

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

DUK SAN NEOLUX CO., LTD.,
Petitioner,

v.

IDEMITSU KOSAN CO., LTD.,
Patent Owner.

Case IPR2016-00148
Patent 9,056,870 B2

Before JUSTIN T. ARBES, BRIAN P. MURPHY, and
KIMBERLY McGRAW, *Administrative Patent Judges*.

McGRAW, *Administrative Patent Judge*.

FINAL WRITTEN DECISION
35 U.S.C. § 318 and 37 C.F.R. § 42.73

I. INTRODUCTION

Duk San Neolux Co., Ltd. (“Petitioner”) filed a Petition (Paper 1 “Pet.”), supported by a declaration of Benjamin J. Schwartz, Ph.D. (Ex. 1003), requesting *inter partes* review of claims 1, 3, 4, and 14–26 of U.S. Patent No. 9,056,870 B2 (Ex. 1001, “the ’870 patent”). Idemitsu Kosan Co., Ltd. (“Patent Owner”) filed a Patent Owner Preliminary Response. Paper 5 (“Prelim. Resp.”). Pursuant to 35 U.S.C. § 314, we instituted trial for claims 1, 3, 4, and 14–26 on certain grounds of unpatentability asserted in the Petition. Paper 8 (“Dec. on Inst.”).

After institution, Patent Owner filed a Patent Owner Response (Paper 13, “PO Resp.”), supported by a declaration of John Anthony, Ph.D. (Ex. 2007). Petitioner filed a Reply to Patent Owner’s Response (Paper 17, “Reply”), supported by a second declaration of Dr. Schwartz (Ex. 1033).

Oral hearing was requested by both parties. Papers 25, 27, 28. A hearing was held on February 9, 2017. The transcript of the hearing has been entered into the record. Paper 34 (“Tr.”).

Also before the Board is Patent Owner’s Motion to Exclude Evidence (Paper 26), Petitioner’s Opposition to Patent Owner’s Motion to Exclude (Paper 30), and Petitioner’s Reply in Support of Motion to Exclude Evidence (Paper 31).

We have jurisdiction under 35 U.S.C. § 6. This Final Written Decision, issued pursuant to 35 U.S.C. § 318(a), addresses issues and arguments raised during trial. For the reasons discussed below, we determine that Petitioner has not proven by a preponderance of the evidence that claims 1, 3, 4, and 14–26 of the ’870 patent are unpatentable. We also dismiss Patent Owner’s Motion to Exclude Evidence as moot.

II. BACKGROUND

A. Related Proceedings

Patent Owner identifies U.S. Patent Application Nos. 14/634,069, 14/987,249, and 15/379,130 as related matters. Papers 4, 7, 23. In addition, the parties identify Case IPR2017–00197, also challenging the '870 patent, as a related matter. Papers 16, 24.

B. The '870 Patent

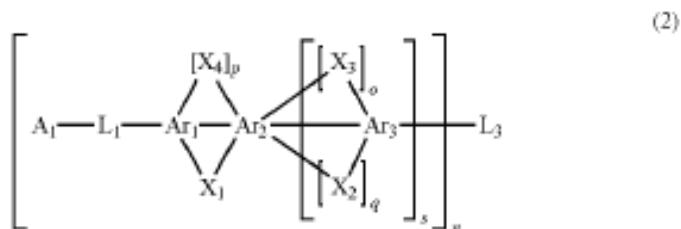
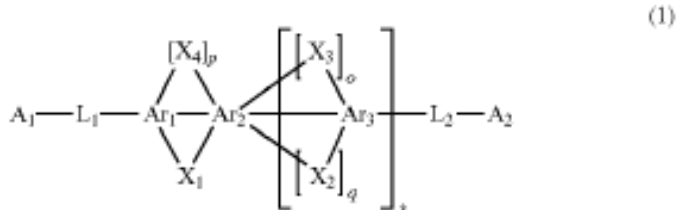
The '870 patent, titled “Material for Organic Electroluminescence Device and Organic Electroluminescence Device Using the Same,” issued on June 16, 2015 based on U.S. Patent Application No. 13/173,486, filed June 30, 2011, which claims priority to U.S. Patent Application No. 12/253,586, filed October 17, 2008.

In the Background Art section, the '870 patent explains that organic electroluminescence devices (OLEDs) have a material that emits light when an electric field is applied as a result of energy released by the “recombination of holes injected from an anode and electrons injected from a cathode.” Ex. 1001, 1:24–31. The '870 patent states the object of the invention is to provide materials for an OLED “which shows high luminous efficiency, is free of any pixel defect, and has a long lifetime.” *Id.* at 3:15–21.

