

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 RESPONSE

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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)
EX2016	Declaration of Dr. E. Fred Schubert in <i>Pictiva Displays Int’l Ltd. v. Samsung Electronics Co. Ltd., et al.</i> , Case No. 2:23-cv-000495 (E.D. Tex. Nov. 12, 2024) on behalf of real parties-in-interest
EX2017	2024-12-09 Email from Samsung to Pictiva re “IPR2024-01095 – Stipulation”
EX2018	Deposition Transcript of Dr. Schubert with Ex. 1 of the deposition (Schubert Declaration) and Ex. 9 of the deposition (Sugiura reference)
EX2019	[UNDER SEAL] Declaration of Dr. Marc Sims (submitted with Patent Owner Response)
EX2020	Deposition Transcript of Dr. Russell J. Holmes, April 18, 2025
EX2021	Yuanmin Wang et al., <i>Green to white to blue OLEDs by using PBD as a chromaticity-tuning layer</i> , Science Direct, Displays 25 (2004) 237–239
EX2022	Y.B. Yoon et al., <i>Electroluminescence Mechanism for the Efficiency Enhancement and the Color Stabilization of Yellow Organic Light-Emitting Devices with a Mixed</i>

	<i>Layer</i> , Mol. Cryst. Liq. Cryst., Vol. 459, pp. 3/[283]–10/[290], 2006
EX2023	Venla M. Manninen <i>et. al.</i> , <i>Synthesis and characterization of tris-(5-amino-8-hydroxyquinoline)aluminum complexes and their use as anode buffer layers in inverted organic solar cells</i> , J. Mater. Chem., 2012, 22, 22971
EX2024	US7,911,129 issued to Hofmann, Mar. 22, 2011
EX2025	Deposition Transcript of Barry P. Rand, Ph.D., Apr. 3, 2025
EX2026	Gufeng He <i>et al.</i> , <i>Very high-efficiency and low voltage phosphorescent organic light-emitting diodes based on a p-i-n junction</i> , J. Appl. Phys. 95, 5773-5777 (2004)
EX2027	US6,303,238 issued to Thompson, Oct. 16, 2001
EX2028	Joint Claim Construction Chart, Ex. 1, Doc #161-1, Case 2:23-cv-00495
EX2029	Forrest <i>et al.</i> , US Publication No. 2008/0116536 A1, published May 22, 2008
EX2030	US9,403,849 issued to Stoessel, Aug. 2, 2016
EX2031	[UNDER SEAL] Excerpts from Expert Report of Dr/ Ioannis Kymissis Regarding Validity of U.S. Patent Nos. 8,558,223 and 8,723,164
EX2100	US10,333,070 issued to Thompson, Jun. 25, 2019
EX2101	US8,679,647 issued to Pflumm, Mar. 25, 2014
EX2102	US10,586,926 issued to Hartmann, Mar. 10, 2020
EX2103	US8,119,037 issued to Zeika, Feb. 21, 2012
EX2104	US8,212,245 issued to Birnstock, Jul. 3, 2012

I. Introduction

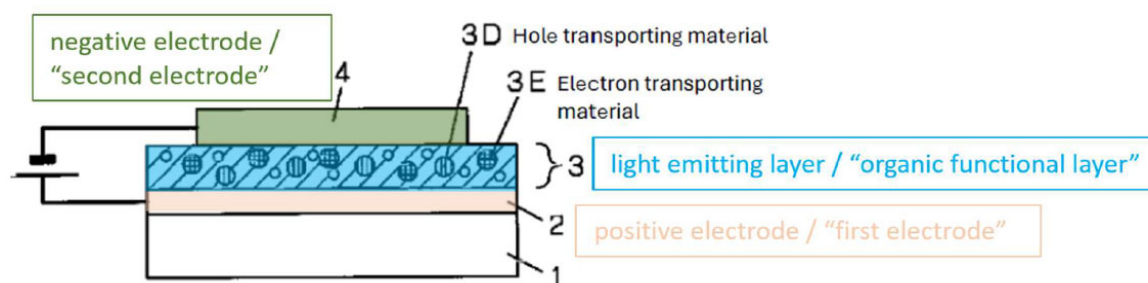
The inventors of the '164 patent recognized that, in an OLED, the balance of electrons to “holes” transported in the OLED’s emission layer is critical to obtaining high efficiency. EX1001, 1:23-29. The inventors’ novel approach is to include at least three matrix materials (also known as host materials) in the emission layer, one with hole transport properties, another with electron transport properties, and a third which can affect hole and/or electron transport. EX1001, 1:46-48, 2:24-29, 3:17-34. But the prior art cited in the Petition does not disclose that novel solution. Instead, the Petition attempts to force-fit the prior art to the claimed invention by treating any material in the emission layer as a “matrix material,” regardless of what the prior art says about the use, distribution or type of material.

For example, for Ground 1, the Petition maps the three recited matrix materials onto only one actual matrix material (“host material, PVK”) and two dopants (e.g., TPD). Pet., 24-25; *see infra*, Section IV.A. However, the recited “matrix material[s]” do not encompass dopants where, as here, the patent distinguishes between matrix materials and dopants. *See infra*, Section III.A. Petitioner’s own art and other literature also distinguishes matrix materials from dopants. *See id.* Thus, Ground 1 fails at least because it maps one or more of the recited matrix materials onto dopants, where a POSITA would understand matrix materials do not encompass dopants.

Ground 1 fails for a second, independent reason. Dr. Holmes conceded that he proceeded solely under anticipation for all but claims 2, 4, 10, and 13-14. EX2020, 167:5-168:12.¹ Thus, even if Petitioner were to argue that a dopant can be a matrix material in some contexts (it cannot per Section III.A), Choulis does not unambiguously disclose that *its* TPD and PBD materials *are* matrix materials, and therefore Petitioner cannot meet its burden of proving anticipation.

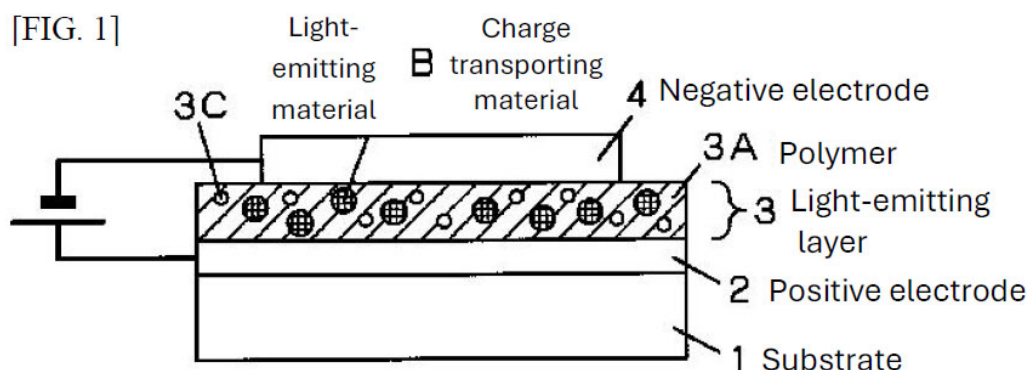
Ground 3, the only other ground challenging claim 1, maps two of the three recited matrix materials onto a hole transporting material 3D and electron transporting material 3E which are distributed as segregated and dispersed agglomerations in polymer 3A. Pet., 53-55; *see infra*, Section VI.

¹ The Petition's inclusion of the word "obvious" in the heading and generic statement about that "to the extent any limitation is not disclosed by Choulis, it would have been strongly suggested to a POSITA for the same reasons discussed in Ground I below for that limitation" (Pet., 20) does not present a valid obviousness challenge. The Petition sets forth no proposed modification, reasoning, or analysis, and therefore fails to set out an obviousness challenge with the required particularity. *See* 35 U.S.C. § 312(a)(3).

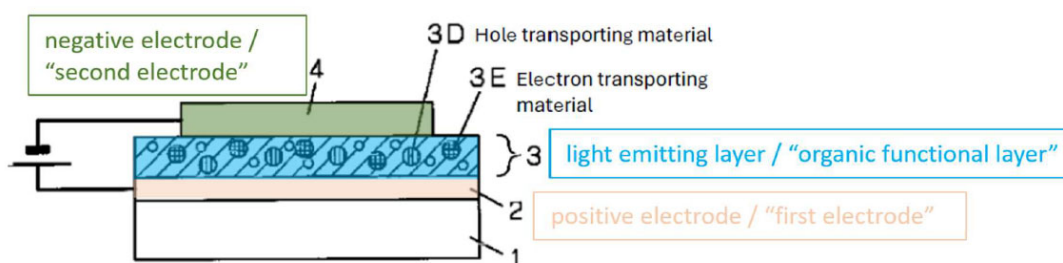


Pet., 54 (annotating Sugiura, Fig. 4).

However, a “matrix material” does not encompass such dispersed agglomerations. *See infra*, Section III.B. And while the Board provisionally construed “matrix material” to “include not only materials that form a continuous phase but also materials embedded within such a matrix” (Paper 11 (“DI”), 29), on a more developed record, Pictiva submits that a POSITA would understand the claims, the intrinsic evidence, and the extrinsic evidence support Pictiva’s interpretation. *See id.* Contrary to a POSITA’s understanding of “matrix material,” Sugiura’s 3D and 3E materials are clearly dopants or guest materials, not host materials. *See* Section III.A (the terms matrix materials and host materials are used interchangeably, including by Petitioner). For example, in a different embodiment, Sugiura discloses a light-emitting material 3C in the form of Nile Red, which Petitioner equates with a dopant. *See* Pet., 59. That light-emitting material 3C is depicted as dispersed and segregated agglomerations in the host materials 3A with no other materials embedded in them. *See* below.



