [0373]; *see* Diekmann, 40. Thus, a POSITA would have understood that Suzuki discloses color filters that are highly transmissive to one spectral subrange of generated radiation while being highly absorbent to another spectral subrange. Ex.1003, ¶¶176-77.

Even had Suzuki not disclosed this element, it would have been obvious to use the claimed color filter in view of Suzuki's teachings. A POSITA would have been motivated to use such a color filter because Suzuki teaches the need for converting colors and matching the color filter characteristics to efficiently convert light generated by the emission layer. Suzuki, [0336], [0348], [0373]. Indeed, the use of such color filters that are highly transmissive in one spectral range and highly absorbent in another was well-known. Diekmann, 40 (explaining use of color filters allowing one color to pass through unhindered while another color is absorbed), 41, 129-130. A POSITA would have reasonably expected success using such filters in Suzuki because it would have been a straightforward, routine modification, and using effective color filters was known in the art. Suzuki, [0336], [0348], [0373]; Diekmann, 40-41, 129-30. Ex.1003, ¶¶178-79.

- 5. Claim 7: The device according to claim 6, wherein the cathode comprises one of: Silver, Magnesium, or an alloy comprising Silver and Magnesium.**

See §VIII.A.1.xii [10K]. Ex.1003, ¶180.

- 6. Claim 8: The device according to claim 6, wherein the cathode is in direct contact with a Lithium containing layer.**

Suzuki (alone or modified by Ma) satisfies this element. Ex.1003, ¶¶181-85.

First, Suzuki discloses this element. For example, Suzuki discloses OLEDs with the cathode directly contacting a cathode buffer layer in the following order: “anode / anode buffer layer / hole transport layer / light emission layer / hole blocking layer / electron transport layer / *cathode buffer layer* / *cathode*.” Suzuki, [0287], [0292]-[0293], [0295]. This optional “cathode buffer layer” is the layer immediately following the cathode, and thus in direct contact with it. Suzuki, [0287], [0292]. Suzuki describes that the cathode buffer layer is an “alkali metal compound buffer layer[] typified by *lithium fluoride*.” Suzuki, [0295]. Ex.1003, ¶¶182-84.

Second, Suzuki/Ma combination renders obvious this element for the reasons in §VIII.A.1.xiii [10L]. Ex.1003, ¶185.

- 7. Claim 9: The device according to claim 6, wherein the [ETL] comprises 8-hydroxyquinolinolato-lithium.**

See §VIII.A.1.x [1I/10I]. Ex.1003, ¶186.

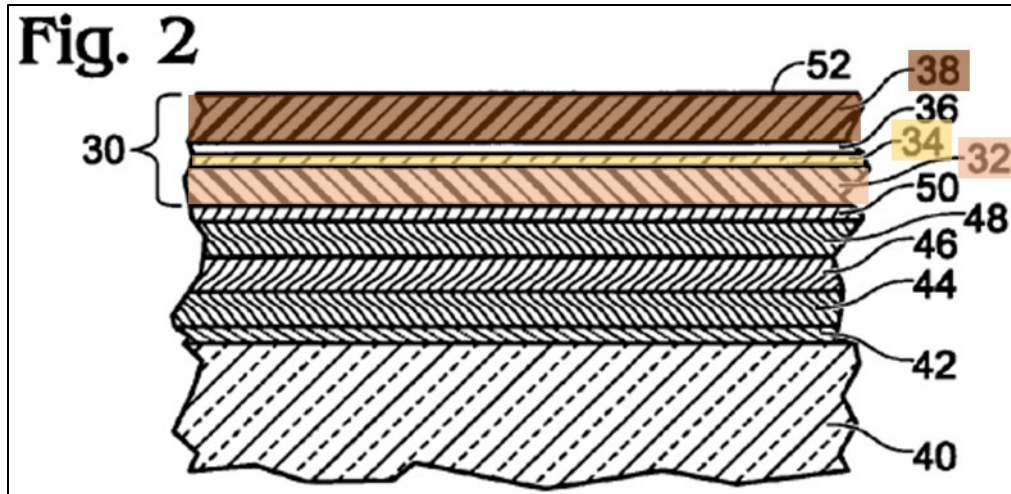
B. Grounds 3-4: Suzuki, Ma, and Lee Render Obvious Claims 3, 11-12, and 15-16 (Ground 3); Suzuki and Lee Render Obvious Claims 11 and 13-15 (Ground 4)

1. Claim 3

- i. [3A] The device of claim 1, wherein the encapsulation comprises a first encapsulation layer and a second encapsulation layer,**

It would have been obvious to modify Suzuki (alone or combined with Ma) in view of Lee, and the modified OLED satisfies this element. As explained in §VIII.A.1.v, Suzuki discloses an encapsulation, a “gas barrier thin film laminate 9” including “buffer film 3,” “barrier film 4,” another “buffer film 3,” and silicon oxide film, and that the encapsulation may include multiple barrier films and multiple buffer films. Suzuki, [0274]; *id.*, [0275]-[0279]. Ex.1003, ¶¶187-88.

Lee teaches improving encapsulation of OLEDs by using two layers with independent volume structures and different levels of crystallinity. Specifically, Lee discloses a first encapsulation layer (“second semi-crystalline parylene-based polymer layer 38”) and a second encapsulation layer (“first semi-crystalline parylene-based polymer layer 32”) as illustrated below.



Lee, Fig. 2, [0021]-[0022]. Ex.1003, ¶189.

A POSITA would have been motivated to apply Lee's encapsulation to Suzuki to improve the sealing, for example, by replacing Suzuki's encapsulation with Lee's multi-layered encapsulation. Lee teaches forming semi-crystalline and highly-crystalline polymer barrier layers with improved performance in that they “decouple” adjacent inorganic layers to prevent the propagation of defects between inorganic layers, but also themselves help block water vapor and oxygen permeation into the OLED.” Lee, [0020]; *id.*, [0010], [0021], [0042]-[0043]. Lee also discloses that its encapsulation improves over conventional encapsulations and achieves a low water vapor transport rate (“WVTR”) and oxygen transport rate (“OTR”). Lee, [0007]-[0008], [0020], [0031], [0034]. Lee explains that its encapsulation has “low-enough WVTR and OTR values” and has “a significantly improved lifetime compared to prior OLEDs having polyacrylate or amorphous parylene barrier layers” that were known to have a WVTR of “approximately 10^{-5} - 10^{-6} g/m²/day/atm”

(Lee, [0007], [0020]), which was still less than Suzuki's encapsulation providing a WVPR of about " 10^{-3} g/m²/day" (Suzuki, [0020], [0061], [0078], claim 6). Ex.1003, ¶¶190-93.

Use of encapsulations for protection from the ambient environment was well-known. Lee, [0002], [0036]; Diekmann, 130; Ex.1025; Ex.1026. As Lee explains, "the low work function metals typically used as cathodes in OLEDs are environmentally sensitive, and may be easily oxidized by moisture or oxygen from air. Therefore, it is important to protect these materials from air both during processing and during use." Lee, [0005]. Lee teaches specific benefits of its encapsulation. Lee, [0020] (the semi-crystalline and highly-crystalline polymer barrier layers "prevent the propagation of defects between inorganic layers" (such as ceramics or silicon oxide) and block water vapor and oxygen permeation to "significantly improve[] lifetime"), [0029] (providing "thermally stable" films). A POSITA would have been motivated to integrate Lee's encapsulation into Suzuki to protect OLEDs and improve device lifetimes. Lee, [0020]; Suzuki, [0067]. Ex.1003, ¶193.

A POSITA would have reasonably expected success in applying Lee's encapsulation to Suzuki, alone or as modified by Ma. Suzuki already contemplates an encapsulation with alternating layers of multiple "buffer films" and denser, multiple "barrier films," and silicon oxide film. Indeed, the use of such a multilayer

encapsulation with alternating organic and inorganic layers was well-known to be operable. Lee, [0020]-[0024], Fig. 2; Suzuki, [0274]; Diekmann, 94, Figs. 13, 17A; Ex.1025; Ex.1026. Applying Lee's encapsulation merely replaces one set of alternating layers with another, to obtain Lee's benefits, which would have been within a POSITA's ability. Lee, [0007]-[0008], [0020]-[0021], [0029], [0031], [0034], [0036]-[0038], [0042]-[0043]. Applying Lee's technique would have merely involved routine optimization; Lee teaches methods to implement its technique. Ex.1003, ¶¶194-96.

ii. [3B] the first and the second encapsulation layer each having a respective volume structure,

Suzuki (alone or combined with Ma) as modified by Lee renders obvious this element. As explained in §VI.B, during prosecution of the '514 Application, Applicant explained the meaning of "volume structure." Consistent with that, Lee teaches encapsulation layers having respective independent volume structures. Applicant distinguished between the arrangement inside a solid ("volume structure") and that at the surface ("surface structure"). Ex.1017, 1386. Applicant argued that "volume structure" "comprise[s] any structure ranging from polycrystalline to polyamorphous," including "crystalline, partly crystalline and/or polycrystalline or completely amorphous." Ex.1017, 1241. Ex.1003, ¶¶197-98.