C. The Challenged Claims

Petitioner challenges claims 1, 3, 4, and 14–26. Claim 1 is the sole independent claim at issue and is reproduced below:

1. A material for an organic electroluminescence device represented by the following general formula (1) or (2):



where:

Ar_1 and Ar_3 each independently represent a substituted benzene group or an unsubstituted benzene group, and Ar_2 represents a substituted benzene group, an unsubstituted benzene group, a substituted naphthalene group, or an unsubstituted naphthalene group, provided that, Ar_1 , Ar_2 , and Ar_3 each may have one substituent Y or multiple substituents Ys, in the case of multiple substituents Ys,

the substituent Ys may be different from each other, Y represents an alkyl group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, an alkoxy group having 1 to 20 carbon atoms, an aralkyl group having 7 to 24 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with Ar_1 , Ar_2 , or Ar_3 through a carbon-carbon bond;

X_1 represents N- R_1 ;

X_2 represents O or S;

X_3 and X_4 each independently represent O or S;

R_1 represents a substituted aromatic hydrocarbon group wherein the aromatic hydrocarbon group is selected from the group consisting of phenyl, naphthyl, biphenyl, terphenyl, fluorenyl, phenanthrenyl, triphenylenyl, perylenyl, chrysenyl, fluoranthrenyl,

benzofluorenyl, benzotriphenylenyl, benzochrysenyl and anthracenyl, and wherein the substituent of said substituted aromatic hydrocarbon group is an aromatic heterocyclic group having a ring formed of 3 to 40 atoms; or

R₁ represents a substituted or unsubstituted aromatic heterocyclic group having a ring formed of 3 to 24 atoms, wherein the substituent of said substituted aromatic heterocyclic group is selected from the group consisting of an unsubstituted phenyl group, an aromatic heterocyclic group having a ring formed of 3 to 40 atoms, an amino group substituted with an aromatic hydrocarbon group having a ring formed of 6 to 40 carbon atoms, an ester group having an aromatic hydrocarbon group having a ring formed of 6 to 40 carbon atoms, a cyano group, a nitro group and a halogen atom;

o and p each represent 0, q represents 1, s represents 1, and n represents 2, 3, or 4, and the material represented by the formula (2) comprises a dimer using L₃ as a linking group for n=2, a trimer using L₃ as a linking group for n=3, or a tetramer using L₃ as a linking group for n=4;

L₁ represents a single bond, an alkyl or alkylene group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl or cycloalkylene group having a ring formed of 3 to 20 carbon atoms, a monovalent or divalent silyl group having 2 to 20 carbon atoms, a substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, monovalent or divalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with Ar₁ through a carbon-carbon bond;

L₂ represents a single bond, an alkyl or alkylene group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl or cycloalkylene group having a ring formed of 3 to 20 carbon atoms, a monovalent or divalent silyl group having 2 to 20 carbon atoms, a substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, monovalent or divalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with Ar_a through a carbon-carbon bond, provided that, when both X₁ and X₂ represent CR₂R₃, o and p each represent

0, q represents 1, and both L_1 and L_2 represent substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon groups each having a ring formed of 6 to 24 carbon atoms, or when both X_1 and X_3 represent CR_2R_3 , p and q each represent 0, o represents 1, and both L_1 and L_2 represent substituted or unsubstituted, monovalent or divalent aromatic hydrocarbon groups each having a rings formed of 6 to 24 carbon atoms, a case where L_1 and L_2 are simultaneously linked at para positions with respect to Ar_2 is excluded;

when n represents 2, L_3 represents a single bond, an alkylene group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkylene group having a ring formed of 3 to 20 carbon atoms, a divalent silyl group having 2 to 20 carbon atoms, a substituted or unsubstituted, divalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, divalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with Ar_3 through a carbon-carbon bond, when n represents 3, L_3 represents a trivalent alkane having 1 to 20 carbon atoms, a substituted or unsubstituted, trivalent cycloalkane having a ring formed of 3 to 20 carbon atoms, a trivalent silyl group having 1 to 20 carbon atoms, a substituted or unsubstituted, trivalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, trivalent aromatic heterocyclic group which has 3 to 24 atoms and which is linked with Ar_3 through a carbon-carbon bond,

