

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. IPR2024-01095
Patent No. 11,828,425

**PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO.
11,828,425 UNDER 35 U.S.C. §§ 311-319 AND 37 C.F.R. § 42.100 *et seq.***

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TABLE OF EXHIBITS

Exhibit No.	Description
1001	U.S. Patent No. 11,828,425
1002	File History for U.S. Patent No. 11,828,425
1003	Declaration of Dr. Russell J. Holmes
1004	Certified Translation of International Patent Application Publication No. WO 2008/040323 A2 (“Diekmann”)
1005	International Patent Application Publication No. WO 2008/040323 A2 (“Diekmann”)
1006	Certified Translation of Japanese Patent Application Publication No. JP 2007-277631 A (“Suzuki”)
1007	Japanese Patent Application Publication No. JP 2007-277631 A (“Suzuki”)
1008	U.S. Patent Application Publication No. 2005/0146267 (“Lee”)
1009	U.S. Patent Application Publication No. 2006/0214892 (“Harada”)
1010	J.W. Ma et al., <i>Organic light-emitting diodes based on new n-doped electron transport layer</i> , Synthetic Metals 158 (2008) (“Ma”)
1011	U.S. Patent Application Publication No. 2003/0159910 (“Caldwell”)
1012	U.S. Patent Application Publication No. 2008/0211395 (“Koshihara”)
1013	M. A. Baldo et al., <i>Highly efficient phosphorescent emission from organic electroluminescent devices</i> , 395 Nature 151 (1998).
1014	M. A. Baldo et al., <i>Very high-efficiency green organic light-emitting devices based on electrophosphorescence</i> 75 Appl. Phys. Lett. 4–6 (1999)
1015	Chihaya 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)
1016	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)

Exhibit No.	Description
1017	L. S. Hung et al., <i>Enhanced electron injection in organic electroluminescence devices using an Al/LiF electrode</i> , 70 Appl. Phys. Lett., 152–154 (1997)
1018	Zugang Liu et al., <i>Improved electron injection in organic LED with lithium quinolate/aluminium cathode</i> , 128 Synthetic Metals 211–214 (2002)
1019	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”).
1020	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)
1021	Anna B. Chwang et al., <i>Thin film encapsulated flexible organic electroluminescent displays</i> , 83 Appl. Phys. Lett. 413–415 (2003)
1022	V. Bulovic et al., <i>Transparent light-emitting devices</i> , 29 Nature 380 (1996)
1023	INTENTIONALLY LEFT BLANK
1024	U.S. Patent No. 6,879,319 (“Cok”)
1025	File History for U.S. Patent Application No. 13/139,514
1026	File History for U.S. Patent Application No. 15/651,508
1027	File History for U.S. Patent Application No. 16/790,198
1028	U.S. Patent Application Publication No. 2011/0260201 (“Klein”)
1029	Harald Gross et al., <i>High Power Efficiencies at Record Lifetimes: NOVALED’S PIN-OLEDs</i> , FPD Yokohama 2005
1030	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)
1031	A. G. Werner et al., <i>Pyronin B as a donor for n-type doping of organic thin films</i> , 82 Appl. Phys. Lett. 4495–4497 (2003)
1032	U.S. Patent No. 5,594,469 (“Freeman”)
1033	M. H. Lu et al., <i>High-efficiency top-emitting organic light-emitting devices</i> , 81 Appl. Phys. Lett. 3921–3923 (2002)

Exhibit No.	Description
1034	First Amended Complaint, <i>Pictiva Displays International Ltd. v. Samsung Electronics Co., Ltd., et al.</i> , Case No. 2:23-cv-00495, Dkt. #17 (E.D. Tex. Mar. 1, 2024)
1035	Docket Control Order, <i>Pictiva Displays International Ltd. v. Samsung Electronics Co., Ltd., et al.</i> , Case No. 2:23-cv-00495, Dkt. #40 (E.D. Tex. Apr. 17, 2024)

I. INTRODUCTION

Samsung Display Co., Ltd. (“Petitioner”) petitions for *inter partes* review (“IPR”) seeking cancellation of claims 1-19 (the “Challenged Claims”) of U.S. Patent No. 11,828,425 (Ex.1001, “the ’425 patent”), assigned to Pictiva Displays International Ltd.

The ’425 patent relates to a device comprising an “organic light-emitting diode” (OLED) which includes an organic layer sequence comprising an n-doped electron transport layer and an emission layer comprising an iridium-containing compound. The OLED is disposed on a substrate and sealed by an encapsulation, and the light generated by the OLED exits through a “radiation exit area.” ’425 patent, 1:28-38, 24:37-62.

This OLED structure was not novel. *See, e.g.*, Ex.1003, ¶¶23-44, 90-253. Rather, it was specifically disclosed by the prior art Diekmann reference (Ex.1004), as the examiner of the ’425 patent’s great-grandparent application determined. Claims in that application were granted when the applicant added detailed limitations related to the encapsulation that are not in the ’425 patent’s claims. The ’425 patent’s application was assigned to a different examiner, who did not address Diekmann, even though the ’425 patent claims only a generic encapsulation.

Diekmann thus anticipates most of the claims in the ’425 patent. As does another reference—Suzuki (Ex.1006)—that was not considered during the

prosecution of the '425 patent. The remaining challenged claims add features known to be useful in OLEDs and thus are unpatentable for obviousness. The challenged claims should be canceled. *See* Ex.1003, ¶¶23-255.

II. STANDING, MANDATORY NOTICES AND FEE AUTHORIZATION

Grounds for Standing: Pursuant to 37 C.F.R. § 42.104(a), Petitioner certifies that the '425 patent is available for IPR and that Petitioner is not barred or estopped from requesting an IPR challenging the '425 patent on the grounds identified in this petition.

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

Related Matters: Patent Owner has asserted the '425 patent in litigation against Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. in *Pictiva Displays International Ltd. v. Samsung Electronics Co., Ltd.*, Case No. 2:23-cv-00495 (E.D. Tex.).

Lead and Back-Up Counsel: Petitioner designates Scott C. Weidenfeller (Reg. No. 54,531, sweidenfeller@cov.com) as lead counsel, of Covington & Burling LLP, One CityCenter, 850 Tenth Street, NW, Washington, DC 20001 (postal and hand delivery), telephone: (202) 662-6000, facsimile: (202) 662-6291.

Petitioner designates David A. Garr (Reg. No. 74,932, dgarr@cov.com) as back-up counsel, of Covington & Burling 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 of all documents via electronic mail at SDC-Pictiva-IPR@cov.com.

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

III. SUMMARY OF CHALLENGE

Petitioner requests IPR of claims 1-19 of the '425 patent based on the following grounds:

- ***Ground I:*** Claims 1, 3, 5-8, 13-16, 18-19 are anticipated by and obvious over Diekmann
- ***Ground II:*** Claims 2, 17 are obvious over Diekmann in view of Ma
- ***Ground III:*** Claim 4 is obvious over Diekmann in view of Lee
- ***Ground IV:*** Claims 9-11 are obvious over Diekmann in view of Koshihara
- ***Ground V:*** Claim 12 is obvious over Diekmann in view of Harada

- **Ground VI:** Claims 1, 3, 5-8, 13-16, 18-19 are anticipated by and obvious over Suzuki
- **Ground VII:** Claims 2, 17 are obvious over Suzuki in view of Ma
- **Ground VIII:** Claim 4 is obvious over Suzuki in view of Lee
- **Ground IX:** Claims 9-11 are obvious over Suzuki in view of Caldwell
- **Ground X:** Claim 12 is obvious over Suzuki in view of Harada

The '425 patent was filed on January 18, 2023, claims the benefit of an international application filed on December 9, 2009, and claims priority to a foreign application filed on December 11, 2008. Petitioner's challenge is based on the following references, which are available as prior art under 35 U.S.C. § 102 (pre-AIA)¹ as shown in the following table:

Exhibit	Reference	Date(s)	Availability as Prior Art
Ex.1005 (Diekmann)	International Patent Application Publication No. WO 2008/040323 A2 (certified translation provided as Ex.1004)	Filed Sep. 26, 2007 Published Apr. 10, 2008	§§ 102(a), 102(b)

¹ Because the application for the '425 patent was filed prior to March 16, 2013, the pre-AIA conditions for patentability apply.

Exhibit	Reference	Date(s)	Availability as Prior Art
Ex.1007 (Suzuki)	Japanese Patent Application Publication No. JP 2007-277631 A (certified translation provided as Ex.1006)	Published Oct. 25, 2007	§§ 102(a), 102(b)
Ex.1010 (Ma)	Ma, J. W., et al. “Organic light-emitting diodes based on new n-doped electron transport layer.” 158 <i>Synthetic Metals</i> 810-814 158.21-24 (2008): 810-814.	Published Aug. 29, 2008	§§ 102(a), 102(b)
Ex.1008 (Lee)	United States Patent Application Publication No. US 2005/0146267 A1	Filed Dec. 8, 2004 Published Jul. 7, 2005	§§ 102(a), 102(b), 102(e)
Ex.1012 (Koshihara)	United States Patent Application Publication No. US 2008/0211395 A1	Filed Feb. 12, 2008 Published Sep. 4, 2008	§§ 102(a), 102(b), 102(e)
Ex.1009 (Harada)	United States Patent Application Publication No. US 2006/0214892 A1	Filed Mar. 24, 2006 Published Sep. 28, 2006	§§ 102(a), 102(b), 102(e)
Ex.1011 (Caldwell)	United States Patent Application Publication No. US 2003/0159910 A1	Filed Oct. 15, 2002 Published Aug. 28, 2003	§§ 102(a), 102(b), 102(e)

IV. OVERVIEW OF THE '425 PATENT

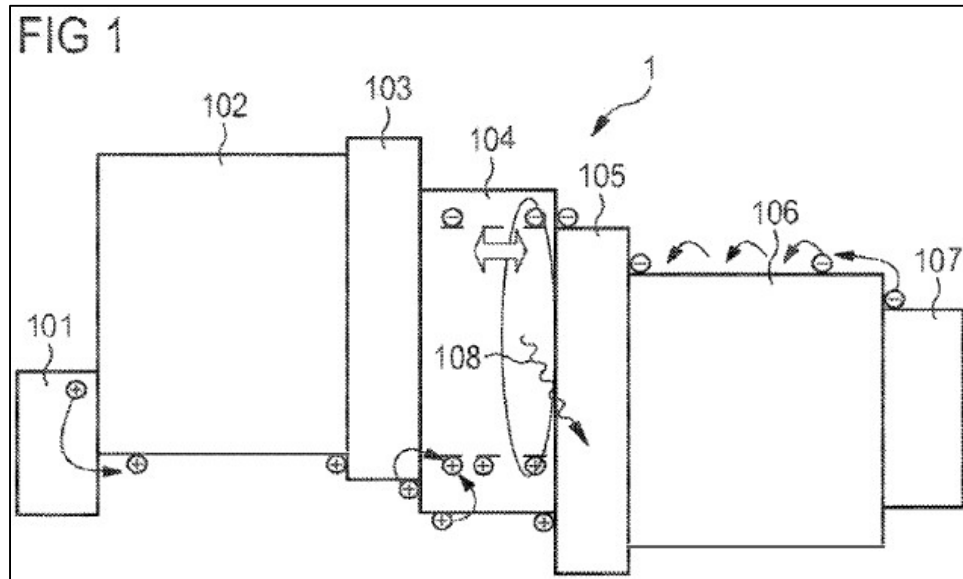
The '425 patent is directed to a device comprising an “organic light-emitting diode.” '425 patent, Abstract. A stated object of the patent is “to provide organic

light-emitting diodes which can be used particularly diversely.” *Id.*, 1:26-27. For example, the patent describes “organic light-emitting diodes which are transparent, emit on both sides, emit white light, emit colored light, emit infrared radiation, emit light diffusely, are rigid, are flexible and/or emit directional radiation.” *Id.*, 1:39-43.

The patent states that this objective may be achieved by “an organic light-emitting diode comprising an organic layer sequence, a radiation exit area and an encapsulation,” where the organic layer sequence “comprises at least one radiation-emitting region which generates electromagnetic radiation in the spectral range from infrared radiation to UV radiation during operation.” *Id.*, 1:28-38. Additionally, the radiation exit area “is structured, so that the electromagnetic radiation has a directional emission profile,” and the encapsulation “forms a seal of the organic layer sequence against environmental influences.” *Id.*, 1:28-38.

Figure 1 shows an exemplary “organic light-emitting diode 1” comprising a “first electrode 101” as an anode, a “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,” *id.*, 24:37-40. The OLED further includes a radiation-emitting region 104 which “[d]uring the operation of the organic light-emitting diode 1, [generates] electromagnetic radiation.” *Id.*, 24:46-54. 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.*, 24:59-62. The hole transport layer 102 and electron transport layer 106 “comprise, for example, a matrix material that is p- and n-doped, respectively.” *Id.*, 24:63-67.



The '425 patent includes one independent claim (claim 1) and eighteen dependent claims (claims 2-19). Ex.1003, ¶¶45-62.

A. Prosecution History

The '425 patent is a continuation of Application No. 16/790,198 (“198 Application”), which is a continuation of Application No. 15/651,508 (“508 Application”), which is a continuation of Application No. 13/139,514 (“514 Application”), filed as PCT Application No. PCT/DE2009/001741 on December 9, 2009. Ex.1003, ¶¶52-53.

During prosecution of the '514 Application, the then-pending claims were subject to numerous Section 112 and 103 rejections, Ex.1025, 1050-1080, 1154-

1192, 1269-1293, 1326-1357, including a rejection of some claims as anticipated by, or obvious over, Diekmann in view of other references. *Id.*, 1406-1413; Ex.1003, ¶¶54-58. Specifically, the Examiner determined that Diekmann teaches an “organic light-emitting diode” comprising a “plurality of functional layers” with “at least one radiation-emitting region in which electromagnetic radiation is generated...in the spectral range from infrared radiation to UV radiation during operation,” an “encapsulation” with layers having “unique volume structure,” comprising “silicon oxide and silicon nitride,” and formed by a “PECVD method.” *Id.*, 1406-1411.

The Examiner also indicated that some claims were allowable because they included features not taught by the references of record. The allowed claims included narrow limitations such as a “first encapsulation layer being in crystalline or polycrystalline form and having lattice defects which form a permeation path for moisture and/or oxygen” and a “second encapsulation layer is amorphous and does not continue the lattice defects of the first encapsulation layer.” *Id.*, 1413-1414; Ex.1003, ¶55.

Applicants did not dispute the Examiner’s findings. Instead, Applicants amended the claims so each independent claim included the allowable subject matter identified by the Examiner, and the claims were allowed. *Id.*, 2038-2042, 2050-2056. Thus, the ’514 Application claims were only allowed over Diekmann because they included highly specific limitations about encapsulation or pre-encapsulation layers.

The then-pending claims of the '508 and '198 Applications were also rejected numerous times under Sections 112, 102, and 103, but Diekmann was not cited by the Examiner and was not substantively discussed. *See generally* Exs. 1026, 1027; Ex.1003, ¶¶59-61.

During prosecution, the '198 Application was reassigned to a different Examiner who withdrew all rejections and allowed the claims to issue. Ex.1027, 420-424, 449-456. That Examiner allowed the '425 Patent to issue without any rejections.

The record is silent on whether the '425 Examiner considered Diekmann, even though the '514 Examiner considered it highly relevant to the claims of the '514 Application with substantively identical limitations to those in the '425 Patent. As noted above, Applicants obtained the '514 patent's allowance over Diekmann only by incorporating highly specific limitations that are not present in any of the claims of the '425 Patent. Ex.1003, ¶¶55-61.

B. “Volume Structure” and “Amorphicity”

During prosecution of the '514 Application, Applicants repeatedly sought to explain the meaning of the terms “volume structure” and “amorphicity,” which also appear in claim 4 of the '425 Patent.

Applicants argued that “volume structure” is “a term of art to a person of ordinary skill in the pertinent art,” and that it is distinct from “surface structure”:

Thus, in 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.1025, 1386; *see also id.*, 1241, 1313.

Applicants also argued that “[i]n the present application, the term ‘volume structure’ was chosen to comprise any structure ranging from polycrystalline to polyamorphous,” and that “examples of volume structures” include “crystalline, partly crystalline and/or polycrystalline or completely amorphous.” *Id.*, 1241; *see also id.*, 1313-1314, 1386-1387; Ex.1003, ¶¶57-58.