Lee's encapsulation includes a first "*highly crystalline*" encapsulation layer with "up to 70% of crystallinity" and a second "*semi-crystalline*" "parylene-based

polymer layer” with “at least 10%” of crystallinity.” Lee, [0023], [0027]; *id.*, [0020]-[0021]. If two solids have different levels of crystallinity, they also have different internal molecular and atomic arrangements. Ex.1003, ¶199. Thus, Lee discloses encapsulation layers with their own respective distinct volume structures. *Id.* Thus, the encapsulation taught by Lee includes a first and second encapsulation layer each having respective independent volume structures, as explained in §VIII.B.1.i. Ex.1003, ¶¶199-200.

iii. [3C] wherein the volume structure of the second encapsulation layer is independent of the volume structure of the first encapsulation layer, and

Suzuki (alone or combined with Ma) as modified by Lee renders obvious this element. As explained in §VIII.B.1.i-ii, Lee discloses first and second encapsulation layers with distinct, independent volume structures: the first (highly-crystalline) layer has “up to 70% of crystallinity” and the second (semi-crystalline) layer has “at least 10%” of crystallinity. Lee, [0023], [0027]; *id.*, [0020]-[0021]. Ex.1003, ¶¶201-02.

iv. [3D] the volume structure of the second encapsulation layer has a higher amorphicity than the volume structure of the first encapsulation layer.

Suzuki (alone or combined with Ma) as modified by Lee renders obvious this element. As explained in §VIII.B.1.i-ii, Lee’s encapsulation includes semi-crystalline parylene-based polymer layer 32 (“second encapsulation layer”) with

about 10% crystallinity, and highly crystalline parylene-based polymer layer 38 (“first encapsulation layer”), which may have about 70% crystallinity. Lee, [0020]-[0021], [0023]-[0027]. Amorphicity and crystallinity both describe the volume structure of solids, and have an inverse relationship; the higher a material’s crystallinity is, the lower its amorphicity. Because Lee discloses a second encapsulation layer with lower crystallinity than the first encapsulation layer, Lee’s encapsulation satisfied this element. Ex.1003, ¶¶203-04.

2. Independent Claims 11 and 16

i. [11Pre/16Pre] A device comprising:

See §VIII.A.1.i [1Pre/6Pre/10Pre]. Ex.1003, ¶205.

ii. [11A/16A] an organic light-emitting diode comprising:

See §VIII.A.1.ii [1A/6A/10A]. Ex.1003, ¶206.

iii. [11B/16B] an organic layer sequence,

See §VIII.A.1.iii [1B/6B/10B]. Ex.1003, ¶207.

iv. [11C/16C] a radiation exit area, and

See §VIII.A.1.iv [1C/6C/10C]. Ex.1003, ¶208.

v. [11D/16D] an encapsulation,

Suzuki (alone or modified by Ma) in combination with Lee satisfies this element for the reasons in §VIII.B.1 [Claim 3]. Ex.1003, ¶209.

- vi. [11E/16E] wherein the organic layer sequence and the encapsulation are disposed on a carrier,**

Suzuki (alone or modified by Ma) in combination with Lee satisfies this element because the modified encapsulation is disposed on Suzuki's substrate for the same reasons in §VIII.A.1.vi [1E/6E/10E]. Ex.1003, ¶210.

- vii. [11F/16F] wherein the organic layer sequence comprises at least one radiation-emitting region configured to generate electromagnetic radiation in a spectral range from infrared radiation to UV radiation during operation,**

See §VIII.A.1.vii [1F/6F/10F]. Ex.1003, ¶211.

- viii. [11G/16G] wherein the organic layer sequence comprises an [ETL] that is n-doped;**

Suzuki/Lee combination by itself or modified by Ma satisfies this element for the reasons in §VIII.A.1.viii [1G/6G/10G]. Ex.1003, ¶212.

- ix. [11H/16H] wherein the organic layer sequence comprises an emission layer comprising an iridium-containing compound;**

See §VIII.A.1.ix [1H/6H/10H]. Ex.1003, ¶213.

- x. [16I] wherein the [ETL] comprises 8-hydroxyquinolinolato-lithium;**

It would have been obvious to modify the Suzuki/Lee OLED in view of Ma, and the modified OLED satisfies this element, for the reasons in §VIII.A.1.x [1I/10I]. Ex.1003, ¶214.

- xi. [11J/16J] wherein at least one part of the encapsulation is formed by an insulation layer, the insulation layer comprising at least one of: resin, silicon oxide, silicon nitride; [and]**

Suzuki discloses or teaches this element. *See* §VIII.A.2 [Claim 2]. Moreover, Lee discloses its encapsulation includes inorganic barrier layer 34 formed by insulating materials SiO_x or Si_xN_y . Lee, [0022], [0031]-[0032]. Accordingly, the encapsulation of Suzuki/Lee combination (by itself or modified by Ma) includes an insulation layer that satisfies this element. *See* §VIII.B.1. Ex.1003, ¶¶215-16.

- xii. [11K/16K] wherein the encapsulation comprises a first encapsulation layer and a second encapsulation layer,**

See §VIII.B.1.i [3A]. Ex.1003, ¶217.

- xiii. [11L/16L] the first and the second encapsulation layer each having a respective volume structure,**

See §VIII.B.1.ii [3B]. Ex.1003, ¶218.

- xiv. [11M/16M] wherein the volume structure of the second encapsulation layer is independent of the volume structure of the first encapsulation layer, [and]**

See §VIII.B.1.iii [3C]. Ex.1003, ¶219.

- xv. [11N/16N] the volume structure of the second encapsulation layer has a higher amorphicity than the volume structure of the first encapsulation layer.**

See §VIII.B.1.iv [3D]. Ex.1003, ¶220.

- xvi. **[16O] wherein the organic light-emitting layer sequence comprises a cathode having a thickness of at least 1 nm and at most 50 nm;**

See §VIII.A.1.xi [6J/10J]. Ex.1003, ¶221.

- xvii. **[16P] wherein the cathode comprises one of: Silver, Magnesium, or an alloy comprising Silver and Magnesium; and**

See §VIII.A.1.xii [10K]. Ex.1003, ¶222.

- xviii. **[16Q] wherein the cathode is in direct contact with a Lithium containing layer.**

Suzuki/Lee combination as modified by Ma satisfies this element for the reasons in §VIII.A.1.xiii [10L]. Ex.1003, ¶223.

- 3. **Claim 12: The device of claim 11, wherein the [ETL] comprises 8-hydroxyquinolinolato-lithium.**

See §VIII.B.2.x [16I]; §VIII.A.1.x [1I/10I]. Ex.1003, ¶¶224-25.

- 4. **Claim 13: The device of claim 11, wherein the organic light-emitting layer sequence comprises a cathode having a thickness of at least 1 nm and at most 50 nm.**

See §VIII.A.1.xi [6J/10J]. Ex.1003, ¶226.

- 5. **Claim 14: The device of claim 13, wherein the cathode comprises one of: Silver, Magnesium, or an alloy comprising Silver and Magnesium.**

See §VIII.A.1.xii [10K]. Ex.1003, ¶227.

6. Claim 15: The device of claim 13, wherein the cathode is in direct contact with a Lithium containing layer.

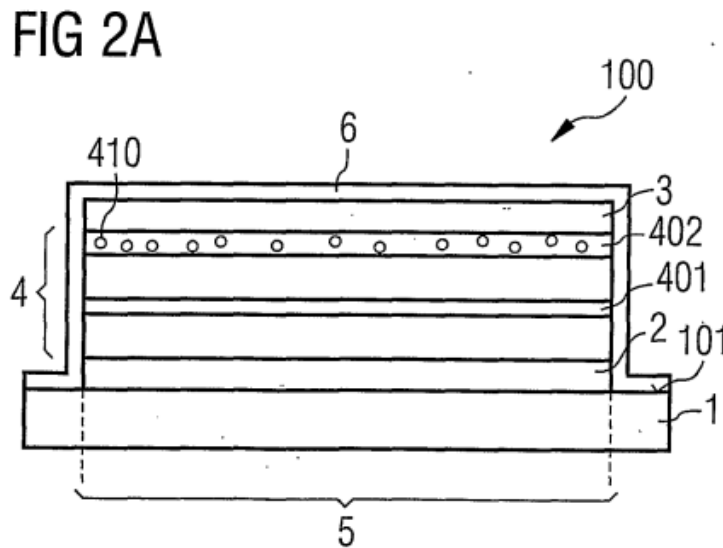
Suzuki discloses this element, or in combination with Ma renders obvious this element, for the reasons in §VIII.A.6 [Claim 8] and §VIII.A.1.xiii [10L]. Ex.1003, ¶228.