or when n represents 4, L_3 represents a tetravalent alkane having 1 to 20 carbon atoms, a substituted or unsubstituted, tetravalent cycloalkane having a ring formed of 3 to 20 carbon atoms, a silicon atom, a substituted or unsubstituted, tetravalent aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted, tetravalent aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with Ar_3 through a carbon-carbon bond, provided that, when both X_1 and X_2 represent CR_2R_3 , o and p each represent 0, q represents 1, and both L_1 and L_3 represent substituted or unsubstituted, monovalent, divalent, trivalent, or tetravalent aromatic hydrocarbon groups each having a ring formed of 6 to 24 carbon atoms, or when both X_1 and X_3 represent CR_2R_3 , p and q each

represent 0, o represents 1, and both L_1 and L_3 represent substituted or unsubstituted, monovalent, divalent, trivalent, or tetravalent aromatic hydrocarbon groups each having a rings formed of 6 to 24 carbon atoms, a case where L_1 and L_3 are simultaneously linked at para positions with respect to Ar_2 is excluded;

A_1 represents a hydrogen atom, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with L_1 through a carbon-carbon bond, provided that, when L_1 represents an alkyl or alkylene group having 1 to 20 carbon atoms, a case where A_1 represents a hydrogen atom is excluded;

A_2 represents a hydrogen atom, a substituted or unsubstituted cycloalkyl group having a ring formed of 3 to 20 carbon atoms, a silyl group having 3 to 20 carbon atoms, a substituted or unsubstituted aromatic hydrocarbon group having a ring formed of 6 to 24 carbon atoms, or a substituted or unsubstituted aromatic heterocyclic group which has a ring formed of 3 to 24 atoms and which is linked with L_2 through a carbon-carbon bond, provided that, when L_2 represents an alkyl or alkylene group having 1 to 20 carbon atoms, a case where A_2 represents a hydrogen atom is excluded, and, when X_1 and X_2 each represent O, S, or CR_2R_3 , o and p each represent 0, q represents 1, and both L_1 and L_2 represent single bonds, or when both X_1 and X_3 each represent O, S, or CR_2R_3 , p and q each represent 0, o represents 1, and both L_1 and L_2 represent single bonds, a case where A_1 and A_2 simultaneously represent hydrogen atoms is excluded;

A_1 , A_2 , L_1 , L_2 , and L_3 are each free of any carbonyl group.

D. The Instituted Grounds of Unpatentability

We instituted *inter partes* review of claims 1, 3, 4, and 14–26 of the '870 patent on the following grounds of unpatentability asserted in the Petition.

Claim(s)	Basis	References
1, 3, 4, and 14–26	§ 103(a) ¹	Heil ² and Kawaguchi ³
1, 3, 4, 15, 16, and 22–26	§ 103(a)	Kai ⁴ and Kawaguchi
21	§ 103(a)	Kai, Kawaguchi, and Heil

III. ANALYSIS

A. Claim Construction

In an *inter partes* review, claim terms in an unexpired patent are given their broadest reasonable construction in light of the specification of the patent in which they appear. 37 C.F.R. § 42.100(b); *see Cuozzo Speed*

¹ The Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011) (“AIA”), amended 35 U.S.C. § 103. Because the challenged claims of the '870 patent have an effective filing date before the effective date of the applicable AIA amendment, we refer to the pre-AIA version of 35 U.S.C. § 103.

² WO 2007/022845 A1 (“Heil”). Ex. 1013; Ex. 1015 (English translation); *see* Ex. 1025 (translation affidavit). When referring to the foreign language references in this Decision, we refer to the English translations filed by Petitioner.

³ Kawaguchi et al., *Synthesis, Structures, and Properties of Unsymmetrical Heteroacenes Containing Both Pyrrole and Furan Rings*, Organic Letters, Vol. 10, No. 6, pp. 1199-1202 (2008) (“Kawaguchi”). Ex. 1016.

⁴ WO 2008/056746 A1 (“Kai”). Ex. 1017; Ex. 1019 (English translation); *see* Ex. 1026 (translation affidavit).

Techs., LLC v. Lee, 136 S. Ct. 2131, 2144–46 (2016). Under the broadest reasonable construction standard, claim terms are generally given their ordinary and customary meaning, as would be understood by one of ordinary skill in the art in the context of the entire patent disclosure. *In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007).

In the Decision on Institution, we noted Petitioner asserted a person of ordinary skill in the art “would have understood each term in each of the Challenged Claims to have its plain and ordinary meaning, and would have understood that no term requires special construction for purposes of this Petition” and that Patent Owner did not dispute Petitioner’s argument. Dec. on Inst. 7. We determined that, based on the record at the time, no express construction of any term was necessary in order to resolve the disputes before us. *Id.* During the instituted trial, neither party disputed our conclusion that no express claim construction was required. Upon review of the entire record, we maintain that no express construction of any term is required to resolve the disputes currently before us.