V. LEVEL OF ORDINARY SKILL

A person of ordinary skill in the art (“POSITA”) at the time of the alleged invention of the ’425 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. Ex.1003, ¶63. An individual with additional education could have less research or industrial experience and vice versa. *Id.*

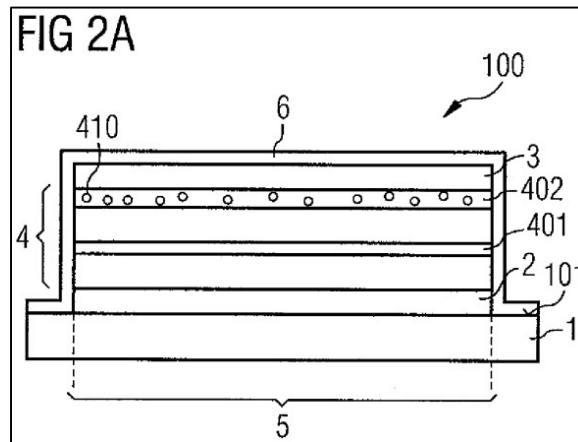
VI. CLAIM CONSTRUCTION

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

VII. OVERVIEW OF PRIOR ART

A. Diekmann (Ex.1004)

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



Diekmann, Fig. 2A. This device comprises a substrate 1 having a first main surface 101, to which a first electrode 2 is applied. An 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. 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, which acts as an electron donor.” *Id.* The lighting device further comprises a thin-film encapsulation 6 that is “applied directly to the second electrode.” *Id.*, 92; Ex.1003, ¶¶67-70.

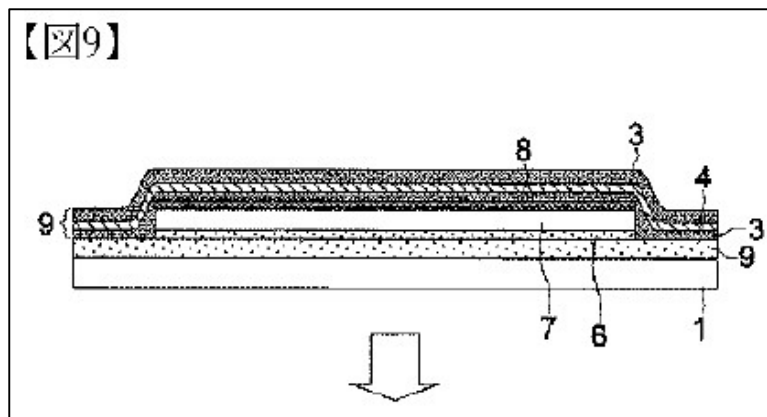
The lighting device is “designed to be transparent to visible light, in particular to light generated by the organic layer stack.” *Id.* For this purpose, the substrate, the

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.

B. Suzuki (Ex.1006)

Suzuki relates to, among other things, “an organic electroluminescent device” using a “gas barrier resin substrate material.” Suzuki [0001]. Figure 9 illustrates an embodiment of the organic electroluminescent device:



Suzuki, Fig. 9. This device comprises, in order from the bottom, a resin substrate material 1, a gas barrier thin film laminate 9, an anode 6, an organic layer 7 that includes “a hole transport layer, a light emission layer, [and] an electron transport layer,” a cathode 8, and another gas barrier thin film laminate 9 comprising a buffer film 3, a barrier film 4, and another buffer film 3 for sealing the device (i.e., an encapsulation). *Id.*, [0274]. Figure 9 an encapsulation with two buffer films and one barrier film, but Suzuki specifies that the encapsulation may “comprise two or more barrier films and two or more buffer films.” *Id.* The arrow in Figure 9 “indicates the

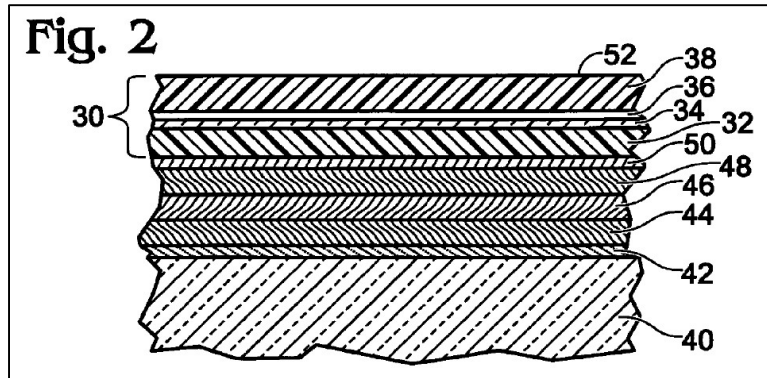
direction of light extraction.” *Id.* Suzuki’s device is thus a bottom-emitting OLED. Ex.1003, ¶¶71-73.

C. Ma (Ex.1010)

Ma is a study of “[o]rganic light-emitting diodes with 8-hydroxy-quinolinato lithium doped 4’7-diphenyl-1,10-phenanthroline as electron transport layer.” Ma, Abstract. Ma examined the “conductivity of carrier transport layers with different doping concentration” and concluded that a “doping concentration of the Liq” (short for 8-hydroxy-quinolinato lithium) in the electron transport layer results in increased current density and reduced driving voltage compared to the undoped device, and that a certain doping ratio of Liq to Bphen (electron transport layer material) can “improve the electron transport ability of the co-deposited layer.” *Id.*, 813. Ma attributed the improved current and power efficiency to “the improved conductivity of the transport layers and the efficient charge balance in the emission zone.” *Id.*, Abstract; Ex.1003, ¶¶74-75.

D. Lee (Ex.1008)

Lee relates to “an organic light emitting device having a barrier for protection against environmental degradation.” Lee, [0002]. Figure 2 illustrates an embodiment of such an organic light emitting device:

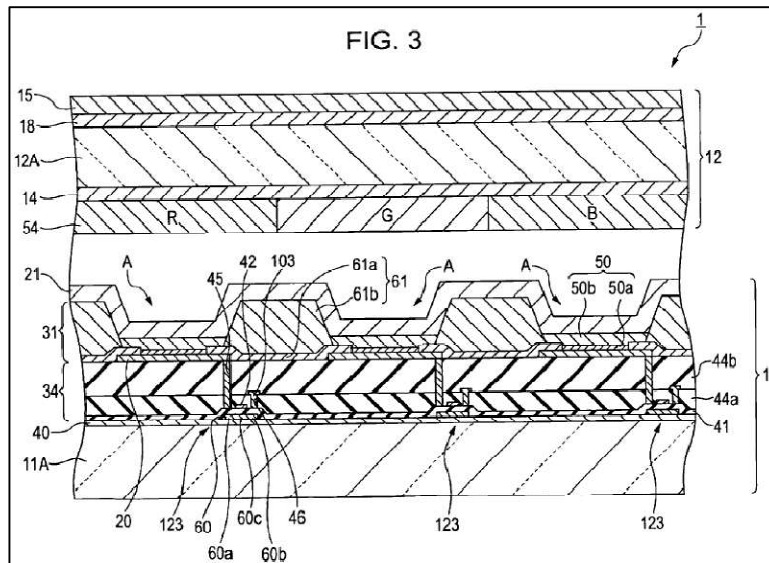


Lee, Fig 2. Lee teaches an OLED with a multi-layered encapsulation, including parylene-based polymer layers 32 and 38 sandwiching an inorganic barrier layer 34. *Id.*, [0022]. Layer 32 is formed by depositing a “semi-crystalline parylene-based polymer,” and layer 38 is formed by depositing a semi-crystalline parylene-based polymer and annealing it to form a “highly crystalline parylene-based polymer.” *Id.*, [0021]. Annealing increases the crystallinity of the polymer film. *Id.*, [0024]. Thus, the layers 32 and 38 have different levels of crystallinity; specifically, “the first semi-crystalline and second highly crystalline parylene-based polymer layers respectively have at least 10% and up to 70% of crystallinity.” *Id.*, [0023].

The 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,” but this is merely exemplary, and “any other suitable architecture may be used.” *Id.*, [0022]; Ex.1003, ¶¶76-79.

E. Koshihara (Ex.1012)

Koshihara relates to a “touch-sensitive organic EL device.” Koshihara [0002], [0028]. Figure 3 illustrates an embodiment of this device:

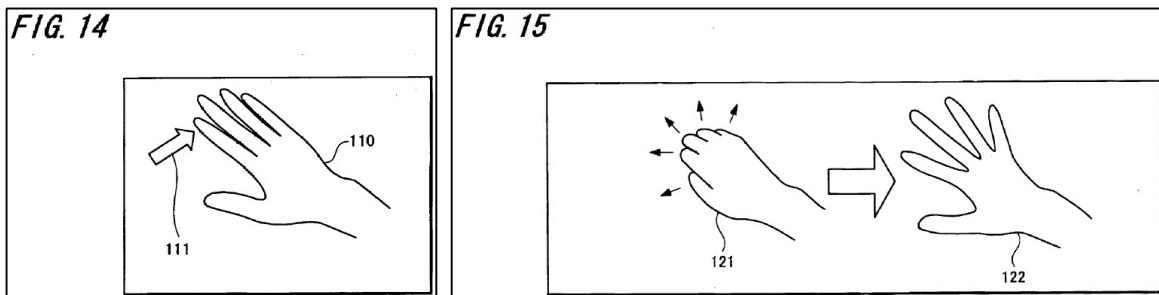


Koshihara, Fig. 3. Koshihara teaches a touch panel unit integrated into the sealing substrate that protects the OLED from water and oxygen. *Id.*, [0030]-[0031]. Specifically, “[a] combination of the first detection electrode 14, the second detection electrode 18, the dielectric film 15, and the detection unit 16,” which is not shown, operates as a touch panel unit to detect touch inputs. *Id.*, [0031]. As shown in Figure 3, “[t]he first detection electrode 14 is provided on the inner surface of the counter sealing substrate 12.” *Id.*; Ex.1003, ¶¶80-82.

F. Harada (Ex.1009)

Harada relates to “a display technology capable of receiving light in parallel with emitting light,” which can be applied to an “organic EL (Electro-Luminance)

display.” Harada [0003]. This “I/O display” can “detect not only a touch that is a state of the screen being touched, but also an object approached to the screen.” *Id.*, [0039]. Thus, Harada’s display can recognize gestures. Figure 14 “shows an example of gesture recognition using a hand shape” in which “the shape of a hand 110 touched (or approached) to a display panel is recognized, and the hand shape recognized is displayed as an image and then with a display object move 111, some processing is performed.” *Id.*, [0071]. Similarly, Figure 15 “shows an example in which a hand closed 121 is changed to a hand opened 122 and the touch or approach of the hand (121, 122) in each condition is recognized as an image on the display panel and the processing based on the image-recognition is executed.” *Id.*, [0072]; Ex.1003, ¶¶83-86.

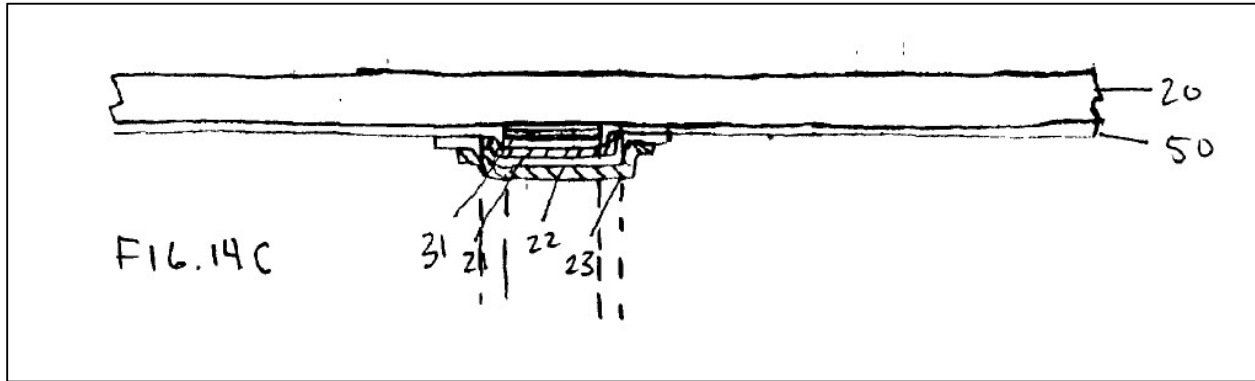


Harada, Figs. 14, 15.

G. Caldwell (Ex.1011)

Caldwell “relates to relates to integration of touch sensors with light emitting devices,” Caldwell [0007], where light emission can be provided by OLEDs, *id.*,

[0004]-[0006]. Figure 14C illustrates an embodiment of a bottom-emitting device with an integrated touch sensor:



Caldwell, Fig. 14C. This device comprises an anode 21, an emissive stack 22, and a cathode 23 as a light-emitting device, and a touch electrode 31 overlying the layers of the light-emitting device, with an “[i]nsulating layer 50 separat[ing] electrode 31 from the layers of the light emitting device.” *Id.*, [0074]. Each of these components are “borne on substrate 20.” *Id.*; Ex.1003, ¶¶88-89.

VIII. APPLICATION OF PRIOR ART TO THE CHALLENGED CLAIMS

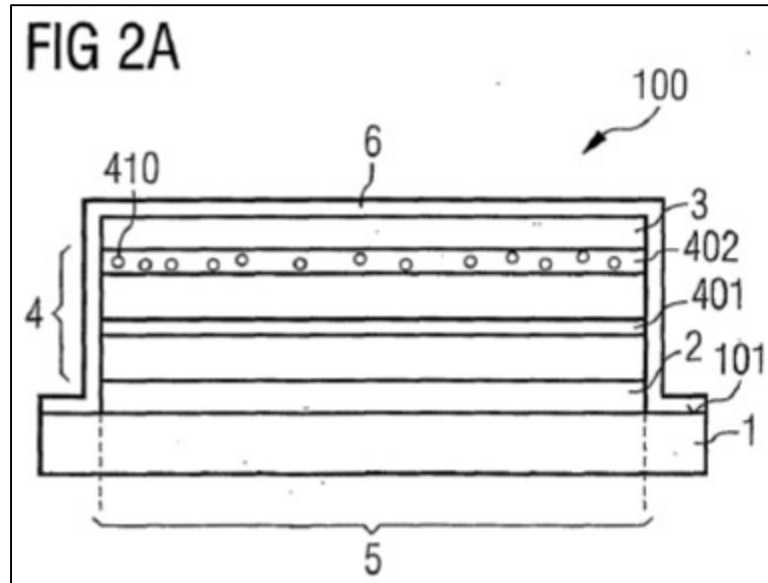
A. Ground I: Claims 1, 3, 5-8, 13-16, and 18-19 are obvious over Diekmann

Diekmann discloses a device that teaches or suggests all elements of claims 1, 3, 5-8, 13-16, and 18-19 of the '425 patent. Ex.1003, ¶¶90-138.