C. Grounds 5-6: Diekmann and Ma Render Obvious Claims 1-2, 4-5, and 8-10 (Ground 5); Diekmann Anticipates or Renders Obvious Claims 6-8 (Ground 6)

1. Independent Claims 1, 6, and 10

i. [1Pre/6Pre/10Pre] A device comprising:

To the extent the preamble is limiting, Diekmann discloses it. Diekmann discloses a “lighting device” 100:

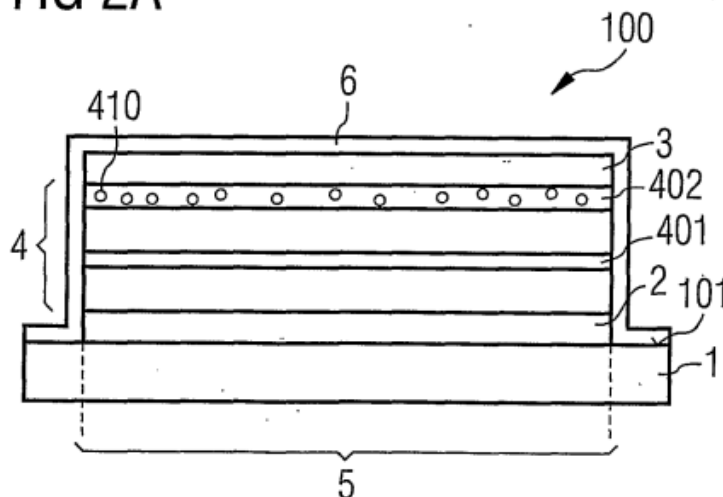


Diekmann, 87, 91; *id.*, Fig. 2A. Diekmann discloses display devices and lighting equipment incorporating this lighting device. *Id.*, Abstract, 1, 134; *id.*, Fig 40A. Ex.1003, ¶229.

ii. [1A/6A/10A] an organic light-emitting diode comprising:

Diekmann discloses this element. Diekmann's lighting device includes, for example, an organic light-emitting diode comprising a "first electrode 2 [which] is the anode," a "second electrode 3 [which] is the cathode," and an "organic layer stack 4 with at least one layer 401 suitable for generating light":

FIG 2A

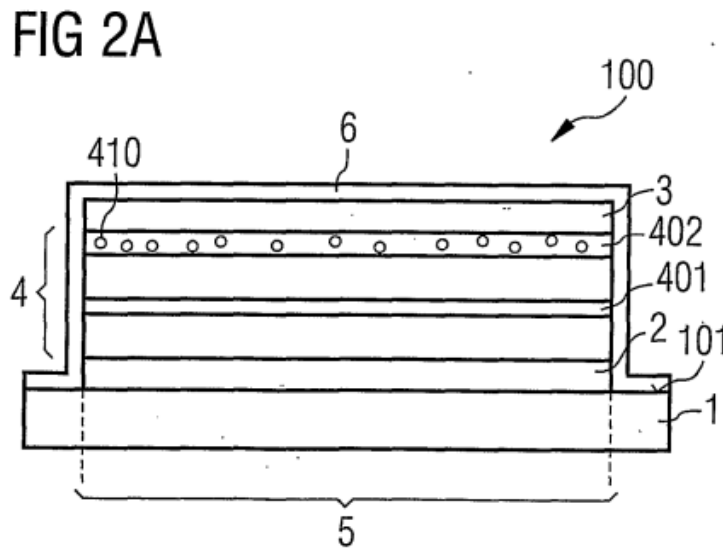


Diekmann, 91, Fig. 2A. The anode “injects holes into the organic layer stack,” and the cathode “injects electrons into the organic layer stack.” *Id.*, 3. The recombination of holes and electrons in the organic layer stack generates light. This describes an organic light-emitting diode. Ex.1001, Fig. 1, 24:39-25:4. Ex.1003, ¶¶230-31.

iii. **[1B/6B/10B]** an organic layer sequence,

Diekmann discloses this element. Diekmann discloses an organic radiation-emitting component comprising a first electrode, an “organic layer or a layer sequence with at least one organic layer with an active area that can emit

electromagnetic radiation during operation,” and a second electrode. Diekmann, 73. For instance, Diekmann describes the first electrode 2 serves as an anode, the second electrode 3 serves as the cathode, and the organic radiation-emitting component comprises the organic layer stack 4 with multiple organic layers with at least one organic layer 401 being an active area for generating light, as illustrated below:

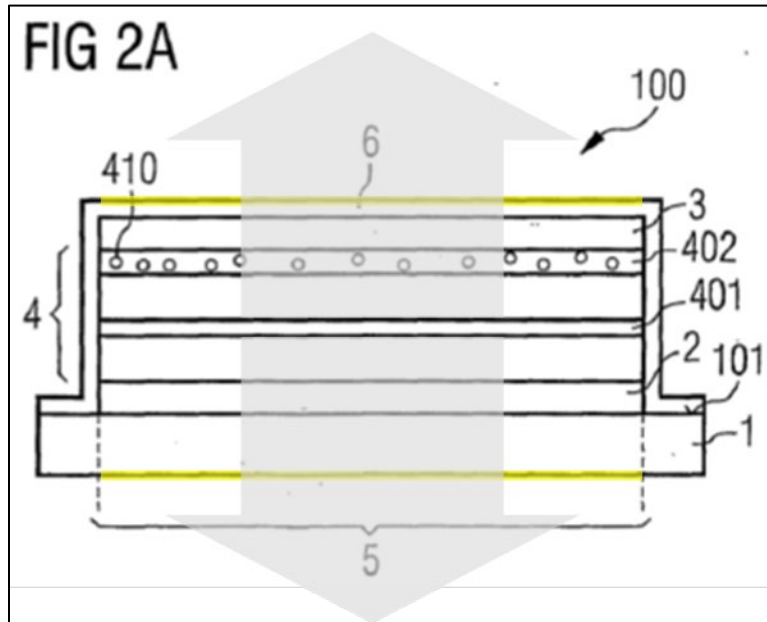


Diekmann, 73-74, 91-92, Fig. 2A. Diekmann thus discloses an organic layer sequence including the anode, “organic layer stack” comprising multiple organic layers, and cathode. Ex.1003, ¶¶232-33.

iv. [1C/6C/10C] a radiation exit area, and

Diekmann discloses this element. “The lighting device according to Figure 2A is designed to be transparent to visible light, in particular to light generated by the organic layer stack 4.” Diekmann, 92. For example, substrate 1, first electrode 2, organic layer stack 4, second electrode 3, and thin-film encapsulation 6 are each

designed to be “transparent to visible light” that is “generated by the organic layer stack.” *Id.*, 92, 94. Diekmann’s OLEDs include radiation exit areas at the top and bottom of the OLED, as illustrated below:



Diekmann, 5, Fig. 2A. A POSITA would have understood that the surface of any OLED component below the substrate or above the encapsulation where light exits is a radiation exit area. Ex.1003, ¶¶234-35.

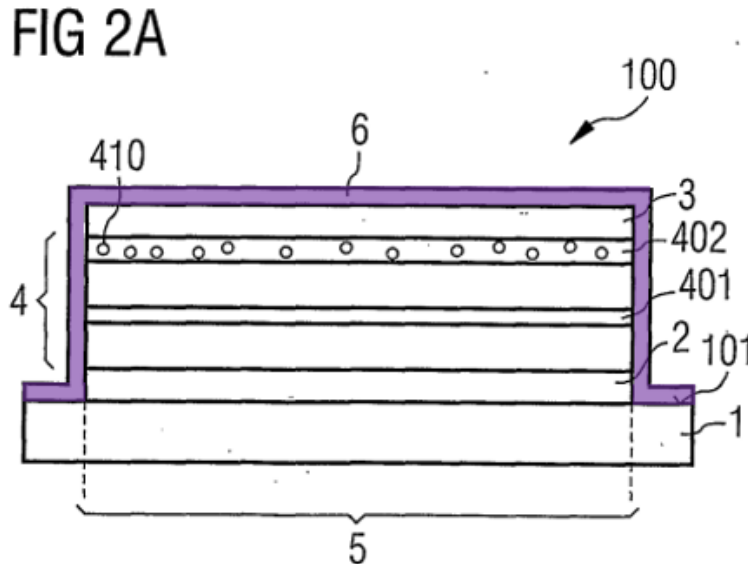
- v. **[1D/6D/10D] an encapsulation [wherein the encapsulation forms a seal of the organic layer sequence against environmental influences],⁴**

Diekmann discloses this element. Diekmann’s OLEDs include a “thin-film encapsulation 6” (purple) as illustrated below. Diekmann explains that this

⁴ Bracketed text appears only in [1D].

encapsulation forms a seal of the organic radiation-emitting component of Diekmann's lighting devices and protects the component against environmental influences such as "oxygen and moisture as well as other atmospheric gases."

Diekmann, 11, 13-14, 46, 75, 92.