B. The Level of Ordinary Skill in the Art

Petitioner asserts that a person of ordinary skill in the art would generally have had “a bachelor’s degree in chemistry, physics, materials science or a related discipline and two to three years of relevant experience, which could be obtained either through graduate studies or work experience.” Pet. 18–19 (citing Ex. 1003 ¶ 8). Petitioner also asserts that a person of ordinary skill in the art would have been “aware of various aspects of luminescent materials and of the use of such materials in conjunction with, at least, anodes, cathodes, host materials, doping materials, hole injecting materials, and electron injecting materials, and would have had a

good understanding of the mechanism of operation of organic EL [electroluminescence] devices” and have had “an understanding of the electronic structure of organic materials and how the electronic structure of such materials impacts their spectroscopic properties and performance in organic EL devices.” *Id.*

Patent Owner provides a substantively comparable definition of one ordinarily skilled in the art (PO Resp. 7) but disagrees that a person having a bachelor’s degree in physics would be considered a person of ordinary skill in the art, contending such a person would lack a basic understanding of the “molecular modifications necessary to make an obviousness determination” (*id.* at 8).

For the purposes of this Decision, we agree with and adopt the definition of a person of ordinary skill in the art proposed by Petitioner. We further note, however, that our Decision is not impacted by which proposed definition of a person of ordinary skill in the art is adopted.

*C. Asserted Obviousness of Claims 1, 3, 4, and 14–26
over Heil and Kawaguchi*

Petitioner asserts that independent claim 1 and dependent claims 3, 4, and 14–26 would have been obvious over Heil and Kawaguchi. Pet. 17, 27–39. A claim is unpatentable for obviousness:

if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

35 U.S.C. § 103; *see KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). Obviousness is a question of law based on underlying factual

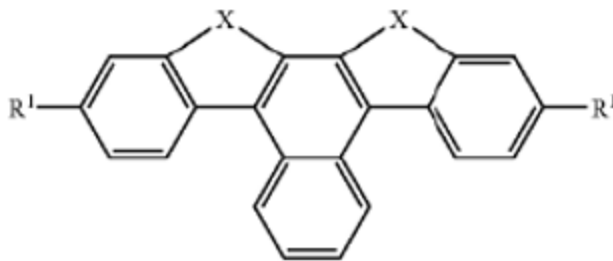
findings: (1) the scope and content of the prior art; (2) the differences between the claims and the prior art; (3) the level of ordinary skill in the art; and (4) objective indicia of nonobviousness. *See Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). As the party challenging the patentability of the claims at issue, Petitioner bears the burden of proving obviousness by a preponderance of the evidence. *See* 35 U.S.C. § 316(e).

We instituted trial on claims 1, 3, 4, and 14–26 based on Petitioner’s arguments and cited testimony of Dr. Schwartz that it would have been obvious to one of ordinary skill in the art to modify the compound of Formula 2(a) of Heil to select an O atom for one X and NR¹ for the other X. Dec. on Inst. 15–17. Now, after considering the evidence and arguments of the parties fully developed on the record before us, for the reasons set forth below, we determine that Petitioner has not provided persuasive evidence of the requisite motivation to combine the teachings of Heil and Kawaguchi to arrive at the claimed compounds of claim 1. Therefore, Petitioner has not met its burden of showing that independent claim 1 or dependent claims 3, 4, and 14–26 are unpatentable by a preponderance of the evidence.

1. Scope and Content of Prior Art

a. Overview of Heil

Heil, which Petitioner asserts was cited during prosecution of the ’870 patent as the closest prior art, discloses compounds for use as a material for an OLED, including compounds of Formula 2(a):



Ex. 1015, 10:20–26; Pet. 9, 40 (citing Ex. 1002, 11).