1. Independent Claim 1

a. Preamble: A device comprising:

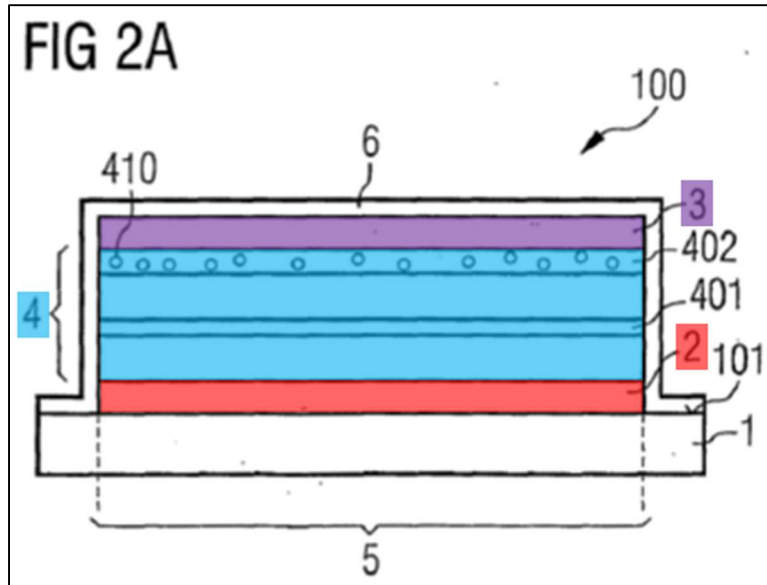
To the extent the preamble is limiting, Diekmann discloses it. Ex.1003, ¶¶90-91. Diekmann discloses a “lighting device” 100:



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

b. Element 1[a]: an organic light-emitting diode comprising:

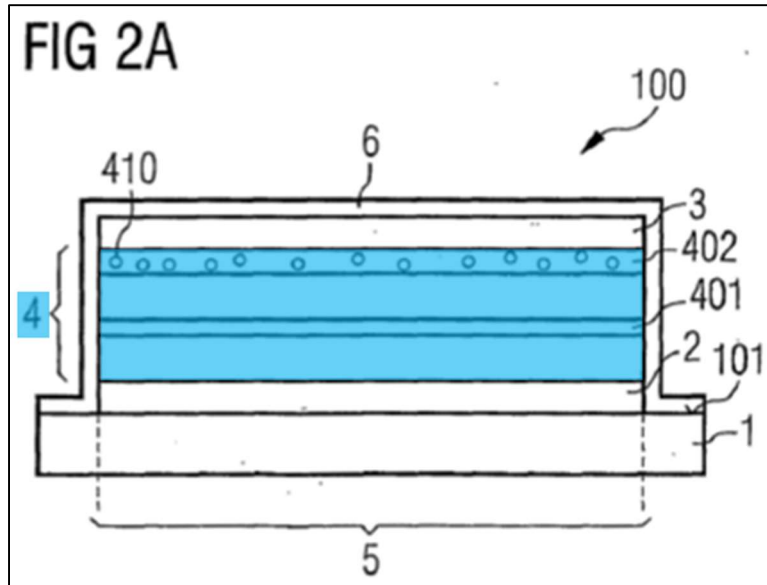
Diekmann discloses this element. Ex.1003, ¶¶92-93. Diekmann's lighting device includes an organic light-emitting diode comprising a "first electrode 2 [which] is the anode," a "second electrode 3 [which] is the cathode," and an "organic layer stack 4 with at least one layer 401 suitable for generating light":



Diekmann, Fig. 2A (annotated); *id.*, 91. 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.1003, ¶¶92-93; *see* ’425 patent, Fig. 1, 24:30-62.

c. Element 1[b]: an organic layer sequence,

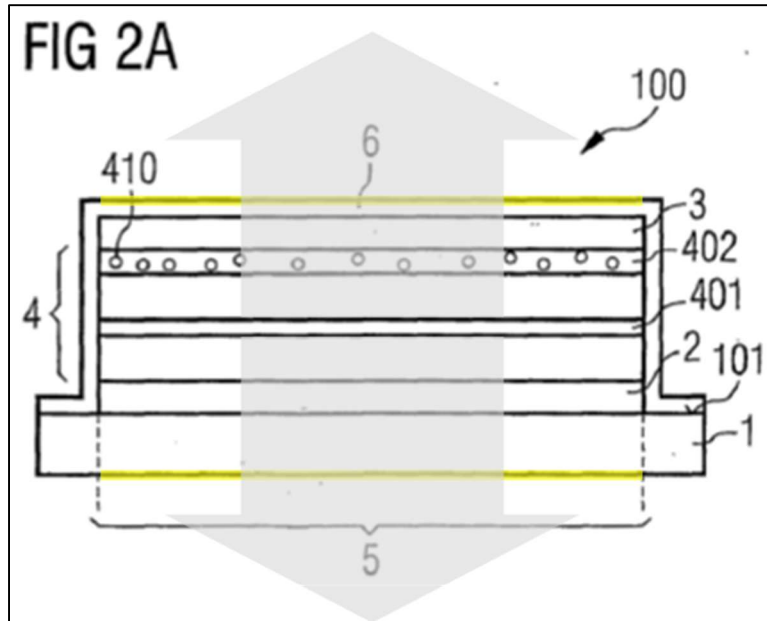
Diekmann discloses this element. Ex.1003, ¶¶94-95. Diekmann’s OLED includes an organic layer sequence, which it labels as “organic layer stack 4 with at least one layer 401 suitable for generating light.”



Diekmann, Fig. 2A (annotated), 91. Diekmann explains that organic layer stack 4 includes multiple layers applied in sequence to the first electrode 2. *Id.*, 91.

d. Element 1[c]: a radiation exit area, and

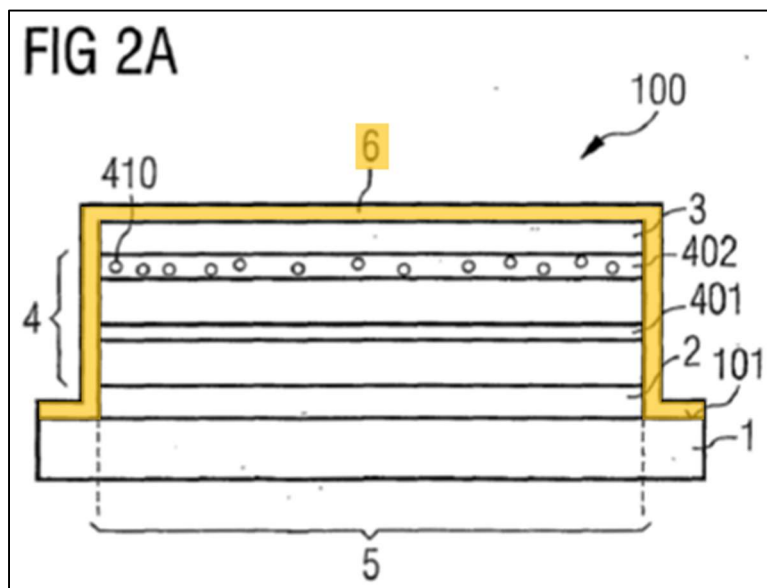
Diekmann discloses this element. Ex.1003, ¶¶96-97. Diekmann discloses “[t]he lighting device according to Figure 2A is designed to be transparent to visible light, in particular to light generated by the organic layer stack 4.” Diekmann, 92. Substrate 1, first electrode 2, organic layer stack 4, second 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 OLED includes radiation exit areas at the top and bottom of the OLED, as illustrated below:



Diekmann, Fig. 2A (annotated); Ex.1003, ¶96.

e. Element 1[d]: an encapsulation,

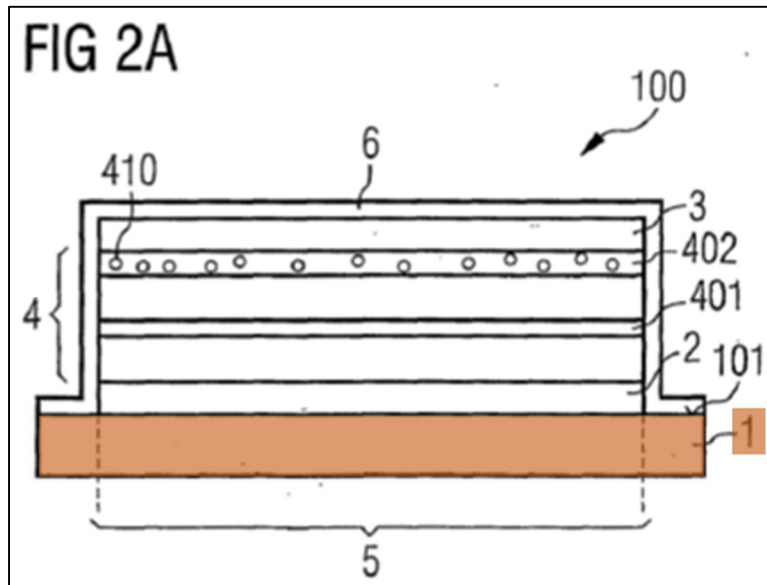
Diekmann discloses this element. Ex.1003, ¶¶98-99. Diekmann's OLED includes a "thin-film encapsulation 6":



Diekmann, Fig. 2A (annotated); *id.*, 92; Ex.1003, ¶98.

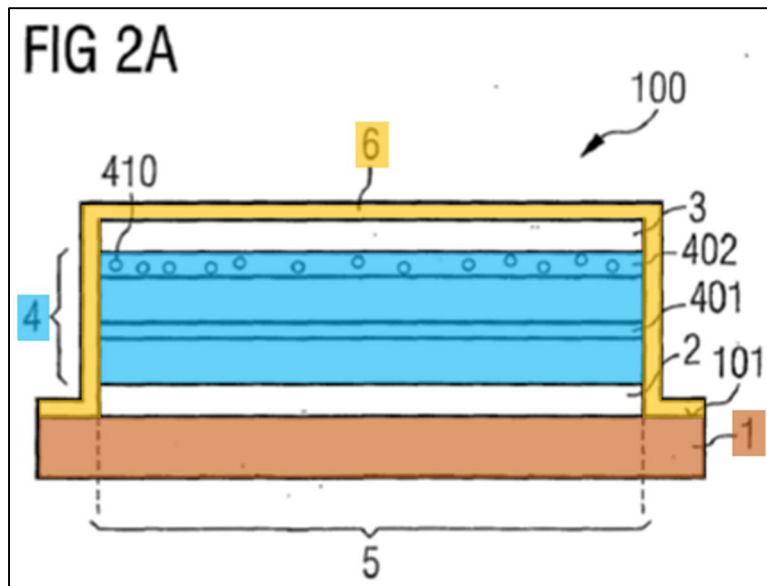
f. Element 1[e]: wherein the organic layer sequence and the encapsulation are disposed on a carrier,

Diekmann discloses this element. Ex.1003, ¶¶100-102. Diekmann's OLED includes a carrier, "substrate 1":



Diekmann, Fig. 2A (annotated); *id.*, 91; Ex.1003, ¶100.

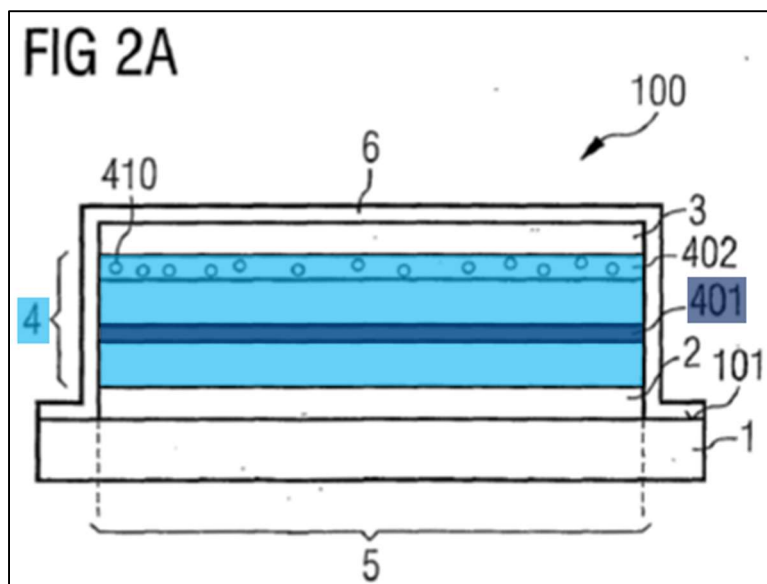
Diekmann explains that the “organic layer stack 4...is arranged on the first electrode 2,” which is applied to the substrate 1. Diekmann, 91. The organic layer sequence is thus disposed on the carrier, as depicted in Figure 2A. Further, the “thin-film encapsulation 6 is applied directly to the second electrode 3,” which is applied to the “organic layer stack 4.” *Id.*, 92. The encapsulation is thus also disposed on the carrier, as depicted in Figure 2A:



Diekmann, Fig. 2A (annotated); Ex.1003, ¶101.

- g. **Element 1[f]: 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. Ex.1003, ¶¶103-105. Diekmann's organic layer stack 4 includes "at least one layer 401 suitable for generating light":



Diekmann, Fig. 2A (annotated), *id.*, 91. 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 (emphasis added); Ex.1003, ¶103.

h. Element 1[g]: wherein the organic layer sequence comprises an electron transport layer that is n-doped; and

Diekmann discloses or at a minimum suggests this element. Ex.1003, ¶¶106-110. Diekmann discloses that its organic layer sequence (organic layer stack 4) “has a doped layer 402 with a dopant 410, which acts as an electron donor...The dopant 410 can be for example cesium, barium or lithium fluoride.” Diekmann, 91.

Diekmann’s doped layer 402 is situated between cathode 3 and radiation-emitting region 401 and 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; *see also id.*, 91. A POSITA would recognize doped layer 402 to be an “electron transport layer” which, as explained by the ’425 patent, serves the function of “transport[ing] negative charge carriers—electrons—from the...cathode, to the radiation-emitting region.” ’425 patent, 24:59-62; Ex.1003, ¶¶32-42, 106-110.

Moreover, Diekmann discloses exemplary materials for its electron-conducting layer, such as Alq3, BAlq, and TPBi, that were well-known materials for

electron transport layers. *See, e.g.*, Ex.1014; Ex.1003, ¶108. The '425 patent itself lists Balq and TPBi as exemplary electron transport layer materials. '425 patent, 26:32-43.

Diekmann further discloses that its electron transport layer, doped layer 402, “is generally an n-doped layer” in which “[p]referred n-dopants are cesium, barium and lithium fluoride.” Diekmann, 10; *see id.*, 91, 119. As such, a POSITA would understand that doped layer 402 is an n-doped electron transport layer. Ex.1003, ¶¶109-110.

Even had Diekmann not disclosed that its doped layer is an n-doped electron transport layer, it would have been obvious to a POSITA to include an n-doped electron transport layer in the organic stack 4. At the time of the '425 patent, using n-doped electron transport layers was well-known in the art. *See, e.g.*, Exs.1019, 1029, 1030. A POSITA would have been motivated to include an n-doped electron transport layer to promote injection of electrons from the cathode and improve transportation of electrons to the light-emitting region. Diekmann, 10. Further, doing so was known to result in improved device characteristics, such as lower driving voltage and better power efficiency. Ex.1003, ¶¶32-42, 110; Ma, 810.

In light of these well-known benefits, a POSITA would have been motivated to include an n-doped electron transport layer in Diekmann's OLED. A POSITA also would have had a reasonable expectation of success, as n-doped electron

transport layers were widely used at the time in OLEDs for this reason. Ex.1003, ¶¶110-111.

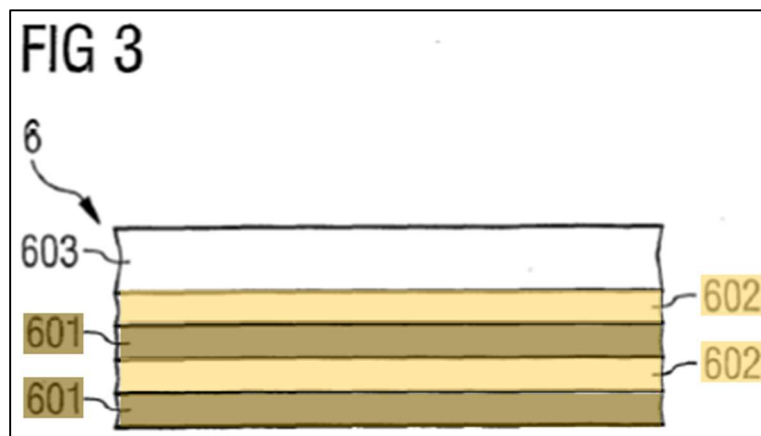
- i. **Element 1[h]: wherein the organic layer sequence comprises an emission layer comprising an iridium-containing compound.**

Diekmann discloses this element. Ex.1003, ¶112. Diekmann's organic layer sequence (organic layer stack 4) 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-phenylpyridyl)iridium complex)." *Id.*, 91 (emphasis added); Ex.1003, ¶112.

2. Dependent Claim 3

- a. **The device of claim 1, wherein at least one part of the encapsulation is formed by an insulation layer,**

Diekmann discloses this element. Ex.1003, ¶¶113-114. As discussed above, Diekmann discloses a thin-film encapsulation (6), seen below.



Diekmann, Fig. 3 (annotated); *id.*, 94. 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.* Silicon oxide and silicon nitride are insulating materials. Ex.1003, ¶114.

b. wherein the insulation layer comprises at least one of: resin, silicon oxide, silicon nitride.

Diekmann discloses this element. Ex.1003, ¶115. As discussed above, Diekmann’s thin-film encapsulation includes barrier layers 601 and 602, which are insulation layers comprising silicon oxide or silicon nitride. Diekmann, 94.

3. Dependent Claim 5: The device according to claim 1, wherein the organic light-emitting diode comprises a hole transport layer that is p-doped.

Diekmann discloses or at a minimum renders obvious this claim. Ex.1003, ¶¶116-120. Diekmann’s organic layer sequence comprises a hole transport layer 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 further 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, Ex.1003, ¶¶37-42, 116; *see also* Ex.1016; Ex.1019.

A POSITA would thus have understood that Diekmann's hole-conducting layer is a hole transport layer. Ex.1003, ¶116.

Diekmann further discloses that this hole transport layer is p-doped. Diekmann teaches that "the organic layer stack comprises a doped organic layer with a dopant," with the doped organic layer preferably being an "outermost layer of the organic layer stack" such that it "forms a common interface with the respective electrode facing it." Diekmann, 10. The doped organic layer is p-doped if "arranged so that it faces the anode or is adjacent to it." *Id.* Diekmann therefore discloses a p-doped hole transport layer within its organic layer stack. Ex.1003, ¶117.