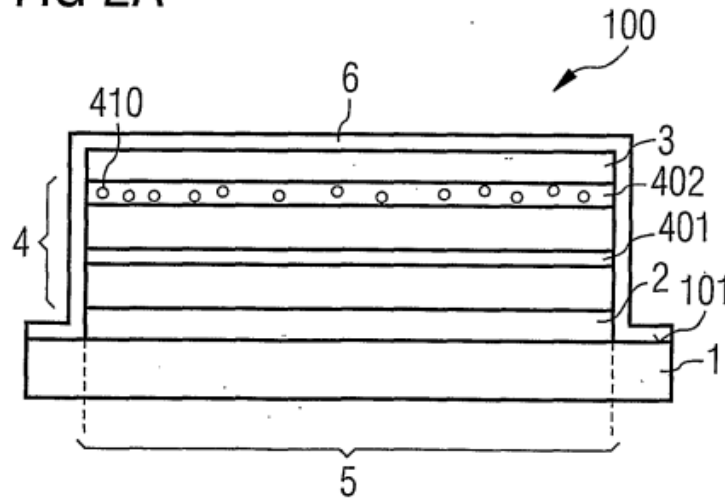


Diekmann, Fig. 2A. Ex.1003, ¶¶236-38.

vi. [1E/6E/10E] wherein the organic layer sequence and the encapsulation are disposed on a carrier,

Diekmann discloses this element. Diekmann discloses that the organic radiation-emitting component with the first electrode 2, organic layer stack 4, second electrode 3 as well as thin-film encapsulation 6 are disposed on a carrier, "substrate 1" as illustrated below:

FIG 2A

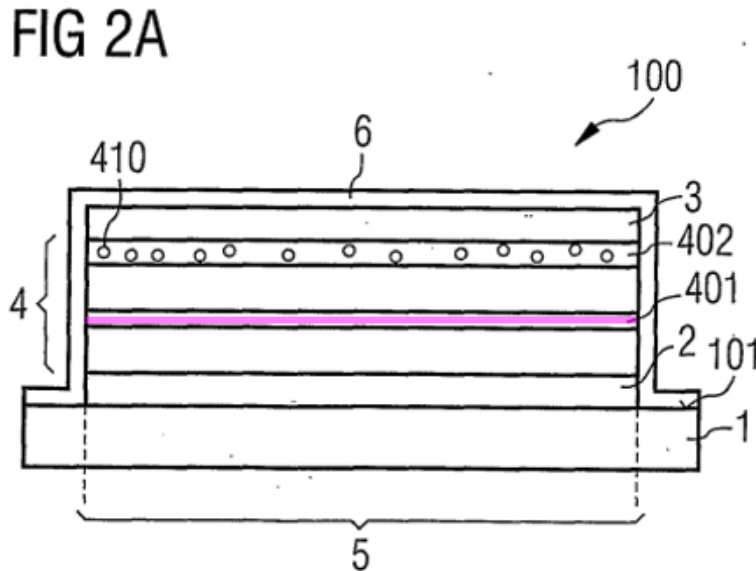


Diekmann, 91, Fig. 2A. Diekmann explains that the “organic layer stack 4...is arranged on the first electrode 2,” which is applied to the substrate 1. Diekmann, 91. The “thin-film encapsulation 6 is applied directly to the second electrode 3,” which is applied to the “organic layer stack 4.” *Id.*, 92. Accordingly, Diekmann discloses the organic layer sequence and the encapsulation being disposed on a carrier. *Id.*, Fig. 2A. Ex.1003, ¶¶239-41.

- vii. **[1F/6F/10F] wherein the organic layer sequence comprises at least one radiation-emitting region configured to generate electromagnetic radiation in a spectral range from infrared radiation to UV radiation during operation,**

Diekmann discloses this element. Diekmann’s organic layer stack 4 of the organic radiation-emitting component (including the first electrode 2, organic layer stack 4, and second electrode 3) includes “at least one layer 401 suitable for generating light” by electron-hole recombination of the active area and thus

containing a radiation-emitting region (e.g., indicated in pink highlighting below) that emits light. Diekmann, 73, 91, 95.



Diekmann, Fig. 2A. Diekmann explains “[t]he electromagnetic radiation generated by the active area of the radiation-emitting component may in particular have a spectrum with wavelengths *in an ultraviolet to infrared spectral range*.” Diekmann, 76; Ex.1017, 1407. Ex.1003, ¶¶242-43.

Diekmann also discloses that the radiation-emitting region of organic layer stack 4 generates “white light” (e.g., “similar to daylight”) in a spectral range from infrared to UV. Diekmann, 91, 122; *id.*, 41, 66. For example, Diekmann explains that its OLED devices emit “white light” to cover such a full spectral range, including visible wavelengths, using a “broadband emitter” and a combination of emitters, as a POSITA would understand. Diekmann, 41. Based on the full spectral range of emission, Diekmann explains using the OLEDs for backlights, multi-

colored devices, or using the white light to provide desired colors. Diekmann, 41, 65-66, 70. Ex.1003, ¶¶245-47.

As explained in §VI.A and §VIII.A.1.vii, in IPR2024-01095, Patent Owner’s expert admitted that “white light” meets the claimed “spectral range from infrared radiation to UV radiation” as taught by Diekmann. Ex.1051, 76:1-14. This is consistent with a POSITA’s understanding based on usage in the art. Suzuki, [0096], [0118], [0264], [0274]-[0279], [0299], [0316]-[0319], [0369]-[0370]. Ex.1003, ¶248.

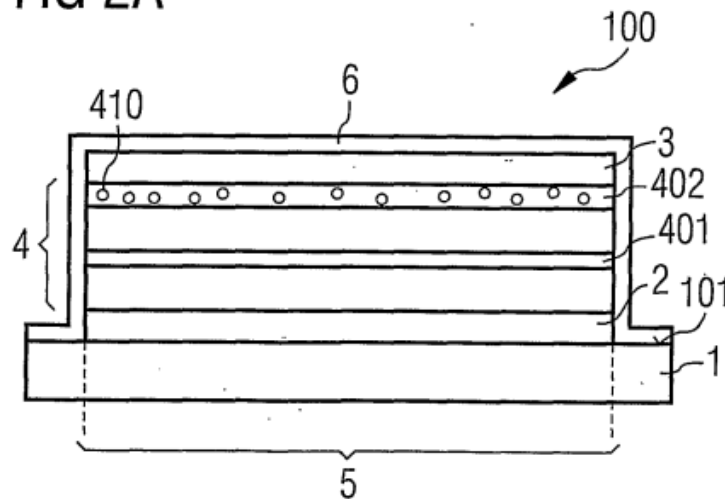
Accordingly, and for the reasons in §VI.A, Diekmann discloses “radiation in a spectral range from infrared radiation to UV radiation” encompassing the full spectrum from infrared-to-UV, and at a minimum, visible light. Ex.1003, ¶¶249-50.

viii. [1G/6G/10G] wherein the organic layer sequence comprises an electron transport layer that is n-doped[; and]

Diekmann discloses or suggests this element. Diekmann discloses that its organic radiation-emitting component includes an organic function layer that is an “electron transport layer[.]” Diekmann, 73. Diekmann discloses that the organic radiation-emitting component with organic layer stack 4 “has a doped layer 402 with a dopant 410.... The dopant 410 can be for example cesium, barium or lithium fluoride.” Diekmann, 91. Doped layer 402 can be “arranged so that it faces the cathode or is adjacent to the cathode.” Diekmann, 10, consistent with where ETLs are located within OLEDs. Ex.1003, ¶251. As shown below, the doped layer 402 is

situated between cathode 3 and radiation-emitting region of layer 401, and is “an n-doped layer.” Diekmann, 10. Diekmann explains that doped layer 402 is doped to “*increase[] the conductivity* of the doped organic layer and...lead[] to better injection of electrons from the cathode into the organic layer stack.” Diekmann, 10, 91. A POSITA would have recognized doped layer 402 to be an ETL which, as explained by the '250 patent, serves the function of “transport[ing] negative charge carriers—electrons—from the...cathode, to the radiation-emitting region.” Ex.1001, 25:1-4; Diekmann, 10, 73.

FIG 2A



Diekmann, 87, 91, Fig. 2A; *id.*, 115-16, 118-19, Fig. 2A. Ex.1003, ¶251.

Moreover, Diekmann discloses exemplary materials for its electron-conducting layer, such as Alq₃, BAlq, and TPBi, that were well-known ETL materials. Diekmann, 5; Ex.1038. The '250 patent itself lists BAlq and TPBi as exemplary ETL materials. Ex.1001, 26:44-55. Ex.1003, ¶252.

Diekmann discloses that its ETL, doped layer 402, is an “n-doped layer” in which “n-dopants are cesium, barium and lithium fluoride.” Diekmann, 10, 91, 119. Thus, a POSITA would understand that doped layer 402 is an n-doped ETL. Ex.1003, ¶253.