Sugiura's 3D and 3E in Figure 4 are likewise depicted as dispersed and segregated agglomerations in the host material 3A (blue shaded material) with no other materials embedded in them.



Pet., 54.

Yet, somehow the Petitioner contends that Sugiura unambiguously discloses that materials 3A, 3D, and 3E are all matrix or host materials, while at the same time the similarly dispersed material 3C is an emitter material used as a dopant. Those are irreconcilable positions and, at the very least, show that Petitioner has not established that Sugiura "describe[s] the claimed invention with *sufficient precision and detail* to establish that the subject matter existed in the prior art." *Verve, LLC v. Crane Cams, Inc.*, 311 F.3d 1116, 1120 (Fed. Cir. 2002) (emphasis added). Thus,

Ground 3 fails at least because the challenge is based on mapping two of the three recited matrix materials onto dispersed agglomerations, which would be understood to be dopants or guest materials within a host, not individual matrix materials.

Ground 3 also fails for a second, independent reason. Like Ground 1, Dr. Holmes conceded that he proceeded solely under anticipation. EX2020, 168:18-170:14. Thus, for Ground 3 (which does not include claims 2 and 4), Petitioner must show Sugiura's Example 8 unambiguously discloses every element as arranged in the claims, either expressly or inherently.² However, Sugiura does not mention HOMO or LUMO at all. Indeed, to satisfy the HOMO and LUMO limitations of claim 1 (Elements 1[f] and 1[g]), the Petition cites to Sugiura's FIG. 8 and a single paragraph mentioning "ionization potential" and "electron affinity." *See* Pet., 55-58 (citing to Sugiura, [0049] & FIG. 8). But there is no analysis or reasoning as to why FIG. 8 discloses the various HOMO and LUMO limitations, or how the discussed "ionization potential" and "electron affinity" relate to HOMO and LUMO values. The fact is that Sugiura is rife with ambiguity and does not tie its discussion of "ionization potential" and "electron affinity" in any way to HOMO and LUMO

² Ground 3 contains the same passing references to obviousness as Ground 1 (*see* Pet., 51), with no modification, reasoning or analysis, and therefore also falls far short of setting forth a proper obviousness challenge.

values, and in fact contains other disclosure which suggests they are different. *See* Section VI.B. That is insufficient under the law of anticipation. “Ambiguous references do not anticipate a claim.” *Wasica Finance GmbH v. Continental Automotive Systems, Inc.*, 853 F.3d 1272, 1284 (Fed. Cir. 2017).

Ground 4, based on Thompson and challenging claims 15-16, fails because again the Petition maps two of the three recited matrix materials to dopants, and for additional reasons. *See infra*, Section VII. Finally, the challenge of claims 2, 4, 9, 10, and 13-16 under Grounds 1-2 fails to establish unpatentability for additional reasons. *See infra*, Sections IV.C.-IV.E & V.

II. The '164 Patent

In order to achieve high efficiency, the inventors proposed a novel arrangement in which an OLED emission layer is constructed to include 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, 1:23-29, 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. 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.” *Id.*, 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. Conversely, to create an electron, electrons are injected into the LUMO of a material, “which is energetically favored with energetically lower LUMOs.” *Id.*, 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. These relationships are recited in elements 1[f] and 1[g].

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.” *Id.*, 3:17-20. Because the second and third matrix materials are respectively for hole and electron transport, they are contemplated to have sufficiently short molecular distances to facilitate electron/hole hopping. EX2019, ¶35 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. That is why both the second and third materials are claimed as “matrix materials,” as opposed to

simply “materials” or “dopants.” EX2019, ¶¶35-37.

III. Claim Construction

Petitioner expressly states that it “does not believe that any specialized constructions are necessary for this petition.” Pet., 12. Therefore, it did not propose any construction for the term “matrix material,” but instead treated any material that happened to be in an emission layer as a matrix material. EX2020, 27:5-9, 342:16-343:10. And, while the Board did not agree with Pictiva that the phrase “matrix material” should be limited to materials in sufficient amounts to form a continuous phase in which other materials can be embedded (DI, 29), that does not mean the term has no bounds and can encompass any material at all, least of all materials which the ’164 patent specifically distinguishes from matrix materials (e.g., dopants). That is, the term “matrix,” which is used to limit each of three distinctly-recited materials, must be afforded full patentable weight.

However, the dispute here does not require the Board to determine all that may encompass a “matrix material,” only that which is **not** fairly encompassed under the term’s ordinary and customary meaning. Specifically, the Board need only address the discrete issues of whether the ordinary and customary meaning of the term “matrix material” would be understood by a POSITA to (1) encompass a dopant, and (2) encompass dispersed agglomerations. *See Realtime Data, LLC v. Iancu*, 912 F.3d 1368, 1375 (Fed. Cir. 2019) (“The Board is required to construe

‘only those terms. . . that are in controversy, and only to the extent necessary to resolve the controversy.’”) (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)). If the Board determines that the term “matrix material” would not be understood by a POSITA as including dopants, Petitioner’s Grounds 1, 2 and 4 fail for the reasons under Sections IV, V, and VII below. And, if the Board determines that the term “matrix material” would not be understood by a POSITA as including a dispersed agglomerations, Ground 3 fails for the reasons under Section VI below. EX2019, ¶38.

A. A POSITA Would Understand that the Term “Matrix Material” Does not Encompass Dopants, Such as Emitter Materials.

1. Intrinsic Evidence

The ’164 patent repeatedly distinguishes matrix materials from dopants, such as emitter materials. *See* EX1001, 1:22-23 (“Emission layers thereby have ***a matrix material, which is doped with emitter molecules.***”)³; 6:14-16 (“The emission layer 30 can have a first, a second, and a third matrix material and be doped with an emitter material.”); 7:12-15 (describing how “matrix materials and/or doping substances can be evaporated onto the deposition substrate 60.”); 7:15-17 (“In order to be able

³ Emphasis added throughout, unless otherwise indicated.

to determine the individual concentration of the matrix material and/or the doping substances precisely ...”); EX2019, ¶¶40-41.

Moreover, 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, which is disclosed as a dopant, differs from the first, second and third matrix material. EX2019, ¶42. Consistent with that, 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; 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”). Thus, the ’164 patent consistently distinguishes between matrix materials, on the one hand, and between materials used as dopants such as emitters, on the other hand. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1320-21 (Fed. Cir. 2005) (“[T]he **specification is the single best guide** to the meaning of a disputed term, and that the specification acts as a dictionary when it expressly defines terms used in the

claims *or when it defines terms by implication.*”) (internal citations omitted); *Bell Atl. Network Servs., Inc. v. Covad Communications Group, Inc.*, 262 F.3d 1258, 1271 (Fed. Cir. 2001) (“Thus, when a patentee uses a claim term throughout the entire patent specification, in a manner consistent with only a single meaning, he has defined that term ‘by implication’.”). In fact, Dr. Holmes admitted that, in the ’164 patent, “there’s a distinction between the matrix materials used and the emitter material.” EX2020, 298:18-22.

That the ’164 patent describing “matrix materials” as distinct from dopants, such as emitter materials, is purposeful. The ’164 patent aims to balance holes and electrons in an organic layer, as described above. *See* Section II. 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.”). EX2019, ¶¶28-31.

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. EX2019, ¶¶33-39.

As to the first matrix material, it is described in the preferred embodiments as playing a role in finely adjusting the distances between charge carrier molecules. EX1001, 3:17-34, 6:57-7:2, 1:25-29. Thus, it would be understood to exist in sufficient quantities to effectively modulate (e.g., increase) the molecule distances to a desired level. As Dr. Sims explains, “[f]or 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.” EX2019, ¶37.

Similarly, nothing in the prosecution history suggests matrix materials encompass dopants. EX2019, ¶¶43-44.

2. General Understanding in the Art

Claim terms are to be construed in accordance with their plain and ordinary meaning *as would have been understood by the ordinarily skilled artisan* at the time of the invention and within the context of the entire patent disclosure. *See Phillips*, 415 F.3d at 1313. For example, expert testimony and prior art, including Samsung’s own experts and prior art, are instructive on this point.