Even were the p-doping not expressly disclosed, it would have been obvious to a POSITA to dope Diekmann's hole transport layers adjacent to the anode with p-dopants. Ex.1003, ¶¶118-120. It was well-known at the time that using a p-doped hole transport layer could improve current and power efficiencies of an OLED. Ex.1003, ¶¶37-42, 118-120; Ma, 810. Indeed, Diekmann specifically teaches that doing so would result in "better hole injection from the anode into the organic layer stack." Diekmann, 10. Moreover, a POSITA would also have recognized that it would have been beneficial to use a p-doped hole transport layer together with an n-doped electron transport layer. Ex.1003, ¶¶37-42, 119-120. A POSITA would understand, as taught by Ma, that an OLED can achieve a good balance of electrons and holes by using a "p-i-n device" (an OLED with a p-doped hole transport layer

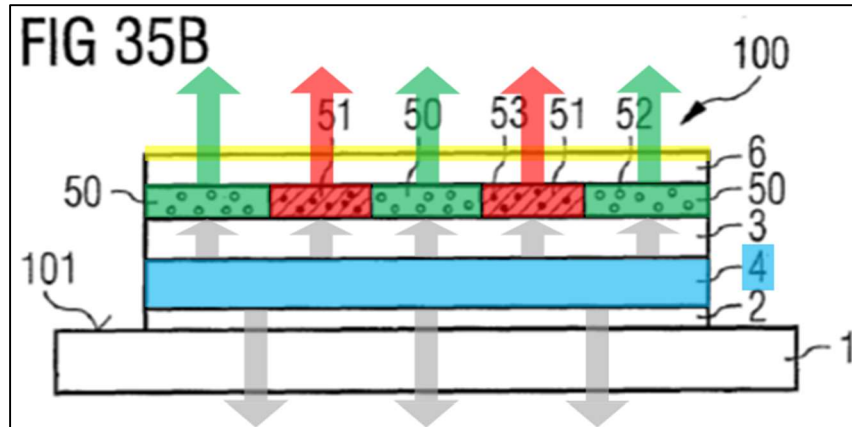
and n-doped electron transport layer) resulting in “good lifetime.” *Id.*; *see also* Ex.1019, Abstract; Ex.1029, 5-14; Ex.1030, 3911-12.

A POSITA would have reasonably expected success in using a p-doped hole transport layer together with an n-doped electron transport layer in Diekmann’s OLED. Diekmann already contemplates both an n-doped electron transport layer and a p-doped hole transport layer. Further, “*p-i-n*” OLEDs using both n-doped and p-doped transport layers were well-known by the time of the ’425 patent and adding a p-dopant to a hole transport layer would be a routine matter well within a POSITA’s ability for which a POSITA would have had a reasonable expectation of success. Ex.1003, ¶120; *see also* Exs.1019; Ex.1029; Ex.1030.

4. Dependent Claim 6

- a. 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. Ex.1003, ¶¶121-122. Diekmann discloses that its OLED may include a color filter layer to form differently colored subregions and a “multicolored” output. Diekmann, 37-38, 40, 128-130. Annotated Figure 35B below shows the color filters are arranged between the emission layer (within organic layer stack 4), and the radiation exit area:



Diekmann, Fig. 35B (annotated); *id.*, 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”), 40.

- b. wherein the color filter is configured to be highly transmissive for a first spectral subrange of the generated electromagnetic radiation and highly absorbant for a second spectral subrange of the generated electromagnetic radiation.**

Diekmann discloses this element. Ex.1003, ¶123. Diekmann discloses that a “first color sub-region emits light of a first color” and a “second color sub-region emits light of a second color,” the first color being different from the 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; Ex.1003, ¶123.

5. Dependent Claim 7: The device according to claim 1, wherein the encapsulation is flexible.

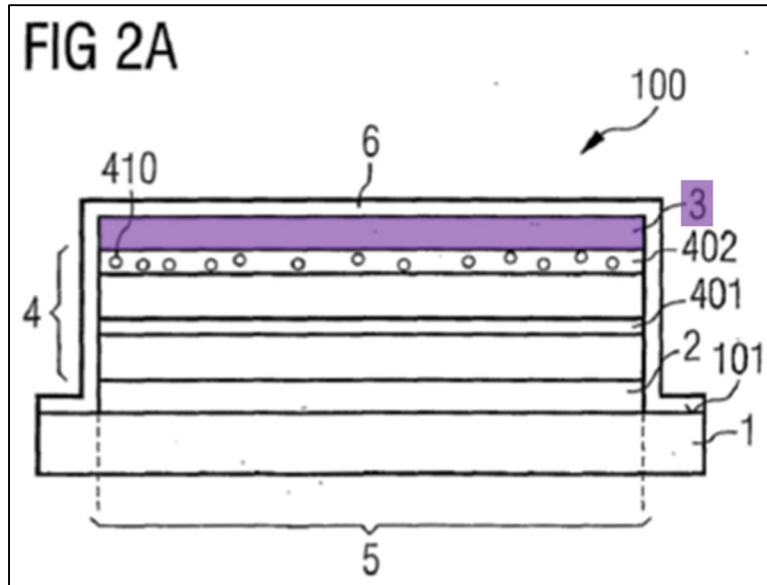
Diekmann discloses this claim. Ex.1003, ¶124. Diekmann discloses that its “thin film encapsulation” is flexible. Diekmann, 30-31. For example, “the encapsulation [that] is formed from one or more barrier layers, as described, for example, in connection with Figure 3...is designed as a flexible thin-film encapsulation.” Diekmann, 120; Ex.1003, ¶124.

6. Dependent Claim 8: The device according to claim 7, wherein the carrier comprises a film, a plastic film or a laminate.

Diekmann discloses this claim. Ex.1003, ¶125. Diekmann explains that “the substrate 1...can, for example, be made of...a flexible plastic film.” Diekmann, 92. Diekmann also teaches the substrate may be a “plastic film” or “laminate.” *Id.*, 119, 121; Ex.1003, ¶125.

7. Dependent Claim 13: The device according to claim 1, 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 this claim. Ex.1003, ¶¶126-129. Diekmann’s OLED comprises an organic light-emitting layer sequence that includes a “second electrode 3 [which] is the cathode”:



Diekmann, Fig. 2A (annotated); *id.*, 91. Diekmann discloses the cathode “can, for example, have a metallic layer that contains...silver and *has a thickness of approximately 30 nm.*” *Id.*, 92 (emphasis added); Ex.1003, ¶¶126-127.

In addition, 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. “[T]o be permeable to the light emitted by the organic layer stack, the metallic layer must be sufficiently thin. Preferably, the thickness of such a semi-transparent metallic layer is between 1 nm and 100 nm, inclusive.” Diekmann, 8; *see also id.*, 75. Thus, in addition to disclosing a cathode thickness of approximately 30 nm, Diekmann teaches a range of cathode thicknesses to provide transparency. Diekmann’s range overlaps the claimed range, and the upper bound of 50 nm in the claimed range is not critical to the claimed invention; the ’425 patent specification

merely describes the 1-50 nm range as an example thickness for a transparent metal layer. *See* '425 patent, 3:1-4, 5:16-41, 32:13-22; Ex.1003, ¶¶24-25, 128-129.

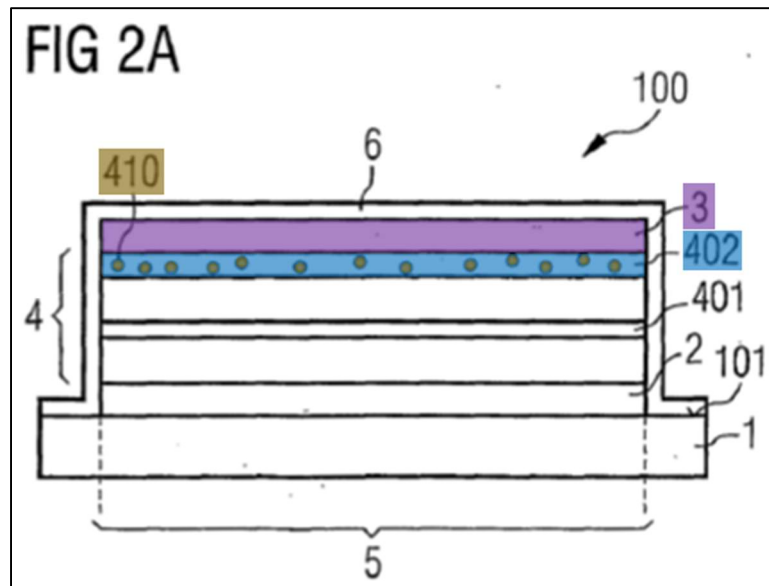
8. Dependent Claim 14: The device according to claim 13, wherein the cathode comprises one of: silver, magnesium, or an alloy comprising silver and magnesium.

Diekmann discloses this claim. Ex.1003, ¶¶130-131. Diekmann explains that the cathode “can, for example, have a metallic layer that contains...silver.” Diekmann, 92; *see also id.*, 91, 3-4.

Diekmann further 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. Diekmann also explains that the cathode “preferably has a material that has a low work function for electrons.” *Id.*, 3-4. Silver-magnesium alloys were well-known in the art as a suitable cathode material for OLEDs because they have a low work function and can be made sufficiently transparent for top-emission OLEDs. Ex.1003, ¶¶24-25, 130-131; *see also* Exs. 1022, 1033.

9. Dependent Claim 15: The device according to claim 13, wherein the cathode is in direct contact with a lithium containing layer.

Diekmann discloses this claim. Ex.1003, ¶¶132-133. In Figure 2A, the cathode is in direct contact with organic layer 402 containing dopant 410:



Diekmann, Fig. 2A (annotated); *id.*, 91. Diekmann explains the “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 further discloses that the doped organic layer “preferably forms a common interface with the respective electrode facing it.” *Id.*, 10; Ex.1003, ¶133.

10. Dependent Claim 16: The device according to claim 13, wherein the cathode comprises silver, magnesium, or alloy consisting of at least one of the abovementioned materials.

Diekmann discloses this claim for the same reasons articulated for claim 14 in §VIII.A.8 above. Ex.1003, ¶134.

11. Dependent Claim 18

- a. The device according to claim 1, wherein at least one part of the encapsulation is formed by an insulation layer, which can contain at least one of the following electrically insulating materials: resin, silicon oxide, silicon nitride,**

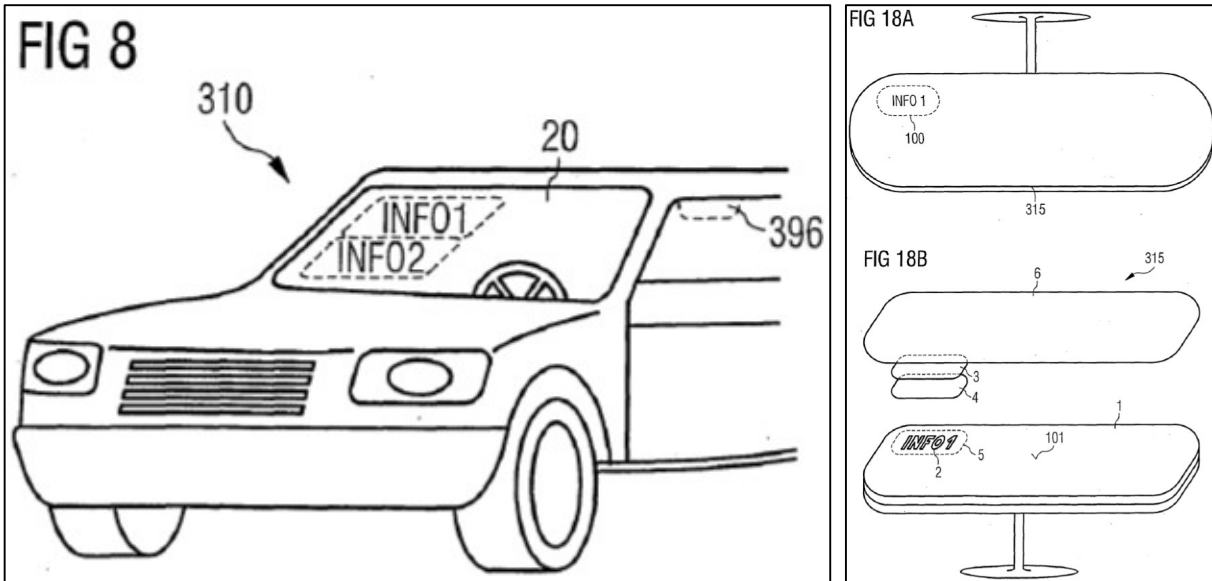
Diekmann discloses this element for the same reasons discussed for elements 3[a]-3[b] in §VIII.A.2 above. Ex.1003, ¶135.

- b. and wherein at least one part of the encapsulation is formed by a PECVD method.**

Diekmann discloses this element. Ex.1003, ¶136. Diekmann explains that “at least one thin film layer, such as the barrier layer” of its thin film encapsulation “is applied by means of a thin film process, such as...plasma-enhanced CVD.” Diekmann, 13, 94. Plasma-enhanced CVD is a PECVD method. Ex.1003, ¶136.

12. Dependent Claim 19: The device according to claim 1, wherein the organic light-emitting diode is configured for installation in a vehicle.

Diekmann discloses this claim. Ex.1003, ¶¶137-138. Diekmann explains that the lighting device can be “integrated into a window” of a “motor vehicle” to display information to the driver, Diekmann, 102; used as “vehicle interior lighting,” *id.*; or integrated into “a motor vehicle mirror,” Diekmann, 112-113:



Diekmann, Figs. 8, 18A-18B; Ex.1003, ¶137.

B. Ground II: Claims 2, 17 are obvious over Diekmann in view of Ma

1. Dependent Claim 2: The device of claim 1, wherein the electron transport layer comprises 8-hydroxyquinolinolato-lithium.

Claim 2 would have been obvious to a POSITA based on Diekmann in view of Ma. Ex.1003, ¶¶139-146. As explained above, Diekmann discloses, or at minimum renders obvious, an n-doped electron transport layer. *See* above §VIII.A.1.h. It would have been obvious to a POSITA to use 8-hydroxyquinolinolato-lithium as the dopant in Diekmann’s n-doped electron transport layer as taught by Ma. Ex.1003, ¶¶139-146. Ma teaches an OLED with an electron transport layer doped with 8-hydroxy-quinolinatolithium (“Liq”). Ma, Abstract, 810-811.

A POSITA would have been motivated to use an Liq-doped electron transport layer in the organic layer stack of Diekmann due to the known benefits of an Liq-doped electron transport layer. Ex.1003, ¶¶140-143. As Ma explains, “[s]ince the discovery of organic light-emitting devices (OLEDs), there has been a considerable interest in developing OLEDs with high efficiency.” Ma, 810. “In order 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 electron transport layer results in increased current density and reduced driving voltage, compared to the undoped device. *Id.*, 813. Ma further teaches that “a certain doping ratio of Liq to Bphen can improve the electron transport ability of the co-deposited layer.” *Id.*

Moreover, Diekmann teaches that the n-dopant for its electron transport layer should be “suitable for emitting electrons” and “preferably has a low diffusion constant within the organic layer stack, as is usually the case with large atoms or molecules, for example.” Diekmann, 10. Liq was known to have good electron injection and transport properties and has a larger molecular weight than Diekmann’s preferred n-dopants (cesium, barium, and lithium fluoride). *See* Ex.1003, ¶¶144-145; *see also* Ex.1031, 4495; Ex.1018. A POSITA thus would have

recognized that Liq would be an advantageous dopant for Diekmann's doped layer. Ex.1003, ¶144.

A POSITA would also have reasonably expected success in implementing Liq as the dopant in the n-doped electron transport layer in Diekmann's OLED . Ex.1003, ¶¶145-146. Doing so would be a routine practice for a POSITA to implement with a high probability of success, particularly as Diekmann already contemplates an n-doped electron transport layer. Ex.1003, ¶145.

2. Dependent Claim 17: The device according to claim 1, wherein the electron transport layer comprises at least 8-hydroxyquinolinolato-lithium.

Claim 17 would have been obvious to a based on Diekmann and Ma for the same reasons discussed for claim 2. *See above* §VIII.B.1; Ex.1003, ¶147.