Even had Diekmann not expressly disclosed this element, it would have been obvious to include an n-doped ETL in Diekmann’s OLED. A POSITA would have been motivated to include an n-doped ETL to increase conductivity, improve electron transport, and promote electron injection. Diekmann, 10. The advantages of using n-doped ETLs were well-known. Ex. 1024, 1254-1255; Diekmann, 10, 91, 119; Ex.1020; Ex.1021; *see* §VIII.A.1.viii. Doing so was known to result in improved device characteristics, such as lower driving voltage and better power efficiency. Ma, 810. Further, n-doping Diekmann’s ETL would be nothing more than applying a known technique to a known structure to improve it in a similar way. Ex.1003, ¶¶254-55; 35-38. As explained in §VIII.A.1.viii, a POSITA would have reasonably expected success in using n-doped ETLs, as implementing such a feature would have been a straightforward, routine modification to Diekmann’s ETL, as shown in numerous prior art references. Diekmann, 10; Ma, 812-14; Ex.1018; Ex.1020; Ex.1021; Suzuki, [0333]; *see* §VIII.C.1.x. Ex.1003, ¶256.

ix. [1H/6H/10H] wherein the organic layer sequence comprises an emission layer comprising an iridium-containing compound; and

Diekmann discloses this element. Diekmann's organic radiation-emitting component with organic layer stack comprises a layer containing Ir(ppy)₃, a green light-emitting iridium-containing compound. Diekmann explains that "[t]he organic layer stack 4 can, for example, comprise the layers of the organic layer stack of Figure 1," *id.*, 92, which includes "a TMM-004:***Ir(ppy)3***(15%) layer (Irppy = fac-tris(2-phenyl-pyridyl)***iridium complex***)," *id.*, 91. Ex.1003, ¶¶257-58.

x. [1I/10I] wherein the electron transport layer comprises 8-hydroxyquinolinolato-lithium.

Diekmann in view of Ma renders obvious this element. As explained in §VIII.C.1.viii, Diekmann (alone or in combination with Ma) teaches an n-doped ETL. It would have been obvious to a POSITA to use 8-hydroxyquinolinolato-lithium ("Liq") as the dopant in Diekmann's n-doped ETL as taught by Ma. As explained in §VIII.A.1.x, Ma discloses an OLED with an ETL doped with Liq and teaches its benefits. Ma, Abstract, 810-14. Ex.1003, ¶¶259-63.

A POSITA would have been motivated to use an Liq-doped ETL in Diekmann's OLED for the same reasons explained in §VIII.A.1.x. As discussed above, Ma teaches the benefits of Liq-doping. Ma, 810-14. Ma teaches that Liq-doping the ETL can result in increased current density and reduced driving voltage, *id.*, 811-14, and "improve the electron transport ability of the co-deposited layer,"

id., 813. Liq-doped ETLs were known to have these benefits. Ex. 1034, L800, L802; Ex. 1050, 062101-1. Ex.1003, ¶¶260-63. Like Ma, Diekmann contemplates n-doping for “increas[ing] the conductivity” of ETLs and “better injection of electrons,” Diekmann, 10, so a POSITA would have recognized that Liq is an advantageous dopant for Diekmann’s ETL. Ex.1003, ¶¶264, 41.

Doping with large molecules like Liq was known to be beneficial. Diekmann teaches that the n-dopant for its ETL “advantageously increases the conductivity of the doped organic layer” and “preferably has a low diffusion constant within the organic layer stack, as is usually the case with large atoms or molecules.” Diekmann, 10; Ex.1003, ¶¶265-67. Since Liq was known to have good transport and electron injection properties and has a larger molecular weight than Diekmann’s preferred n-dopants (cesium, barium, lithium fluoride), a POSITA would have recognized Liq as an advantageous n-dopant. Diekmann, 10, 91, 119; Ma, 813-14; Suzuki, [0333]; *see* Ex.1051, 187:19-188:7; Ex.1028, 211, 212-14; *compare* Ex.1029 with Ex.1030-Ex.1032. Ex.1003, ¶269.

Further, Liq was known to be more stable when used to n-dope an ETL, compared to Diekmann’s n-dopants, like cesium and barium. Ex.1039, 252; Ex.1003, ¶268. Liq was easier to process than LiF, another example n-dopant. Ex.1039, 253. Liq also has electron transporting properties, while LiF could block electron injection. Ex.1028, 212-13. A POSITA would have expected Liq to have better EL

characteristics (luminance, current density, power efficiency) than LiF as an n-dopant. Ex.1034, L802, Figs. 4-5; Ex.1003, ¶268.

Combining Diekmann and Ma would have merely amounted to applying a known technique (Ma's Liq-doping the ETL) to improve similar OLEDs (Diekmann's devices with n-doped ETLs) in the same way. Ex.1003, ¶270. Diekmann recognizes that it was desirable to use an n-doped ETL as in Ma. Diekmann, 10; Ma, 810-14. The prior art has examples of n-doped ETLs in OLEDs with an emissive layer including an iridium-containing compound (Ir(ppy)_3), based on the same type of ETL and emissive layer taught by Ma and Diekmann, respectively. Ex.1003, ¶270. It was well-known that n-doping the ETL would lead to improved OLED performance. *Id.*; Ma, 813-14; Diekmann, 10, 91, 119; Ex.1051, 187:19-188:7. Liq was an art-recognized n-dopant for the ETL, known for facilitating electron transport and injection, and interchangeable with other n-dopants. Ma, 813; Ex.1034, L800. Ex.1003, ¶¶46-48, 270, 49-52.

A POSITA would have reasonably expected success in using an Liq-doped ETL in Diekmann, particularly as Diekmann already contemplates an n-doped ETL, and for the same reasons in §VIII.A.1.x. Diekmann, 10. Using an Liq-doped ETL merely involves using a different dopant, which would have been a routine matter within a POSITA's ability. Ex.1003, ¶¶49-52, 271. Particularly so because Diekmann has blocking layers to address potential dopant diffusion. Ex.1003, ¶¶272,

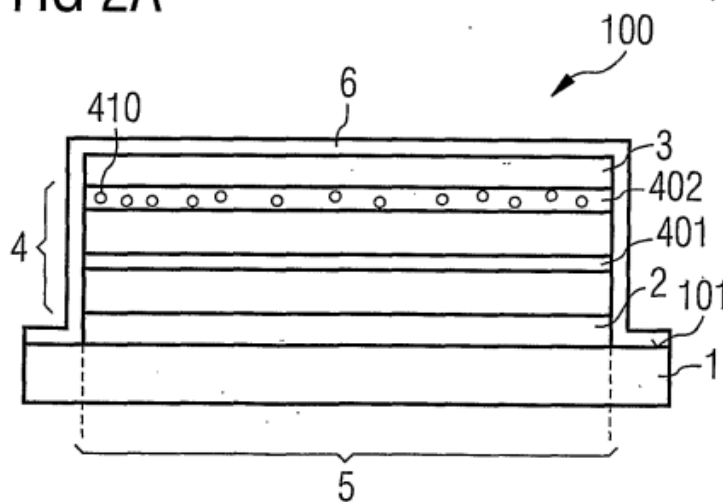
42-43, 37. Further, Liq's mechanism for improving electron injection is analogous to LiF's (one of Diekmann's preferred n-dopants), supporting interchangeability. Ex.1003, ¶271. As explained above, it was well-known that elements in Ma's devices were applicable to the type of OLED devices disclosed in Diekmann. Ex.1018, Abstract, 5773-76 (n-doping BPhen ETL (like in Ma) in OLED with Ir(ppy)₃ in emissive layer (like in Diekmann)); *see* Ma, 810-14; Diekmann, 91-92. Conductivity-doped phosphorescent OLEDs were well-known, and a POSITA would have reasonably expected success in using Liq-doped ETL in Diekmann's Ir-based OLED devices. Ex.1003, ¶¶270-74.

A POSITA would have reasonably expected success in applying the same known dopant to different ETL materials (and vice versa) in different OLEDs, for the reasons discussed in §VIII.A.1.x. Ex.1003, ¶275. It was well-known that applying Liq as a dopant to ETL materials such as BPhen (Ma's ETL) and Alq₃ (Diekmann's ETL) improved OLED performance. Ma, 810-14; Diekmann, 5; Ex.1034, L800-802. It was within a POSITA's skill to determine appropriate materials and doping concentrations. Ex.1003, ¶¶276-77. A POSITA would have applied teachings concerning electron and hole transport layers from fluorescent OLEDs (Ma) to phosphorescent OLEDs (Diekmann) with a reasonable expectation of success, as explained in §VIII.A.1.x. Ex.1003, ¶¶278-79.

- xi. [6J/10J] wherein the organic light-emitting layer sequence comprises a cathode having a thickness of at least 1 nm and at most 50 nm;

Diekmann discloses or suggests this element. For example, Diekmann's OLEDs comprise an organic light-emitting layer sequence that includes a "second electrode 3" serving as the cathode:

FIG 2A



Diekmann, 91, Fig. 2A. Diekmann describes the cathode as a "metallic layer that contains...silver and has a *thickness of approximately 30 nm.*" *Id.*, 92. Diekmann explains that "[t]he second electrode 3 is also transparent to visible light, in particular to light generated by the organic layer stack 4." Diekmann, 92; *id.*, 8 ("[T]o be permeable to the light emitted by the organic layer stack, the metallic layer must be sufficiently thin."); Ex.1003, ¶¶280-81.

Diekmann's cathode thickness of about 30 nm for a transparent or semi-transparent cathode is within the claimed range. The '250 patent does not disclose

any part of its claimed range as critical to the claimed invention; it merely describes the 1-50 nm range as an example thickness for a transparent metal layer. Ex.1001, 3:8-11. While Diekmann mentions the thickness can generally be between 1 nm and 100 nm, Diekmann specifically discloses a cathode thickness of about 30 nm, which is transparent or semi-transparent. Diekmann, 92. Accordingly, Diekmann discloses cathode thicknesses anticipating (by being within and overlapping with) the claimed 1-50 nm range. Ex.1003, ¶¶281-83.