To that end, Samsung’s expert on validity explained that “[i]n OLED design, ‘doping’ refers to the intentional introduction of a foreign material (or impurity) into a host at low concentrations to modify its electronic or optical properties.” EX2031

(Kymissis Report), ¶814. He also notes that emitter materials “are doped into the light emitting layer” and that “[t]his doping approach enables efficient energy transfer from the host to the emitter, thereby optimizing light emission while preventing issues like aggregation or quenching that can occur at higher concentrations.” *Id.*

Similarly, Samsung’s claim construction expert relied on the distinction between dopant and matrix material. EX2016, ¶140 (“[T]he presence of dopant/guest molecules changes the electronic structure around the matrix molecules process.”). Prior art also consistently and repeatedly distinguishes matrix materials from dopants. For example, Samsung’s Thompson reference states that, “[i]f a dopant capable of producing blue phosphorescence is inserted in such a device utilizing the existing materials and structures, the emission will only come, if at all, inefficiently *from the matrix material, and not from the phosphorescent dopant material.*” EX1007, [0006]; *see also id.*, [0023], (“The HOMO energy levels of the phosphorescent dopants are typically higher in energy than those of the matrix materials into which they are doped. This means that the dopants are capable of trapping holes and transporting them through the matrix if the doping level is high enough.”), [0025] (“the emissive material is dispersed in the host matrix together with the charge carrying dopant material”), [0057] (“The polystyrene acted as an inert matrix in which the dopants were supported.”). Other patents by Thompson

confirm this. *See* EX2100 (US10,333,070), 4:30-36, 8:4-7 (“Dopants can be present in the organic matrix material in an amount sufficient to increase conductivity relative to undoped organic matrix.”); EX2102 (US10,586,926), 1:22-27 & 2:33-40, Abstract (“organic doping agent for doping an organic ... matrix material”), 2:21-24 (“HOMO of the matrix material” and “LUMO of the doping agent”); EX2103 (US 8,119,037), 3:13-18 (“an organic ... matrix material that is doped with at least one dopant in order to change the electronic properties of the ... matrix material”), 3:23-27 (“dopant for doping an organic ... matrix material”); EX2104 (US8,212,245), 12:41-45 (“matrix material and dopant precursors substantially homogeneously embedded therein”); EX2024 (US7,911,129), 5:9-13, 7:19-35 (distinguishing between “matrix material” and “dopants,” such as emitters); EX2019, ¶47.

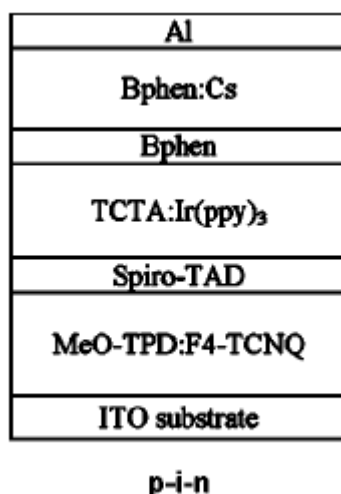
Samsung’s prior art references also use the term “host” material interchangeably with “matrix.” *E.g.*, EX1004 (Choulis), [0044] (“In some embodiments, the light emitting layer includes materials that are insulated *matrices*, that is, *the host* does not have transport properties”); EX1007 (Thompson), [0035] (“wide gap host material layer 40, also referred to as matrix material”), [0023], [0025], [0028]-[0029]; EX2020, 266:4-18 (Dr. Holmes acknowledging that Thompson uses the term “host matrix” in the same way as “matrix material” is used). Other patents in the OLED field also confirm that host materials and matrix materials

are used interchangeably. *See* EX2100 (US10,333,070), 4:7-13 (“an **organic matrix (or host) material**”); EX2101 (US8,679,647), 89:50-51 (“a matrix material (host) and a dopant”); EX2019, ¶48 (Dr. Sims explaining that “[a] POSITA would also understand that the term “matrix material” is synonymous with the term “host” or “host material”).

Dr. Holmes’s own prior publications previously also equated “host” and “matrix.” *See* EX1016, 3 (p. 3819) (“With a UGH2 **host** also **doped** with 10% FIr6”), 4 (p. 3820) (“Thus, for guest concentrations >5%, both electrons and holes are transported by FIr6, with UGH2 acting as an inert **host matrix**.”). Samsung’s expert in IPR2024-01094, Dr. Rand, testified that he understands the term matrix material to refer to host, where usually “the host or matrix is there in larger quantities.” EX2025, 165:11-14. Dr. Rand also testified that he would not consider the emitter to be a matrix material. *Id.*, 162:8-13 (“In the emitting layer, especially in a phosphorescent OLED, I would consider the emitter to be, to not be the matrix”); 164:10-165:6 (associating the term “matrix” with “host”).

US7,911,129 similarly equates “matrix material” with host material. EX2024, 4:24-26 (“An organic matrix material in the sense of the invention is every organic host material to which further materials such as dopants or emitter substances”). The ’129 patent also describes a study by He et al. EX2024, 3:4-22; EX2026. The patent noted that He’s structure (reproduced below) “contains at least four matrix

materials.” In He’s structure, there are 4 host materials and 3 dopants (green text) in the organic layers: Bphen, Cs, TCTA, Ir(ppy)₃, Spiro-TAD, MeO-TPD, F4-TCNQ. EX2019, ¶49. That the ’129 patent describes the structure as having “at least four” instead of “at least seven” matrix materials indicates that a POSITA regards a host material, but not a dopant, as a matrix material. *Id.*; see also EX2024, 4:24-27 (“An organic matrix material ... is every organic host material to which further materials such as dopants or emitter substances, ... can be admixed (doping).”), 16:7-8 (“an emission layer comprising k (k=1, 2, 3, ...) organic matrix materials”).



(EX2026, 3 (Fig. 1))

Thompson confirms that host materials do not include dopants; in fact, they are mutually exclusive terms. See EX2027 (US6,303,238), 2:42-44 (“Whenever a dopant is present, the predominant material in the charge carrier layer may be referred to as a host compound or as a receiving compound. Materials that are present

as host and dopant are selected so as to have a high level of energy transfer from the host to the dopant material.”), 8:52-67.

Therefore, the term “matrix material” would be understood by a POSITA to not include dopants. EX2019, ¶¶40-51.

B. A POSITA Would Understand that the Term “Matrix Material” Does Not Encompassed Dispersed Agglomerations.

Petitioner’s real parties-in-interest (“Samsung”) proposed in the district court that the three claimed “matrix material[s]” are each “part of [a] same matrix,” with “matrix” meaning “a continuous phase of the mixture of matrix materials.” EX2005, 16-17. While all three matrix materials need not belong to the same matrix, in the context of the ’164 patent, a matrix material is part of a continuous phase in the at least one organic functional layer in which guest materials can be embedded. Samsung’s expert in the district court, Dr. Schubert, apparently agrees with that view. EX2016, ¶131 (citing EX2001, ¶37); *see also*, EX2016, ¶129 (Dr. Schubert: “To be effective, a matrix needs to be in a continuous phase to not only encourage the efficient transport of electrons and holes through, ... but to also ensure the desired distribution and stable housing of the emitter material.”).

Nevertheless, the dispute between the parties for purposes of this IPR centers not directly on the meaning of the term “matrix,” but whether the term modifies the “material” itself or whether it is referring to some *other* matrix into the which the

recited “matrix material” is otherwise embedded. Pictiva submits that a POSITA would understand that “matrix” qualifies the term “material” itself such that *the claims do not encompass dispersed agglomerations*. And while the Board provisionally construed “matrix material” to “include, not only materials that form a continuous phase themselves, but also materials embedded within such a matrix” (DI, 29), on this more developed record, Pictiva submits that the claims, the intrinsic evidence, and the extrinsic evidence support Pictiva’s interpretation.

1. The Claims and Specification

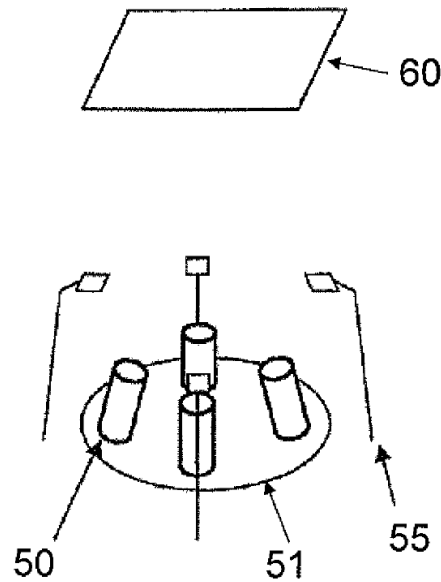
Samsung cannot dispute that the term “matrix” in the claims modifies the immediately following term, “material,” and that a “matrix material” is not just any “material.” EX2028, 8 (seeking constructions of both “matrix” and “matrix material”). To be clear, the three matrix materials need not be of the same matrix, since the claims only require that they belong to the “at least one organic functional layer.” EX1001, 9:10-12. But construing materials that are dispersed and discontinuous in all directions as a “matrix material” simply reads “matrix” out of “matrix materials.” The notion that any material in a continuous phase is a matrix material also eliminates the claimed and repeatedly-described distinction between matrix material and emitter material, which are both part of the same continuous phase (emissive layer). *See e.g.*, EX1001, 4:10-13, 4:44-52, 6:14-16, 7:21-61 (a

preferred embodiment with an emitting layer that includes the three matrix materials and an emitter material); *compare* Element 1[e] to 1[h].

Thus, while the claims do not preclude the first, second, and third matrix materials from being embedded into a further matrix or belonging to different matrices, a POSITA would understand the term “matrix” must describe the nature of the “material” itself. EX2019, ¶¶54-59.

The specification is in accord. While the specification envisions that the first, second, and third matrix materials may be embedded into a matrix in *some* embodiments (EX1001, 4:24-26), the specification is also clear that a matrix material need not be embedded in a broader matrix at all, meaning that “matrix” necessarily defines the material itself. *See id.* 1:22-23 (describing an emission layer with a single matrix material); EX2019, ¶56.

Moreover, with reference to FIG. 5 shown below, the specification describes using evaporation deposition to apply matrix materials and emitter from a number of evaporation sources 50 onto a substrate 60.



Specifically, the specification states that “[f]our evaporation sources 50 are applied on a holder 51, for example, from which matrix materials and/or doping substances can be evaporated onto the deposition substrate 60.” EX1001, 7:12-15. A POSITA would understand that each evaporation source 50 is providing a single type of material, and three of those materials are “matrix material[s]” and the fourth a doping “emitter material.” EX2019, ¶¶57-58.

