

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

PATENT OWNER'S PRELIMINARY RESPONSE

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<i>Virtek Vision Int’l ULC v. Assembly Guidance Sys.</i> , 97 F.4th 882 (Fed. Cir. 2024)	38
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EXHIBIT LIST

Exhibit No.	Document Description
EX2001	Declaration of Dr. Marc Sims
EX2002	Dictionary definition of “matrix” from online version for A Dictionary of Chemistry (6th ed.), Oxford University Press (2008), available from https://www.oxfordreference.com/display/10.1093/acref/9780199204632.001.0001/acref-9780199204632-e-2628?rskey=JZee15&result=2921 (last access Oct. 25, 2024)
EX2003	Dictionary definition of “matrix” from Merriam-Webster’s Collegiate Dictionary (11th ed.), Merriam-Webster, Incorporated (2007)
EX2004	Dictionary definition of “matrix” from Cambridge Advanced Learner’s Dictionary, Cambridge University Press (2003)
EX2005	Samsung Proposed Claim Constructions for the Terms and Phrases Identified for Construction per Local Patent Rule 4-2 in <i>Pictiva Displays Int’l Ltd. v. Samsung Electronics Co. Ltd., et al.</i> , Case No. 2:23-cv-000495 (E.D. Tex. Oct. 22, 2024)
EX2006	Harald Gross et al., <i>High Power Efficiencies at Record Lifetimes: NOVALED’s PIN-OLEDs</i> , FPD Yokohama 2005 (obtained from IPR2024-01095)
EX2007	B.C. Krummacher et al., <i>General method to evaluate substrate surface modification techniques for light extraction enhancement of organic light emitting diodes</i> , 100 J. Appl. Phys. 054702 (2006)
EX2008	Chelsea M. Hess et al., <i>Dielectric Dependence of Single-Molecule Photoluminescence Intermittency: Nile Red in Poly(vinylidene fluoride)</i> , 118 J. Phys. Chem. 8905-8913 (2014)
EX2009	E. H. Martin & J. Hirsch, <i>Charge Transport and Carrier Mobilities in Insulating Polymers</i> , 4 J. Non-Crystalline Solids 133-137 (1970)

EX2010	Ying Wang et al., <i>Hole mobility and conductance of iridium complex doped NPB emission layers for organic light-emitting diodes</i> , 244 Synthetic Metals 61-65 (2018)
EX2011	WO2002/074015 to Thompson & Forrest (“Thompson WO”)
EX2012	Dictionary definition of “matrix” from A Dictionary of Chemistry (5th ed.), Oxford University Press (2004)
EX2013	Dictionary definition of “matrix” from Chambers Dictionary of Science and Technology, Chambers (2007)
EX2014	Federal Court Management Statistics for U.S. District Courts, available from https://www.uscourts.gov/statistics/table/na/federal-courtmanagement-statistics/2024/06/30-1
EX2015	Samsung Invalidity Contentions in <i>Pictiva Displays Int’l Ltd. v. Samsung Electronics Co. Ltd., et al.</i> , Case No. 2:23-cv-000495 (E.D. Tex. Jun. 11, 2024)

I. Introduction

As the inventors succinctly summarize in the '164 patent, in OLEDs, [i]n the emission layer, excitons are formed by a recombination of electrons and “holes,” which lead to light emission. In order to obtain a high efficiency of the electronic device, the ratio between electrons and “holes” which are transported in the emission layer is decisive. A nonbalanced ratio between hole and electron transport results in a low radiation efficiency of the device.

EX1001, 1:23-29. The inventors' solution to this problem is to include in the emission layer at least three matrix materials, one with hole transport property, a second with electron transport property, and a third one that can directly or indirectly affect the hole and/or electron transport in the emission layer. EX1001, 1:46-48, 2:24-29, 3:17-34.

Specifically, because charge transport depends on both charge carrier mobility and the number of charge carriers present, (*see id.*, 2:64-7:3, 2:40-45), the '164 patent disclose how to control both factors. First, the number of charge carriers, which relates to hole or electron creation, depend “on the position of the energy level HOMO and LUMO of the matrix materials.” *Id.*, 2:40-45; EX2001, ¶¶26-27. The patent further teaches, “[t]o create a hole in the matrix, which is composed of the three matrix materials, an electron must be removed from the HOMO, ... which is more difficult with an energetically low HOMO than with an energetically higher

one.” EX1001, 2:46-49. Consequently, the inventors teach that the second matrix material, to be used as a hole transport material, should have a HOMO level that is energetically higher than the other two materials. *Id.*, 2:50-52, 1:52-55; EX2001, ¶28. Conversely, to create an electron, electrons are injected into the LUMO of a material, “which is energetically favored with energetically lower LUMOs.” EX1001, 2:52-55. Thus, the third matrix material, for use as an electron transport material, is disclosed as having a LUMO with a lower energy level than the other two matrix materials. *Id.*, 2:55-57, 1:48-51; EX2001, ¶29. These relationships are recited in elements 1[f] and 1[g]. EX2001, ¶30.

Second, concerning charge carrier mobility, “[t]he mobility of electrons and holes ... depend on the molecule distance—that is, the average distance between charge carrier-transporting molecules in the individual matrix material.” EX1001, 3:17-20. Because the second and third matrix materials are respectively for hole and electron transport, they are contemplated to have sufficiently close molecular distances to have good charge carrier mobility. As such, they exist in sufficient quantities in the organic functional layer so that the molecules are sufficiently close to each other to facilitate hole or electron transport. EX2001, ¶32. That is why both the second and third materials are claimed as “matrix materials,” as opposed to simply “materials” or “dopants.” EX2001, ¶¶32-33; EX2005, 16-17 (dictionary definitions for “matrix” include “[a] continuous solid phase in which particles ... are

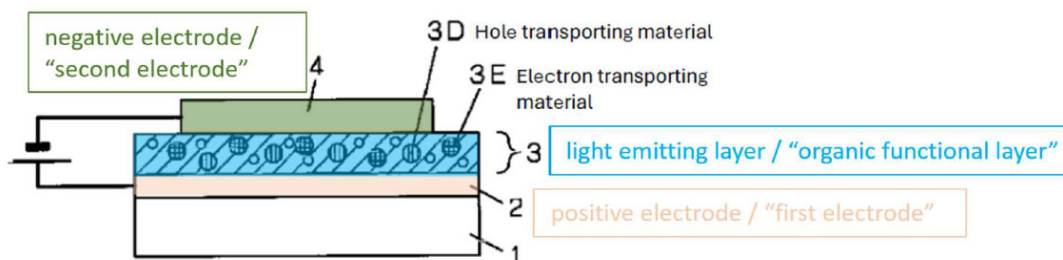
embedded” and “[m]ore or less continuous matter in which something is embedded”).

Petitioner, however, fails to explain why the prior art references disclose three matrix materials in the emission layer (or another organic functional layer). Instead, it simply assumes that any material, regardless of their concentrations and distributions, can be the claimed matrix materials. That is incorrect.

As discussed in detail in Section II.A.1, the '164 patent distinguishes between a matrix material and a dopant (such as the emitter material with up to 10 wt% concentration in the mixture). *See* EX1001, 1:22-23, 3:61-63, 4:15-16, 6:13-15, 6:48-49, 7:11-35. The prior art also distinguishes between a dopant and a matrix material. Choulis's emission layer uses a formulation containing 9wt% TPD, and describes it as a “light emitting layer co-doped with [a] matching material.” EX1004, [0054], [0024], [0032]. That emission layer formulation follows the recipe reported by the Yang research group. *See* § II.A.3 below; EX2001, ¶38. The Yang group observed that when the concentration of TPD exceeded 13 wt%, TPD began to “disturb[] the balance of carrier injection and transport,” (EX1017, 2478), the two purported advantages imparted by Choulis's incorporation of TPD into the emission layer (EX1004, [0032] (“When organic moieties are mixed in with the light emitting material and host, the moieties can move the holes and electrons throughout the [emission] layer, as well as inject them to the light emitting material”). Thus, a

POSITA would not arbitrarily increase the TPD concentration to turn it into a “matrix material.” EX2001, ¶¶39-40; *In re Gordon*, 733 F.2d 900 (Fed. Cir. 1984) (no suggestion or motivation for a proposed modification that would render the prior art invention being modified unsatisfactory for its intended purpose), *accord* MPEP 2143.

Likewise, Petitioner has failed to show either Sugiura or Thompson discloses three matrix materials. Sugiura, for example, depicts its hole transport material 3D and electron transporting material 3E as discontinuous phases in a host material (material annotated with the blue shaded lines). Petitioner does not explain why 3D and 3E are matrix materials, and not dopants or guest materials. EX2001, ¶¶36-37 (Dr. Sims explaining that a POSITA would not view 3D and 3E as matrix materials because like the emitter dopant (open circles), they are dispersed as segregated particles in the host material (blue shaded material) with no other materials embedded in them).



(Pet. 54)

Likewise, Thompson describes its system as including “a wide gap inert host

doped with two dopants.” EX1007, abstract. Again, the Petition does not explain why Thompson’s system involves three matrix materials.

Petitioner also fails in other material aspects. For example, the claims recite specific relationships of the HOMO and LUMO levels of the three matrix materials. *See* EX1001, 9:13-20, 9:23-28, 9:29-33, 10:27-40, 10:50-57. But Sugiura does not even mention HOMO or LUMO. *See* EX1006. Instead, Petitioner assumes that the energy diagrams such as the one in Figure 8 depict HOMO and LUMO levels of the various materials. Pet. 54-58. Petitioner does not at all link the ionization potential and electron affinity that Sugiura does discuss with the HOMO and LUMO energy levels that are claimed, especially in light of the fact that those are not identical. *Id.*; *compare* EX1006, [0053] (disclosing that Alq₃ has an ionization potential of 5.7 eV and an electron affinity of 3.0eV) *with* EX1010, 756, Fig. 1 (Alq₃’s HOMO and LUMO levels were shown as at 5.62eV and 2.85eV respectively).

Because of these and other fatal flaws described below, the Board should deny institution. To aid the Board, Patent Owner has asked Dr. Marc Sims, who has had over two decades years of academic and industrial experience in OLEDs—including at DuPont Displays and Solvay OLED—to comment on certain issues that Dr. Holmes fails to consider.

II. Petitioner Has Not Shown a Reasonable Likelihood of Success for Grounds 1-2.

A. Petitioner Does Not Explain Why Organic Moieties TPD and PBD Are Second and Third Matrix Materials

The claims require an organic functional layer having “at least a first matrix material, a second matrix material, and a third matrix material.” EX1001, 9:10-12. Petitioner points to Choulis’s “host material” PVK, “a first organic moiety” (TPD), and “a second organic moiety” (PBD) as the first, second, and third matrix materials. Pet. 24-25. TPD and PBD are also respectively the alleged hole transporting and electron transporting materials. Pet. 33-34. Petitioner, however, has provided no competent evidence on why TPD or PBD are “matrix material(s)” given Choulis’s characterization that TPD and PBD were “*doped*” into the emitting layer. Choulis, [0032] (“the light emitting layer can be “co-doped with organic moieties”). The deficiency is particularly glaring for TPD, which had around 9% concentration in the mixture, *i.e.*, below the concentration allowed for a “doping substance” in the ’164 patent. EX1004, [0054]; EX1001, 6:13-15, 6:48-49.