Even had Diekmann not disclosed this element, it would have been obvious to use a cathode thickness in the 1-50 nm range in Diekmann's OLEDs. Diekmann teaches the benefits of using a transparent electrode to improve luminance, specifically a transparent or semi-transparent cathode that is about 30 nm. Diekmann, 8, 92. As explained in §VIII.A.1.xi, it was well-known that using a cathode thickness in the 1-50 nm range to be transparent or semi-transparent would improve emitted-light transmission. Suzuki, [0289]; Ex.1023, 29. A POSITA would have been motivated to use a cathode thickness between 1-50 nm in Diekmann to achieve improved light output, and would have reasonably expected success in applying a 1-50 nm thick cathode because such a cathode (e.g., made of magnesium, silver, or Mg/Ag alloy) was well-known to improve luminescence due to its transparency. Diekmann, 92; Suzuki, [0288]-[0290]; Ex.1023, 29. Ex.1003, ¶¶26, 284.

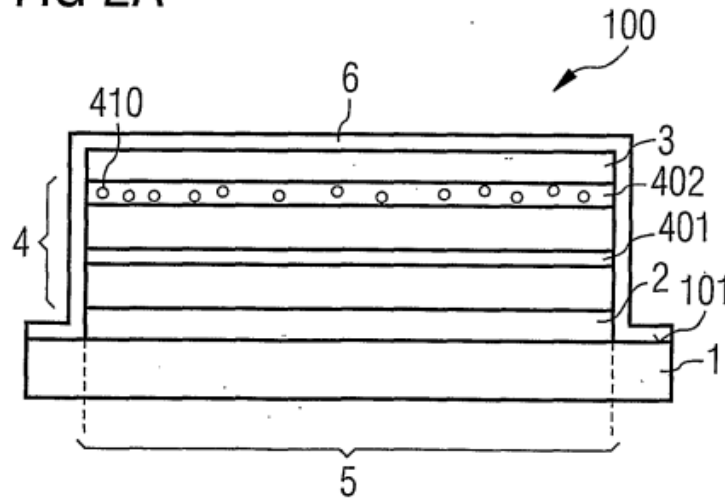
xii. [10K] wherein the cathode comprises one of: Silver, Magnesium, or an alloy comprising Silver and Magnesium; and

Diekmann discloses this element. Diekmann describes the cathode is “metallic layer that contains...silver.” Diekmann, 91-92; *id.*, 3-4. Diekmann explains that “compounds, combinations and alloys” of silver and magnesium “can prove to be advantageous as cathode material,” allowing the cathode to be transparent for a “top emitter” OLED. Diekmann, 75. Ex.1003, ¶¶285-87.

xiii. [10L] wherein the cathode is in direct contact with a Lithium containing layer.

Diekmann/Ma combination satisfies this element. As explained in §VIII.C.x, it would have been obvious to use Liq in Diekmann’s n-doped ETL (organic layer 402) as taught by Ma. In this Diekmann/Ma system, the cathode is in direct contact with a Li containing layer—organic layer 402 containing Liq—as Diekmann describes that the cathode is in direct contact with organic layer 402 containing dopant 410, for example, as shown below:

FIG 2A



Diekmann, Fig. 2A; *id.*, 10, 91. Ex.1003, ¶¶288-89.

2. Claim 2

- i. [2A] The device of claim 1, wherein at least one part of the encapsulation is formed by an insulation layer, and

Diekmann discloses this element. As discussed above, Diekmann discloses a thin-film encapsulation 6, illustrated below.

FIG 3

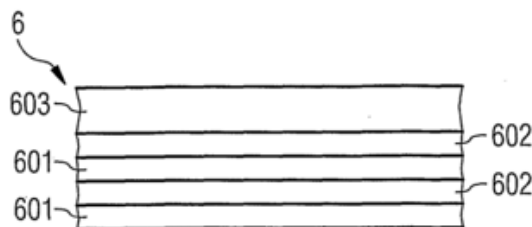
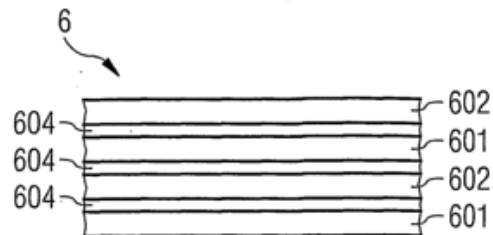


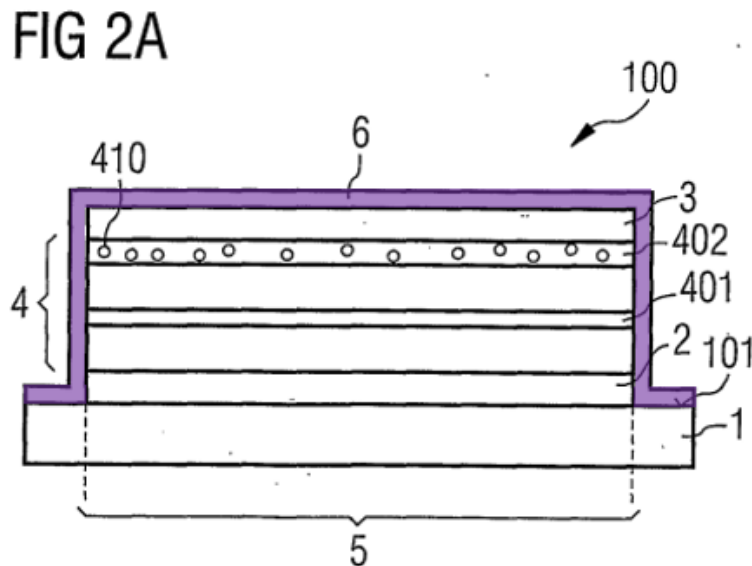
FIG 17A



Diekmann, 94, 109, Figs. 3, 17A. Diekmann explains “the thin-film encapsulation 6 comprises two first barrier layers 601, which comprise silicon oxide or consist of silicon oxide, and two second barrier layers 602, which comprise silicon nitride or

consist of silicon nitride.” *Id.*, 94. Silicon oxide and silicon nitride are insulating materials. Moreover, a POSITA would have understood that Diekmann’s encapsulation layers electrically insulate the cathode and anode from each other, for instance, as depicted below, or otherwise the sides of the electrodes would be short-circuited. Thus, Diekmann’s encapsulation is formed by an insulation layer.

Ex.1003, ¶¶290-91.



Diekmann, Fig. 2A.

- ii. **[2B] wherein the insulation layer comprises at least one of: resin, silicon oxide, or silicon nitride.**

Diekmann discloses this element. As discussed above, Diekmann’s thin-film encapsulation 6 includes barrier layers 601 and 602, which are insulation layers comprising silicon oxide or silicon nitride. Diekmann, 94. Ex.1003, ¶¶292-93.

3. Claim 4: The device according to claim 1, wherein the organic light-emitting diode comprises a hole transport layer that is p-doped.

Diekmann discloses this element, or suggests it alone or in combination with Ma. Diekmann's organic layer sequence comprises an HTL that is p-doped. Diekmann explains that "[t]he organic layer stack 4 can, for example, comprise the layers of the organic layer stack of Figure 1," Diekmann, 92, which includes "a 1-TNATA layer" and "a sp-TAD layer," *id.*, 4-5. Diekmann discloses that these materials are used in "hole-conducting" layers. Diekmann, 4-5. Indeed, the materials taught by Diekmann are well-known to transport holes from the anode to the emissive layer. *See* Ex.1018; Ex.1020. A POSITA would thus have understood that Diekmann's hole-conducting layer is an HTL. Ex.1003, ¶294.

Diekmann discloses that this HTL is p-doped. Diekmann teaches that "the organic layer stack comprises a doped organic layer with a dopant" whose layer may be an "outermost layer of the organic layer stack" such that it "forms a common interface with the respective electrode facing it." Diekmann, 10. The p-doped organic layer is "arranged so that it faces the anode or is adjacent to it." *Id.* Diekmann therefore discloses a p-doped HTL within its organic layer stack. Ex.1003, ¶295.

Even were p-doping not expressly disclosed, it would have been obvious to dope Diekmann's HTLs adjacent to the anode with p-dopants as taught by Diekmann and Ma. It was well-known that using a p-doped HTL was beneficial because it

allows the capability to improve current and power efficiencies of OLEDs. Ma, 810. Indeed, Diekmann specifically teaches that doing so allows “better hole injection from the anode into the organic layer stack.” Diekmann, 10. A POSITA would have recognized that it would have been beneficial to use a p-doped HTL with an n-doped ETL as discussed in §VIII.A.3. A POSITA would understand, as taught by Ma, that an OLED including an p-doped HTL and n-doped ETL provides substantial flexibility to tune electron/hole currents to optimize charge balance, benefiting efficiency and lifetime. *See* §VIII.A.3; Ex.1018, Abstract; Ex.1021, 5-14. Ex.1003, ¶¶296-98.