A POSITA would understand that, unlike solution-based approaches, the three matrix materials formed by joint evaporation would be continuous, and not as a mixture of dispersed agglomerations. EX2019, ¶58. In short, nothing in the specification supports a reading that fully dispersed agglomerations, which happen to otherwise be embedded into a matrix, are matrix materials.

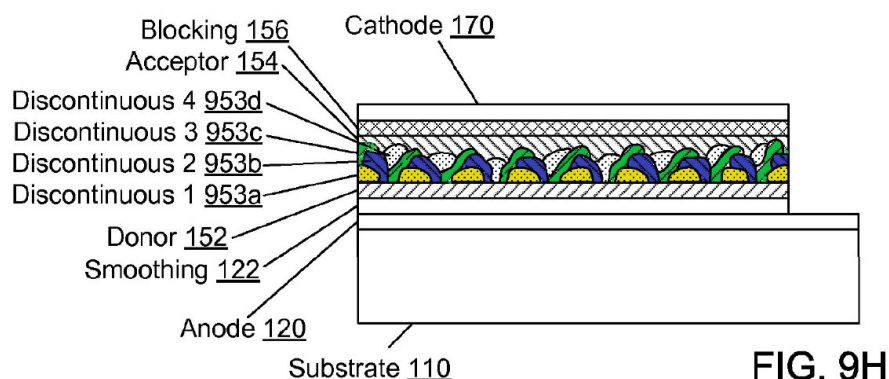
Thus, the specification, which is “the single best guide to the meaning of a disputed term,” would be understood by a POSITA as conveying that the term “matrix” is defining the material itself. *Phillips*, 415 F.3d at 1315 (citation omitted).

2. The Prosecution History

Nothing in the prosecution history dictates a different result. At institution, the Board relied on the fact that the Examiner read the “discontinuous layers” of Forrest on the claimed “matrix materials,” and the applicant did not argue against this assumption on reply. DI, 26. But the examiner’s statement cannot act as a disclaimer, and an applicant is not required to respond to every theory by the examiner. *Salazar v. Procter & Gamble Co.*, 414 F.3d 1342, 1347-48 (Fed. Cir. 2005) (“the examiner’s unilateral remarks alone do not affect the scope of the claim” and applicant’s silence to such remarks does not affect the claim scope).

In any event, Forrest does not disclose *dispersed* agglomerations, nor did the examiner allege that it does. Instead, Forrest uses the term “discontinuous” and “continuous” in the context of types of *layers*. For example, Forrest describes depositing layers of materials in the production of photosensitive optoelectronic device. See e.g., EX2029, [0026]. These layers can be deposited as “continuous layers” or “discontinuous layers.” See *id.*, [0026]. This is what is reflected in FIG. 9H, which shows the result of depositing a “continuous donor layer 152” prior to depositing a number of “discontinuous layers 953,” after which a “continuous

acceptor layer 154 fills exposed gaps and recesses in the underlying discontinuous layers 953 a-d.” *Id.*, [0081]-[0083].⁴



Forrest describes that the “material of each discontinuous layer [is] in direct contact with material of at least one adjacent discontinuous layer” *Id.*, [0026]. As a result, “[m]ost of the nanocrystals of the donor material shown in the cross-section directly contact the continuous donor layer 152, providing electrically conductive pathways for dissociated holes from [discontinuous] layer 953c to the anode 120 in the finished device.” *Id.*, [0081]. Similarly, “[m]ost of the nanocrystals of acceptor material in discontinuous layer 953b shown in the cross-section directly contact the continuous acceptor layer 154, providing electrically conductive pathways for dissociated electrons from layer 953b to the cathode in the finished device.” *Id.*, [0082]; *see also* [0035]. In other words, while the discontinuous layers

⁴ Dr. Holmes was reluctant to map any of 953a-d as a matrix material. EX2020, 273:9-275:14.

in Forrest may be horizontally discontinuous with gaps and holes to be filled by subsequent layers, the layers are at least vertically continuous to provide conductive pathways through the respective layers, and therefore are not dispersed agglomerations. EX2019, ¶¶60-63. Therefore, Forrest does not disclose, nor was it relied on for suggesting, that dispersed agglomerations could comprise a “matrix material.”

3. General Understanding in the Art

The extrinsic evidence, including evidence cited by Samsung in the parallel litigation, also supports that a POSITA would understand that the term “matrix material” does not include dispersed agglomerations. EX2002-EX2005; EX2019, ¶64.

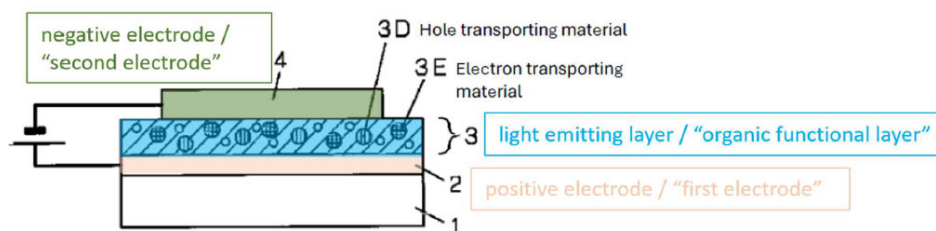
Therefore, the term “matrix material” would not be understood by a POSITA to include dispersed agglomerations.

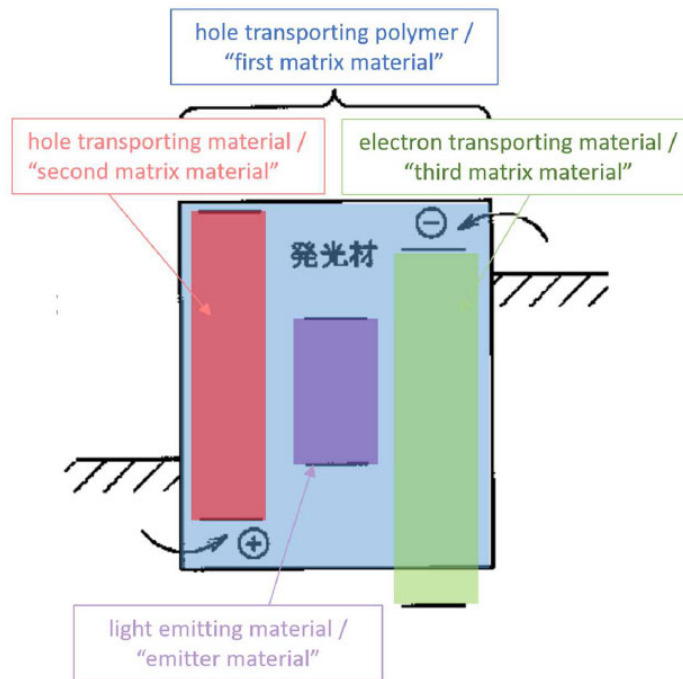
C. Principles of Claim Construction Require That the Term “Matrix” Have the Same Meaning Throughout the Claims

It is axiomatic that a claim term should have the same meaning throughout a claim. *See e.g., Digital Biometrics, Inc. v. Identix, Inc.*, 149 F.3d 1335, 1345 (Fed. Cir. 1998) (“[W]hatever interpretation we assign should encompass both uses because the same word appearing in the same claim should be interpreted consistently.”); *see also Phonometrics, Inc. v. Northern Telecom Inc.*, 133 F.3d

1459, 1464 (Fed. Cir. 1998) (“A word or phrase used consistently throughout a claim should be interpreted consistently.”). Indeed, there is even a strong presumption that a term should have the same meaning when used in different claims. *In re Varma*, 816 F. 3d 1352, 1363 (Fed. Cir. 2016) (“[T]he principle that the same phrase in different claims of the same patent should have the same meaning is a **strong** one”).

In this context, it would be improper for the term “matrix” to define a property of the immediately following “material” term in some instances, but not others. Yet, this is exactly what Petitioner has done when it mapped the term “matrix” in “first matrix material” to a physical characteristic of the immediately following “material” for Sugiura’s polymer 3A (annotated by Petitioner below in blue), but not for Sugiura’s 3D and 3E. Instead, Petitioner mapped “matrix” in the second and third “matrix material[s]” to an entirely different material—apparently mapping back to the same physical characteristic of polymer 3A as being a matrix.





Pet., 54-55. As shown above, the alleged “first matrix material” of Sugiura is depicted with the blue annotation as a continuous phase matrix. Thus, “matrix” in the phrase “first matrix material” means the material itself forms a continuous phase. In contrast, the alleged “second matrix material” and “third matrix material” do not form a continuous phase matrix themselves, nor are alleged to, but instead are embedded within the host matrix (blue material). Thus, “matrix” in the phrase “second matrix material” and “third matrix material” no longer defines a *physical property* of the respective materials themselves, under Samsung’s theory, but instead would define a *location* of the material, i.e., embedded in a matrix. EX2019, ¶¶65-67. This results in the same term (matrix) having inconsistent meanings, which is violative of basic principles of claim construction and should be rejected.