1. The ’164 Patent Characterizes Additives of Up to 10 wt% As “Dopant,” not “Matrix Materials”

The ’164 patent distinguishes between a “matrix material” and a “doping substance[.]” For example, when describing the process for producing an inventive electronic device, the specification discloses that “[f]our evaporation sources 50 are applied on a holder 51, ... from which matrix materials and/or doping substances

can be evaporated onto the deposition substrate 60.” EX1001, 7:12-15. This disclosure makes clear that a matrix material is not a doping substance (or dopant).

The '164 patent's specification also indicates to a POSITA that additives up to 10 wt% in an organic function layer would be regarded as a dopant, and not as a matrix material.¹ For example, the '164 patent consistently describes emitter materials that can be “up to 10 wt%” in an emission layer as a dopant, and never as a matrix material. EX1001, 1:22-23 (“Emission layers ... have a matrix material, which is doped with emitter molecules.”); 3:61-63 (“The organic functional layer can be an emission layer and be doped with at least one emitter material.”); 3:65-66 (“The concentration of the emitter material in an emission layer can be up to 10 wt%.”); 4:15-16 (“By not *doping with emitter material*”); 6:13-15 (“The emission layer 30 can have a first, a second, and a third matrix material and be *doped with an emitter material*”).

This usage is consistent with contemporaneous literature. For example, a paper by the Choulis authors described work by Yang and Neher (EX1017) as involving the use of PVK as a host, which “is then *molecularly doped with ... (TPD), ... (PBD),* and Ir(mppy)₃, components that serves the purpose of carrier

¹ To be clear, this does not mean that additives at a loading above 10 wt% is necessarily a matrix material.

transport and emission.” EX1022-2 (original p. 203502-1). This description matches that given by Yang and Neher themselves. EX1017-2, abstract (“We demonstrate efficient single-layer polymer phosphorescent light-emitting devices based on a green-emitting iridium complex and *a polymer host co-doped with electron-transporting and hole-transporting molecules*”).

In particular, Yang and Neher repeatedly described their devices as involving co-doped TPD. EX1017, 2476-77 (“PPLEDs, *co-doped* with ... (TPD),” “TPD-doped device”), 2476 (“TPD was earlier shown to function as a hole trap at low concentration and a hole-transporting moiety at high loading when *doped* into PVK”), 2478 (“*co-doping with hole-transporting moieties such as TPD* may be a general scheme to improve the efficiency of PVK:PBD based devices”; “co-doping the emission layer with TPD”).

Yang and Neher’s devices mostly used about 10 wt% TPD in the emission layer:

- EX1017, 2476 (Figure 1 showing “a device, based on PVK emission layer containing 25 wt% PBD, 1 wt% Ir(mppy)₃ and *10 wt% TPD*”);
- EX1017, 2477 (“Figure 2(b) shows EL spectra of devices with a constant *TPD concentration of ~ 10 wt%* but different Ir(mppy)₃ concentrations”);

- EX1017, 2478, Figure 3 caption (“... a device containing PVK (0.61) + PDB (0.24) + Ir(mppy)₃ (0.06) + **TPD (0.09)**...”); *id.* (“Figure 3 shows the current density-brightness-voltage properties of a device with ~ 6 wt% Ir(mppy)₃ and **9 wt% TPD**”)
- EX1017, 2477, Table 1 (TPD concentration ranging from 0% to 19% with an Ir(mppy)₃ concentration of ~ 6 wt%).

Thus, both the '164 patent and the contemporaneous literature regarded at least additives of up to 10 wt% as dopants, and not matrix materials. Such an understanding would be consistent with the common meaning of matrix that connotes substance in which additives (or guest materials) are embedded. *See, e.g.* EX2002_Dictionary_of_Chem_Oxford (“(in chemistry) A continuous solid phase in which particles (atoms, ions, etc.) are embedded”); EX2003_Merriam-Webster, 766 (3b: “material in which something is enclosed or embedded”); EX2004_CambridgeDictionary, 770 (“a substance in which other things are fixed, buried, etc.”); EX2005_Samsung_PR4_2, 16-17 (Samsung quoting dictionary definitions for “matrix,” including “[a] continuous solid phase in which particles ... are embedded” from EX2012, 364 and “[m]ore or less continuous matter in which something is embedded” from EX2013, 744).

That is why even references cited by Petitioner differentiates “dopant” on the one hand and “matrix” material (sometimes also called “host”) on the other hand.

E.g., EX1010, Abstract (describing “a red fluorescent dye” “doped into a mixed matrix” of Alq₃ and rubrene); EX1017, 2476, Abstract (“We demonstrate efficient single-layer polymer phosphorescent light-emitting devices based on a green-emitting iridium complex and *a polymer host co-doped with electron-transporting and hole-transporting molecules*”), *id.*, 2478 (“co-doping the emission layer with TPD”).

In contrast, as explained on pages 2-3 above and in the next section, the inventors of the '164 patent characterized the three materials as “matrix materials” because the inventors contemplate that they would exist in sufficient amounts to affect charge carrier mobilities. EX2001, ¶32 (Dr. Sims opining “[i]n the context of the '164 patent, because the second and third matrix materials are responsible respectively for hole and electron transport, a [POSITA] would understand that they are contemplated to have sufficiently close molecular distance to have good charge carrier mobility. As such, a [POSITA] would understand that they would exist in sufficient quantities in the organic functional layer ... so the charge carriers can be sufficiently close to one another to facilitate charge transport”); ¶33 (“in the context of the '164 patent, the matrix materials each exist in more than a dopant-level such that each forms a more or less continuous phase in the organic functional layer in which it is deposited”). Thus, in a preferred example of three matrix materials and an emitter dopant, the first matrix material mCP was deposited at a rate of 3.8 Å/s,

the second and third matrix materials were each deposited at a rate of 8 Å/s, and the emitter material was deposited at a rate of 0.2 Å/s. EX1001, 7: 21-33. This resulted in a layer with 40 volume percent of each of the second and third matrix materials, 19 volume percent of the first matrix material, and 1 volume percent of the emitter material. *Id.*, 7:33-35. The emitter layer therefore included a significant amount of each of the matrix materials and a small amount of the emitter material. *Id.*; EX2001, ¶49 (Dr. Sims explaining “in an evaporated process[,] the molecules are co-deposited in a comingled fashion throughout the organic layer”).

A POSITA would understand that the term “matrix materials” refers to materials for forming one or more matrices. Thus, interpreting “matrix materials” as materials that would exist in sufficient amounts to form a continuous phase in which other materials can be embedded is consistent with both the ’164 patent’s disclosures and the meaning of “matrix.” *See* EX2002 (“(in chemistry) A continuous solid phase in which particles (atoms, ions, etc.) are embedded”); EX2003, 766 (“material in which something is enclosed or embedded”); EX2004, 770 (“a substance in which other things are fixed, buried, etc.”); EX2005, 16-17 (Samsung proposing to construe “matrix” as “a continuous phase of the mixture of matrix materials”); EX2001, ¶34 (“matrix materials—or materials for forming one or more matrices—should not exist as ‘islands in a sea,’ ... The term connotes a more or less continuous phase in which other materials can be embedded”).

2. “Matrix Material” Is Material to ’164 Inventions

It is not an accident that ’164 patent recites “matrix materials.” Specifically, the ’164 patent aims to tune the ratio of holes and electrons in an organic layer. *See* EX1001, 1:25-29 (“In order to obtain a high efficiency of the electronic device, the ratio between electrons and ‘holes’ which are transported in the emission layer is decisive. A nonbalanced ratio between hole and electron transport results in a low radiation efficiency of the device.”). But charge carrier transport depends not only on the ease of charge creation (a property dependent on the HOMO and LUMO levels, *see* EX1001, 2:46-57), but also on the charge carrier mobility. EX1001, 2:58-59 (“If holes and electrons are created, the mobility of these charge carriers in the material plays a role.”); EX2001, ¶26. “The mobility of electrons and holes can depend on the molecule distance—that is, the average distance between charge carrier-transporting molecules in the individual matrix material. Thus, the concentration of a matrix material in the mixture of several matrix materials plays a role.” *Id.*, 3:17-21.

Hence, in the context of the ’164 patent, the second and third matrix materials, functioning as hole transport material and electron transport material respectively, are contemplated to exist in sufficient amounts and in more or less a continuous phase to provide sufficiently close molecule distance for adequate hole or electron

mobility. EX2001, ¶32. That is, they should exist in more than a dopant-level so that the molecule distances are not too distant. EX2001, ¶33.

The first matrix material, which can optionally fine-tune the molecule distances between charge carriers by diluting their concentrations, should also exist in more or less a continuous phase to effect that molecule distance adjustment by effectively separating the charge carrier molecules. EX2001, ¶35. That is, as disclosed in the '164 patent, in preferred embodiments, even if a matrix material does not directly participate in charge carrier transport, it plays a role in finely adjusting the distances between charge carrier molecules; thus, it is also contemplated to exist in sufficient quantities to effectively modulate (e.g., increase) the molecule distances to a desired level. *Id.* (“For a material to play a role in finely adjusting the distances between charge carrier molecules, it is contemplated to exist in sufficient quantities to effectively modulate (e.g., increase) the molecular distances to a desired level. Hence, it also needs to exist in a sufficiently continuous phase.”); *see also* EX1001, 3:26-34 (“Depending on the selected concentration of the second and third matrix material, the distance between the individual molecule change. The microscopic charge carrier transport depends on the molecule distance between the charge carrier transporting molecules in the individual matrix material, so that by the adjustment of the concentration, the mobility of electrons and holes in the matrix ... can be absolutely adjusted separately from one another.”).

Put another way, the '164 inventors teach a way to adjust the hole and electron mobilities in the emission layer to control the recombination zone. In that regard, the inventors found that sometimes lower charge carrier mobility could lead to better performance. EX1001, 6:57-7:2 (simulation suggests that “a reduction in the absolute value of the charge carrier mobility in the emission layer 30, in comparison to the hole transport layer 31 and the electron transport layer 32, the recombination zone is shifted from the borders of the emission layer to the middle.”), 1:25-29. The charge carrier mobilities are optimized by depositing the first, second and third materials as part of the matrices and not dopants.

3. Choulis’s Composition, Like Those of Yang and Neher, Used 9 wt% TPD

Choulis’s composition was similar to those used by Yang and Neher as indicated by the comparison below:

Choulis (EX1004)	Yang and Neher (EX1017)
[0054] (“The light emitting layer includes 61% PVK, 24% PBD, 9% TPD and 6% Ir(mppy) ₃ .”).	EX1017-2 (original p. 2476) (“a device, based on PVK emission layer containing 25 wt% PBD, 1 wt% Ir(mppy) ₃ and 10 wt% TPD”); EX1017-4, Figure 3 caption (“... a device containing PVK (0.61) + PDB

	(0.24) + Ir(mppy)₃ (0.06) + TPD (0.09)...”); EX1017-3 (“Figure 2(b) shows EL spectra of devices with a constant TPD concentration of ~ 10 wt% but different Ir(mppy)₃ concentrations”); EX1017-4 (“Figure 3 shows the current density-brightness-voltage properties of a device with ~ 6 wt% Ir(mppy)₃ and 9 wt% TPD”).
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As explained above, in the context of the ’164 patent, a POSITA would understand that an additive such as TPD that has a weight percentage of about 10 wt% is a dopant, and not a matrix material. *E.g.*, EX1001, 6:13-15 (“The emission layer 30 can have a first, a second, and a third matrix material and be **doped with an emitter material**”); 6:48-49 (“The emitter material has a concentration of ≤ 10 wt% in the emission layer”).