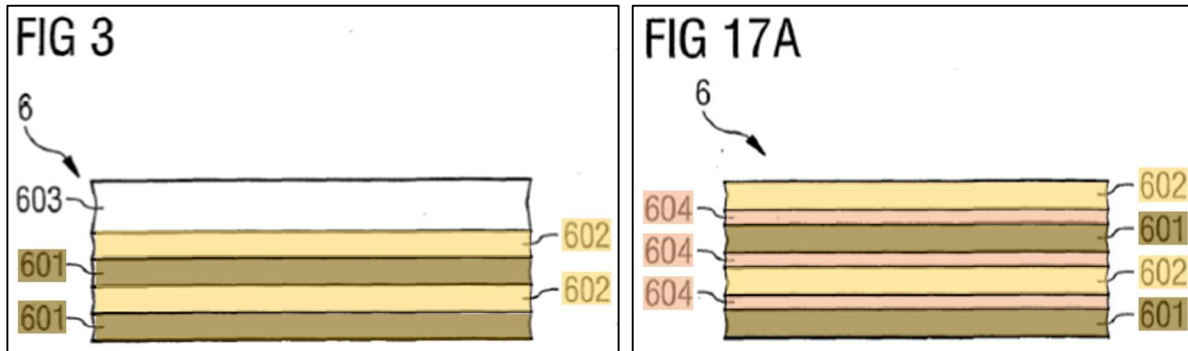
C. Ground III: Claim 4 is obvious over Diekmann in view of Lee

1. Dependent Claim 4

a. The device of claim 1, wherein the encapsulation comprises a first encapsulation layer and a second encapsulation layer,

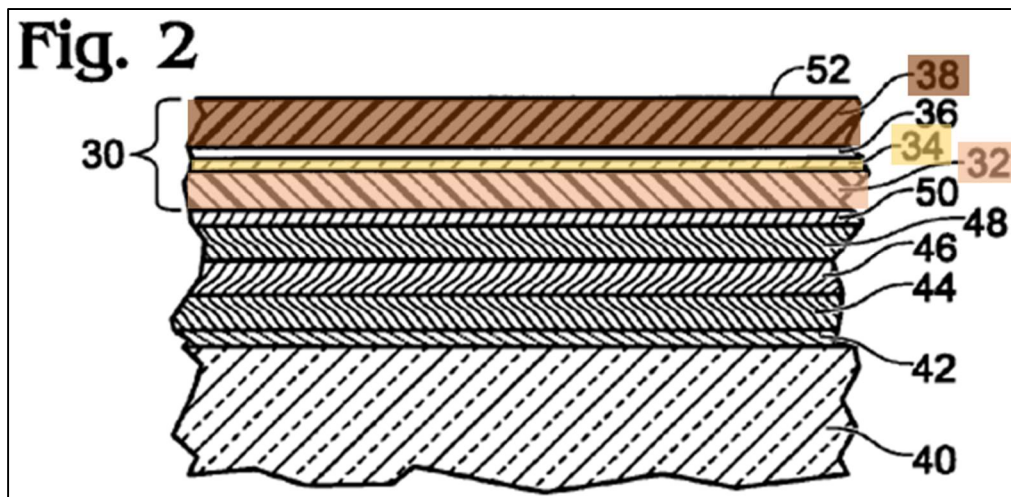
This element would have been obvious to a POSITA based on Diekmann in view of Lee. Ex.1003, ¶¶148-151. As explained above, Diekmann teaches an encapsulation which comprises multiple encapsulation layers. *See above* §VIII.A.1.e. Diekmann's "thin-film encapsulation 6" comprises "two first barrier layers 601" (a first encapsulation layer), and "two second barrier layers 602" (a second encapsulation layer), Diekmann, 94, which "are separated from each other

by intermediate polymer layers 604,” *id.*, 109, as seen in annotated Figures 3 and 17A below:



Diekmann, Figs. 3, 17A (annotated); Ex.1003, ¶148.

Lee likewise teaches an encapsulation for an OLED comprising 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.”).



Lee, Fig. 2 (annotated); [0021]-[0022]; Ex.1003, ¶149.

A POSITA would have been motivated to use Lee's multi-layered encapsulation with Diekmann's OLED. Ex.1003, ¶¶150-151. The use of encapsulations in order to protect OLEDs from the ambient environment was well-known at the time. Ex.1003, ¶150; *see also, e.g.*, Exs.1020, 1021. 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 also teaches the specific benefits of the type of multi-layer encapsulation that it discloses, explaining that semi- and highly-crystalline parylene-based polymer films "not only '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." *Id.*, [0020]. Thus, Lee's encapsulation formed of semi-crystalline and highly-crystalline polymer barrier layers may provide "a significantly improved lifetime compared to prior OLEDs having polyacrylate or amorphous parylene barrier layers." *Id.* 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]; Ex.1003, ¶¶150-151.

A POSITA would have reasonably expected success in combining Lee's multi-layered encapsulation with Diekmann's OLED. Diekmann already contemplates a multi-layered encapsulation with alternating layers of inorganic barrier layers and polymer interlayers. Applying Lee's encapsulation merely replaces one set of alternating layers of inorganic barriers and polymers with another, to obtain the benefits taught in Lee. Moreover, the use of such a multilayer OLED encapsulation consisting of alternating organic and inorganic layers was already well-known in the art at the time. Ex.1003, ¶¶43-44, 151; *see also, e.g.*, Exs. 1020, 1021. This modification would have been well within the ability of a POSITA. Ex.1003, ¶151.

b. the first and the second encapsulation layer each having a respective volume structure,

This element would have been obvious to a POSITA based on Diekmann in view of Lee. Ex.1003, ¶¶152-157.

As explained above in §IV.B, during prosecution of the '425 patent's predecessor, the '514 patent, the applicants offered numerous different explanations as to the meaning of "volume structure." Regardless of which meaning is applied, however, Lee teaches encapsulation layers having respective, independent volume structures. Specifically, the '514 applicants distinguished between the atomic and molecular arrangement inside of a solid ("volume structure") and that at the solid's surface ("surface structure"). Ex.1025, 1386. They also argued that "volume

structure” “comprise[s] any structure ranging from polycrystalline to polyamorphous,” including “crystalline, partly crystalline and/or polycrystalline or completely amorphous.” Ex.1025, 1241. 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]. If two solids have different levels of crystallinity, they necessarily also have different internal molecular and atomic arrangements. Ex.1003, ¶156. Therefore, Lee discloses encapsulation layers with their own respective, distinct volume structures. *Id.*

c. wherein the volume structure of the second encapsulation layer is independent of the volume structure of the first encapsulation layer, and

This element would have been obvious to a POSITA based on Diekmann in view of Lee. Ex.1003, ¶¶158-159. As discussed above in §VIII.C.1.b regarding claim 4[b], Lee discloses a first and second encapsulation layer with volume structures which are distinct and independent from one another. Lee, [0023]; Ex.1003, ¶159.

d. the volume structure of the second encapsulation layer has a higher amorphicity than the volume structure of the first encapsulation layer.

This element would have been obvious to a POSITA based on Diekmann in view of Lee. Ex.1003, ¶¶160-161.

As explained above, 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, [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 will be. Ex.1003, ¶161. As such, because Lee discloses a second encapsulation layer with lower crystallinity than the first encapsulation layer, Lee discloses a second encapsulation layer that has a higher amorphicity than the first encapsulation layer. *Id.*

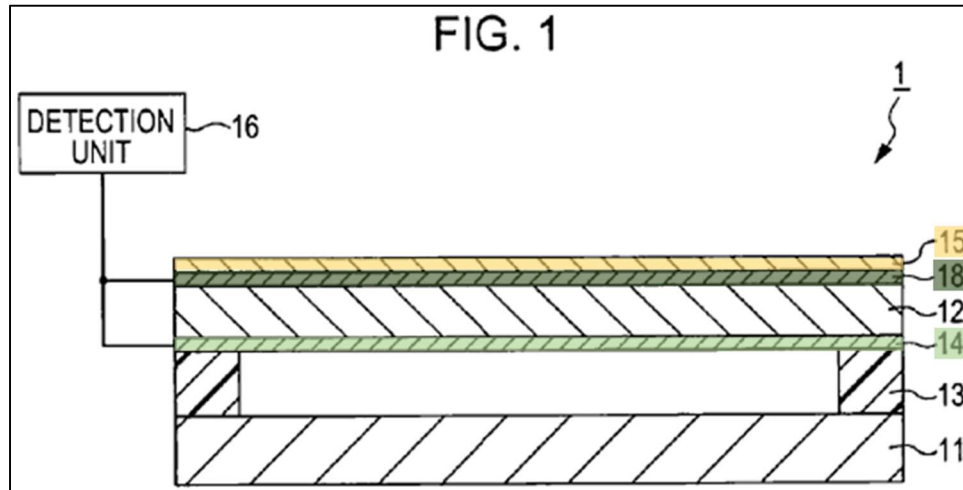
D. Ground IV: Claims 9-11 are obvious over Diekmann in view of Koshihara

1. Dependent Claim 9

- a. The device according to claim 1, wherein the device comprises at least one touch-sensitive operating element, and**

This element would have been obvious to a POSITA based on Diekmann in view of Koshihara. Ex.1003, ¶¶162-167. As explained above in §VIII.A.1.a, Diekmann teaches an OLED, and display devices incorporating it. It would have been obvious to a POSITA to implement touch sensing functionality in an OLED according to Diekmann by incorporating touch-sensitive operating elements as

taught by Koshihara. Ex.1003, ¶¶162-165. Koshihara teaches a “touch-sensitive organic EL device” with a “touch panel unit”:



Koshihara, Fig. 1 (annotated), [0028], [0031]. Koshihara explains that “[a] combination of the first detection electrode 14, the second detection electrode 18, the dielectric film 15, and the detection unit 16 constitutes a so-called a [sic] touch panel unit that operates in compliance with the so-called capacitive sensing scheme.” *Id.*, [0031]. Koshihara’s touch panel unit senses touch, using a “detection unit 16” to detect a position where electrostatic capacitance is generated by a “touching object.” *Id.*, [0031]; Ex.1003, ¶¶163-164.

A POSITA would have been motivated to incorporate touch sensing functionality to Diekmann’s OLED. Diekmann already contemplates that its OLED will be operable through user control, for example to be switched on or off, or to control the brightness or color of light output. Diekmann, 45-50, 53, 70, 139. Diekmann further contemplates integrating sensors for controlling operation of the

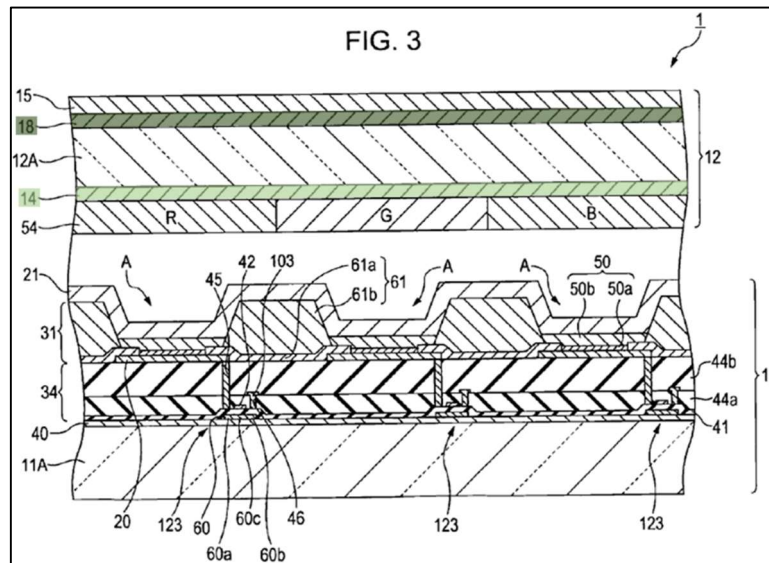
device “depending on the measured values determined by the sensor.” Diekmann, 49-50, 64, 143. Using touch sensors as input devices for controlling electronic devices was already well-known by the time of the ’425 patent. *See, e.g.*, Caldwell, [0004]-[0007]; Ex.1003, ¶¶165-166. A POSITA would have been motivated to incorporate touch sensors to “allow[] a user to manually input instructions” intuitively by touch. Koshihara, [0004]; Ex.1003, ¶¶165-166.

Further, a POSITA would have recognized the benefits of integrating Koshihara’s touch sensor into Diekmann’s OLED. Koshihara’s touch sensor is integrated with the sealing substrate for “preventing a light emitting layer, which is formed on a negative electrode or in a light emission element layer portion, from becoming oxidized,” Koshihara, [0030], allowing a touch-sensitive OLED to be formed without additional material and manufacturing costs associated with connecting a separate touch panel with touch sensors formed on another substrate, Caldwell, [0006]-[0007], as well as achieving a thinner profile for the device. *See, e.g.*, Ex.1024, 3:2-7; Ex.1003, ¶¶165-166.

A POSITA would have reasonably expected success in incorporating touch sensing functionality in Diekmann’s OLED. Ex.1003, ¶167. Implementing Koshihara’s touch sensor would have been a routine matter well within the ability of a POSITA. Ex.1003, ¶167.

b. wherein the at least one touch-sensitive operating element comprises at least one touch sensor.

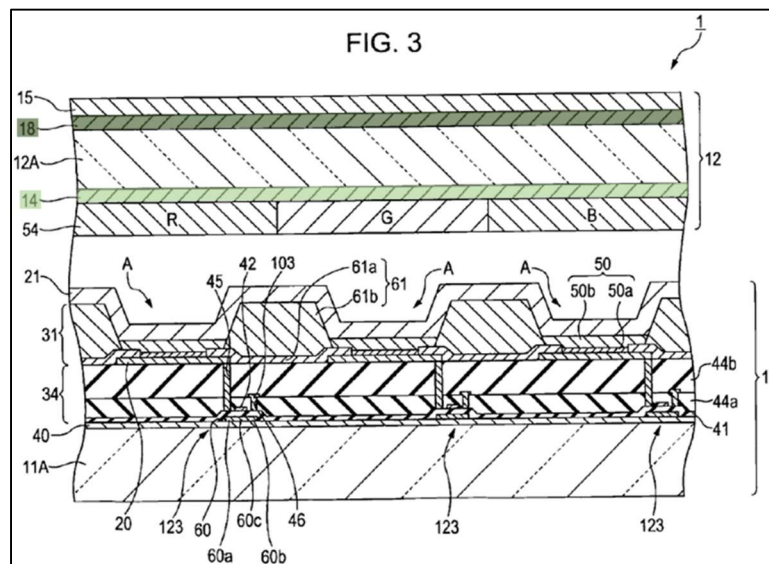
This element would have been obvious to a POSITA based on Diekmann in view of Koshihara. Ex.1003, ¶¶168-169. Koshihara’s touch panel unit includes two touch sensors, a “first detection electrode 14” and a “second detection electrode 18”:



Koshihara, Fig. 3 (annotated), [0031]. Koshihara explains that “[t]he detection unit 16 detects a position at which electrostatic capacitance is generated via the dielectric film 15 between the first detection electrode 14 and the second detection electrode 18 (generated via the dielectric film 15 between the first detection electrode 14, the second detection electrode 18, and a touching object).” *Id.* Thus, Koshihara’s touch-sensitive operating element comprises at least one touch sensor. Ex.1003, ¶¶168-169.

2. Dependent Claim 10: The device according to claim 9, wherein the at least one touch sensor is integrated into the organic light-emitting diode.

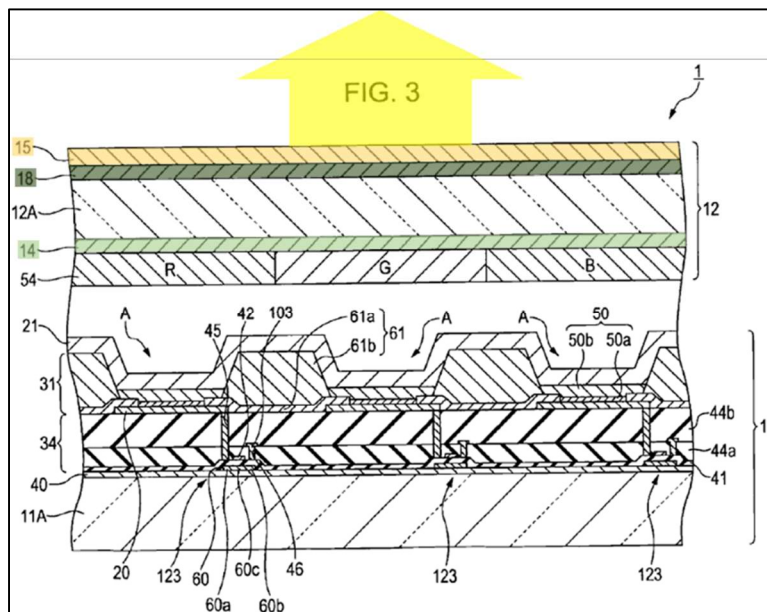
This claim would have been obvious to a POSITA based on Diekmann in view of Koshihara. Ex.1003, ¶¶170-171. As discussed above in §VIII.D.1 regarding claim 9, Koshihara discloses a touch-sensitive operating element (the “touch panel unit”) which includes two touch sensors, “first detection electrode 14” and a “second detection electrode 18.” Koshihara further discloses that these touch sensors are integrated into the organic light-emitting diode. Koshihara’s “first detection electrode 14 is provided on the inner surface of the counter sealing substrate 12,” and its “second detection electrode 18 is provided on the outer surface of the counter sealing substrate 12”:



Koshihara, Fig. 3 (annotated), [0031], [0046]; Ex.1003, ¶¶170-171.

3. Dependent Claim 11: The device according to claim 10, wherein the touch-sensitive operating element is arranged at the radiation exit area of the device.