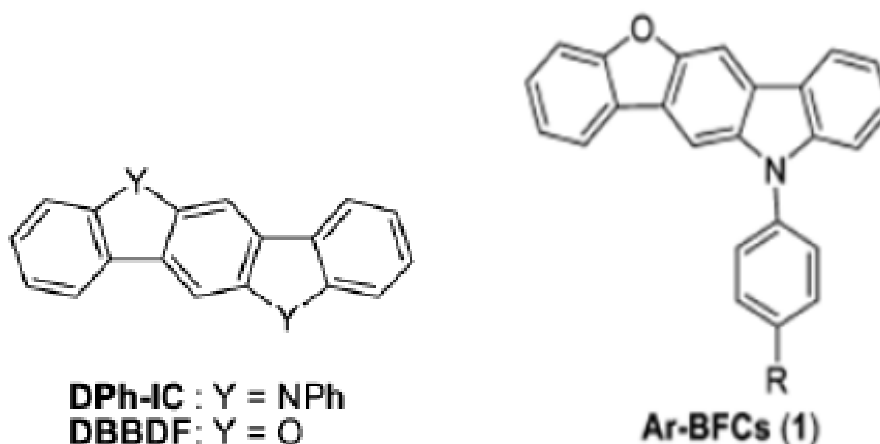
Heil does not state that one X of Formula 2(a) is oxygen (O) or sulfur (S) and the other X is N(R¹), as recited in claim 1 of the '870 patent. Rather, Heil states that X can be, either identically or differently, a divalent bridge selected from a number of different substituents, including S, O, and N(R¹), where R¹ contains at least one aryl or heteroaryl group. *See, e.g.*, Ex. 1015, 12:20–25 (stating each X is preferably, identically or differently, a divalent bridge selected from C(R¹)₂, N(R¹), P(R¹), P(=O)R¹, particularly preferably C(R¹)₂ and N(R¹), in particular C(R¹)₂).

b. Overview of Kawaguchi

Kawaguchi discloses the synthesis of organic semiconducting compounds for use as organic field-effect transistors (“OFETs”). Ex. 1016, 1. Kawaguchi discloses modifying symmetrical compounds DPh-IC (which has two N bridging atoms) or DBBDF⁵ (which has two O bridging atoms) to produce asymmetrical heteroacene compounds Ar-BFCs⁶ having one N and one O bridging atom. *Id.* at Abstract, 2. The chemical structure of the DPh-IC, DBBDF, and Ar-BFC compounds are shown below:

⁵ dibenzo[*d,d'*]benzo[1,2-*b*:4,5'-*b'*]difuran

⁶ 11-arylbenzofuro-[3,2-*b*]carbazole



Id. at 2.

Kawaguchi explains that one of the key factors responsible for high electronic performance of OFET materials is their “solid-state packing structure.” *Id.* at 2. Kawaguchi states that, in general, strong electronic interactions between π -electron-rich frameworks of adjacent molecules, such as that resulting from a cofacial π -stacking structure, lead to high charge-carrier mobility through the material and high OFET performance. *Id.* In contrast, structures that have dominant edge-to-face interactions, such as the symmetric DBBDF and DPh-IC compounds, do not have strong interaction “resulting in much lower OFET performance.” *Id.*

Kawaguchi states the “antiparallel cofacial π -stacking arrangements” of the asymmetrical Ar-BFC compounds are “expected to cause significant orbital interaction,” resulting in improved charge carrier mobility and improved OFET performance as compared to the symmetrical DBBDF and DPh-IC compounds, which demonstrate edge-to-face interactions, resulting in lower OFET performance. *Id.* at 2, 3. Kawaguchi further states:

Ar-BFCs . . . exhibit an antiparallel cofacial π -stacking structure in the solid state, which would cause strong electronic coupling. Such a π -stacking pattern presumably results from their

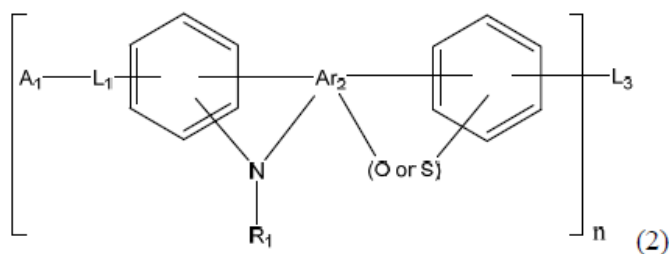
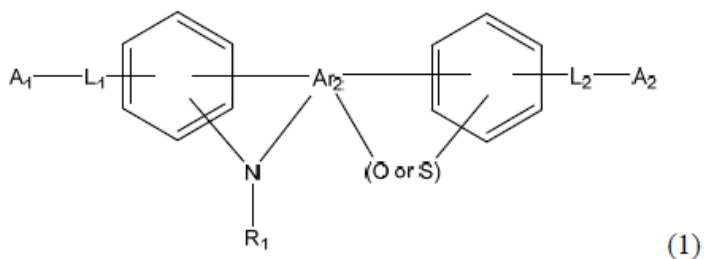
unsymmetrical structures. Thus the present molecular design of the unsymmetrical introduction of a substituent on a (hetero)acene core would provide a guide to cofacial arrangement of the (hetero)acene core.

Id. at 4.