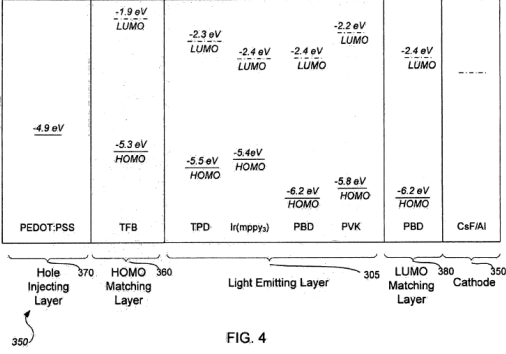
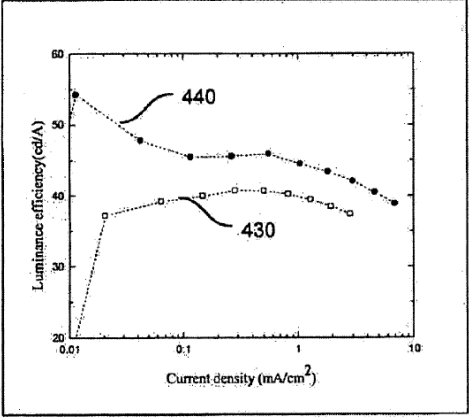
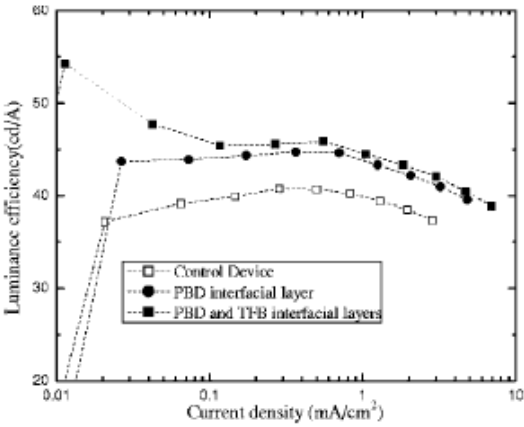
Choulis also characterizes PVK as a “host” material, a term it uses interchangeably with “matrix.” *E.g.*, EX1004, [0044] (“In some embodiments, the light emitting layer includes materials that are insulated **matrices**, that is, **the host** does not have transport properties”). In contrast, it describes embedding

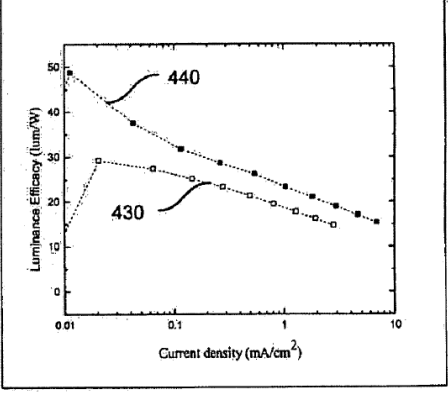
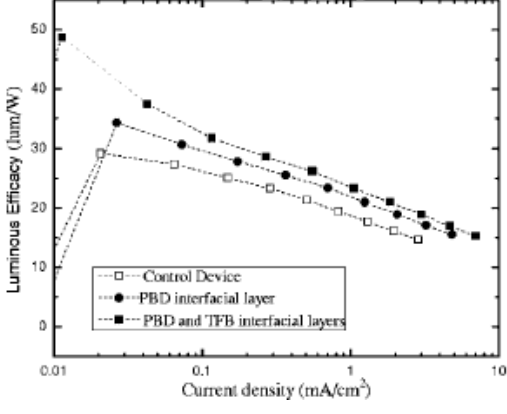
“organic moieties” TPD and PBD as “co-dop[ing].” *Id.*, [0032].

Given (1) the '164 patent's distinction between a matrix material and a doping substance (dopant) (*see* Sections II.A.1-II.A.2 above), (2) Choulis's own characterization of the organic moieties as a “dop[ant]” (Choulis, [0032]), and (3) the prior art's characterization of a 10wt% of TPD in PVK as a dopant (*see* discussions of Yang (EX1017) on pp. 8-9 above), Petitioner should have explained, but did not explain, why a POSITA would have regarded TPD as a matrix material as opposed to a dopant in the context of the '164 patent.²

This is not a technicality. Choulis had a reason to limit the amount of TPD in the mixture. First, a POSITA would have recognized that the device reported in Choulis EX1004, Figure 4 is the same as the device with matching layers on both sides of the emission layer reported in EX1022, because they have the same material compositions and the same reported performance:

² In fact, Choulis regards PBD at 24 wt% also as a dopant. EX1022-2 (describing Yang and Neher (EX1017) as involving a PVK host that “is then *molecularly doped with ... (TPD), ... (PBD)*, and Ir(mppy)₃, components that serve[] the purpose of carrier transport and emission”).

EX1004 (Choulis)	EX1022 (Choulis)
the same material composition:	
 FIG. 4 Fig. 4, [0054] (“The light emitting layer includes 61% PVK, 24% PBD, 9% TPD and 6% Ir(mppy)₃”)	EX1022, 203502-2 (second device architecture having “ITO/CH8000 PEDOT:PSS (60 nm) /TFB (≤3 nm) /LEP(70 nm) /PBD (3 nm) /CsF (1 nm)/Al (200 nm)” with LEP being “61% PVK+24% PBD +9% TPD + 6% Ir(mppy)₃”)
The same performance (compare plots for 430 with those for Control Device of EX1022 (open squares) and plots for 440 with those for “PBD and TFB Interfacial Layers” (filled squares):	
	

 EX1004, Fig. 5	 EX1022, Fig. 3
EX1004, [0054] (“Graphs 410 and 412 show[] the peak luminance efficacy power of the control device 430 as 29 lm/Watt and luminance efficiency reaching 40 cd/A. The matching layer device 440 had a peak luminance efficacy of about 50 lm/W and luminescence efficiencies reaching about 55 cd/A.”)	EX10202, 203502-3 (“The peak luminous efficacy of the control device (without interfacial layers) was 29 lm/W with a luminance efficiency reaching 40 cd/A. ... When both PBD and TFB interfacial layers were used, the highest peak luminous efficacy of 50 lm/W with luminance efficiencies reaching 55 cd/A was achieved.”).

Second, a POSITA would also have been aware that Choulis based its emission layer composition on the one optimized by Yang. Compare EX1004, [0054] (Choulis’s “light emitting layer includes **61% PVK**, **24% PBD**, **9% TPD** and **6% Ir(mppy)₃**”) with EX1017_Yang, Fig. 3(a) caption (listing device as containing “**PVK(0.61)+PBD(0.24)+Ir(mppy)₃(0.06)+TPD(0.09)**”); see also EX1022, 203502-1 (referencing Reference No. 6 that reported a PVK host doped with PBD, TPD and Ir(mppy)₃), 203502-3 (Reference No. 6 is EX1017, the Yang paper); EX2001, ¶38

(Dr. Sims confirming that “Choulis used one of Yang’s ‘optimized’ test composition for its emission layer”).

Third, a POSITA would have known of Yang’s observation that when TPD concentrations exceeded 13 wt%, luminous efficiency began to decrease likely because “*a large concentration of TPD disturbs the balance of carrier injection and transport.*” EX1017, 2478.

Choulis, however, incorporates hole and electron transport moieties to “improv[e] the efficiency of an OLED.” EX1004, [0007]. Choulis states that “the moieties can move the holes and electrons throughout the layer, as well as inject them to the light emitting material,” that is, for carrier injection and transport. EX1004, [0032]. In this way, Choulis postulates that recombination zone could be expanded and device efficiency could be improved. *Id.*

As such, Petitioner should have explained, but does not explain, why a POSITA reading Choulis as a whole would still have loaded TPD to a “matrix material” level, a modification that would negatively affect Choulis OLED’s performance (charge transport and injection property and color purity) and Choulis’s stated object of improved efficiency and better charge transport and injection properties. EX2001, ¶40 (referencing Choulis’s stated objectives in [0032], Dr. Sims concluded that a POSITA “would not modify Choulis’s emission layer composition to disturb its balance of carrier injection and transport... Otherwise, the

objective of Choulis would be undermined.”).

A modification that would undermine the primary reference’s principle of operation would not have been obvious. *Plas-Pak Industries, Inc. v. Sulzer Mixpac AG*, 600 F.App’x 755, 758-59 (Fed. Cir. 2015) (citations and quotation marks omitted) (finding lack of motivation where the proposed modification would “fundamentally alter[] [primary reference]’s principle of operation”); *Surgalign Spine Technols., Inc. v. Lifenet Health*, IPR2019-00569, Paper 73 at 40 (PTAB Aug. 26, 2020) (finding non-obviousness because the “proposed modification to Boyce ... would be inconsistent with Boyce’s central purpose and its principle of operation”).

A POSITA would also not increase TPD levels in Choulis’s emission layer because “good color purity” is a desired feature for OLEDs. EX1017, 2476. But Yang reports that TPD and PBD would form exciplexes that emit at about 470 nm, outside the emission spectrum of Ir(mppy)₃. EX1017, 2477. Higher concentrations of TPD and PBD increase this undesired emission. *See id.*, Fig. 2(a) (40%TPD + 40%PBD (dash-dot line) showing a PL intensity of about 1.0 at 470 nm versus 10% TPD and 25% PBD (dashed line) showing a PL intensity below 0.2). Hence, a POSITA would not further increase TPD’s concentrations to reduce Choulis device’s color purity.

Given the adverse effects of high TPD concentrations in the PVK/PBD/TPD

mixture, it is not surprising that Choulis does not disclose an emission layer with three matrix materials as required by the claims.

Because Petitioner has not shown that a material limitation of the '164 patent—an organic functional layer having a first, a second and a third matrix material—is disclosed by Choulis and because it does not argue for any modification, (*see* Pet. 24-25), it has not demonstrated a likelihood of success for either anticipation or obviousness.

B. Petitioner Has Not Provided any Competent Evidence on Why a POSITA Would Have Replaced PVK with PMMA for Claims 2, 4, and 15-16

Claims 2 and 15 both require that “the first matrix material ha[ve] a LUMO which is energetically higher than the LUMO of the second matrix material and the LUMO of the third matrix material, and a HOMO which is energetically lower than the HOMO of the second matrix material and the HOMO of the third matrix material.” EX1001, 9:23-28, 10:35-40.

Claims 4 and 16 both require that “the first matrix material has a charge carrier mobility which is lower than the charge carrier mobilities of the second and third matrix materials.” *Id.*, 9:34-37, 10:58-60.

For these limitations, Petitioner resorts to PMMA instead of PVK as the first matrix material, in contrast to claim 1. *Compare* Pet. 26, 44, 47 (annotating PVK as

the “first matrix material” for claim 1, element 15 [e], and element 16[e]) *with* Pet. 29, 33, 45, 48 (relying on PMMA for claims 2, 4 and elements 15[h] and 16[h]). Petitioner does not suggest changing other components of the emission layer. *Id.*

First, Petitioner has not shown a reasonable likelihood of success for anticipation because it has not shown that Choulis discloses all elements of these claims “arranged or combined in the same way as in the claim[s].” *Net MoneyIN, Inc. v. VeriSign, Inc.*, 545 F.3d 1359, 1369-72 (Fed. Cir. 2008) (collecting cases). This is because Choulis does not contain a discussion suggesting or linking PMMA with the use of TPD or PBD in the same emission layer as Petitioner suggests, and Petitioner does not contend that it does. Pet. 29-30 (suggesting substituting PVK with PMMA while still using TPD and PBD); EX1004, [0044].