IV. Ground 1: Choulis Does Not Anticipate or Render Obvious Claims 1-8 and 10-16.

A. Choulis's TPD and PBD Are Dopants, Which are Not Encompassed by the Term "Matrix Material."

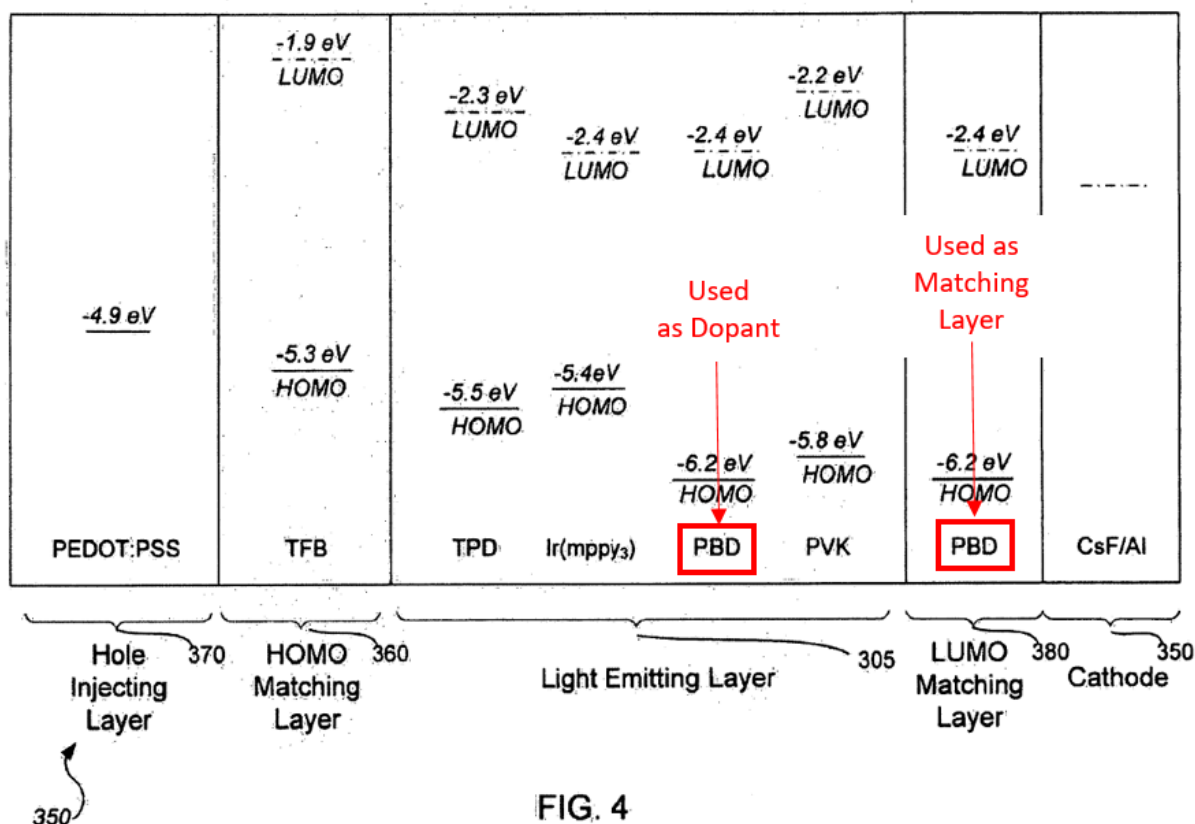
The claims require an organic functional layer having "at least a first matrix material, a second matrix material, and a third matrix material." EX1001, 9:10-12. Petitioner points to Choulis's "host material" PVK, "a first organic moiety" (TPD), and "a second organic moiety" (PBD) as allegedly being 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. However, for the reasons described above in Section III.A, a POSITA would understand that the term "matrix materials" does not encompass dopants.⁵

Specifically, Choulis 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, Choulis explicitly describes TPD and PBD as "organic moieties." *See e.g.*, EX1004, [0030] (describing FIG. 4

⁵ The Board need not resolve the issue of what constitutes a dopant, such as at what concentration a dopant is no longer a dopant, for example, because Choulis explicitly and singularly describes TPD and PBD as dopants.

as including “a first organic moiety 330, triphenyldiamine (TPD) and a second organic moiety 335, PBD.”); [0031]. Choulis explains that its moieties are used as dopants in the light emitting layer. *See id.*, [0032] (“the light emitting layer can be *co-doped with organic moieties*”). Choulis’s characterization of TPD and PBD as dopants in the light emitting layer is not inadvertent or casual. It is the proximate result of Choulis’s decision to use a PVK host. EX2019, ¶¶73-74.

Moreover, Choulis expressly contrasts the use of PBD as a dopant in the light emitting layer with its *separate* use as a matrix material in the LUMO matching layer 380. *See id.*, [0031] (“PBD is *also* used as a LUMO matching layer (or interfacial layer) between the light emitting layer 305 and a cathode 350.”); see below.



EX1004, FIG. 4 (annotated); EX1022, 203502-1 (PVK host “doped with” TPD and PBD”) *versus* 2023502-2 (“PBD ...based electron injected interfacial layer”); EX2019, ¶69.

This is consistent with Yang, on which Choulis’ emission layer composition is based. *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); EX2019, ¶70 (confirming that “Choulis used one of Yang’s ‘optimized’ test composition for its emission layer”); *see id.*, ¶¶71-74 (explaining why TPD and PBD made with Choulis’s solution-based process are not matrix materials).

APOSITA would understand that TPD and PBD used in Choulis’s light emitting layer 305 are dopants, which are beyond the ordinary and customary meaning of “matrix material,” per Section III.A above. Thus, the Petitioner has not carried its burden of proving anticipation under Ground 1.

Finally, to the extent that Samsung argues that that TPD and PBD are matrix materials by virtue of being embedded in the PVK host material, that is improper as a matter of law because, in addition to the fact that “matrix materials” do not encompass dopants, the argument requires assigning inconsistent meanings to the term “matrix.” *See* Section III.C.

B. Petitioner Has Not Established that Choulis’s Organic Moieties TPD and PBD Are Second and Third Matrix Materials.

The Petition presents Choulis as an anticipating reference; and indisputably, Dr. Holmes presented only anticipatory arguments for claims 1, 3, 5-8 and 11-12. EX2020, 167:5-168:12. Anticipation requires that the prior art reference “not only disclose all elements of the claim within the four corners of the document, but must also disclose those elements ‘arranged as in the claim.’” *See Net MoneyIN, Inc. v.*

VeriSign, Inc., 545 F.3d 1359, 1369 (Fed. Cir. 2008). Moreover, “it has long been understood that ambiguous references do not, as a matter of law, anticipate a claim.” *Wasica*, 853 F.3d at 1284; *see id.* (“Record evidence suggests that Oselin could use signals of either constant or nonconstant frequency. Oselin is thus ambiguous as to whether it discloses the pertinent features of claim 6. Ambiguous references do not anticipate a claim.”); *see also In re Turlay*, 304 F.2d 893, 899 (1962).

Thus, even if a dopant can *sometimes* be a matrix material (it cannot per Section III.A), because Choulis does not *unambiguously* disclose that *its* TPD and PBD materials are in fact host or matrix materials, the Petition must show that TPD and PDB are inherently host or matrix materials in order to prevail.⁶ But Petitioner has not done so, nor can it. Petitioner makes no attempt to present an inherency argument at all, but the record evidence beyond Choulis’s own disclosure also establishes TPD and PDB are not inherently host or matrix materials. For example, an article authored by the Choulis inventors 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 transport and emission.” EX1022-2, 203502-1. Moreover, Choulis’s emission layer formulation follows the recipe

⁶ The elements for which Petitioner invokes obviousness do not concern whether TPD and PBD are second and third matrix materials.

reported by Yang. Yang matches the description of the Choulis paper. *See* 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 repeatedly described its 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***”; “co-doping the emission layer with TPD”).

The concentrations of TPD doping in Choulis is 9wt%, the same as in the Choulis papers and as in some examples of Yang. EX2019, ¶¶70-72. But Petitioner has presented no evidence that TPD at this concentration is capable of being a matrix or host materials, let alone that it inherently is. Thus, Ground 1’s anticipation challenge fails.

Petitioner ostensibly includes obviousness in view of Choulis under Ground 1, but fails to propose any actual modification to Choulis, including any actual modification to the nature of Choulis’s TPD and PBD dopants, let alone any reasoning in support. And while the Petition attempts to use the decision in *Realtime Data, LLC v. Iancu*, 912 F.3d 1368 (Fed. Cir. 2019) as a ‘savings clause’ for its empty obviousness theory (*see* Pet. 20), the PTAB and Federal Circuit have made it

clear that the “[t]ests for anticipation and obviousness are different,” and that “[t]he elements of proof for anticipation and obviousness are different, and “[t]hus, ‘it does not follow that every technically anticipated invention would also have been obvious.’” *SNF S.A., v. Chevron U.S.A., Inc.*, Case IPR2022-01534, Paper 46 at 8 (P.T.A.B. April 18, 2024) (citing *Cohesive Techs., Inc. v. Waters Corp.*, 543 F.3d 1351, 1364 (Fed. Cir. 2008) and *Duro-Last, Inc. v. Custom Seal, Inc.*, 321 F.3d 1098, 1107-08 (Fed. Cir.2003)).