2. *Whether One of Ordinary Skill in the Art Would Have Combined and/or Modified the Prior Art to Achieve the Claimed Invention*

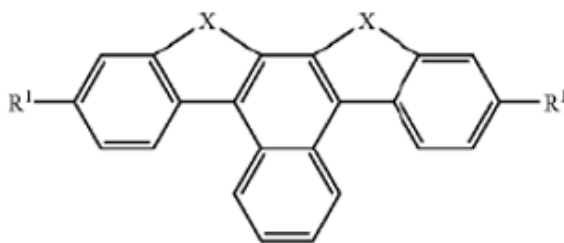
Turning to the merits of the ground of unpatentability, we first focus on the differences between claim 1 and the prior art and whether Petitioner has established the requisite motivation to modify the references to arrive at the claimed invention.

Claim 1 requires, *inter alia*, a material for an organic electroluminescence device of Formula (1) or (2), shown below, where Ar_2 is either benzene or naphthalene and R_1 is a particular heteroaryl or heteroaryl substituted aryl:



Ex. 1001, 399:9–401:44; PO Resp. 8–9.

As noted above, Heil teaches compounds for use as a material for an organic electroluminescence device, including compounds of Formula 2(a):



where X can be, either identically or differently, a divalent bridge selected from a number of different substituents, including O, and NR¹, where R¹ contains at least one aryl or heteroaryl group. Ex. 1015, 5:20–6:4, 6:18–21, 6:27–28, 11:1–2, 12:20–33. Heil does not explicitly teach selecting NR₁ for one X and O for the other X.

Kawaguchi teaches modifying compounds having a symmetric acene core of either a pair of nitrogen atoms (“N/N”) or a pair of oxygen atoms (“O/O”) as divalent bridges to produce asymmetric Ar-BFC compounds having a nitrogen and oxygen atom (“N/O”) as a divalent bridge for use in OFETs. *See, e.g.*, Ex. 1016, 2.

Petitioner states that the improved Kawaguchi compounds “show antiparallel cofacial π -stacking arrangements between heteroacene cores, which are expected to cause significant orbital interaction.” Pet. 49 (citing Ex. 1016, 2). “Thus,” Petitioner states, “Kawaguchi teaches the [person of ordinary skill in the art] to utilize an asymmetrical arrangement of two different hetero atoms in constructing an acene core . . . of the type of Heil for improving oxidative stability and improved orbital interaction of stacked molecules.” *Id.* (citing Ex. 1016, 2, 4; Ex. 1003 ¶ 53). Petitioner also relies upon testimony by Dr. Schwartz stating Kawaguchi demonstrates that “asymmetrically modifying [compounds, such as those having an aromatic

backbone as taught by Heil] to include dissimilar heteroatoms (such as N and O) produced new compounds that strongly π -stacked in the solid state.”

Ex. 1003 ¶ 53. Dr. Schwartz further testifies that “[t]his molecular interaction improves the oxidative stability of these compounds, and also improves the π -electron overlap, greatly increasing the carrier mobility.” *Id.* Dr. Schwartz further testifies that compounds with a backbone known to work in OLEDs modified to provide a high carrier mobility in organic FETS “are highly likely to be excellent candidates for organic EL devices themselves.” *Id.*

Patent Owner responds by agreeing the modifications taught by Kawaguchi increase π -stacking. PO Resp. 30–31. However, Patent Owner contends that one skilled in the art would not have been motivated to modify Heil’s compounds to increase π -stacking because, *inter alia*, doing so would cause the dominant charge transport axis to be oriented parallel to the substrate, which is detrimental for OLED structures. *Id.* at 30–49. Patent Owner explains that in a typical OLED configuration, such as that shown in Figure 1 below, the charge-carriers move between cathode and anode through a layer perpendicular to the substrate in which the layer is formed. *Id.* at 38 (citing Ex. 2007 ¶¶ 21–22).

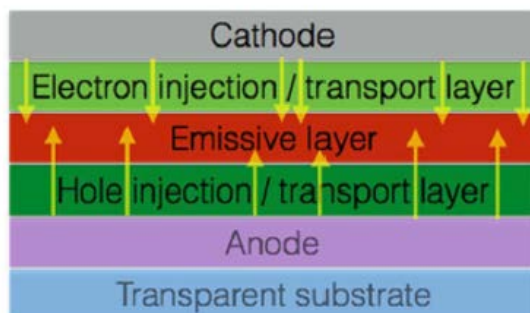


Figure 1. Typical OLED Configuration.