In particular, Choulis, [0044] relied on by Petitioner states:

The light emitting layer can include a host material. The hole material can be PVK, *as described above*, which is a non-conjugated polymer having mostly hole transporting properties. ... *In some embodiments*, the light emitting layer includes materials that are insulated matrices, that is, the host does not have transport properties, such as polycarbonate (PC), polymethyl methacrylate (PMMA) or polystyrene sulphonate (PSS).

EX1004, [0044] (cited on Pet. 29). Earlier, PVK is referenced expressly in connection with Figure 4. *See* EX1004, [0030] (when discussing “FIG. 4,” noting

the light emitting layer 305 includes a host material 310, PVK, along with TPD and PBD). Thus, a POSITA would understand the reference to “as described above” for PVK refers to its use in the Figure 4 embodiment. On the other hand, nothing in [0044] links PMMA to the device in the Figure 4 embodiment. Instead, Choulis just mentions in passing that in some unspecified embodiments, PMMA may be used, without explaining what other organic moieties should be used with PMMA in those cases. EX1004, [0044]. Hence, Choulis does not anticipate claims 2, 4, 15 and 16.

Second, Choulis also does not render obvious these claims. As explained on pp. 14-15 above, Choulis used Yang’s optimized emission layer formulation. *See also* EX2001, ¶38. But Yang’s finding is limited: they only postulated that “co-doping with hole-transporting moieties such as TPD may be *a general scheme to improve the efficiency of PVK:PBD based devices.*” EX1017, 2478. Simply put, Yang limits its finding to devices with an emission layer having both PVK and PBD. *Id.* Yang does not suggest that doping TPD would work in any random systems. EX2001, ¶41 (Dr. Sims noting “PMMA and PVK may have very different miscibility with TPD or the solvent used for spin coating. There is no demonstration ... a suitable solvent could be found to process PMMA, TPD, PBD and the emitter at the desired concentrations” and noting his experience of PMMA phase separation in solution-based processes). In fact, Yang has formulated a mixture of TPD and PBD in polystyrene to investigate the formation of exciplexes between TPD and

PBD, (EX1017, 2477), but the group never reported any OLED devices built with that mixture, indicating that a POSITA would not have simply substituted PVK with another random host material.

Petitioner nevertheless argues that a POSITA would have used PMMA because they allegedly “would have understood that the host material, which serves as a matrix in which guest materials are dispersed, preferably would have a wide energy gap so as not to interfere with the charge transport of the second and third matrix materials.” Pet. 31 (citing EX1004, [0031], [0041]). Dr. Sims observes that if PVK participates in hole transport, then substituting in PMMA that does not participate in hole transport “would affect hole-charge recombination and would degrade the performance of the resulting OLED system”; but if PVK already does not participate in hole transport (*e.g.*, because PVK’s HOMO is sufficiently low in energy), then it already is not interfering with charge transport and there would be no benefit to substitute in PMMA. EX2001, ¶42. That is, in either case, Petitioner’s reasoning for replacing PVK with PMMA fails.

Furthermore, Choulis’s paragraphs 31 and 41 do not support Petitioner’s theory. Choulis [0031] examines the relative HOMO level of TPD and the LUMO level of PBD compared to those of the emitter material to facilitate hole and electron injection, and suggests that other “suitable materials ... can ... be selected according to the properties described herein.” EX1004, [0031]. It does not disclose or suggest

using a wide energy gap material such that it would not interfere with the charge transport of the second and third matrix materials. *Id.*

Likewise, [0041] describes suitable materials for “the organic material that emits light,” *i.e.*, the emitter material rather than the host or first matrix material. *Id.* As such, it also does not disclose or suggest using a wide bandgap material so as not to interfere with the charge transport of the second and third matrix materials. *Id.*

Testimony by Dr. Holmes also does not provide the requisite support. EX1003, ¶100 (cited on Pet. 29). He supports the parroting conclusion by cross referencing to Section IV.A.2 of his declaration on mixed EML, which includes paragraphs 30-31. To the extent that such nested incorporation by reference is permitted, the testimony still does not support the proposition that a POSITA would have had a reason to use a wide-band gap material of the claimed properties with PBD, TPB and the Iridium phosphor. Specifically, paragraph 30 of EX1003 describes the preferred properties of hole and electron transport materials (*i.e.*, second and third matrix materials). Paragraph 31 mentions the use of “ultra-wide energy gap” (UGH) materials, but neither reference discussed in the paragraph supports a finding that a POSITA would have found it desirable to use PMMA in place of PVK in Choulis’s devices. The first reference to UGH is a Holmes paper which contains only UGH and an emitter material, with no reference to second or third matrix materials or the use of PMMA. *See* EX1016, abstract (referencing

doping a blue phosphorescence in two UGH's and Professor Holms, the declarant and the author of the paper, does not assert that either UGH is PMMA). Furthermore, both UGH1 and UGH2 referenced in the Holmes paper admittedly "transport electrons," even though they block hole transport. EX1017, 3820. Hence, Petitioner's assertion that UGH1 and UGH2 would not "interfere with the charge transport of the second and third matrix materials" is plainly wrong because these materials can at least facilitate electron transport. *Contra* EX1003, ¶100 (cited on Pet. 31).

The second reference, the Yang paper (EX1017), fares no better, as it teaches using the same combination of materials as Choulis, *i.e.*, TPD, PBD, Ir(mppy)₃ in a PVK host. EX1003, ¶31; *see* pp.14-15 above. But given EX1017's use of PVK instead of PMMA and given that PVK's HOMO is higher than that of PBD, EX1017 also does not teach or suggest that the UGH material should have a HOMO that is energetically lower than the second and third matrix materials and a LUMO that is energetically higher than the second and third matrix materials as required by claims 2 and 15 of the '164 patent. And because Petitioner does not contend that PVK's charge carrier mobility is lower than those of PBD and TPD, (*see* Pet. 33), it follows that there is also no evidence that EX1017 teaches or suggests using a host material (such as PVK) that has a lower charge mobility than those of the second and third matrix materials as required by claims 4 and 16 of the '164 patent.

Simply put, for Ground 1, Petitioner has not pointed to anything in the record that teaches a UGH meeting the limitations of claims 2, 4, 15 and 16. As Petitioner concedes, these are material limitations. Pet. 11-12 (listing claim elements that the Office found to be absent from the prior art). As such, Petitioner cannot rely on common sense, but must specifically point to disclosures in the prior art where such is taught. *Arendi S.A.R.L. v. Apple Inc.*, 832 F.3d 1355, 1362 (Fed. Cir. 2016) (warning that “references to ‘common sense’—whether to supply a motivation to combine or a missing limitation—cannot be used as a wholesale substitute for reasoned analysis and evidentiary support, especially when dealing with a limitation missing from the prior art references specified”).

Petitioner has not done so. Instead, as explained above, the disclosures it relies on are either irrelevant or teach the opposite. For instance, Dr. Holmes’ own paper demonstrates that UGHs (alleged suitable material for the first matrix material) can participate in electron transport; and EX1017, like Choulis, demonstrates that a UGH, such as PVK, not only can participate in hole transport, but can also have HOMO and LUMO levels that do not meet the recited requirements. *See* EX1004, Fig. 4 (PVK has a HOMO that is higher in energy than PBD), [0044] (PVK is a hole transport material).

Moreover, even if a UGH is preferred, that does not explain why a POSITA would have used PMMA in particular with PBD, TPD and Ir(mppy)₃. Petitioner has

not presented any evidence of PMMA being used with TPD and PBD or similar materials at the time of the invention, and their suitability for use in Choulis's applications. Pet. 29-31, 33; *see also* discussions on pp. 23-24 above regarding issues with PMMA.

Additionally, Petitioner's rationale that PMMA has a lower charge carrier mobility than PBD and TPD lacks support of competent evidence. Pet. 33. Essentially, Petitioner argues that because PMMA is described as not having transport properties, it has a lower charge carrier mobility. *Id.* But as the inventors explain, "[i]f a charge carrier transport does not take place in a matrix material, ... then that can be attributed to the fact that charge carriers are not created *or* that there is no mobility of the charge carrier." EX1001, 2:64-3:1.

Petitioner has not demonstrated why the lack of charge transport is due to low charge carrier mobility instead of no charge carriers being created. Pet. 33. For instance, if PMMA does have a deep lying HOMO and high lying LUMO, then it may be more difficult to create holes and electrons, leading to a negligible number of holes/electrons created. EX2001, ¶45; *see also* EX1017, 2476 (noting "the rather large hole-injection barrier of ~0.7 eV from the ... (PEDT:PSS) anode into the(HOMO) level of PVK," which barrier would increase by a further 1.5eV for PMMA as PMMA's HOMO allegedly lies at -7.3eV versus -5.8eV for PVK); EX1001, 2:46-57 (creating a hole "is more difficult with an energetically low

HOMO than with an energetically higher one” and creating electrons “is energetically favored with energetically lower LUMOs”). The lack of holes and electrons can also result in (pure) PMMA not participating in charge transport. *See* EX1001, 2:64-3:1; EX2001, ¶45; *see also id.*, ¶44 (“charge carrier mobility and band gap are two distinct concepts”). Simply put, there is no competent evidence of PMMA’s charge carrier mobility compared to those of TPD and PBD.

In short, Petitioner has not presented any competent evidence that a POSITA would have substituted PVK in Choulis’s Figure 4 embodiment with PMMA to arrive at claims 2, 4, 15 and 16.

C. Petitioner Has Not Provided any Competent Evidence on Why a POSITA Would Have Replaced Figure 4’s PHOLED with Rubrene (Claim 10)

Claim 10 requires the LUMO of the emitter material to be energetically lower than the LUMO of all three matrix materials and the HOMO of the emitter to be energetically higher than the HOMO of all three matrix materials. EX1001, 9:55-59. Choulis’s Ir(mppy)₃ does not have the claimed property because its LUMO lies at the same level as PBD. *See* EX1004, Fig. 4. Petitioner thus proposes substituting it with rubrene. Pet. 35-36.

As with claims 2, 4, 15 and 16, Petitioner has not shown that Choulis anticipates claim 10 because nothing in Choulis links the use of rubrene to the Figure 4 embodiment. For instance, while Choulis lists rubrene as a candidate fluorescent

emitter, it does not specifically state that rubrene is a suitable emitter material for use with the Figure 4 embodiment. EX1001, [0043]. In fact, Choulis discloses the opposite. For example, Choulis desires to have the LUMO energy level of the emitter material to be substantially the same as the LUMO level of at least one of the interface materials on the cathode side, that is, within 0.1-0.2eV of the LUMO energy level of an interface material on the cathode side. *See* EX1004, [0015] (“The first electrode can be a cathode and the first charges can be electrons. The first interface layer can have a LUMO level substantially equal to a LUMO level ... of the phosphorescent organic material. ... The first interface layer can have a LUMO level that is within 0.2 eV, such as within 0.1 eV, of a LUMO level ... of the phosphorescent organic material.”). In connection with the Figure 4 embodiment, Choulis discusses the use of a PBD interface or matching layer whose LUMO level at -2.4 eV is “approximately equal to that of Ir(mppy)₃,” to facilitate “directly inject[ing] electrons into the Ir(mppy)₃.” *Id.*, [0029]; *see also id.*, [0028] (LUMO for Ir(mppy)₃ is -2.4 eV).