This claim would have been obvious to a POSITA based on Diekmann in view of Koshihara. Ex.1003, ¶¶172-173. Koshihara discloses a top-emitting OLED, where “light emitted from a light-emitting layer formed on (i.e., in) the element substrate 11 of the top-emission type organic EL device 1 goes out through the counter sealing substrate 12 thereof.” Koshihara, [0029]. Koshihara discloses that its touch-sensitive operating element (the “touch panel unit”) is arranged at the radiation exit area (counter sealing substrate 12): “[t]he first detection electrode 14 is provided on the inner surface of the counter sealing substrate 12” and “[t]he second detection electrode 18 is provided on the outer surface of the counter sealing substrate 12.” *Id.*, [0031]; *see also id.*, [0046]; Ex.1003, ¶¶172-173.



Koshihara, Fig. 3 (annotated).

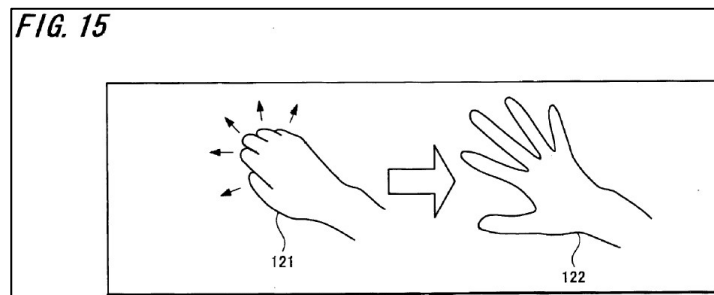
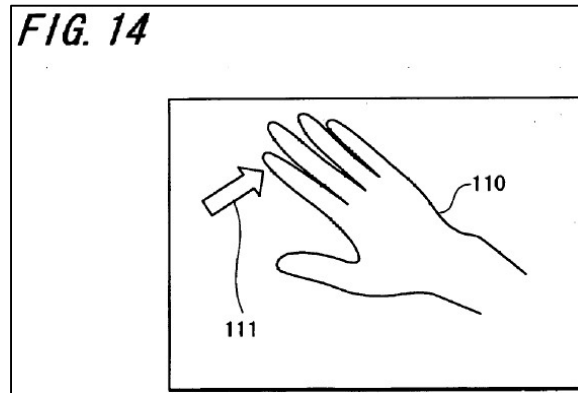
E. Ground V: Claim 12 is obvious over Diekmann in view of Harada

1. Dependent Claim 12: The device according to claim 1, wherein the device is drivable by means of a gesture control.

This claim would have been obvious to a POSITA based on Diekmann in view of Harada. Ex.1003, ¶¶174-178. As explained above in §VIII.A.1.a, Diekmann teaches an OLED and display devices incorporating this OLED. It would have been obvious to a POSITA to implement gesture control for operating Diekmann's OLED as taught by Harada. Ex.1003, ¶¶174-178.

Harada teaches “a display technology capable of receiving light in parallel with emitting light,” which can be applied to “an organic EL (Electro-Luminance) display.” Harada, [0003], [0086]. Specifically, Harada's organic EL display includes an “I/O display” capable of both emitting light and receiving light, which can detect both when the screen is touched and also when an object approaches the screen. *Id.*, [0039], [0050]-[0051], [0082]-[0085]. The display device performs “gesture recognition using a hand shape” by recognizing “the shape of a hand 110 touched (or approached) to a display panel.” *Id.*, [0071]. For one example, shown in Figure 14, “the hand shape recognized is displayed as an image and then with a display object move 111, some processing is performed.” *Id.* For another example, shown in Figure 15, “a hand closed 121 is changed to a hand opened 122 and the touch or approach of the hand (121, 122) in each condition is recognized as an image on the

display panel and the processing based on the image-recognition is executed.” *Id.*, [0072].



Id., Figs. 14, 15. Harada further explains that the device can be operated by providing instructions or commands “based on those recognitions.” *Id.*, [0073]; Ex.1003, ¶¶175-176.

A POSITA would have been motivated to incorporate gesture control functionality in Diekmann’s OLED. Diekmann contemplates its OLED being operable through user control, for example to be switched on or off, or to control the brightness or color of light output. Diekmann, 45-50, 53, 70, 139. Diekmann further contemplates the use of sensors integrated with the OLED for controlling its operation “depending on the measured values determined by the sensor.” Diekmann,

49-50, 64, 143. Indeed, Diekmann explicitly contemplates using a “photodiode” or “photodetector” integrated with the OLED as a sensor for detecting the brightness of light and controlling the operation of the OLED based on the measured value. Diekmann, 49, 137-140, 142. A POSITA would have been motivated to implement gesture control based on the received light as taught by Harada to allow a user to operate the device “in more natural ways.” Harada, [0073]; Ex.1003, ¶¶177-178.

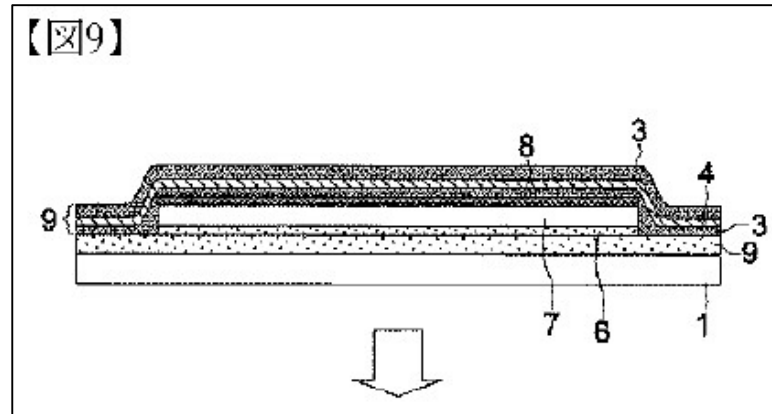
A POSITA would have reasonably expected success in incorporating gesture control functionality in Diekmann’s OLED. OLEDs with integrated sensors for gesture recognition and control were well-known in the art at the time, with applications for controlling the functionality of devices including OLED displays and OLED light sources. Ex.1003, ¶178; Ex.1032; Harada. Implementing gesture control functionality based on light detection as taught by Harada to allow a user to control an OLED would have been a routine matter well within the ability of a POSITA. Ex.1003, ¶178.

F. Ground VI: Suzuki anticipates and renders obvious claims 1, 3, 5-8, 13-16, and 18-19

1. Independent Claim 1

a. Preamble: A device comprising:

To the extent the preamble is limiting, Suzuki discloses it. Ex.1003, ¶¶179-181. Suzuki discloses an OLED, and devices incorporating this OLED. Figure 9, below, illustrates “an organic EL device” according to Suzuki:

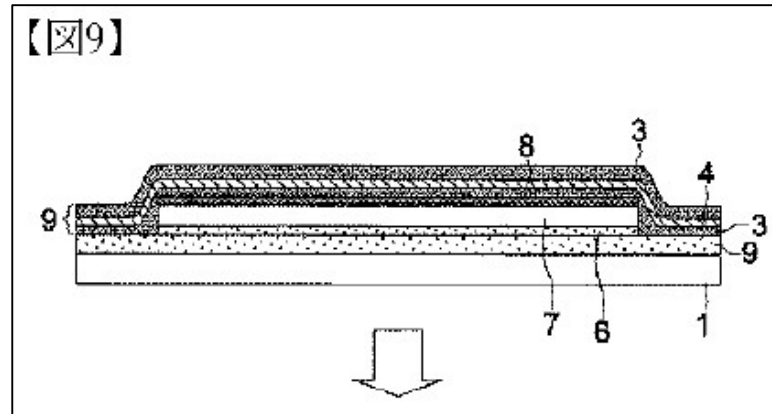


Suzuki, Fig. 9, [0274].

Suzuki explains that “the organic EL element of the present invention can be used as a display device, a display, and various light-emitting light sources” and that the “[d]isplay devices and displays include TVs, PCs, mobile devices, ... information displays in automobiles, and the like,” Suzuki, [0343]-[0344], as well as “[i]llumination devices” such as “home lighting, in-car lighting,” and other devices. Suzuki, [0345].

b. Element 1[a]: an organic light-emitting diode comprising:

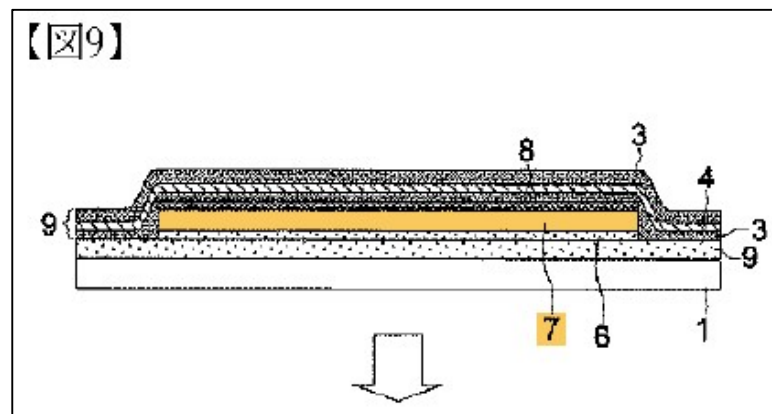
Suzuki discloses this element. Ex.1003, ¶¶182-183. Suzuki discloses “an organic EL device”:



Suzuki, Fig. 9, [0274].

c. Element 1[b]: an organic layer sequence,

Suzuki discloses this element. Ex.1003, ¶¶184-185. Suzuki's OLED includes "an organic layer (comprising a hole transport layer, a light emission layer, an electron transport layer, and the like)." Suzuki, [0274]. Suzuki thus teaches an organic layer sequence (7):



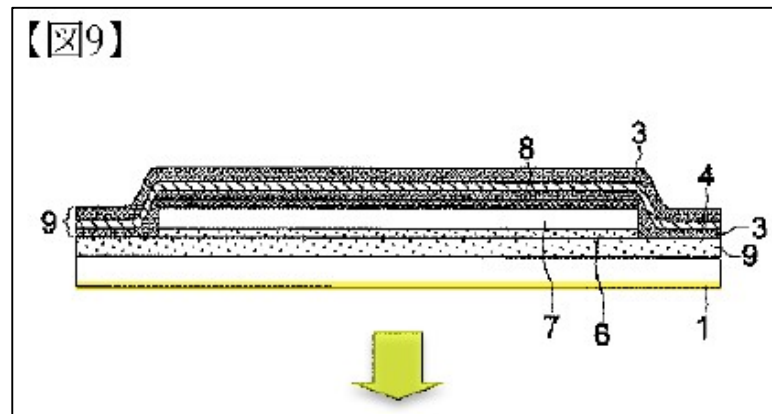
Suzuki, Fig. 9 (annotated); Ex.1003, ¶¶184-185.

d. Element 1[c]: a radiation exit area, and

Suzuki discloses this element. Ex.1003, ¶¶186-187. Suzuki's OLED is bottom-emitting, and the light generated by the OLED exits from the bottom after

passing through the resin substrate (1). Suzuki's radiation exit area is illustrated in Figure 9 below where "the arrow indicate[s] the direction of light extraction."

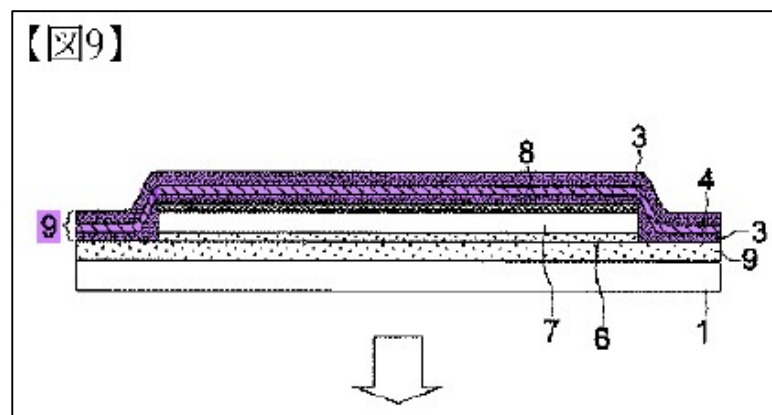
Suzuki, [0274]:



Suzuki, Fig. 9 (annotated); Ex.1003, ¶¶186-187.

e. Element 1[d]: an encapsulation,

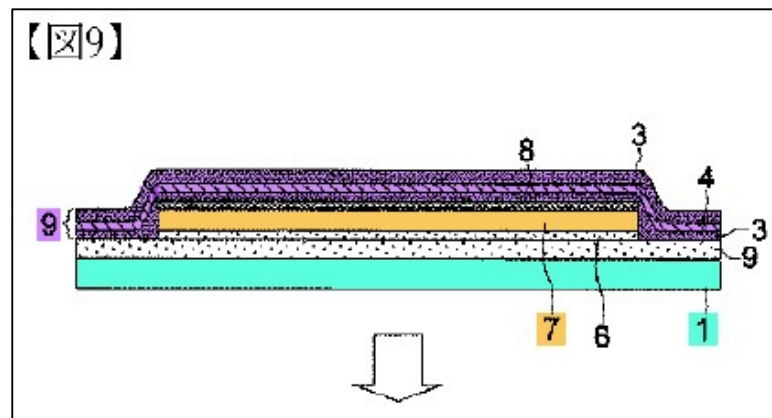
Suzuki discloses this element. Ex.1003, ¶¶188-189. Suzuki's OLED includes an encapsulation in the form of "gas barrier thin film laminate 9" comprising a "buffer film 3," "a barrier film 4," and another "buffer film 3." Suzuki, [0274]. This encapsulation is "formed on the cathode and sealed," *id.*, creating "the sealed organic electroluminescent device[]." *Id.*, [0273].



Suzuki, Fig. 9 (annotated); Ex.1003, ¶¶188-189.

f. Element 1[e]: wherein the organic layer sequence and the encapsulation are disposed on a carrier,

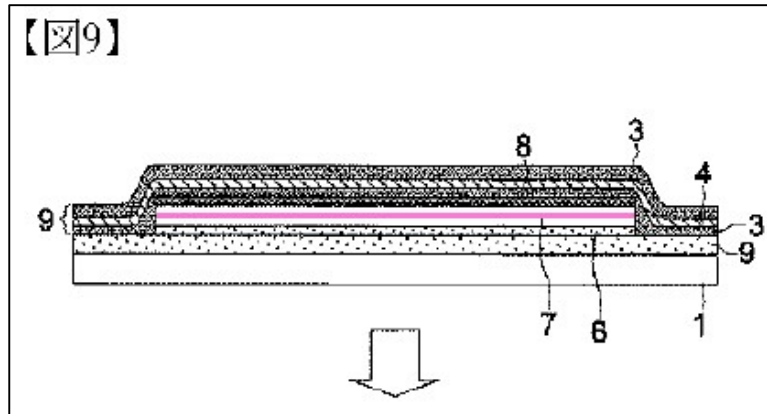
Suzuki discloses this element. Ex.1003, ¶¶190-191. Suzuki's OLED which, as explained above, comprises an organic layer sequence sealed by an encapsulation, is disposed on a carrier, "a resin substrate material 1":



Suzuki, Fig. 9 (annotated), [0121]; Ex.1003, ¶¶190-191.

g. Element 1[f]: 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. Ex.1003, ¶¶192-193. Suzuki's organic layer sequence (organic layer 7) comprises "a light emission layer" containing a light-emitting region in which electromagnetic radiation is emitted in the form of light. Suzuki, [0274]. This radiation-emitting region can be seen highlighted below:



Suzuki, Fig. 9 (annotated); Ex.1003, ¶192.

Suzuki explains that its light emission layer “emits light by recombination of electrons and holes injected from the electrode or the electron transport layer and the hole transport layer...” Suzuki, [0299]. Suzuki also discloses using various “light emission hosts” which “may be used in combination” and explains 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]. For example, “[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.*; Ex.1003, ¶¶192-193.

A POSITA would understand that by disclosing emission of lights of various colors, Suzuki discloses generating electromagnetic radiation in a spectral range from infrared radiation to UV radiation. Ex.1003, ¶193.

h. Element 1[g]: wherein the organic layer sequence comprises an electron transport layer that is n-doped; and

Suzuki discloses or at a minimum suggests this element. Ex.1003, ¶¶194-195. Suzuki's organic layer sequence (organic layer 7) comprises "an electron transport layer," Suzuki, [0274], Suzuki discloses that the "electron transport layer comprises a material having the function of transporting electrons." Suzuki, [0329]. Suzuki specifies that "an electron transport layer with a high n nature doped with impurities can also be used" and lists applications and publications that include examples of this doped electron transport layer. Suzuki, [0333]. A POSITA would understand that this refers to an electron transport layer which has been n-doped, particularly as the publications cited by Suzuki as examples explicitly disclose n-doped electron transport layers. Ex.1003, ¶194; Ex.1019.