While a reference’s teachings may be used to find obviousness even when they are insufficient to find anticipation, that applies “so long as the record contains some reason why one of skill in the art would modify the prior art to obtain the claimed invention.” *Nike, Inc. v. Adidas AG*, 812 F.3d 1326, 1335 (Fed. Cir. 2016); *see also Adasa Inc. v. Avery Dennison Corp.*, 55 F.4th 900, 910 (Fed. Cir. 2022). But here, the Petition sets forth no proposed modification to Choulis’s light emitting layer 305 and no reasoning for any such unstated modification. Including the word “obvious” in a heading and summarily concluding that “to the extent any limitation is not disclosed by Choulis, it would have been strongly suggested to a POSITA for the same reasons discussed in Ground 1 below for that limitation,” (Pet., 20), does not convert Petitioner’s anticipation theory into an obviousness challenge under the law. “To satisfy its burden of proving obviousness, ... [t]he petitioner must ... articulate *specific* reasoning, based on evidence of record, to support the legal

conclusion of obviousness.” *In re Magnum Oil*, 829 F.3d 1364, 1380 (Fed. Cir. 2016) (emphasis added).

Similarly, Petitioner’s citation to over 90 paragraphs of Dr. Holmes’ declaration is not only an improper incorporation by reference, but fails to provide competent evidence on obviousness as Dr. Holmes admits that he only analyzed under anticipation for claim 1. EX2020, 167:5-9; EX1003, ¶¶72-96 (asserting, for each element of claim 1, that allegedly “a POSITA would have appreciated that Choulis discloses this element”). In short, the Petition has failed to describe any alleged basis for obviousness under Ground 1, let alone “with particularity,” beyond what it stated for anticipation. *See* 35 U.S.C. § 312(a)(3); *see also Scanstrut, Inc. et al. v. National Products, Inc.*, Case No. IPR2020-01542, Paper 7, 11 (P.T.A.B. March 16, 2021) (“Merely including a combination of references in a heading does not provide the particularity required by the statute or our rules.”).

In sum, the Petition has not established that Choulis unambiguously discloses that the TPD and PBD used in Choulis’s light emitting layer 305 are matrix materials, within the meaning of the ’164 patent, and therefore the Petitioner has not established that Choulis anticipates Claims 1-8 and 10-16 under Ground 1. Moreover, any alleged challenge based on obviousness under Ground 1 fails as a matter of law.

C. Choulis Does Not Anticipate or Render Obvious 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 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.*, 545 F.3d at 1369-72 (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]; EX2019, ¶¶78-79.

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).

Id., [0044] (cited on Pet. 29). Earlier, PVK is referenced expressly in connection with Figure 4. *See id.*, [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. EX2019, ¶¶ 81-82. Nothing in [0044] links PMMA to the device in the Figure 4 embodiment. Instead, PMMA is used as an example of “insulated matrices.” *Id.*, [0044]. Neither Petitioner nor Dr. Holmes asserts that PVK, capable of transporting holes, is an insulative matrix. Thus, there is no unambiguous disclosure of using PMMA in place of PVK in Choulis’s relied-upon Figure 4 embodiment. Hence, Choulis does not anticipate claims 2, 4, 15 and 16.

Second, Choulis also does not render obvious these claims. As explained on pp. 28-31 above, Choulis used Yang's optimized emission layer formulation. EX2019, ¶¶70-72. 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. EX2019, ¶ 78 (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 addition, PVK was chosen as the host material to "ensure the confinement of the triplet excited state in the Ir(mppy)₃ guest phosphorescence molecule, and thus prevent luminescence quenching." EX1022, 2. As Dr. Sims explains, luminescence quenching prevention is critical in OLED designs. EX2019, ¶79. There is no evidence that PMMA can similarly confine the triplet energy of Ir(mppy)₃ in Choulis's emissive layer. 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. EX2019, ¶79.

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

Furthermore, Choulis’s paragraphs 31 and 41 do not support Petitioner’s theory. EX2019, ¶¶83-84. Choulis [0031] examines the relative HOMO level of TPD and the LUMO level of PBD relative 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 Ir(mppy)₃. 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 Dr. Holmes, 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. EX2019, ¶85; 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* EX2019, ¶¶70-72, 86. But given Yang’s use of PVK instead of PMMA and given that PVK’s HOMO is higher than that of PBD, Yang (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 Yang (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”).

Moreover, Dr. Holmes’ own paper demonstrates that UGHs (alleged suitable material for the first matrix material) can participate in electron transport; and Yang (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); EX2019, ¶¶85-87.

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. EX2019, ¶88. Petitioner has not presented any evidence of PMMA being used in combination of these 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. 35-37 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 near zero charge carrier density. 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. EX2019, ¶89. The lack of holes and electrons can also result in (pure) PMMA not participating in charge transport. *See* EX1001, 2:64-3:1; EX2019, ¶89. Simply put, there is no competent evidence of PMMA's charge carrier mobility being lower than those of TPD and PBD.

In short, Petitioner has not established that Choulis anticipates claims 2, 4, 15 and 16, or that a POSITA would have substituted PMMA for PVK in Choulis's Figure 4 embodiment to arrive at claims 2, 4, 15 and 16.

D. Choulis Does Not Anticipate or Render Obvious 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.

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); EX2019, ¶91.

In contrast, according to Petitioner, rubrene has a LUMO at -3.15 eV. Pet. 36. This is about 0.75 eV lower than the -2.4 eV LUMO level reported for PBD. EX1004, Fig. 4; EX2019, ¶91. 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], [0007], [0015], [0031]. Hence, Choulis does not disclose the use of rubrene in Figure 4 because rubrene’s LUMO level does not match that of PBD. EX2019, ¶92. As a result, Choulis does not anticipate claim 10 because it does not disclose an embodiment arranged as in the claim.

Thus, under Choulis’s design principle, if the emitter’s LUMO is decreased to about -3.15eV, as in the case with rubrene, the LUMO matching layer would also need to decrease accordingly to a similar level. EX2019, ¶93. But 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 since Petitioner only argues replacing Ir(mppy)₃ with other emitters, it does not explain how the much larger energy gap between the LUMO of PBD (~ -2.4 eV) and the LUMO of rubrene (~ -3.15 eV) 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"). A POSITA would recognize 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). EX2019, ¶94. As Dr. Sims explains, "PBD would stop participating in electron transport as no electrons are created in it anymore." *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.* Replacing Ir(mppy)₃ with rubrene would directly undermine 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 (P.T.A.B. 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; EX2019, ¶95. Hamada uses rubrene as an emitting assist, but not as an emitter. EX1024 (Hamada), Abstract; EX2019, ¶95. 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 (LUMO -2.7 eV) and DCM2 (LUMO -3.11 eV) as the emitter materials. Pet., 36-37 (citing to Kanno (EX1025) and Hamada (EX1024)). This argument fails. First, neither 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. 42-43 above; EX2019, ¶96. For example, the LUMO levels would be 0.3 eV and 0.7 eV lower than the LUMO of the LUMO matching layer material (PBD), higher than the 0.2eV

deviation taught by Choulis. *Id.* Second, 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). Therefore, Petitioner has not presented any evidence that a POSITA would have used PQIr or DCM2 with Choulis's emission layer materials. EX2019, ¶96.

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. EX2019, ¶97. 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. EX2019, ¶97; *see also* EX1007 (Thompson), Fig. 4 (annotated by Petitioner below) (emitter (HT or ET) 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 lack of teaching of claim 10 requirements).

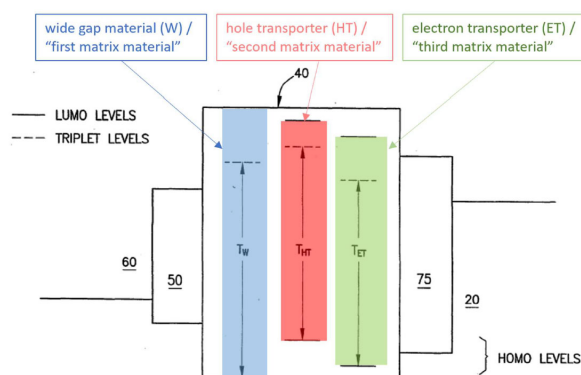


Fig. 4

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. EX2019, ¶¶ 98-99.

In summary, Petitioner has not shown that Choulis anticipates claim 10 nor has it established why a POSITA would have replaced the emitter material used in the Figure 4 example with rubrene, PQIr or DCM2. 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); *Virtek Vision Int’l ULC v. Assembly Guidance Sys.*, 97 F.4th 882, 886-87 (Fed. Cir. 2024). Petitioner has failed to present any competent evidence as to why a POSITA would have made the modification.

E. Choulis Does Not Anticipate or Render Obvious Claim 14 or Element 13(d)

Petitioner argues that Claim 14 is disclosed by Choulis, or met by either evaporating PVK or replacing PVK with some unspecified small molecules. First, Choulis only suggests process polymers as “solutions or suspensions,” and not through evaporation. EX2019, ¶101; EX1004, [0043]-[0044], [0048]. With respect to the first modification, Djobo demonstrates evaporation of PVK leads to decomposition, and there is no demonstration that the resulting material would have the same HOMO/LUMO levels as PVK or that the decomposed materials would provide acceptable performance. EX2019, ¶100. In fact, Dr. Holmes admitted that he is not aware of any literature or anyone who has used evaporation to process PVK. EX2020, 163:13-165:6. As to the second modification, there is no showing that the unspecified small molecules would satisfy the required HOMO/LUMO levels. EX2019, ¶102. As such, Petitioner has not shown that Claim 14 or Element 13(d).

V. Ground 2: Choulis and Yong Do Not Render Claim 9 Obvious

Ground 2 fails for at least the same reasons as Ground 1. Additionally, 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 and looks to Yong for this limitation. Pet., 48-51; EX2020, 172:5-8. But Petitioner fails to establish 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 suggests that because Choulis cites a prior art study to explain that “[t]he recombination current in any of the layers ... can be controlled ... by adjusting dopant concentration,” “[i]t would have been obvious to a POSITA 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. EX2019, ¶104.