In contrast, according to Petitioner, rubrene has a LUMO at -3.15eV. Pet. 36. This is about 0.75eV lower than the -2.4eV LUMO level reported for PBD. EX1004, Fig. 4. This is contrary to Choulis’s repeated emphasis for matching LUMO levels of the emitter material with the LUMO level of the matching material (which is PBD) on the cathode side. *See* EX1004, [0006] (“adding a matching layer on one or

both sides of the light emitting layer” with the “matching layer ha[ving] an energy level similar to that of the emitter material”), [0007] (“organic moieties within the light emitting layer have energy level similar to that of the matching layers”), [0015] (first interfacial layer on the cathode side “can have a LUMO level substantially equal to a LUMO level or about equal to a triplet energy level of the phosphorescent organic material”), [0031] (“PBD has a LUMO level that is approximately equal to that of the Ir(mppy)₃. The PBD is used as a moiety in the light emitting layer rather than as a thin matching layer, as above. PBD is also used as LUMO matching layer ... between the light emitting layer 305 and a cathode 350.”). Hence, Choulis does not disclose the use of rubrene in Figure 4 because rubrene’s LUMO level does not match that of PBD. As a result, Choulis does not anticipate claim 10 because it does not disclose an embodiment arranged as in the claim.

Nor is there any competent evidence that a POSITA would have replaced Figure 4’s emitter material with rubrene. As explained above, the rubrene energy level just does not match with the LUMO level of the PBD matching layer or electron transport moiety designed to facilitate efficient electron injection into the emitter material. *See id.*, [0006]-[0007] (Summary of Invention: adding a matching layer that “has an energy level similar to that of the emitting material” and optionally “adding organic moieties to the light emitting layer” where the organic moieties “have energy level similar to that of the matching layers”), [0032] (“the light

emitting layer can be co-doped with organic moieties, that is, matching material”), [0029] (PBD used as a matching material because it has a LUMO level that is “approximately equal to that” of the emitting material and electrons can be directly injected into the emitting material). Choulis explains that “[i]ncorporating molecules into the light emitting layer that are either formed from the same material as in the matching layers, or from organic materials which have a similar energy level to the matching material can expand the recombination zone within the light emitting layer.” *Id.*, [0056].

Thus, under Choulis’s design principle, when the emitter’s LUMO decreases to about -3.15eV as in the case of rubrene, the electron transport material and the ETL matching layer’s LUMO would also need to decrease accordingly to a similar level. Petitioner does not explain what would then be the appropriate electron transport material and whether the requirements for HOMO/LUMO levels for the first, second and third matrix materials would still hold in that case. Pet. 35-37. That is a fatal failure of proof.

And to the extent that only the emitter material is replaced, Petitioner does not explain how the much larger energy gap between the LUMO of PBD (~ -2.4eV) and the LUMO of rubrene (~ -3.15eV) would affect the electron injection and transport property in the resulting emission layer. *See* EX1004, [0032] (describing the hole and electron transport moieties’ role as “mov[ing] the holes and electrons throughout

the layer, as well as inject[ing] them to the light emitting material”). Dr. Sims explains that given the large difference in the LUMO levels of rubrene and PBD, rubrene would act as an electron trap (that is, electrons would be injected into rubrene and be trapped there). EX2001, ¶43. PBD would stop participating in electron transport as no electrons are created in it any more. *Id.* “That would affect the device’s recombination zone, making it shift towards the electron transport layer and could significantly reduce the OLED’s performance[.]” *Id.* Given Choulis’s stated reason for using PBD and TPD, which is to have a recombination zone “throughout the layer,” (EX1004, [0032]), a change that eviscerates the role intended by PBD and undoes the expansion of the recombination zone would undermine Choulis’s intended operation and would not be obvious to a POSITA.

Because Petitioner has not considered the operating principle of Choulis and has not shown why a POSITA would have deviated from Choulis’ operating principle, it has not shown (and cannot show) that a POSITA would have used rubrene with the same compound mixture as in Choulis’s Figure 4. *See* Pet. 35-36; *Plas-Pak Industries, Inc. v. Sulzer Mixpac AG*, 600 F.App’x 755, 758-59 (Fed. Cir. 2015); *Surgalign Spine Technols., Inc. v. Lifenet Health*, IPR2019-00569, Paper 73 at 40 (PTAB Aug. 26, 2020).

Kang and Hamada do not suggest otherwise: neither reference uses rubrene as an emitter material. Kang, for example, uses DCJTb as the emitter. *See* EX1010

(Kang), Abstract (“We have studied the electroluminescence (EL) properties with a red fluorescent dye ... (DCJTB), doped into a mixed matrix of tris-(8-hydroxyquinoline)aluminum (Alq_3) and rubrene.”). Hamada uses rubrene as an emitting assist. EX1024 (Hamada), Abstract (“We propose an emitting assist (EA) dopant system The EA *dopant (rubrene) did not itself emit* but assisted the energy transfer from the host (Alq_3) to the red emitting dopant (DCM2).”). Thus, neither suggests using rubrene as an emitter material as required by claim 10. Moreover, in neither system was rubrene used with PBD. There is thus no competent evidence that a POSITA would have used rubrene in Choulis’s Figure 4 example.

Petitioner also argues that a POSITA would have used PQIr and DCM2 as the emitter materials. Pet. 36-37. This argument fails. Petitioner does not explain what the HOMO and LUMO levels are for PQIr and DCM2. *Id.* It therefore has not shown that the LUMO of the emitter material is energetically lower than the LUMO levels of PVK, TPD and PBD or that the HOMO of the emitter material is energetically higher than the HOMO levels of PVK, TPD and PBD, as required by claim 10 and Choulis’s emission layer composition. Nor has Petitioner shown that the use of either material would have complied with Choulis’s operating principle of having matching HOMO/LUMO energy levels between the emitting material and at least the interfacial materials. *See* EX1004, [0006]-[0007], discussions on pp. 29-33.

Moreover, neither Kanno nor Hamada discloses using PQIr or DCM2 with TPD, PBD or PVK. *See* EX1025 (Kanno) (using PQIr with CBP); EX1024 (Hamada) (using DCM2 with Alq₃ and rubrene). There therefore is again no evidence that a POSITA would have used PQIr or DCM2 with Choulis's emission layer materials. The inventors of the '164 patent have warned that "[t]he matrix cannot be selected arbitrarily for phosphorescent emitters because of chemical compatibility." EX1001 8:56-57. Petitioner, however, makes no attempt to show such chemical compatibility.

Finally, the cited references do not support Petitioner's theory that a POSITA would have found it obvious to have the LUMO of the guest emitter material lower than those of other materials in the light emitting layer, and the HOMO level of the guest emitter material higher than those of other materials in the light emitting layer. *Contra* Pet. 37.

Kanno, for example, depicts a blue-green phosphor, Ir(flz)₃ doped in mCP. EX1025, 340. The LUMO level of Ir(flz)₃ "is at least 0.5 eV above those of mCP and CBP, as well as other dopants[.]" *Id.*; *see also id.*, Fig. 2 (LUMO for Ir(flz)₃ and mCP is 1.9 and 2.4 eV respectively). But that supposedly is favorable as it "prevent[s] electron leakage from the EML into the adjacent layers." *Id.* In other words, an emitter with a LUMO *higher than*, not lower than, the host material is described as advantageous. This disclosure does not suggest seeking an emitter

material with a LUMO level *lower than* the LUMO level of the host material, as required by Claim 10. *See also* EX1007 (Thompson), Fig. 4 (annotated by Petitioner below) (regardless whether the dopant emitter material is the hole transporter or the electron transporter, it does not have both a LUMO that is lower than the other two materials or a HOMO that is higher than the other two, showing that an emitter material need not or even desirably should have the claimed property).

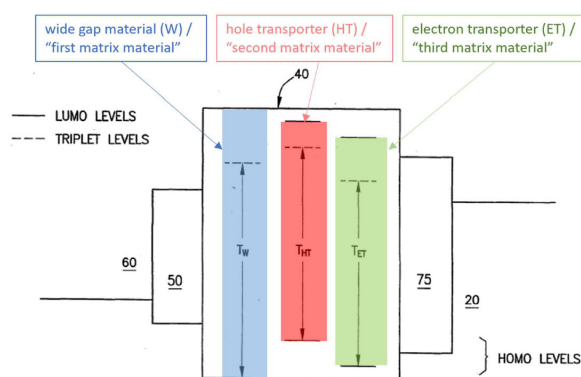
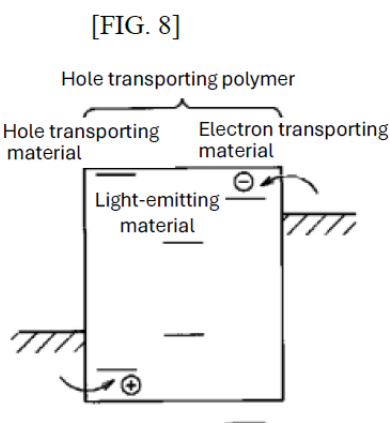


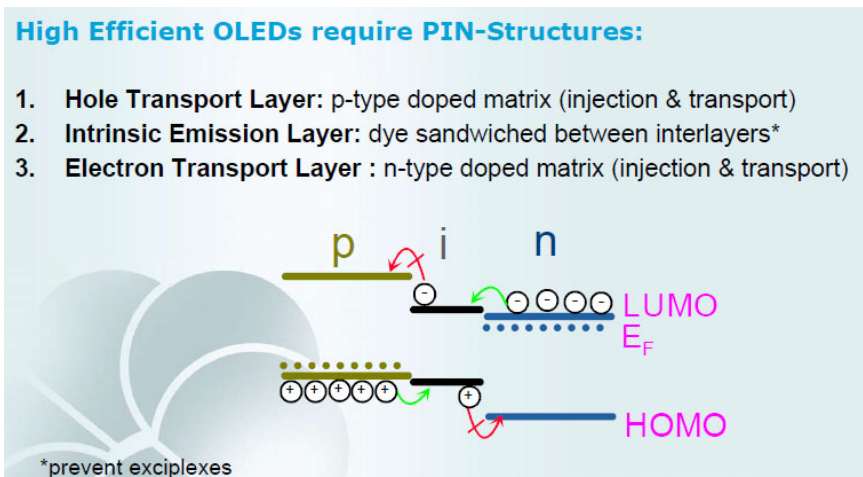
Fig. 4

As another example, Figure 8 of Sugiura (EX1006) cited by Petitioner on Petition, page 37 shows that electrons are transferred into the electron transport material having a higher electron affinity level than the emitter material and holes are transferred into the hole transport material having a lower ionization potential than the emitter material:



This is in contrast to Petitioner's theory that "[e]lectrons tend to lower their energy by traveling 'downhill' to LUMO levels that are lower, and in contrast, holes tend to lower their energy by traveling 'uphill' to HOMO levels that are higher." Pet. 37. But Petitioner's own evidence undermines that theory, showing electrons and holes transferred in the opposite energy direction.

In the '164 patent, the inventors proposed a narrower bandgap for the emitter materials than the matrix materials as recited by claim 10 to make an "ambipolar charge transport" "possible" in the emission layer. EX1001, 4:44-54. No such insights are present in the prior art and thus there is no evidence that a POSITA would have arrived at the invention. *See also* EX2006, p.6 (presentation by Novaled, a subsidiary of Petitioner, showing holes being injected to the emission layer's HOMO whose level is energetically lower than that of the hole transport material, and electrons being injected to emission layer whose LUMO level is slightly higher than the electron transport material, again contrary to Petitioner's theory).