Even had Suzuki not disclosed that its doped layer is an n-doped electron transport layer, it would have been obvious to a POSITA to n-dope the electron transport layer in Suzuki's OLED. At the time of the '425 patent, using n-doped electron transport layers was well-known in the art. Ex.1003, ¶¶37-42, 195; *see also*, *e.g.*, Exs. 1016, 1019, 1029, 1030. A POSITA would have been motivated to include an n-doped electron transport layer to promote transport of electrons from the cathode and to improve electron injection and transport to the light-emitting region. Ex.1003, ¶¶37-42, 195; Ma, 812. A POSITA would have had a reasonable

expectation of success, as n-doped electron transport layers were widely used at the time in OLEDs for this reason, and this would have been a straightforward, routine modification to Suzuki's electron transport layer. Ex.1003, ¶195.

i. Element 1[h]: wherein the organic layer sequence comprises an emission layer comprising an iridium-containing compound.

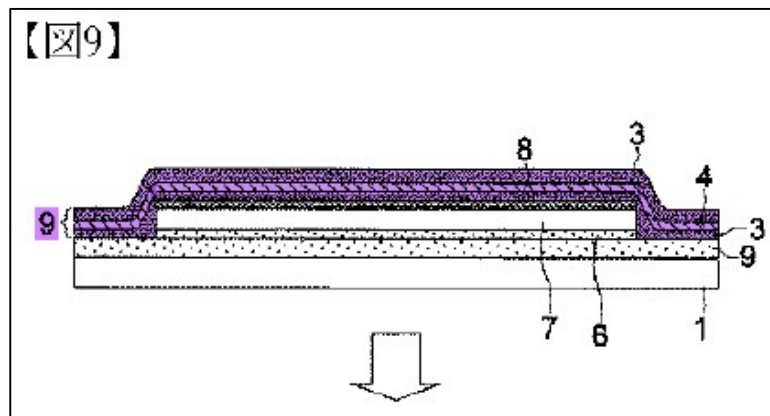
Suzuki discloses this element. Ex.1003, ¶¶196-197. Suzuki's organic layer sequence (organic layer 7) comprises "a light emission layer." Suzuki, [0274], [0299]. Suzuki discloses that the light emission layer "preferably contains a host compound and a dopant compound" "for even higher light emission efficiency." Suzuki, [0300]. Suzuki further discloses that there are "two major types of light emission dopants: fluorescent dopants, which emit fluorescence, and phosphorescent dopants, which emit phosphorescence" and that for phosphorescent dopants, "*iridium* compounds are the most preferable." Suzuki, [0301], [0303] (emphasis added). Thus, Suzuki discloses an organic layer sequence wherein the light emission layer includes an iridium-containing compound. Ex.1003, ¶¶196-197.

2. Dependent Claim 3

a. The device of claim 1, wherein at least one part of the encapsulation is formed by an insulation layer,

Suzuki discloses this element. Ex.1003, ¶¶198-199. Suzuki's OLED includes an encapsulation, "gas barrier thin film laminate 9," comprising a "buffer film 3," "a barrier film 4," another "buffer film 3," and then a "ceramic (silicon oxide film)."

Suzuki, [0274]. Suzuki defines a barrier film as “a dense film with a low water vapor transmission coefficient comprising a ceramic composition with low or no carbon content and having at least Si and O atoms” and defines a buffer film as “a flexible film with a larger water vapor transmission coefficient and a lower density than the barrier film consisting of a film with a high content of carbon atoms with Si, O, and C atoms.” Suzuki, [0117]. A POSITA would understand that barrier film 4, which is a dense intervening layer of insulation between the two more permeable, flexible buffer layers 3, is an insulating layer. Ex.1003, ¶¶198-199.



Suzuki, Fig. 9 (annotated).

- b. wherein the insulation layer comprises at least one of: resin, silicon oxide, silicon nitride.**

Suzuki discloses or at a minimum suggests this element. Ex.1003, ¶¶200-201. As discussed above regarding claim 3[a], Suzuki’s encapsulation is comprised of a buffer film and a barrier film, the latter being an insulation layer. Suzuki, [0274]. Suzuki further discloses that it is preferable that the buffer film and barrier film be

made from “at least one of *silicon oxide*, silicon oxide nitride, and *silicon nitride*.” Suzuki, [0068]-[0069] (emphases added). Suzuki thus discloses an insulation layer that includes silicon oxide or silicon nitride. Ex.1003, ¶200.

Moreover, at the time of the ’425 patent, using an insulation layer comprised of resin, silicon oxide, or silicon nitride, well-known insulating materials, was known in the art. Ex.1003, ¶¶43-44, 201; *see also, e.g.*, Diekmann, 15. These materials would have been obvious for a POSITA to use in Suzuki’s insulation layer. A POSITA would have had a reasonable expectation of success in doing so as this would have been a straightforward, routine modification to Suzuki’s encapsulation. Ex.1003, ¶201.

3. Dependent Claim 5: The device according to claim 1, wherein the organic light-emitting diode comprises a hole transport layer that is p-doped.

Suzuki discloses or at a minimum renders obvious this claim. Ex.1003, ¶¶202-205. Suzuki’s organic layer 7 comprises a “hole transport layer.” Suzuki, [0274], [0323]. Suzuki specifies that “a hole transport layer with a high p nature doped with impurities can also be used” and lists applications and publications as examples of this hole transport layer. Suzuki, [0328]. A POSITA would understand that “a hole transport layer with a high p nature doped with impurities” refers to a hole transport layer which has been p-doped, particularly as the publications cited by Suzuki as

examples of this hole transport layer explicitly disclose p-doped hole transport layers. Ex.1003, ¶¶202; Ex.1019.

Even had Suzuki not disclosed that its doped layer is an p-doped hole transport layer, it would have been obvious to a POSITA to p-dope the hole transport layer in Suzuki's OLED. As discussed above in §VIII.A.3, p-doped hole transport layers were well-known for OLEDs at the time and, in particular, it was well-known that using a p-doped hole transport layer could improve current and power efficiencies of the OLED. Ex.1003, ¶¶37-42, 202-205; Ma, 810.

Moreover, as explained above in §VIII.A.3 regarding Diekmann, POSITA would have recognized that it would have been beneficial to use a p-doped hole transport layer together with an n-doped electron transport layer which, as explained above in §VIII.F.1.h, Suzuki also discloses. A POSITA would understand, as taught by Ma, that an OLED can achieve a good balance of electrons and holes by including an p-doped hole transport layer and n-doped electron transport layer resulting in "good lifetime." Ex.1003, ¶¶37-42, 205; *see also* Ex.1019, Abstract; Ex.1029, 5-14; Ex.1030, 3911-12.

A POSITA would have reasonably expected success in using a p-doped hole transport layer together with an n-doped electron transport layer in Suzuki's OLED. Suzuki already contemplates both an n-doped electron transport layer and a p-doped hole transport layer and "*p-i-n*" OLEDs with both n-doped and p-doped transport

layers were well-known by the time of the '425 patent. Ex.1003, ¶¶204-205; *see also* Ex.1019; Ex.1029; Ex.1030.

4. Dependent Claim 6

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

Suzuki discloses this element. Ex.1003, ¶206. Suzuki discloses that in its OLED “[a] color filter, some other hue improvement 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, [0336]. 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]. A POSITA would understand that for the color filter to have this effect it is placed between the light emission layer and the radiation exit area (i.e., the light must be generated, pass through the color filter, and then exit the device as colored light). Ex.1003, ¶206.

- b. wherein the color filter is configured to be highly transmissive for a first spectral subrange of the generated electromagnetic radiation and highly absorbant for a second spectral subrange of the generated electromagnetic radiation.**

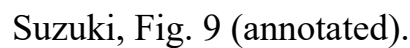
Suzuki discloses this element. Ex.1003, ¶207. Suzuki discloses that the color filters described above correspond to (i.e., are highly transmissive to) a particular

wavelength range and are relatively absorbent to wavelengths falling outside of that wavelength 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] (emphasis added). As discussed above, §VIII.A.4, each “color filter is suitable for filtering light of a specific wavelength range” meaning that “light of this wavelength range is at least partially absorbed by the color filter.” Ex.1003, ¶107; Diekmann, 40. Thus, “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.* As such, a POSITA would understand that Suzuki discloses color filters which are highly transmissive to one spectral subrange of generated electromagnetic radiation while also being highly absorbent to another spectral subrange. Ex.1003, ¶107.

5. Dependent Claim 7: The device according to claim 1, wherein the encapsulation is flexible.

Suzuki discloses this claim. Ex.1003, ¶¶208-209. Suzuki’s OLED includes an encapsulation comprised of a “buffer film 3,” “a barrier film 4,” another “buffer film 3,” and a “ceramic (silicon oxide film).” Suzuki, [0274].

Suzuki explains that this combination of buffer films and barrier films allows the encapsulation to be flexible as “the barrier film, which has a high density and low gas and moisture vapor permeability, is a ceramic film that has a dense structure, is rigid, and breaks easily, and therefore by laminating a flexible ceramic film with



- 6. Dependent Claim 8: The device according to claim 7, wherein the carrier comprises a film, a plastic film or a laminate.**

Suzuki discloses this claim. Ex.1003, ¶¶210-211. Suzuki’s OLED includes a carrier, “resin substrate material 1,” which comprises a polymer (i.e., “plastic”) film:



Suzuki, Fig. 9 (annotated). Suzuki explains that “a polyethylene terephthalate (PET) film is used as the resin substrate material...” Suzuki, [0121]. Thus, Suzuki discloses a carrier comprising polyethylene terephthalate (PET), a polymer. Ex.1003, ¶¶210-211.

7. Dependent Claim 13: The device according to claim 1, 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 this claim. Ex.1003, ¶¶212-214. Suzuki’s OLED comprises “a cathode 8.” Suzuki, [0274]. Suzuki discloses that in order for the emitted light to pass through, it is preferable that “either the anode or 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 of the metal described above to 1-20 nm thick.” *Id.*, [0289]

Suzuki’s range overlaps the claimed range, and the upper bound of 21-50 nm in the claimed range is not critical to the claimed invention; the ’425 patent specification merely describes the 1-50 nm range as an example thickness for a transparent metal layer. *See* ’425 patent, 3:1-4, 5:16-41, 32:13-22; Ex.1003, ¶¶212-213. Moreover, Suzuki also discloses that, in general, a cathode’s “film thickness is ordinarily chosen in the range of 10 nm to 5 μ m,” while the 1-20 nm range is taught for a cathode which is transparent or semi-transparent. Suzuki, [0288]. As such,

Suzuki discloses the cathode having a thickness which falls within the claimed range of 1 nm to 50 nm. Ex.1003, ¶¶212-213.

Even had Suzuki not disclosed that its cathode was in the 1-50 nm range, it would have been obvious to a POSITA to use a cathode with a thickness in the 1-50 nm range in Suzuki's OLED. As discussed above, §VIII.A.7, the use of thin cathodes was well-known for OLEDs at the time and, in particular, it was well-known using a cathode that was sufficiently thin to be transparent or semi-transparent would enable the light generated by the OLED to exit the device. Ex.1003, ¶¶24-25, 212-213; *see also* Ex.1022, 29; Ex.1033, 3921-3923. A POSITA would have been motivated to use a cathode with a thickness between 1-50nm in Suzuki's OLED to achieve these benefits and would have reasonably expected success in making the well-known, routine modification of utilizing a thin transparent or semi-transparent cathode in Suzuki's OLED. Ex.1003, ¶214.

8. Dependent Claim 14: The device according to claim 13, wherein the cathode comprises one of: silver, magnesium, or an alloy comprising silver and magnesium.

Suzuki discloses this claim. Ex.1003, ¶215. Suzuki explains that it is preferable that its cathode be made from conductive materials with “small work functions (4 eV or lower)” such as “magnesium” and “magnesium/silver mixtures” (i.e., a magnesium and silver alloy). Suzuki, [0288]; Ex.1003, ¶215. Thus, Suzuki

discloses a cathode comprising magnesium or an alloy comprised of silver and magnesium. Ex.1003, ¶215.

9. Dependent Claim 15: The device according to claim 13, wherein the cathode is in direct contact with a lithium containing layer.

Suzuki discloses this claim. Ex.1003, ¶¶216-218. Suzuki discloses an “injection layer” located “between the cathode and the light emission layer or electron transport layer” which “includes a hole injection layer (anode buffer layer) and an electron injection layer (cathode buffer layer).” Suzuki, [0293]. This “cathode buffer layer” is the layer immediately following the cathode, and thus in direct contact with it. Suzuki discloses that the layers are stacked in the following order, with the cathode being stacked directly on top of the cathode buffer layer: “anode / anode buffer layer / hole transport layer / light emission layer / hole blocking layer / electron transport layer / *cathode buffer layer* / *cathode*.” Suzuki, [0287] (emphasis added); Ex.1003, ¶¶216-217.

Suzuki further discloses using as a cathode buffer layer “alkali metal compound buffer layers typified by *lithium fluoride*...” Suzuki, [0295] (emphasis added). Thus, Suzuki discloses the cathode in direct contact with the electron injection layer containing lithium. Ex.1003, ¶218.

- 10. Dependent Claim 16: The device according to claim 13, wherein the cathode comprises silver, magnesium, or alloy consisting of at least one of the abovementioned materials.**

Suzuki discloses this claim for the same reasons explained above with regards to claim 14 in §VIII.F.8. Ex.1003, ¶219.

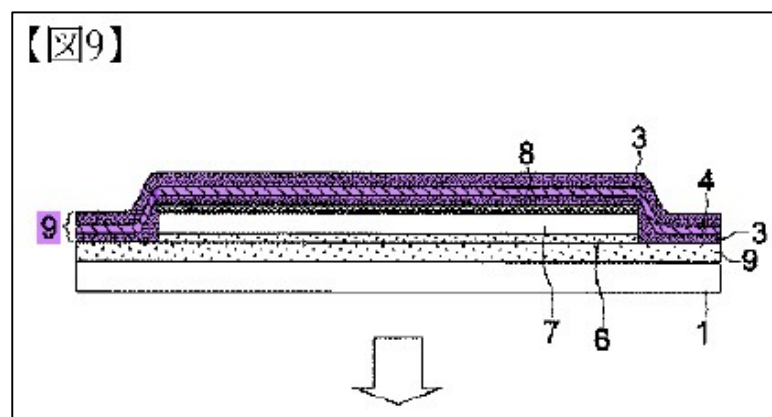
11. Dependent Claim 18

- a. The device according to claim 1, wherein at least one part of the encapsulation is formed by an insulation layer, which can contain at least one of the following electrically insulating materials: resin, silicon oxide, silicon nitride,**

Suzuki discloses this element for the same reasons explained above with regards to claim 3 in §VIII.F.2. Ex.1003, ¶220.

- b. and wherein at least one part of the encapsulation is formed by a PECVD method.**

Suzuki discloses this element. Ex.1003, ¶¶221-222. As discussed above, Suzuki's OLED includes an encapsulation, "gas barrier thin film laminate 9."



Suzuki, Fig. 9 (annotated). Suzuki explains that in forming each of the layers of gas barrier thin film laminate 9 it is preferable to "apply a *plasma CVD method* using

plasma polymerization...” Suzuki, [0165] (emphasis added). A POSITA would understand that “plasma CVD method” refers to plasma-enhanced chemical vapor deposition (PECVD). Thus, Suzuki discloses the layers of the encapsulation are formed using PECVD method. Ex.1003, ¶222.

12. Dependent Claim 19: The device according to claim 1, wherein the organic light-emitting diode is configured for installation in a vehicle.

Suzuki discloses this claim. Ex.1003, ¶223. Suzuki explains that “the organic EL element of the present invention can be used as a display device, a display, and various light-emitting light sources” including “TVs, PCs, mobile devices, ... *information displays in automobiles*, and the like.” Suzuki, [0343]-[0344] (emphasis added). Suzuki further discloses that “[i]llumination devices using the organic EL element of the present invention include, but are not limited to, home lighting, *in-car lighting*,” and other devices. Suzuki, [0345] (emphasis added). Thus, Suzuki discloses the organic light emitting diode configured for installation in a vehicle. Ex.1003, ¶223.

G. Ground VII: Claims 2, and 17 are obvious over Suzuki in view of Ma

1. Dependent Claim 2: The device of claim 1, wherein the electron transport layer comprises 8-hydroxyquinolinolato-lithium.

Claim 2 would have been obvious to a POSITA based on Suzuki in view of Ma. Ex.1003, ¶¶224-228. As explained above in §VIII.F.1.h, Suzuki teaches or at a

minimum suggests an n-doped electron transport layer. It would have been obvious to a POSITA to use 8-hydroxyquinolinolato-lithium (“Liq”) as the dopant in Suzuki’s n-doped electron transport layer which, as discussed above in §VIII.B.1, is taught by Ma. Ma, Abstract, 810-811; Ex.1003, ¶224.

A POSITA would have been motivated to use an Liq-doped electron transport layer of Ma in the organic layer stack of Suzuki due to the known benefits of an Liq-doped electron transport layer, discussed above in §VIII.B.1. Ex.1003, ¶¶32-42, 225-228. A POSITA would have reasonably expected success in using an Liq-doped electron transport layer in Suzuki’s OLED for the same reasons discussed above with regards to Diekmann’s OLED. Ex.1003, ¶¶225-228. Moreover, Suzuki already contemplates an n-doped electron transport layer, so using an Liq-doped electron transport layer merely involves using a different dopant. This would be a routine matter well within the ability of a POSITA. Ex.1003, ¶228.