Moreover, Dr. Holmes mischaracterizes Choulis as allegedly disclosing “various methods and techniques” for applying the emitter material. EX1003, ¶160. Choulis contains no such open-ended disclosure, however. Instead, Choulis discloses that *specific* deposition techniques are preferable for small-molecule light emitting materials. EX1004, [0043]; EX2019, ¶105.

Petitioner then contends that “forming a gradient with an emitter material was well known,” pointing to a single Chinese patent, Yong. Pet., 49. But Yong’s limited disclosure would not have motivated a POSITA to apply a concentration

gradient to Choulis's system. EX2019, ¶106. 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 (2nd paragraph). Yong utilizes one such traditional OLED device, where the emission layer included only a host material and the emitter material. *See id.*, 19 (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 dopants, where Petitioner characterizes TPD as "a hole transport material" and PBD as an "electron transport material." Pet. 33-34; EX1004, Fig. 4 (annotated on Pet. 27). That is, unlike Yong's traditional devices, Choulis includes both hole transport and electron transport materials in the emission layer. EX2019, ¶107. Moreover, according to Yang, the particular composition (at 9 wt% TPD) has good charge carrier balance. EX1017, 2477-78 (TPD concentration above 13 wt% "disturbs the balance of carrier injection and transport").

Petitioner provides no evidence that Choulis suffers the same problem as Yong, which has a completely different architecture, such that the "concentration

distribution of electrons [also] shows a non-linear decreasing trend along the direction from the electron transporting layer to the hole transporting layer.” EX1009, 3. Because Yong’s invention was designed to address this non-linear decrease in electron concentrations from ETL to HTL, a POSITA would not have added steps to Choulis to include a concentration gradient like Yong if the problem to which Yong was directed did not exist in the first place. That is, there is no evidence that Choulis’s device experienced a concentration gradient of electrons from the ETL side to the HTL side, nor does Petitioner even suggest that it does, and therefore Petitioner fails to demonstrate any reason for a POSITA to use Yong’s method in Choulis’s device. EX2019, ¶¶108-109.

In fact, Choulis, with an emission layer that is purported to incorporate both hole and electron transport materials, would have already achieved the goal Yong did with emitter concentration gradient, namely a recombination zone throughout the emissive layer, “[m]ore efficient use of the phosphorescent material” and “extend[ing] the lifetime of the device.” EX1004, [0056]-[0057]; EX2020, 180:7-10 (Dr. Holmes acknowledging the inventions of Yong and Choulis have the “[s]ame general goal”); EX2019, ¶110.

Indeed, regarding the hole-electron charge imbalance problem observed by Yong, Choulis already solved that (1) “by using a specific amount of hole and electron injecting materials within the light emitting layer” to optimize “the cha[r]ge

balance within the light emitting layer” and (2) by “[i]ncorporating matching layers into the light emitting layer [to] 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—a POSITA would not have applied Yong’s emitter concentration gradient to Choulis’s completely different emission layer, which would only have increased the complexity of Choulis’s system. EX2019, ¶¶109-111. *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.”).

Moreover, Petitioner does not assert that a POSITA would have had a reasonable expectation of success in creating an emitter concentration gradient using Choulis’s solution-based approach (it cannot). EX2020, 172:5-8; EX2019, ¶112. At the same time, there is no reason to believe that evaporation could be used to apply PVK, nor is there any reason to believe that a POSITA would use Choulis’s solution-based approach to apply PVK, but then switch to Yong’s evaporation-based to apply the emitter material. EX2019, ¶¶112-113; EX2020, 163:13-165:6. But as explained in connection with Claim 14, Choulis neither discloses nor renders obvious an evaporative process to apply its emissive layer.

VI. Ground 3: Sugiura Does Not Anticipate or Render Obvious Claims 1, 3, 5-8, and 10-13.

Ground 3 is not asserted against claims 2, 4, 9 or 14-16. *See* Pet., 6 (only asserting Sugiura reference against claims 1, 3, 5-8 and 10-13). Moreover, for the reasons below in Sections VI.A-VI.B, Petitioner has not established that Sugiura discloses three matrix materials or that it discloses matrix materials having the claimed HOMO/LUMO relationships.

Just as with Ground 1, here again Petitioner ostensibly includes obviousness in view of Sugiura for Ground 3, but fails to propose any actual modification or reasoning and therefore has failed to describe any obviousness ground based on Sugiura “with particularity.” 35 U.S.C. § 312(a)(3). Instead, for claim 1 the Petition includes the word “obvious” in the heading and summarily concludes that “the extent any limitation is not disclosed by Sugiura, it would have been strongly suggested to a POSITA for the same reasons discussed in Ground 3 below for that limitation.” Pet., 51. Again, however, for the reasons described above, that does not convert Petitioner’s anticipation theory into a proper obviousness challenge under the law. *See supra*, pp. 31-33. And Petitioner’s citation to Dr. Holmes’ declaration is not only improper incorporation by reference, but also does not help its obviousness theory because Dr. Holmes conceded that he only proceeded under anticipation. EX2020, 167:5-168:12; *see also* EX1003, ¶¶167-219 (concluding for each element of claim 1

that allegedly “a POSITA would have appreciated that Sugiura discloses this element”).

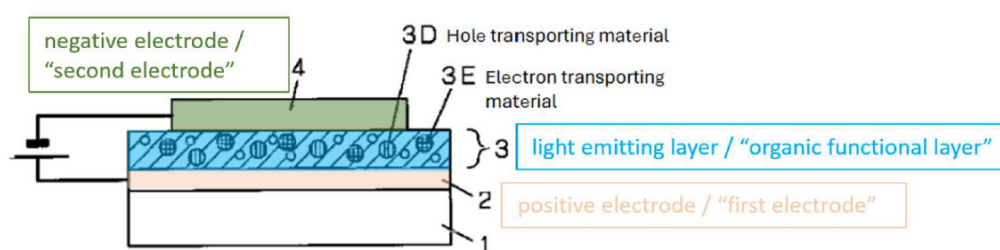
Therefore, any alleged challenge based on obviousness under Ground 3 fails as a matter of law.

A. Sugiura’s Hole and Electron Transporting Materials are Not Matrix Materials

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 III.B, the term “matrix material” does not refer to just any chemical components in an organic functional layer. Rather, the term “matrix material” would be understood by a POSITA to not include dispersed agglomerations. That is, the matrix material itself forms a matrix irrespective of whether it is embedded into a further matrix. *See supra*, Section III.B.

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 distributed as segregated and dispersed aggregation or “islands” in polymer 3A with no interconnections between any of the 3D or 3E agglomerations. *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 agglomerations in polymer 3A, just like 3D and 3E are dispersed in 3A in Figure 4); EX2020, 96:5-97:3 (Dr. Holmes admitting that 3B and 3C are shown as discontinuous and **not** as a matrix); EX2019, ¶¶114-117. Materials 3D and 3E are also not disclosed as capable of having another material embedded therein: the emitter particles (circles with no pattern), for example, are dispersed in the host material, but not in 3D or 3E. EX2019, ¶ 117.

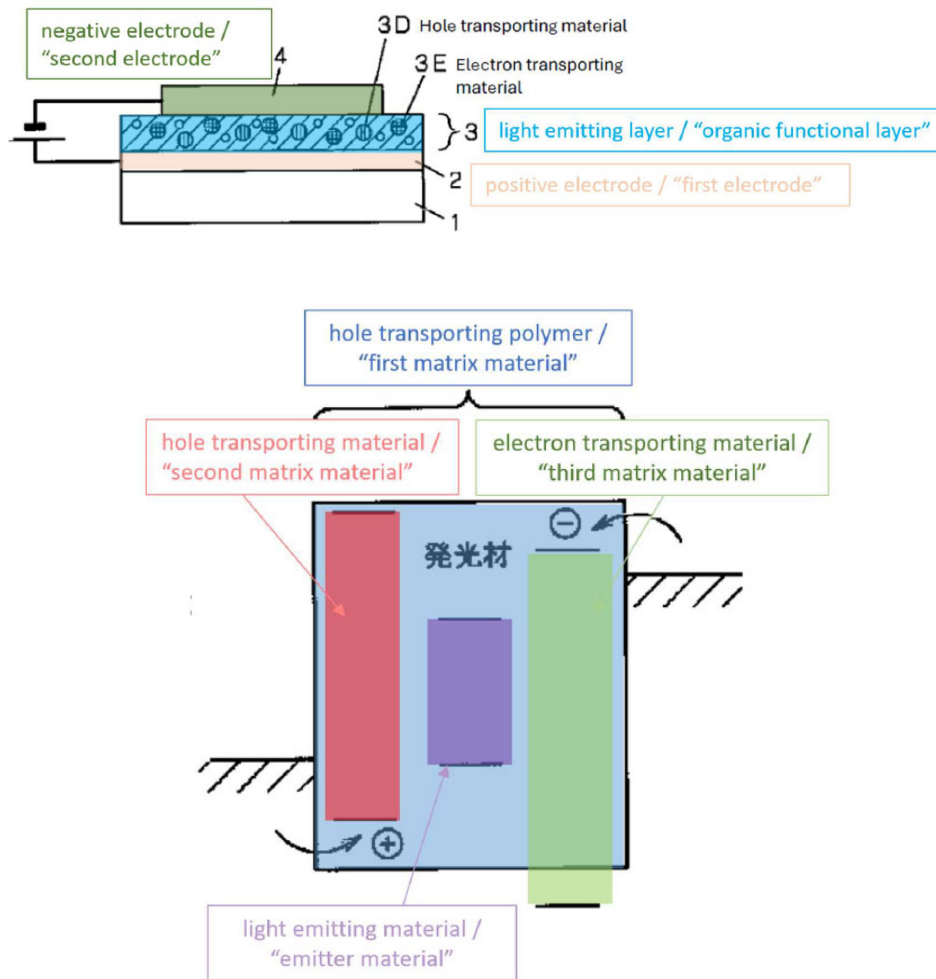


Moreover, a POSITA would understand that Sugiura’s dispersion pattern of for 3D and 3E in 3A is intentional. Specifically, a POSITA would recognize that the configuration of islands of 3D and 3E in sea of 3A would beneficially avoid potential HT-ET exciplex formation that could lead to reduced efficiency and color purity. EX2019, ¶118; EX2030_US9403849, 2:39-41 (“A further disadvantage of AlQ₃ is the instability to holes ... which can always result in problems in the component on long-term use”).