In summary, Petitioner has not shown that Choulis anticipates claim 10 and it has not presented any competent evidence to show why a POSITA would have replaced the emitter material used in the Figure 4 example with rubrene, PQIr or DCM2, other than those known emitter materials. But obviousness concerns not only what was known in the art, but also why a POSITA would have made the modification. *In re Stepan Co.*, 868 F.3d 1342, 1345–46 n.1 (Fed. Cir. 2017) (“Whether a rejection is based on ... combining multiple embodiments from a single reference, or selecting from large lists of elements in a single reference, there must be a motivation to make the combination and a reasonable expectation that such a combination would be successful, otherwise a skilled artisan would not arrive at the claimed combination.”); *Virtek Vision Int’l ULC v. Assembly Guidance Sys.*, 97 F.4th 882, 886-87 (Fed. Cir. 2024) (a reference that discloses two measurement systems could be used interchangeably does not evidence why a POSITA would have made the substitution). Petitioner has failed to present any competent evidence.

D. Petitioner Has Not Provided Any Competent Evidence that a POSITA Would Have Modified Choulis to Apply the First, Second and Third Matrix Materials Simultaneously by Evaporation Coating (Element 13[d], Claim 14)

Petitioner concedes that “Choulis discloses depositing its materials via spin-coating,” which is a solution-based process. Pet. 40; EX2007, 054702-2 (in a contemporaneous paper co-authored by the Choulis inventors, they described a spin-coating procedure to form an emission layer by using a chlorobenzene solution consisting of “**24% (wt) ... (PBD), 9% (wt) ... (TPD), 6% (wt) ... Ir(ppy)₃**, and **61% (wt) (PVK)**, a similar composition to Choulis, [0054]); EX1022, 203502-2 & -3 (citing to Ref. No. 6, the Yang reference, for the emission layer composition); EX1017_Yang, 2476 (PVK, PBD, TPD and Ir(mppy)₃ blended in chlorobenzene for spin coating).

Petitioner argues, however, a POSITA would have used instead an evaporation coating process. Pet. 41-43. Petitioner first argues that “PVK can be deposited via evaporation....” Pet. 41. But obviousness examines not only what a POSITA “could” have done but also whether they “would” have done so. *Belden Inc. v. Berk-Tek LLC*, 805 F.3d 1064, 1073 (Fed. Cir. 2015) (“[O]bviousness concerns whether a skilled artisan not only could have made but would have been motivated to make the combinations or modifications of prior art to arrive at the claimed invention.”).

Petitioner argues that “[a] POSITA would have ... found it obvious to apply PVK via evaporation coating ... as it would improve manufacturability, display quality, and yield” Pet. 41. That general statement is not supported by any competent evidence. Specifically, the paper it cites for vapor-deposition of PVK observes that “not only the chain length of the evaporated polymer thin film is *far smaller*, ... but the emission spectrum is sensibly different to that of the PVK reference power.” EX1023, 132; *see also id.*, 133 (“after evaporation PVK films are formed of vinylcarbazole oligomers with an emission spectrum corresponding to a mixture of PVK and vinylcarbazole”). Petitioner does not explain how depositing PVK using a method that would degrade it would allegedly “improve manufacturability,” “display quality” or “yield.” Pet. 41; EX2001, ¶46 (Dr. Sims, with over 25 years of relevant industrial experience, opines that a POSITA would not have used a method known to degrade PVK to deposit PVK).

The degradation of PVK into oligomers and vinylcarbazole monomers would instead have discouraged a POSITA from using the method because it “would disrupt the charge balance in the emitting layer by altering the resulting materials’ charge carrier mobilities and their HOMO levels (which in turn affect the ability to create charge carriers).” EX2001, ¶46. Specifically, PVK is regarded as a material with “mostly hole transporting properties.” EX1004, [0044]. Choulis explains that “by using a specific amount of hole and electron injecting materials within the light

emitting layer, the charge balance within the light emitting layer can be optimized.” *Id.*, [0058]. Petitioner provides no evidence for the hole transporting properties of the degraded oligomers and monomers, and has not shown that a POSITA would be able to control the charge balance in the resulting emitting layer.

Moreover, Petitioner has presented no evidence of what the HOMO and LUMO levels of the degraded materials would be and hence whether the HOMO/LUMO relationships it relies on for claim 1 (required also for claims 13 and 14) still hold. In other words, Petitioner has not shown that there would have been any reasonable expectation of success in obtaining an organic functional layer with the recited HOMO/LUMO requirement of claim 1.

Indeed, Choulis never suggests that evaporation is a suitable method to deposit PVK: it only suggests using evaporation “if small molecules are used instead of polymers.” EX1004, [0048] (“Polymer organic layers can be applied ... using a variety of techniques such as ink-jet printing an organic solution or by spin-coating. Alternatively, if small molecule materials are used instead of polymers, the layers can be deposited through evaporation”). Likewise, [0059] relied on by Petitioner contrasts “small molecule OLEDs” with “solution processable polymer-based OLEDs.” Again, there is no suggestion of using evaporation to process a polymer like PVK, especially given its known tendency to degrade into oligomers and monomers. *See* EX1004, [0059]; EX1023, 132-33 (PVK degrades when

evaporated). Instead, Choulis repeatedly associate polymer with a solution process. EX1004, [0048], [0059].

Tellingly, other than EX1023, Petitioner has not presented any other references where a POSITA deposited PVK via evaporation: For example, Ground 3 relies on Sugiura which Petitioner acknowledges used PVK as the polymer material. *See* Pet. 54-55 (citing EX1006, [0062]). But Petitioner does not assert that Suigura renders obvious claim 14. *See* Pet. 51 (claim 14 not one of the challenged claims for Ground 3); *see also* EX1017, 2476 (Yang processed the “blend of PVK, PBD, TPD and Ir(mppy)₃ in chlorobenzene **solution**” using “spin coat[ing]”). That is objective evidence that a POSITA would not have viewed it as obvious to use a method known to decompose PVK to manufacture an OLED containing PVK as a host to disperse charge transport moieties and the emitting material.

This is not about the weight of evidence, because Petitioner simply ignores the disclosure of EX1023 and fails to provide any pertinent analysis.

Finally, Petitioner argues that a POSITA **could** use a small molecule as a host material instead of PVK. Pet. 42-43. But Petitioner has not shown a single small molecule material that could satisfy the HOMO/LUMO energy level required for claims, 1, 13 and 14. Simply put, Petitioner has not even shown that a POSITA would have known about a small molecule suitable to serve as a matrix material for a PHOLED at the time of the invention and that satisfies the HOMO/LUMO

requirements of the claims. Without such evidence, Petitioner fails to demonstrate that (1) a POSITA would have had a reasonable expectation of success or even been able to make such a substitution; or (2) a POSITA would have had a reasonable expectation of success or even been able to obtain a device that satisfies all the limitations of claims 1, 13 and 14. *Raytheon Techs. v. Gen. Elec. Co.*, 993 F.3d 1374, 1380-81 (Fed. Cir. 2021) (while a reference may be used to supply claim elements enabled by other prior art or evidence of record, such evidence of enablement still must exist). As in *Raytheon*, Petitioner has not provided any evidence that a small molecule material that could replace PVK with all the requisite properties and HOMO/LUMO levels was known or existed at the time of the invention. *Id.* at 1381-82 (reversing the Board’s finding of obviousness based on the fact that there was no evidence that the materials needed for the invention existed at the time of the invention). Without that evidence, Petitioner has not even shown that a POSITA “could” have replaced PVK with a small molecule that satisfies all the requirements of claim 10, let alone that a POSITA would have done so. Petitioner’s argument based on replacing PVK with an unknown/unspecified small molecule therefore fails as a matter of law.

E. Choulis and Yong Do Not Render Claim 9 Obvious

Claim 9 recites that “the concentration of the emitter material in the emission layer has a gradient.” EX1001, 9:52-54. Petitioner concedes that Choulis does not

disclose this limitation, as it looks to Yong for this limitation. Pet. 48-51. But Petitioner fails to provide any competent evidence that a POSITA would either have had a reason to modify Choulis to generate a concentration gradient of the emitter material in the emission layer or that there is a reasonable expectation of success in doing so with the Choulis system relied on for claim 1.

Petitioner first argues that because Choulis cites a prior art study to explain that “the recombination current in any of the layers can be controlled ... by adjusting dopant concentration,” “[i]t would have been obvious to a POISTA to apply the emitter material in Choulis’s emission layer such that the concentration of the emitter has a gradient.” Pet. 48-49. That leap in logic makes no sense. Petitioner does not explain why trends observed for different devices, all with a uniform emitter concentration within the emission layer, would have suggested having different emitter concentrations throughout the emission layer in the same device. For example, Petitioner does not argue that it would be advantageous to have a gradient in recombination currents through a single emission layer.

Petitioner then contends that “forming a gradient with an emitter material was well known,” pointing to a single Chinese patent, Yong. Pet. 49. Disclosures by a single group of little known engineers do not make the practice “well known,” evidenced by Petitioner’s inability to find any other references making the suggestion.

Nor would Yong's disclosure have motivated a POSITA to apply concentration gradient to the Choulis system. Yong suggests gradient doping of emitter materials because "[i]n general devices, holes are majority carriers, while electrons are minority carriers," such that "[i]n the light emitting layer of phosphorescent devices, the concentration distribution of electrons shows a non-linear decreasing trend along the direction from the electron transporting layer to the hole transporting layer." EX1009-10/33 (Description 3 of 22, 2nd paragraph). Yong utilizes one such traditional OLED device, where the emission layer included only a host material and the emitter material. *See* EX1009, 19 (Description 12 of 22, paragraph 3, disclosing using "host materials DCB and Flrpic" for the emission layer), 18 ("4 is an organic light emitting layer, using small molecule materials as the host material").

But the Choulis's emission layer relied on for claim 1 includes not only a host material, PVK, but also TPD and PBD. *See* EX1004, Fig. 4 (annotated on Pet. 27). Petitioner characterizes TPD as "a hole transport material," (Pet. 33-34), and PBD as an "electron transport material" (Pet. 34). That is, unlike Yong's traditional devices, Choulis includes both hole transport and electron transport materials in the emission layer. Petitioner ignores this critical difference and provides no evidence that in Choulis's emission layer, "concentration distribution of electrons [also] shows a non-linear decreasing trend along the direction from the electron

transporting layer to the hole transporting layer” as in Yong’s device with a completely different architecture. Because Yong’s modification was to address this non-linear decrease in electron concentrations from ETL to HTL, a POSITA would not have added steps to include a concentration gradient like Yong if the problem did not exist in the first place. That is, Petitioner fails to demonstrate any reason for a POSITA to use Yong’s method in Choulis’s device that was not reported to have a concentration gradient of electrons from the ETL side to the HTL side. Pet. 48-51.

In fact, Choulis asserts that “[b]y shifting the hole and electron transfer to the matching materials in the light emitting materials, charge transport can be separated from exciton formation,” which can in turn result in “less voltage application to the device overall” as well as “[e]xpand[] the recombination zone” from the surface of the emitting layer to “throughout the light emitting layer.” EX1004, [0056]. That is, Choulis, with an emission layer that incorporated both a hole transporting and an electron transport material, has already achieved the goal Yong did with emitter concentration gradient, namely “[m]ore efficient use of the phosphorescent material” and “extend[ing] the lifetime of the device.” EX1004, [0056]-[0057].