Figure 1 illustrates an OLED configuration in which the dominant charge-carrier direction is perpendicular to the layers. Patent Owner further contends that in a typical OFET configuration, such as that shown in Figure 2 below, the charge-carriers move *parallel* to the substrate. PO Resp. 37–39 (citing Ex. 2007 ¶¶ 28–30); Ex. 2006, 35:3–36:3, 55:8–20, 56:3–57:3; Ex. 2007 ¶¶ 22, 30, 31.

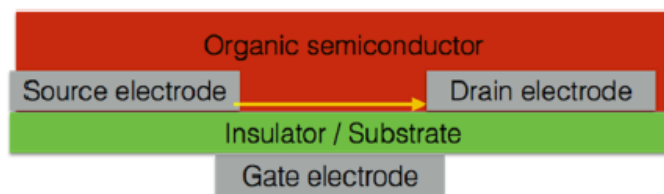


Figure 2. Typical OFET Configuration.

Figure 2 depicts an OFET configuration in which dominant charge-carrier movement from source electrode to drain electrode is parallel to the substrate layer.

Patent Owner asserts “the antiparallel cofacial π -stacking arrangement of Kawaguchi’s Ar-BFCs would be expected to cause the molecules to align with the interacting molecular axis *parallel* to the substrate surface and to grow along the substrate surface,” causing the charge transport axis to be parallel to the substrate. PO Resp. 44 (citing Ex. 2007 ¶ 46). Patent Owner contends because π -stacking results in charge-carriers moving predominantly parallel to the substrate, not perpendicular, one skilled in the art would not provide an asymmetric N/O divalent bridge to increase π -stacking for OLED materials. *Id.* at 30–49.

Patent Owner also argues that, contrary to Petitioner’s assertions, Kawaguchi does not teach that asymmetric heteroatoms improve oxidative stability of the compound. *Id.* at 23–30. Rather, Kawaguchi merely teaches

compound Ar-BFC (which has N/O as bridging atoms) is more oxidatively stable than compound DPh-IC (which has N/N as bridging atoms) and is less oxidatively stable than DBBDF (which has O/O as bridging atoms). *Id.*

In the Reply, Petitioner agrees with Patent Owner that compounds exhibiting significant π -stacking “without steric hindrance have not found general usefulness as OLED materials.” Reply 10. Petitioner’s declarant, Dr. Schwartz, similarly admits that π -stacked compounds “without steric hindrance have not found general usefulness as OLED materials . . . because their emission in the solid state is suppressed due to the formation of excimers or aggregates to their π -stacking.” Ex. 1033 ¶ 59. Recognizing that strong π -stacking creates problems for OLED materials, Petitioner in its Reply argues that one skilled in the art would add bulky side chains to “prevent[] excessive π -stacking and molecular aggregation in the solid state.” Reply 11; *see also* Ex. 1033 ¶ 8 (stating one skilled in the art would have known to “mitigate strong π -stacking interactions” by adding “substituents of appropriate bulk” to the molecule to optimize OLED materials). Petitioner cites to, *inter alia*, Moorthy,⁷ Anthony,⁸ and Toray⁹ as

⁷ Jarugu Narashimha Moorthy et al., *Steric Inhibition of π -Stacking: 1,3,6, 8-Tetraarylpyrenes as Efficient Blue Emitters in Organic Light Emitting Diodes (OLEDs)*, Organic Letters, Vol. 9, No. 25, p. 5215 (Ex. 1030, “Moorthy”).

⁸ John E. Anthony, *Functionalized Acenes and Heteroacenes for Organic Electronics*, Chem. Rev., Vol. 108, p. 5028 (2006) (Ex. 1031, “Anthony”).

⁹ WO 2007/029798 A1 (Ex. 1028, “Toray”). English translation of Patent Application No. PCT/JP2006/317810 (Ex. 1029). We note that Petitioner refers to these references as “Toray.” However, “Toray” is not a listed inventor on this application. Rather, “Toray Industries, Inc.” is listed as the assignee of the application and “Seiichiro Murase” is the first listed inventor. Ex. 1028, 1. Although it is customary to refer to patent documents using the

evidence that one skilled in the art would have been aware of the need to add bulky side chains to convert OFET materials to OLED materials. Reply 10–13; *see also id.* at 4 (stating OFET compounds are “easily modified” to convert into OLED compounds); Ex. 1033 ¶ 59.