2. Dependent Claim 17: The device according to claim 1, wherein the electron transport layer comprises at least 8-hydroxyquinolinolato-lithium.

Claim 17 would have been obvious to a POSITA based on Suzuki in view of Ma for the same reasons articulated above with regards to claim 2. Ex.1003, ¶229.

H. Ground VIII: Claim 4 is obvious over Suzuki in view of Lee

1. Dependent Claim 4

- a. The device of claim 1, wherein the encapsulation comprises a first encapsulation layer and a second encapsulation layer,**

This element would have been obvious to a POSITA based on Suzuki in view of Lee. Ex.1003, ¶¶230-233. As discussed above, §VIII.C.1, Lee teaches an OLED with two encapsulation layers with independent volume structures and different levels of crystallinity. A POSITA would have been motivated to integrate the encapsulation layers taught by Lee into the OLED of Suzuki in order to protect the OLED from outside materials and improve the lifetime of the device for the same reasons discussed above in §VIII.C.1 with regards to Diekmann. Ex.1003, ¶¶148-152, 230-232.

A POSITA would have reasonably expected success in combining Lee's multi-layered encapsulation with Suzuki's OLED. Ex.1003, ¶233. Suzuki already contemplates a multi-layered encapsulation with alternating layers of relatively flexible and permeable "buffer films" and dense, less permeable "barrier films." Indeed, as explained above in §VIII.C.1.a, the use of such a multilayer OLED encapsulation consisting of alternating organic and inorganic layers was well-known in the art at the time. Ex.1003, ¶¶43-44, 231-232; *see also, e.g.*, Exs. 1020, 1021. Applying Lee's encapsulation merely replaces one set of alternating layers with

another, to obtain the benefits taught in Lee, which would have been well within the ability of a POSITA. Ex.1003, ¶233.

b. the first and the second encapsulation layer each having a respective volume structure,

This element would have been obvious to a POSITA based on Suzuki in view of Lee. Ex.1003, ¶¶234-235. As discussed in §VIII.C.1.b above, the encapsulation taught by Lee includes a first and second encapsulation layer each having respective, independent volume structures, regardless of how the term “volume structure” is defined. Ex.1003, ¶¶234-235.

c. wherein the volume structure of the second encapsulation layer is independent of the volume structure of the first encapsulation layer, and

This element would have been obvious to a POSITA based on Suzuki in view of Lee. Ex.1003, ¶¶236-237. As discussed above in §VIII.C.1.c, Lee discloses a first and second encapsulation layer with volume structures which are distinct and independent from one another: the first (highly crystalline) encapsulation layer has “up to 70% of crystallinity” and the second (semi-crystalline) encapsulation layer has “at least 10%” of crystallinity. Lee, [0023]; Ex.1003, ¶¶236-237.

d. the volume structure of the second encapsulation layer has a higher amorphicity than the volume structure of the first encapsulation layer.

This element would have been obvious to a POSITA based on Suzuki in view of Lee. Ex.1003, ¶¶238-239. As discussed above in §VIII.C.1.d, Lee discloses that

its second (semi-crystalline) encapsulation layer has a lower crystallinity, and thus a higher amorphicity, than its first (highly crystalline) encapsulation layer. *Id.*

I. Ground IX: Claims 9-11 are obvious over Suzuki in view of Caldwell

1. Dependent Claim 9

- a. The device according to claim 1, wherein the device comprises at least one touch-sensitive operating element,**

This element would have been obvious to a POSITA based on Suzuki in view of Caldwell. Ex.1003, ¶¶240-243. Suzuki teaches an OLED, and display devices incorporating this OLED. *See above* §VIII.D.1. It would have been obvious to a POSITA to implement touch sensing functionality in an OLED according to Suzuki by incorporating touch-sensitive operating elements such as those taught by Caldwell. Ex.1003, ¶240.

Caldwell teaches a touch-sensitive operating element (a “bottom-emitting touch switch assembly”) comprising at least one touch sensor (electrode 31). Caldwell discloses that the electrode 31 is integrated into the bottom-emitting device which comprises an emissive stack (22), cathode (23), anode (21), wherein the touch electrode 31 “is shown overlying anode 21, which in turn overlies emissive stack 22 and cathode 23” which is “borne on substrate 20” and includes an “[i]nsulating layer 50 [which] separates electrode 31 from the layers of the light emitting device.” Caldwell, [0074]; Ex.1003, ¶¶240-242.

A POSITA would have been motivated to incorporate touch sensing functionality taught by Caldwell into Suzuki's OLED. Using touch sensors as input devices for controlling electronic devices was well-known by the time of the '425 patent. Ex.1003, ¶¶241-242; *see also, e.g.*, Koshihara, [0030]-[0031]. Further, a POSITA would have recognized the benefits of integrating Caldwell's touch sensor directly into Suzuki's OLED. Caldwell teaches that "backlighting can be advantageously aligned with an operative touch surface" and that integrating a touch sensor directly into the light emitting device can "greatly reduce the cost and complexity of using backlighting with touch sensors" and can, for example, "reduce or eliminate the extra material and manufacturing cost associated with the separate touch sensor and lighting assemblies known in the art, which must be electrically coupled and aligned." Caldwell, [0006]-[0007]; Ex.1003, ¶242. An integrated touch sensor would also result in a thinner profile for the OLED. Ex.1003, ¶242; *see also* Ex.1024.

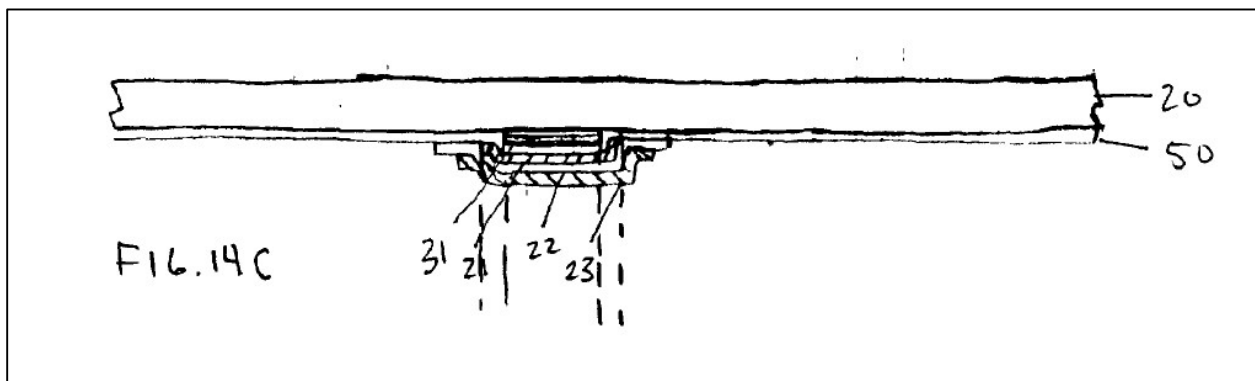
A POSITA would have reasonably expected success in incorporating touch sensing functionality in Suzuki's OLED. As discussed above, incorporating touch sensors in OLEDs was well-known at the time, and integrating Caldwell's touch sensor into Suzuki's OLED would have been a routine matter well within the ability of a POSITA. Ex.1003, ¶243.

- b. wherein the at least one touch-sensitive operating element comprises at least one touch sensor.**

This element would have been obvious to a POSITA based on Suzuki in view of Caldwell. Ex.1003, ¶244. As articulated above regarding claim 9[a], Caldwell discloses a touch-sensitive operating element (a “bottom-emitting touch switch assembly”) which comprises at least one touch sensor (electrode 31). *Id.*

- 2. Dependent Claim 10: The device according to claim 9, wherein the at least one touch sensor is integrated into the organic light-emitting diode.**

This claim would have been obvious to a POSITA based on Suzuki in view of Caldwell. Ex.1003, ¶¶245-246. Caldwell teaches that its touch sensor (electrode 31) is directly integrated into a bottom-emitting OLED. For example, Figure 14C of Caldwell below illustrates “a bottom-emitting touch switch with integrated control circuit assembly according to the present invention including a touch switch with integrated control circuit assembly.” Caldwell, [0074].

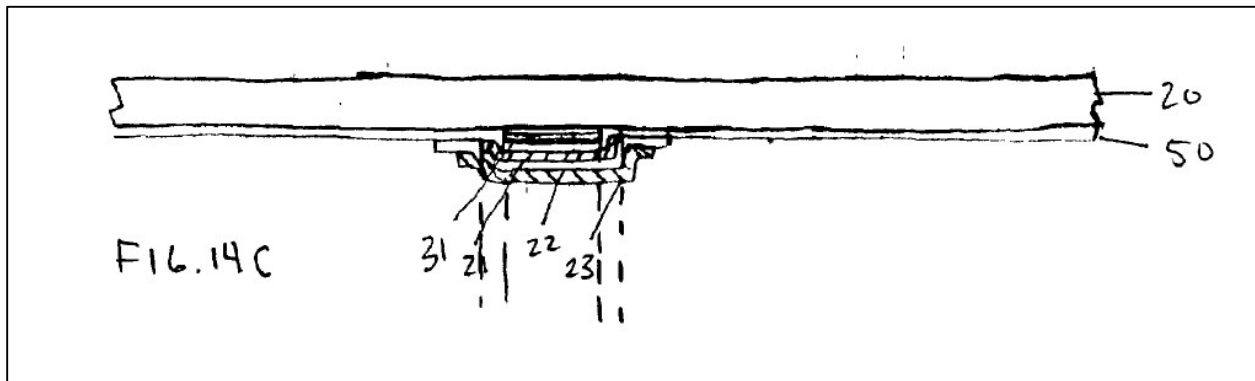


Caldwell, Fig. 14C. Much like the OLED taught by Suzuki, Figure 14C depicts a bottom-emitting OLED which comprises an emissive stack (22), cathode (23), anode

(21), and a touch electrode (31). Caldwell, [0074]. Caldwell teaches that its touch sensor is directly integrated into the OLED as the touch electrode “is shown overlying anode 21, which in turn overlies emissive stack 22 and cathode 23” which is “borne on substrate 20.” Caldwell, [0074]; Ex.1003, ¶¶245-246. Likewise, “[e]lectrode 31 and anode 21 are also preferably transparent.” *Id.*

3. Dependent Claim 11: The device according to claim 10, wherein the touch-sensitive operating element is arranged at the radiation exit area of the device.

This claim would have been obvious to a POSITA based on Suzuki in view of Caldwell. Ex.1003, ¶¶247-248.



Caldwell, Fig. 14C. As seen in Figure 14C above, Caldwell discloses that its touch sensor, (touch electrode 31), is arranged at the “radiation exit area” at bottom of the bottom-emitting OLED (i.e., the area where the light generated by the OLED exits from) allowing light to be exit through the transparent touch electrode. Caldwell, [0074]; Ex.1003, ¶¶247-248.

J. Ground X: Claim 12 is obvious over Suzuki in view of Harada

1. Dependent Claim 12: The device according to claim 1, wherein the device is drivable by means of a gesture control.

This claim would have been obvious to a POSITA based on Suzuki in view of Harada. Ex.1003, ¶¶249-253. It would have been obvious to a POSITA to implement gesture control for operating Suzuki's device. *Id.*

As explained above §VIII.E.1, Harada teaches a display device which performs "gesture recognition using a hand shape" by recognizing "the shape of a hand 110 touched (or approached) to a display panel." *Id.*, [0071]; Ex.1003, ¶¶174-178, 249-253.

A POSITA would have been motivated to incorporate this gesture control functionality in Suzuki's device to allow a user to operate the device "in more natural ways." Harada, [0073]; Ex.1003, ¶¶174-177. As explained above, §VIII.E, gesture control input for controlling electronic devices, including OLED displays, was well-known by the time of the '425 patent. Ex.1003, ¶¶177-178. Moreover, Harada teaches that its gesture control functionality can be applied to OLEDs. Harada, [0003].

A POSITA would have reasonably expected success in incorporating gesture control functionality in Suzuki's device. Implementing gesture control functionality based on light detection as taught by Harada to allow a user to control an OLED

would not have led to unpredictable results, and would have been a routine matter well within the ability of a POSITA. Ex.1003, ¶178.

IX. DISCRETIONARY DENIAL IS INAPPROPRIATE

A. Section 314(a)

The Board should decline to exercise its discretion to deny institution under 35 U.S.C. § 314(a) and *Apple Inc. v. Fintiv, Inc.*, IPR2020-0019, Paper 11 (P.T.A.B. Mar. 20, 2020) (precedential). While the '425 patent has been asserted in *Pictiva Displays International Ltd. v. Samsung Electronics Co., Ltd., et al.*, Case No. 2:23-cv-00495 (E.D. Tex.), that case remains in a very early stage. The '425 patent was first asserted on March 1, 2024. Infringement contentions were served on March 11. Invalidity contentions were served on June 10, 2024. The court issued its initial scheduling order on April 17, scheduling a trial for August 2025. *See* Ex.1035.

Accordingly, the parties have made no material investments in the parallel litigation. Discovery is still in its early stages (with the deadline for fact discovery being March 10, 2025), and the claim construction process has not even begun (the parties will not exchange their proposed claim terms for construction until October 1, 2024). Additionally, this Petition is being filed just three and a half months after service of infringement contentions, demonstrating that Petitioner has acted with diligence in preparing its patent challenge. Finally, Patent Owner will need to narrow the asserted claims in advance of any trial, *see* Ex.1035, 1, such that a trial could not

resolve all of Petitioner's claim challenges. Discretionary denial is further inappropriate because this Petition presents compelling evidence of unpatentability, for the reasons discussed in §VIII, above.

B. Section 325(d)

The Board should likewise not deny institution under 35 U.S.C. § 325(d) and *Advanced Bionics, LLC v. MED-EL Elektromedizinische Geräte GmbH*, IPR2019-01469, Paper 6 (P.T.A.B. Feb. 13, 2020) (precedential).

Here, the Examiner materially erred under *Advanced Bionics* by misapprehending or overlooking Diekmann's disclosures during prosecution of the '425 Patent. *Id.*, 8. "[I]f the record of the Office's previous consideration of the art is not well developed or silent, then a petitioner may show the Office erred by overlooking something persuasive." *Advanced Bionics*, 10. "An example of a material error may include misapprehending or overlooking specific teachings of the relevant prior art where those teachings impact patentability of the challenged claims." *Id.*, 8, n.9.

The Examiner of the ancestor '514 Application, which shares the same specification as the '425 Patent, rejected numerous then-pending claims over Diekmann. Ex.1025, 1406-1413. The claims of that application were ultimately allowed only because they included specific limitations identified by the '514 Examiner as including allowable subject matter. Ex.1025, 1413-1414, 2055-2056.

The '425 Patent claims, however, do not include those limitations. Nonetheless, the Examiner of the '425 Patent—a different Examiner from the '514 Examiner—did not rely on Diekmann or issue any prior art rejections consistent with those in the '514 Application.

The '425 Examiner's identification of limitations that the Examiner believed constitute allowable subject matter highlights the Examiner's error. The '425 Examiner stated that the prior art of record "fails to disclose or fairly suggest...‘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, wherein the organic layer sequence comprises an electron transport layer that is n- doped; and wherein the organic layer sequence comprises an emission layer comprising an iridium-containing compound,’" in combination with the remaining limitations in the independent claim. Ex.1002, 267-268. But the '514 Examiner *expressly* determined that Diekmann teaches "a plurality of functional layers...which comprise at least one radiation-emitting region in which electromagnetic radiation is generated during the operation of the organic light-emitting diode...wherein the organic light-emitting diode generates electromagnetic radiation in the spectral range from infrared radiation to UV radiation during operation." Ex.1025, 1407. And as explained above, Diekmann further discloses or renders obvious each of the limitations of the

independent claim, including the two other “wherein” clauses identified by the ’425 Examiner as missing from the prior art of record. *See supra* §VIII.A.1. The ’425 Examiner therefore materially erred in allowing the Challenged Claims.

X. CONCLUSION

Petitioner respectfully requests *inter partes* review and cancellation of all claims of the ’425 patent.

Date: July 3, 2024

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 13,900 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: July 3, 2024

/Scott C. Weidenfeller/
Scott C. Weidenfeller (Reg. No. 54,531)

CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. §§ 42.6 and 42.105, I hereby certify that on July 3, 2024, I caused a true and correct copy of the foregoing Petition for *Inter Partes* Review of U.S. Patent No. 11,828,425, supporting exhibits, and Power of Attorney to be served via Priority Mail Express on the Patent Owner at the following correspondence address of record as listed on the USPTO Patent Center:

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Petition for *Inter Partes* Review of U.S. Patent No. 11,828,425

Date: July 3, 2024

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