Indeed, regarding the hole-electron charge imbalance problem observed by Yong, Choulis suggests that “by using a specific amount of hole and electron injecting materials within the light emitting layer, the cha[r]ge balance within the

light emitting layer can be optimized” and that “[i]ncorporating matching layers into the light emitting layer can also control the charge balance within the light emitting layer.” *Id.*, [0058]. Given that Choulis has already addressed the root problem—charge imbalance in the emitting layer—that led to Yong’s use of emitter concentration gradient solution, Petitioner has not provided any competent reason why a POSITA would have applied Yong’s emitter concentration gradient to Choulis’s completely different emission layer. Pet. 48-51. *See Kinetic Concepts, Inc. v. Smith & Nephew, Inc.*, 688 F.3d 1342, 1369 (Fed. Cir. 2012) (when two references accomplish similar functions, there is “no reason to combine the features of both devices into a single device.”).

Petitioner has also not shown that there is a reasonable likelihood of success that a POSITA would be able to achieve a concentration gradient in Choulis’s system relied on for claim 1. Specifically, for claim 1, Petitioner relies on PVK, TPD and PBD as the first, second and third matrix materials. *See* Pet. 24-25. Petitioner only asserts that concentration gradient could be achieved via “evaporation” deposition. *See* Pet. 50-51. But Choulis does not disclose or suggest using evaporation to deposit its blend of PVK-based emission layer materials. *See* EX1004, [0048] (suggesting applying polymer organic layers with “ink-jet printing” or “spin-coating”), [0044] (describing PVK as “a non-conjugated polymer”). Petitioner also does not contend for this claim that evaporation is a viable deposition method for the PVK material

used in Choulis. Contemporaneous articles used spin coating to deposit light emitting layers having the same matrix composition as the Choulis application. EX2007, 054702-2; *see also* EX1017, 2476 (blending PVK, PBD, TPD and Ir(mppy)₃, including mixtures with the same composition as Choulis (*see* 2478-Fig. 3 caption), in chlorobenzene for spin coating).

EX1004, [0054]	EX2007,054702-2
“The light emitting layer includes 61% PVK, 24% PBD, 9% TPD and 6% Ir(mppy) ₃ .”	“The green emitting layer (EML) <i>was then spin coated</i> ... to yield a light emitting layer thickness of around 70 nm. The light emitting layer was then annealed at 80 °C for 30 min. The solution for the EML consisted of 24% (wt) 2-4-(biphenyl)-5-(4- <i>tert</i> -butylphenyl)-1,3,4-oxadiazole (PBD), 9% (wt) 4,4'-bis-(<i>m</i> -tolylphenylamino)biphenyl (TPD), 6% (wt) fac-tris(2-phenylpyridine)iridium Ir(ppy)₃ , and 61% (wt) polyvinylcarbazole (PVK) in chlorobenzene.”

Petitioner does not contend that a concentration gradient of the emitter material could be created via a solution-based process such as spin-coating. And Dr. Sims, based on his years of experience in the industry, including in solution-based OLEDs, opined that doing what Petitioner suggests “would be beyond the skill level of even a person with above average skills and generally it would be extremely difficult to do.” EX2001, ¶47. Issues such as phase separation would make it

extremely challenging and not reproducible to create films with controlled concentration gradients. *Id.* As a result, Petitioner has not shown that a POSITA would have had a reasonable expectation of success to create a concentration gradient of the emitter material in Choulis's emitting layer consisting of PVK, PBD and TPD—the three materials that Petitioner relies on for claim 1. Nor does it show that Yong's system would have satisfied the requirements for claim 1. Consequently, Petitioner has not shown that a POSITA would have had a reason to modify Choulis's emitting layer to have an emitter gradient or that they would have had a reasonable expectation of success to do so with Choulis's system that meets the requirement for claim 1.

III. Petitioner Has Not Shown a Reasonable Likelihood of Success for Ground 3.

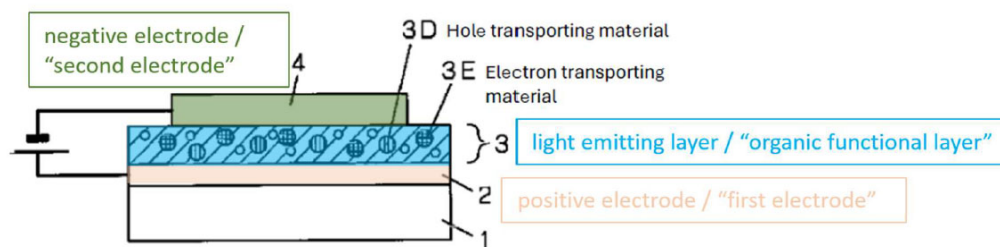
Petitioner does not assert Ground 2 against claims 2, 4, 9 or 14-16. *See* Pet. 6 (only asserting Sugiura reference against claims 1, 3, 5-8 and 10-13). Petitioner also fails to show a likelihood of success for the remaining claims because it has not presented any competent evidence that Sugiura discloses three matrix materials or the specified HOMO/LUMO relationships.

A. Petitioner Does Not Explain Why Sugiura's Hole and Electron Transporting Materials are "Matrix Material[s]"

The claims asserted under Ground 3 all require an organic functional layer having "at least a first matrix material, a second matrix material and a third matrix

material.” EX1001, 9:10-12. As explained in Section II.A, the term “matrix material” does not refer to just any chemical components in an organic functional layer.

Petitioner maps the three matrix materials in Sugiura to the polymer material 3A, the hole transporting material 3D, and the electron transporting material 3E, respectively. Pet. 54-55. But as Petitioner’s own annotated figure shows, the hole transporting material 3D and the electron transporting material 3E are dispersed as segregated and discontinuous particles in polymer 3A. Cf., EX1006, [0041] (when describing Fig. 1, noting “[t]he light emitting layer includes a charge transporting material 3B, a light-emitting material 3C, and *a polymer 3A for dispersing these.*”), Fig. 1 (showing 3B and 3C dispersed as separate particles in polymer 3A, just like 3D and 3E are dispersed in 3A in Figure 4). 3D and 3E are also not disclosed as capable of embedding another material in the light emitting layer: the emitter particle (open circles), for example, are dispersed in the host material, but not in 3D or 3E. See below; EX2001, ¶¶36-37.



Given Sugiura’s express disclosure that the hole transporting and the electron

transporting materials are segregated particles dispersed in polymer 3A and that no other materials embed in them, Petitioner does not explain why the hole transporting material and the electron transporting material are “matrix materials.” Indeed, characterizing 3D and 3E as matrix materials is not even consistent with Samsung’s own proposed construction for “matrix materials” in the district court, where it asserts that “matrix” means “a continuous phase of the mixture of matrix materials,” and “the first, second, and third matrix materials are different materials and are part of the same matrix.” EX2005, 16-17. But in the light emitting layer 3, only the host material (blue shaded lines) is in a continuous phase, in which islands of 3D and 3E, as well as emitter particles, are dispersed. EX2001, ¶37. The mixture of 3A, 3D and 3E does not form a continuous phase in the emission layer; instead, the only continuous phase is formed by host material (blue shaded areas) with 3D and 3E embedded in it at discrete locations. *Id.* Indeed, given that 3D and 3E, like the emitters, are dispersed in host 3A with no other materials embedded in them, “materials 3D and 3E would be regarded as having the same structural nature as the emitter materials—they are all dopants, not matrix materials” *Id.* As such Petitioner has not shown that Sugiura discloses three matrix materials as required by the claims.

B. Sugiura Does Not Disclose HOMO or LUMO Levels

Additionally, Petitioner points to Figure 8 of Sugiura to argue that the mixture has the required relative HOMO and LUMO levels. *See* Pet. 55-58. But the cited

[0049] does not mention HOMO or LUMO. It discusses instead “ionization potential of the hole transporting material.” *Id.*, [0049]. Indeed, Sugiura does not mention HOMO or LUMO at all, discussing instead “ionization potential” and “electron affinity.” *See id.*, [0053], [0062]. The Petition does not explain how the HOMO and LUMO levels relate to ionization potential and electron affinity.

Those values also do not appear to match. For example, Sugiura reports that Alq₃ has an ionization potential of 5.7 eV and an electron affinity of 3.0 eV. EX1006, [0053]. In contrast, Kang reports that Alq₃’s HOMO and LUMO levels are -5.62eV and -2.85 eV respectively. *See* EX1010, Fig. 1. They are therefore not the same. Petitioner has utterly failed to provide any competent evidence explaining why Sugiura’s Figure 8, which depicts relative levels of ionization potential and electron affinity, demonstrates that the HOMO and LUMO relationships recited in the various claims are met. Ground 2 therefore fails as a matter of law.

As an example, the Figures 4 and 8 embodiment relied on by Petitioner uses PVK, Alq₃, TPD and Nile red with the Nile red being the emitter material. Pet. 54-55 (citing EX1006, [0062]); *see also* EX1006, [0052] (“Nile Red, a laser dye, was used for the light-emitting material”). According to Choulis, TPD has a HOMO energy level of -5.5 eV, and a LUMO energy level of -2.3eV. EX1004, Fig. 4. According to the literature, the HOMO and LUMO levels for Nile red are -5.5 eV and -3.2 to -3.5eV respectively. *See* EX2008, 8910, Table 3.

Material	HOMO (eV)	LUMO (eV)
TPD	-5.5	-2.3
Nile Red	-5.5	-3.2 to -3.5

Consequently, the HOMO level of Nile red is not “energetically higher than the HOMO of the first, second, and third matrix materials” as required by claim 10, even if TPD could be regarded as the third matrix material. Put another way, there is no competent evidence that the energy diagrams shown in Figure 8, based on ionization potential and electron affinity, is accurate in terms of relative HOMO and LUMO levels.

Because Petitioner has not presented competent evidence, it cannot prevail on Ground 2.

IV. Petitioner Has Not Shown a Reasonable Likelihood of Success for Ground 4

A. Petitioner Fails to Demonstrate that Thompson Discloses or Suggests Three Matrix Materials

Petitioner only asserts Thompson against Claims 15-16. Pet. 69-82. Both claims require an organic functional layer having “at least a first matrix material, a second matrix material and a third matrix material.” EX1001, 10:24-26, 10:47-49. Pictiva incorporates by reference its discussion in Section II.A on “matrix materials” and its criticality to the inventions of the ’164 patent.

As explained above, the ’164 patent distinguishes between a “matrix material”

and a “doping substance[.]” For example, the patent discloses that “[f]our evaporation sources 50 are applied on a holder 51, ... from which *matrix materials and/or doping substances* can be evaporated onto the deposition substrate 60.” EX1001, 7:12-15. This disclosure makes clear that a matrix material is not a doping substance (or dopant).

The specification and the claims also distinguish between a matrix material and an emitter material. For example, claim 1 recites “wherein the at least one organic functional layer has at least a first matrix material, a second matrix material, and the third matrix material.” EX1001, 9:10-12. Claim 1 additionally recites that “the organic functional layer is an emission layer and is doped with at least one emitter material.” *Id.*, 9:21-22. This makes clear that an emitter material differs from the first, second and third matrix material. And although claims 15 and 16 do not recite an emitter material as claim 1, the same term (“matrix material”) is presumed to have the same meaning in different claims of the same patent. *See Paragon Sols., LLC v. Timex Corp.*, 566 F.3d 1075, 1087 (Fed. Cir. 2009) (“We apply a presumption that the same terms appearing in different portions of the claims should be given the same meaning unless it is clear from the specification and prosecution history that the terms have different meanings at different portions of the claims.” (citations and internal quotation marks omitted)); *Phillips v. AWH Corp.*, 415 F.3d 1303, 1314 (Fed. Cir. 2005) (“Because claim terms are normally

used consistently throughout the patent, the usage of a term in one claim can often illuminate the meaning of the same term in other claims.”).