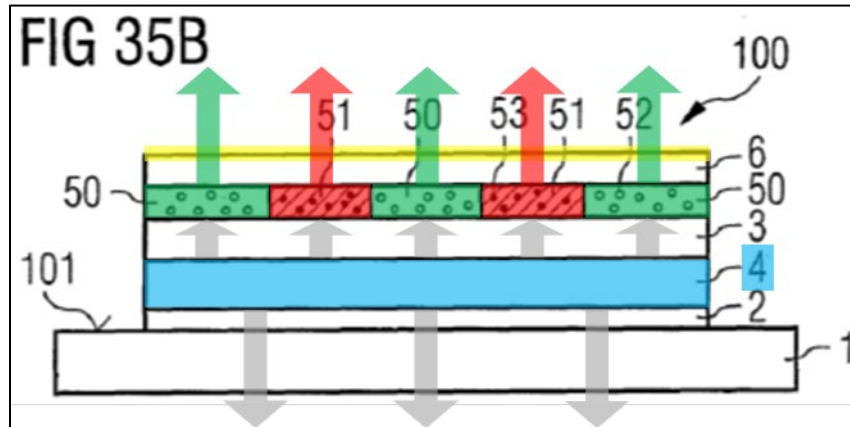
A POSITA would have reasonably expected success in using a p-doped HTL together with an n-doped ETL in Diekmann’s OLED. Diekmann already contemplates both an n-doped ETL and a p-doped HTL. Further, “*p-i-n*” OLEDs using both n-doped and p-doped transport layers were well-known by the time of the ’250 patent and adding a p-dopant to an HTL would have been a routine matter within a POSITA’s ability. *See* Ex.1018; Ex.1021. Ex.1003, ¶¶299-300.

4. Claim 5

- i. [5A] The device according to claim 1, wherein a color filter is arranged between the emission layer and the radiation exit area, and**

Diekmann discloses this element. Diekmann discloses that its OLEDs include a color filter layer to form colored subregions and a “multicolored” output.

Diekmann, 36-38, 40-41, 128-130. For example, Figure 35B below shows the color filters are arranged between the emission layer (within organic layer stack 4) and radiation exit area:



Diekmann, Fig. 35B, 40, 129, 130 (explaining “at least a majority of the electromagnetic radiation generated in the organic layer stack 4 during operation passes through this [color filter] layer”). Ex.1003, ¶¶301-03.

- ii. **[5B] wherein the color filter is configured to be highly transmissive for a first spectral subrange of the generated electromagnetic radiation and highly absorbent for a second spectral subrange of the generated electromagnetic radiation.**

Diekmann discloses this element. Diekmann discloses that a “first color sub-region emits light of a first color” and a “second color sub-region emits light of a [different] second color.” Diekmann, 41; *see id.*, 129-130. Diekmann explains that each “color filter is suitable for filtering light of a specific wavelength range. This means that light of this wavelength range is at least partially absorbed by the color filter. In this way, a first color component can be filtered out of white light, for

example, while a second color component can pass through the color filter essentially unhindered.” *Id.*, 40. A POSITA would have understood Diekmann’s explanation to mean the color filter is highly transmissive for light wavelengths matching the color of the filter, while the filter is highly absorbent for other wavelengths. Diekmann, 40. Thus, a POSITA would have understood that Diekmann discloses color filters that satisfy this element. Ex.1003, ¶304.

5. **Claim 7: The device according to claim 6, wherein the cathode comprises one of: Silver, Magnesium, or an alloy comprising Silver and Magnesium.**

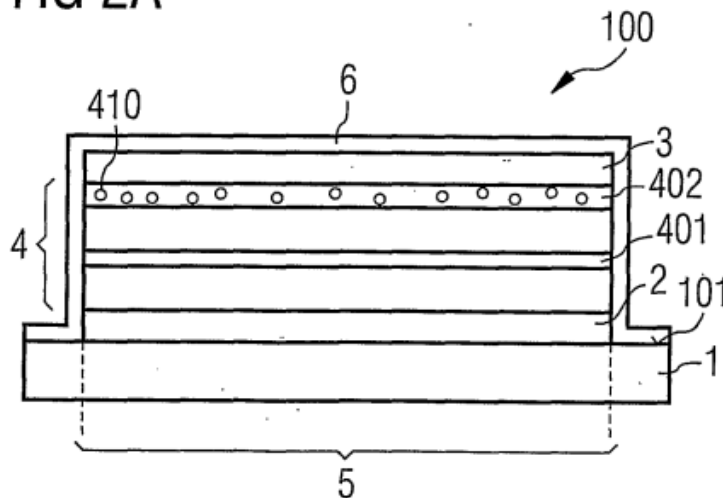
See §VIII.C.1.xii [10K]. Ex.1003, ¶305.

6. **Claim 8: The device according to claim 6, wherein the cathode is in direct contact with a Lithium containing layer.**

Diekmann (alone or modified by Ma) satisfies this element. Ex.1003, ¶¶306-08.

First, Diekmann discloses this element. Diekmann describes that the cathode is in direct contact with organic layer 402 containing dopant 410, for example, as shown below:

FIG 2A



Diekmann, 91, Fig. 2A. Diekmann explains “doped layer 402 with a dopant 410” is on the “outer side” of the organic layer stack “facing the cathode,” and “[t]he dopant 410 can be...lithium fluoride.” *Id.* Diekmann discloses that the doped organic layer “preferably forms a common interface with the respective electrode facing it.” *Id.*, 10. Ex.1003, ¶307.

Second, Diekmann/Ma combination satisfies this element for the reasons in §VIII.C.1.xiii [10L]. Ex.1003, ¶308.

7. Claim 9: The device according to claim 6, wherein the [ETL] comprises 8-hydroxyquinolinolato-lithium.

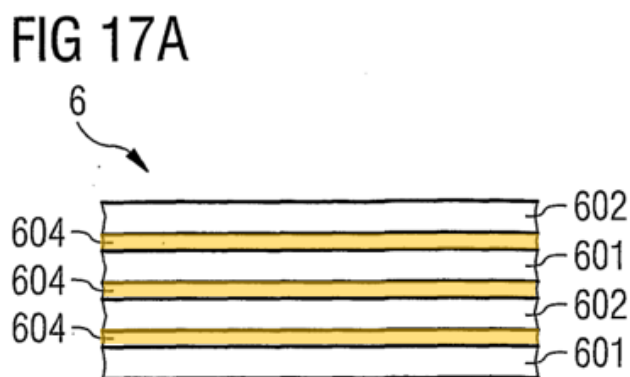
See §VIII.C.1.x [11/10I]. Ex.1003, ¶309.

D. Grounds 7-8: Diekmann, Ma, and Lee Render Obvious Claims 3, 12, and 15-16 (Ground 7); Diekmann and Lee Render Obvious Claims 11 and 13-15 (Ground 8)

1. Claim 3

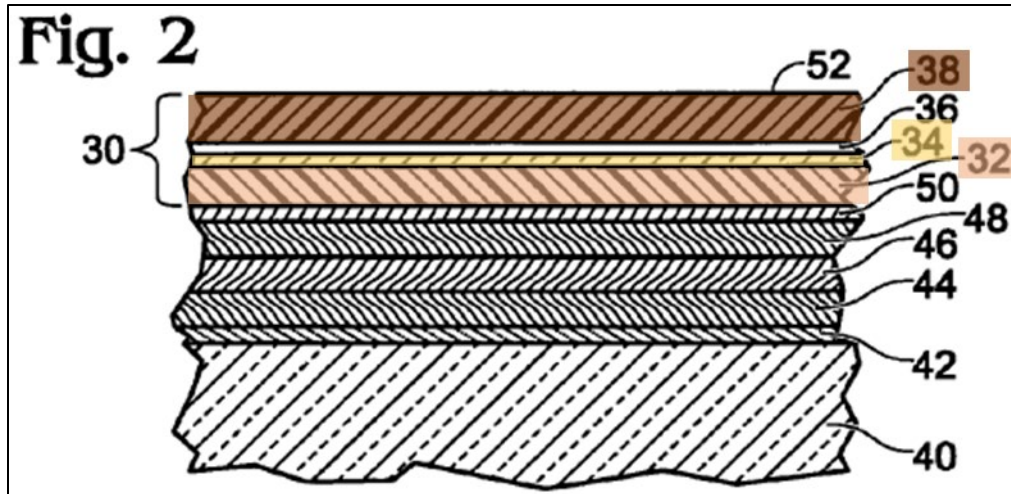
- i. [3A] The device of claim 1, wherein the encapsulation comprises a first encapsulation layer and a second encapsulation layer,

It would have been obvious to modify Diekmann (alone or combined with Ma) in view of Lee, and the modified OLED satisfies this element. As explained above, *see* §VIII.C.2, Diekmann discloses a “thin-film encapsulation 6” that includes barrier layers separated by intermediate polymer layers 604 (colored orange) as shown below:



Diekmann, 94, 109, Fig. 17A. Ex.1003, ¶¶310-11.

As explained in §VIII.B.1.i, Lee teaches improving encapsulation for OLEDs by using a first encapsulation layer (“second semi-crystalline parylene-based polymer layer 38”) and a second encapsulation layer (“first semi-crystalline parylene-based polymer layer 32”) as illustrated below.