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

transporting materials are segregated agglomerations dispersed in polymer 3A with no other materials embedded in them, Petitioner does not establish that 3D and 3E are “matrix materials,” within the meaning of the ’164 patent. The mixture of materials 3A, 3D and 3E does not form a continuous phase in the emission layer; instead, the only non-dispersed phase is formed by host material (blue shaded areas) with materials 3D and 3E embedded therein at discrete locations like “islands in a sea.” EX2019, ¶¶118-119. Indeed, given that materials 3D and 3E, like the emitters, are dispersed in host 3A with no other materials embedded in them, “materials 3D and 3E would be regarded as having the same structural nature as the emitter materials—they are all dopants, not matrix materials.” EX2019, ¶119. And, a POSITA would understand that matrix materials do not encompass dopants. *See supra*, Section III.A.

In fact, Samsung’s matrix material mapping in Sugiura shows why “matrix material” should not encompass any material which happens to be embedded in a matrix. As described above in Section III.C, the term “matrix” in “first matrix material” is mapped to a physical characteristic of the immediately following “material” term (polymer 3A, annotated by Petitioner below in blue). Conversely, “matrix” in the “second matrix material” and “third matrix material” is mapped to a location of the immediately following “material” terms (3D and 3E, respectively); namely, embedded in a matrix. EX2019, ¶120.



Pet., 54-55 (annotating FIG. 4 and 8 of Sugiura).

Such inconsistent interpretation of the same term is contrary to law and contrary to how a POSITA would understand the invention; EX2018, 112:8-14 (“[c]ontinuous phase means that there are no regions ... in which we have phase separation”), 114:13-21 (discussing Sugiura figure, “[i]f these little circles contain only one matrix material, then I would say that this is not a matrix because it does not include a continuous phase of matrix materials. But rather agglomerations of

materials as expressed by the circle features or circular features”).

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

Regarding the particularly-recited HOMO and LUMO levels of claim 1, Petitioner points to only Figure 8 and paragraph [0049] of Sugiura to argue that the mixture has the required relative levels. *See* Pet., 55-58. But the cited [0049] does not mention HOMO or LUMO, instead discussing “ionization potential of the hole transporting material.” EX1006, [0049]; EX2019, ¶¶122.

The Petition also does not explain how the HOMO and LUMO levels relate to ionization potential and electron affinity. Dr. Holmes provides no independent analysis, simply repeating the text from the Petition with no elaboration. *Compare* Pet., 56-58 to EX1003, ¶¶183-188. In fact, the values 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, Manninen reports that Alq₃’s HOMO and LUMO levels are respectively -5.5eV and -2.4 eV; and Kang reports that Alq₃’s HOMO and LUMO levels are -5.62eV and -2.85 eV respectively. *See* EX2023 (Manninen), Fig. 5; EX1010, Fig. 1. They are therefore not the same. EX2019, ¶123. And if Alq₃’s HOMO is -5.5eV, then there isn’t a second matrix material whose HOMO is higher than those of the other two, as required by the

claims. Petitioner has thus utterly failed to provide any competent evidence explaining why (1) Sugiura's discussion of ionization potential and electron affinity, or (2) Figure 8, which includes various unlabeled and unexplained horizontal lines, demonstrate that the HOMO and LUMO relationships recited in the various claims are met.

The Petition has separately failed to show that the HOMO values of claim 10 are satisfied. For 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. *See* 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 a matrix material. EX2019, ¶¶124-125.

The fact is that Sugiura is rife with ambiguity. The various horizontal lines in FIG. 8 and similar diagrams are unlabeled and unexplained, and Sugiura's discussion of "ionization potential" and "electron affinity" is not tied in any way to HOMO and LUMO values, and in fact contains other disclosure which suggests they are different, as noted above. That is insufficient under the law of anticipation. "[I]t has long been understood that ambiguous references do not, as a matter of law, anticipate a claim." *Wasica*, 853 F.3d at 1284; *see also In re Turlay*, 304 F.2d at 899. Ground 3 therefore fails as a matter of law.

Thus, the Petition has not established that Sugiura unambiguously discloses three matrix materials at all, let alone three matrix materials having the recited HOMO and LUMO levels. Therefore, Petitioner has not established that Sugiura anticipates Claims 1, 3, 5-8, and 10-13 under Ground 3. Moreover, any alleged challenge based on obviousness under Ground 3 fails as a matter of law. *See supra*, pp. 31-33, 53.

VII. Ground 4: Thompson Does Not Anticipate or Render Obvious Claims 15-16

Like Grounds 1 and 3, Petitioner ostensibly includes an obviousness challenge for Ground 4, but does not propose any actual modification to the teachings of the primary reference, and therefore has failed to describe any obviousness ground based on Thompson "with particularity." 35 U.S.C. § 312(a)(3); EX2020, 166:11-15 (only

anticipation for claims 15-16). Thus, for the same reasons as for Grounds 1 and 3, any alleged challenge based on obviousness under Ground 4 fails as a matter of law.

A. Thompson Fails to Disclose 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.

As explained above, the ’164 patent distinguishes between a “matrix material” and a dopant, and a POSITA would understand that the term “matrix material” does not include dopants or emitter material. *See supra*, Section III.A. 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)); *Phillip*, 415 F.3d at 1314.

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); EX2019, ¶127. Thompson also distinguishes between a dopant and a matrix material: “The HOMO energy levels of the *phosphorescent dopants* are typically higher in energy than those of *the matrix materials into which they are doped.*” EX1007, [0023]. If anything, Thompson teaches away from the claimed arrangement by restricting the EML materials to 1) a wide band gap layer, 2) an emitter dopant, and 3) a charge carrying dopant opposite the charge carrying type of the emitter dopant. *See id.*, Abstract; EX2019, ¶¶128-129.

Thus, Ground 4 fails because the Petition maps the two dopants, one of which is an emitter, in Thompson to the second and third matrix materials (Pet., 73-74), but a POSITA would not understand that matrix material include dopants, particularly whereas here the prior art reference itself distinguishes the dopants from the “matrix materials” into which they are doped. *See supra*, Section III.A.

Additionally, the ‘164 patent specifically distinguishes between an emitter material and a matrix material. *See supra*, Section III.A; EX2019, ¶130. As such, a POSITA would not understand Thompson’s “phosphorescent dopant,” which Thompson describes as an “emitter dopant” (EX1007, [0042]) to be a matrix material in the context of the ‘164 patent. EX2025, 162:11-13 (“especially in a phosphorescent OLED, I would consider the emitter ... to not be the matrix”).

The hole transporting property of the emitter material does not change the fact

that the alleged “third matrix material” is an emitter dopant and not a matrix material because, even though preferred emitter materials such as Ir(ppy)₃ and Ir(ppy)₂(acac) were known to have hole transport properties. EX1001, 8:27-30; EX2020, 299:20-300:7; EX2019, ¶131 (Dr. Sims explaining that “the emitter materials disclosed in the ’164 patent would also be expected to transport holes, but were never characterized as matrix materials.”).

Therefore, Thompson does not disclose that its dopant phosphorescent emitter constitutes a matrix material in the context of the ’164 patent, nor has the Petitioner proposed and motivated any modification to Thompson that would remedy the defect.

Finally, to the extent that Samsung argues that that Thompson’s dopants are matrix materials by virtue of being embedded in the wide gap host material, that is improper as a matter of law because, in addition to the fact that “matrix materials” do not encompass dopants, it results in the term “matrix” having inconsistent meanings. *See* Section III.C.

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; 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. 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”); EX2019, ¶¶133-134. The lack of holes and electrons can also result in the first matrix material not participating in charge transport. *See id.*

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. EX2019, ¶135. 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 showing Thompson expressly or inherently discloses the last limitation of claim 16, and therefore Thompson cannot anticipate claim 16.

VIII. Conclusions

For the reasons set forth above, the Petitioner has failed to show by a preponderance of the evidence that any claim of the ’164 patent is not patentable.

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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 Response contains 13,971 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.

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I hereby certify, pursuant to 37 C.F.R. section 42.6, that on May 5, 2025, a complete copy of the foregoing document **PATENT OWNER RESPONSE and EXHIBITS 2019-2031 and 2100-2104** were served by electronic mail, as agreed to by the parties, upon the following:

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