The specification likewise draws a distinction between a matrix material and an emitter material. For example, the Background explains that “[e]mission layers thereby ***have a matrix material, which is doped with emitter molecules.***” EX1001, 1:22-23. Figure 2 depicts “first matrix material” 30N, “second matrix material 30B,” “third matrix material 30A,” and separately “emitter material 30E.” EX1001, 6:16-37. The patent further notes there are “concentrations of the emitter material and the matrix materials” *Id.*, 4:10-12; *see also id.*, 4:44-49 (comparing the LUMO and HOMO energy levels of “the emitter material” with those of “the first, second, and third matrix material”); 4:15-16 (“By not doping with emitter materials, it is possible to produce transport, intermediate, and blocking layers.”).

That is, the ’164 patent distinguishes between matrix materials existing in large quantities and dopants existing in small quantities, and between a matrix material and an emitter material.

Thompson, however, makes clear that its emission layer includes only one matrix material, and two dopants (one of which is also an emitter material): “... the emissive layer comprises a wide gap host material ***doped with both a charge carrying dopant material and a phosphorescent dopant material.***” EX1007, [0008] (cited on Pet. 72-73). Thompson also distinguishes between a dopant and a matrix

materials: “The HOMO energy levels of the *phosphorescent dopants* are typically higher in energy than those of *the matrix materials into which they are doped*.” *Id.*, [0023]. Petitioner, however, maps the two dopants to the second and third matrix materials. Pet. 73-74. Petitioner does not explain why these dopants would constitute matrix materials in the context of the ’164 patent, when not only the ’164 patent specifically distinguishes between matrix materials and “doping substances,” as noted above on pp. 54-55 and 6-14, but Thompson itself also distinguishes the dopants from the “matrix materials” into which they are doped.

Additionally, as explained above on page 55, the ’164 patent specifically distinguishes between an emitter material and a matrix material. Petitioner does not explain why Thompson’s phosphorescent dopant would be regarded as a matrix material instead of an emitter material in the context of the ’164 patent. The hole transporting property of the emitter material is not a distinguishing factor, because as Thompson acknowledges, when “[t]he HOMO energy levels of the phosphorescent dopants are ... higher in energy than those of the matrix materials into which they are doped,” “the dopants are capable of trapping holes and transporting them throughout the matrix if the doping level is high enough.” EX1007, [0023].

The ’164 patent discloses emitter materials with a HOMO energy level higher than the matrix materials. *See* EX1001, col. 7, table 1 (emitter rubrene has a HOMO

level of -5.5eV, higher than the three matrix materials mCP, TCTA and TPBi), 4:44-54 (HOMO of emitter higher than those of the first, second and third matrix materials), Fig. 2 (emitter materials 30E's HOMO level above those of the matrix materials 30N, 30A and 30B). Hence, the emitter materials disclosed in the '164 patent would also be expected to transport holes. *See* EX1007, [0023] (expecting emitter with HOMOs higher than the matrix material to transport holes); EX1017, 2477 ("This implies that Ir(mppy)₃ itself participates in charge transport" and Ir(mppy)₃ has a HOMO level higher than those of PVK, PBD and TPD used in EX1017's emission layer, per Choulis, Figure 4). Nevertheless, despite their potential hole transport properties, the '164 patent (as well as prior art) does not describe them as a matrix material. As a result, Petitioner also needs to, but fails to, explain why Thompson's dopant phosphorescent emitter constitutes a matrix material in the context of the '164 patent.

Petitioner also does not argue that these limitations would be obvious in light of Thompson. Pet. 72-74. Hence, there is no competent evidence that Thompson anticipates or renders obvious claims 15-16 of the '164 patent because Thompson does not disclose an organic functional layer comprising at least three "matrix material(s)."

B. Petitioner Fails to Demonstrate that Thompson’s Host Material Has A Lower Charge Carrier Mobility Than Those of the Dopants (Claim 16)

Petitioner assumes that because the host material has a wide band gap that “preferably does not carry a charge within the structure of the OLED,” it has a lower charge carrier mobility than the dopants. Pet. 81-82.

But as the ’164 patent explains, “[i]f a charge carrier transport does not take place in a matrix material, ... then that can be attributed to the fact that charge carriers are not created *or* that there is no mobility of the charge carrier.” EX1001, 2:64-3:1; *see also id.*, 2:58-59 (“*If holes and electrons are created*, the mobility of these charge carriers in the material plays a role.”). Petitioner has not demonstrated why the fact that Thompson’s host matrix material does not carry a charge necessarily results from the host material having a low charge carrier mobility instead of no charge carriers being created. Pet. 81-82. For instance, if the first matrix material has a deep lying HOMO and/or high lying LUMO, then it may be more difficult to create holes and electrons, leading to a negligible number of holes/electrons created. *See* EX1001, 2:46-57 (creating a hole “is more difficult with an energetically low HOMO than with an energetically higher one” and creating electrons “is energetically favored with energetically lower LUMOs”); EX2001, ¶45. The lack of holes and electrons can also result in the first matrix material not participating in charge transport. *See* EX1001, 2:64-3:1; EX2001, ¶45.

For example, Thompson discloses the use of polystyrene as his inert matrix. EX1007, [0054]. But it was reported that at 80°C, “the hole mobility in practically amorphous polystyrene” was $5 \times 10^{-5} \text{ cm}^2\text{sec}^{-1}\text{V}^{-1}$. See EX2009, Abstract. Petitioner has not provided any evidence that the dopants’ charge carrier mobilities are higher than $5 \times 10^{-5} \text{ cm}^2\text{sec}^{-1}\text{V}^{-1}$ at 80°C. Pet. 81-82. For instance, it is reported that “light doping of NPB with Ir(ppy)₃ almost do not alter the hole mobility of NPB.” EX2010, Abstract. This would have suggested that the iridium-based phosphor is not contributing to hole transport. But under Petitioner’s logic, if a substance does not participate in charge carrier transport, then it has no appreciable charge carrier mobility. Then under that logic, Ir(ppy)₃ would have no mobility, and therefore a lower mobility than polystyrene.

There is thus a complete lack of competent evidence that Thompson discloses the last limitation of claim 16. Petitioner therefore has not shown a reasonable likelihood of success.

C. Thompson Was Considered By the Examiner and 325(d) Applies

Petitioner concedes that the PCT application of Thompson was submitted to the Office during prosecution. Pet. 84 (conceding “Thompson WO” was cited in an IDS during prosecution). Thompson is the US national stage of PCT Application No. PCT/US02/07492. EX1007, cover, field (86). PCT/US02/07492 was published as WO2002/074015, identified as “WO 02/074015” on the IDS. EX1002-243.

Unsurprisingly, Thompson WO and Thompson are substantively the same since Thompson is the national stage of Thompson WO. *Compare* EX2011 *with* EX1007.

The examiner, Mr. Anthony Ho, considered the reference, as evidenced by his signature on the IDS form and the note “ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.H./.” EX1002-243. The examiner considered the reference by March 22, 2013. *Id.* (see “Date Considered”). That was before the notice of allowance issued on August 19, 2013. EX1002-266. Thus, when the examiner remarked that the “prior arts of record do not disclose or suggest” certain limitations, that included Thompson WO which was part of the record he considered. Moreover, Thompson WO was not one of a large number of references disclosed. It was one of five references submitted on November 30, 2010. *See* EX1002-46 to EX1002-49; EX1002-242 to 243. And Thompson WO was specifically called out on the PCT search report as relevant to claims 1-15 of the pending claims. EX1002-53. Because the examiner relied on the search report’s first reference, US2008/116536 (see EX1002-52) to reject the pending claims (see EX1002-233), the examiner likely considered the other references listed in the search report as well. Hence, step 1 of *Advanced Bionics* is satisfied.

As to step 2, Petitioner has not shown any material error made by the examiner. First, Petitioner does not challenge claims 1-14 using Thompson, therefore not challenging the examiner’s patentability conclusion with respect to

claims 1-14 in view of Thompson. Second, for claims 15 and 16, as explained above, even though Petitioner may disagree with the examiner's conclusion, Thompsons does not disclose three matrix materials or the relative mobilities of the materials. Hence, Step 2 of *Advanced Bionics* is satisfied as well.

V. The Board Should Exercise Its Discretion Under 314(a)

The Board should also exercise its discretion to deny institution under 35 U.S.C. § 314(a) and *Apple Inc. v. Fintiv, Inc.*, IPR2020-0019, Paper 11 (PTAB, Mar. 20, 2020) (precedential).

First, there is no stay requested and there is no evidence that Judge Gilstrap would grant a stay if a trial is instituted. In fact, Judge Gilstrap frequently denies stays in such cases. *Netlist, Inc. v. Micron Tech., Inc.*, Civ. No. 2:22-cv-00294-JRG, Dkt. 72 (E.D. Tex., Mar. 12, 2024) (denying motion to stay pending instituted IPRs); *Netlist, Inc. v. Samsung Elec. Co., Ltd.* Civ. No. 2:22-cv-00293-JRG, Dkt. 180 (E.D. Tex., Oct. 17, 2023) (same); *Id.*, Dkt. 689 (E.D. Tex., Mar. 11, 2024) (same).

Second, as Petitioner acknowledges, trial is scheduled for August 4, 2025, (Pet. 75; EX1017), more than six months before the projected statutory deadline of mid-to-late January 2026 for a final written decision ("FWD") in this proceeding. August 4, 2025 is about 21.6 months from October 19, 2023, the date when Pictiva filed its complaint against Samsung. Currently, the median time-to-trial in the Eastern District of Texas also happens to be about 21-22 months. *See* EX2014, 35.

Third, by the projected institution date, the parties would have completed their claim construction briefing and substantially completed their document production and exchanged privilege logs. *See* EX1026 at 4-5.

Fourth, there is a significant overlap between this proceeding and the parallel district court action given that Samsung has also asserted the same art in the district court (*see* EX2015, 36-37), and has not filed any stipulation regarding the use of the references that it has raised or could have reasonably raised in the district court.

Fifth, Petitioner admits that the named defendants in the parallel district court case—its parent company, Samsung Electronics Co., Ltd., and its sibling company, Samsung Electronics America, Inc.—are real parties-in-interest. Pet. 5.

Additionally, as demonstrated above, the petition lacks compelling merits. For these reasons, the Board should exercise its discretion to deny institution.

VI. Conclusions

The Board should not institute because Petitioner has not shown a reasonable likelihood that it would prevail with respect to any of the challenged claims.

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Respectfully submitted,

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CERTIFICATE OF WORD COUNT

I hereby certify, pursuant to 37 C.F.R. section 42.24, that the foregoing Patent Owner Preliminary Response contains 13,984 words, excluding the words in the table of contents, table of authorities, exhibit list, this certificate of word count, signature block and certificate of service. The word count is based on the word count of the Microsoft Word program used to prepare the Patent Owner Preliminary Response.

/Susan M. Langworthy/
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CERTIFICATE OF SERVICE

I hereby certify, pursuant to 37 C.F.R. section 42.6, that on October 28, 2024, a complete copy of the foregoing document **PATENT OWNER'S PRELIMINARY RESPONSE and EXHIBITS 2001-2015** were served by electronic mail, as agreed to by the parties, upon the following:

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