Lee, Fig. 2, [0021]-[0022]. Lee explains that its encapsulation improves the sealing performance over the structures taught by Diekmann (Lee, [0007]-[0008], [0020], [0031], [0034]), and thus it would have been obvious to apply Lee's technique, for example, by replacing Diekmann's encapsulation with Lee's multi-layered encapsulation. As another example, it would have been obvious to replace Diekmann's intermediate polymer layers 604 with Lee's first and second encapsulation layers. Ex.1003, ¶¶312-13.

A POSITA would have been motivated to use Lee's encapsulation with Diekmann's OLEDs to improve the encapsulation for the reasons explained in §VIII.B.1.i (explaining Lee's benefits). Lee notes that its technique provides "a significantly improved lifetime compared to prior OLEDs having polyacrylate or amorphous parylene barrier layers." Lee, [0020]. Diekmann's intermediate polymer layers are "vapor-deposited as monomers and...cross-linked using UV radiation," Diekmann, 15, which is the precise prior art structure that Lee's encapsulation is

intended to improve upon. Lee, [0008]. A POSITA would have been motivated to incorporate Lee's encapsulation with "low-enough WVTR and OTR values" and "significantly improved lifetime compared to prior OLEDs" with polymer-based barriers. Ex.1003, ¶¶314-15.

A POSITA would have reasonably expected success in applying Lee to Diekmann's OLEDs, alone or as modified by Ma. Diekmann contemplates an encapsulation with alternating layers of inorganic barrier layers and polymer interlayers. Applying Lee merely replaces one set of alternating layers with another, to obtain the benefits taught in Lee, within a POSITA's ability as taught by Lee. The use of such a multilayer OLED encapsulation was well-known to be operable, as explained in §VIII.B.1.i. Applying Lee's technique would have merely involved routine optimization; Lee teaches methods to implement its technique. Ex.1003, ¶¶316-18.

ii. [3B] the first and the second encapsulation layer each having a respective volume structure,

Diekmann (alone or combined with Ma) as modified by Lee renders obvious this element. *See* §IV.B and §VIII.D.1.i. Lee teaches encapsulation layers having respective, independent volume structures. Lee, [0023]; *see* §VIII.B.1.ii. Ex.1003, ¶¶319-22.

- iii. **[3C] wherein the volume structure of the second encapsulation layer is independent of the volume structure of the first encapsulation layer, and**

Diekmann (alone or combined with Ma) as modified by Lee renders obvious this element. *See* §VIII.D.1.i-ii. Lee discloses a first and second encapsulation layer with volume structures which are distinct and independent from one another. Lee, [0023], [0037]; *see* §VIII.B.1.iii. Ex.1003, ¶¶323-24.

- iv. **[3D] the volume structure of the second encapsulation layer has a higher amorphicity than the volume structure of the first encapsulation layer.**

Diekmann (alone or combined with Ma) as modified by Lee renders obvious this element. *See* §VIII.D.1.i-iii. Lee discloses a second encapsulation layer that has a higher amorphicity than the first encapsulation layer. Lee, [0023]; *see* §VIII.B.1.iv. Ex.1003, ¶¶325-26.

2. Independent Claims 11 and 16

- i. **[11Pre/16Pre] A device comprising:**

See §VIII.C.1.i [1Pre/6Pre/10Pre]. Ex.1003, ¶327.

- ii. **[11A/16A] an organic light-emitting diode comprising:**

See §VIII.C.1.ii [1A/6A/10A]. Ex.1003, ¶328.

- iii. **[11B/16B] an organic layer sequence,**

See §VIII.C.1.iii [1B/6B/10B]. Ex.1003, ¶329.

- iv. **[11C/16C] a radiation exit area, and**

See §VIII.C.1.iv [1C/6C/10C]. Ex.1003, ¶330.

v. [11D/16D] an encapsulation,

Diekmann (alone or modified by Ma) in combination with Lee satisfies this element for the reasons in §VIII.D.1 [Claim 3]. Ex.1003, ¶331.

vi. [11E/16E] wherein the organic layer sequence and the encapsulation are disposed on a carrier,

Diekmann (alone or modified by Ma) in combination with Lee satisfies this element because the modified encapsulation is disposed on Diekmann's substrate for the same reasons in §VIII.C.1.vi [1E/6E/10E]. Ex.1003, ¶332.

vii. [11F/16F] wherein the organic layer sequence comprises at least one radiation-emitting region configured to generate electromagnetic radiation in a spectral range from infrared radiation to UV radiation during operation,

See §VIII.C.1.vii [1F/6F/10F]. Ex.1003, ¶333.

viii. [11G/16G] wherein the organic layer sequence comprises an [ETL] that is n-doped;

Diekmann/Lee combination satisfies this element for the reasons in §VIII.C.1.viii [1G/6G/10G]. Ex.1003, ¶334.

ix. [11H/16H] wherein the organic layer sequence comprises an emission layer comprising an iridium-containing compound;

See §VIII.C.1.ix [1H/6H/10H]. Ex.1003, ¶335.

- x. **[16I] wherein the [ETL] comprises 8-hydroxyquinolinolato-lithium;**

It would have been obvious to modify the Diekmann/Lee OLED in view of Ma, and the modified OLED satisfies this element, for the reasons in §VIII.C.1.x [1I/10I]. Ex.1003, ¶336.

- xi. **[11J/16J] wherein at least one part of the encapsulation is formed by an insulation layer, the insulation layer comprising at least one of: resin, silicon oxide, silicon nitride; [and]**

Diekmann discloses this element. *See* §VIII.C.2 [Claim 2]. Moreover, Lee discloses its encapsulation includes inorganic barrier layer 34 formed by insulating materials SiO_x or Si_xN_y. Lee, [0022], [0031]-[0032]. Accordingly, the encapsulation of Diekmann/Lee combination (by itself or modified by Ma) includes an insulation layer that satisfies this element. *See* §VIII.D.1. Ex.1003, ¶¶337-38.

- xii. **[11K/16K] wherein the encapsulation comprises a first encapsulation layer and a second encapsulation layer,**

See §VIII.D.1.i [3A]. Ex.1003, ¶339.

- xiii. **[11L/16L] the first and the second encapsulation layer each having a respective volume structure,**

See §VIII.D.1.ii [3B]. Ex.1003, ¶340.

- xiv. **[11M/16M] wherein the volume structure of the second encapsulation layer is independent of the volume structure of the first encapsulation layer, [and]**

See §VIII.D.1.iii [3C]. Ex.1003, ¶341.

- xv. **[11N/16N] the volume structure of the second encapsulation layer has a higher amorphicity than the volume structure of the first encapsulation layer.**

See §VIII.D.1.iv [3D]. Ex.1003, ¶342.

- xvi. **[16O] wherein the organic light-emitting layer sequence comprises a cathode having a thickness of at least 1 nm and at most 50 nm;**

See §VIII.C.1.xi [6J/10J]. Ex.1003, ¶343.

- xvii. **[16P] wherein the cathode comprises one of: Silver, Magnesium, or an alloy comprising Silver and Magnesium; and**

See §VIII.C.1.xii [10K]. Ex.1003, ¶344.

- xviii. **[16Q] wherein the cathode is in direct contact with a Lithium containing layer.**

Diekmann/Lee combination as modified by Ma satisfies this element for the reasons in §VIII.C.1.xiii [10L]. Ex.1003, ¶345.

3. **Claim 12: The device of claim 11, wherein the [ETL] comprises 8-hydroxyquinolinolato-lithium.**

See §VIII.D.2.x [16I]; §VIII.C.1.x [1I/10I]. Ex.1003, ¶346.

4. **Claim 13: The device of claim 11, wherein the organic light-emitting layer sequence comprises a cathode having a thickness of at least 1 nm and at most 50 nm.**

See §VIII.C.1.xi [6J/10J]. Ex.1003, ¶347.

5. **Claim 14: The device of claim 13, wherein the cathode comprises one of: Silver, Magnesium, or an alloy comprising Silver and Magnesium.**

See §VIII.C.1.xii [10K]. Ex.1003, ¶348.

6. Claim 15: The device of claim 13, wherein the cathode is in direct contact with a Lithium containing layer.

Suzuki discloses this element, or in combination with Ma renders obvious this element, for the reasons in §VIII.C.6 [Claim 8] and §VIII.C.1.xiii [10L]. Ex.1003, ¶349.

IX. Conclusion

Petitioner requests cancellation of all claims of the '250 patent.

Date: November 18, 2025

Respectfully submitted,

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CERTIFICATION UNDER 37 C.F.R. §42.24(D)

I certify that the foregoing complies with the type-volume limitation of 37 C.F.R. §42.24 and contains 13,895 words based on the word count indicated by the word-processing system used to prepare the paper, and excluding those portions exempted by §42.24(a).

Date: November 18, 2025

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CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. §§42.6 and 42.105, I hereby certify that on November 18, 2025, I caused a true and correct copy of the foregoing Petition for *Inter Partes* Review of U.S. Patent No. 12,158,250, supporting exhibits, and Power of Attorney to be served via FedEx Priority Overnight, a means at least as fast and reliable as Priority Mail Express®, on the following correspondence address of record for patent owner:

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