Petitioner also restates its motivation to combine argument. In the Reply, Petitioner argues one skilled in the art would have been motivated to modify compounds in Heil having symmetric N/N divalent bridging atoms to have asymmetric N/O bridging atoms because (1) “Kawaguchi teaches improved oxidative stability provided by the N/O heteroatom arrangement compared with the N/N heteroatom arrangement” and (2) “Heil includes N” as a preferred heteroatom, and O within its X possibilities. Reply 3–4 (citing Ex. 1016, 2:34–43; Ex. 1015 6:18–21, 12:23–24).

After reviewing the record in total, the arguments and evidence presented by both parties, and the prior art itself, we find that Petitioner has not provided persuasive evidence of a reason or motivation for a person of ordinary skill in the art to have combined the teachings of Heil and Kawaguchi.

First, we note that Petitioner presents arguments in its Reply that are procedurally improper and not entitled to consideration. Pursuant to 37 C.F.R. § 42.23(b), a reply “may only respond to arguments raised in the corresponding . . . patent owner response.” *See also Intelligent Bio–Systems, Inc. v. Illumina Cambridge Ltd.*, 821 F.3d 1359, 1369–70 (Fed. Cir. 2016) (concluding that the Board did not abuse its discretion in refusing to

first listed inventor, for clarity and consistency, we will refer to Ex. 1028 as Petitioner has.

consider reply brief arguments advocating a “new theory” of unpatentability under 37 C.F.R. § 42.23(b)).

“Respond” in the context of 37 C.F.R. § 42.23(b) does not mean embark in a new direction with a new approach as compared to the position originally taken in the Petition. Accepting such belatedly presented new arguments would be unjust to Patent Owner and we decline to do so. See *Apple Inc. v. e-Watch, Inc.*, Case IPR2015–00412, slip op. at 44 (PTAB May 6, 2016) (Paper 50); see also Rules of Practice for Trials Before the Patent Trial and Appeal Board and Judicial Review of Patent Trial and Appeal Board Decisions; Final Rule, 77 Fed. Reg. 48,612, 48,620 (Aug. 14, 2012) (“Oppositions and replies may rely upon appropriate evidence to support the positions asserted. Reply evidence, however, must be responsive and not merely new evidence that could have been presented earlier to support the movant's motion.”); Office Patent Trial Practice Guide, 77 Fed. Reg. 48,756, 48,767 (Aug. 14, 2012) (“While replies can help crystalize issues for decision, a reply that raises a new issue or belatedly presents evidence will not be considered and may be returned. . . . Examples of indications that a new issue has been raised in a reply include new evidence necessary to make out a *prima facie* case for the patentability or unpatentability of an original or proposed substitute claim, and new evidence that could have been presented in a prior filing.”).

In the Petition, Petitioner argued one of ordinary skill in the art would have been motivated to use the asymmetric heteroatoms taught by Kawaguchi in the heteroacene core of Heil to provide compounds that “show antiparallel cofacial π -stacking arrangements between heteroacene cores, which are expected to cause *significant* orbital interaction.” Pet. 49

(emphasis added). Dr. Schwartz testifies Kawaguchi teaches “asymmetrically modifying [compounds] to include dissimilar heteroatoms” to “produce[] new compounds that strongly π -stacked in the solid state,” and this “molecular interaction improves the oxidative stability of these compounds, and also improves the π -electron overlap, greatly increasing the carrier mobility.” Ex. 1003 ¶ 53; *see also* Pet. 49 (stating Kawaguchi teaches one of ordinary skill in the art to provide two different hetero atoms N/O in the acene core “of the type of Heil for improving oxidative stability and improved orbital interaction of stacked molecules”).

However, in the Reply, Petitioner admits that compounds exhibiting strong π -stacking “have not found general usefulness as OLED material,” and Petitioner changes its position to assert that one of ordinary skill in the art would have known to add bulky side chains “to produce steric hindrance between adjacent molecules for preventing excessive π -stacking and molecular aggregation in the solid state.” Reply 11 (citing Exs. 1030, 1031, 1033 ¶ 59). Dr. Schwartz similarly testifies that “strong π -stacking interactions . . . can lead to excimer or aggregate formation and thus potentially a loss of luminescence efficiency” in OLED materials. Ex. 1033 ¶ 8. Dr. Schwartz states that adding bulky side chains can “mitigate strong π -stacking interactions” (*id.*) and that a person of ordinary skill in the art would have known to add bulky substituents to the heteroacene core to “‘convert’ potential OFET materials to potential OLED materials” (*id.* ¶ 58).

Therefore, Petitioner has recast its original rationale for modifying the prior art, namely to provide asymmetric heteroatoms for strong π -stacking, to an inconsistent rationale of providing asymmetric heteroatoms for *strong* π -stacking *and* bulky side chains to *mitigate* strong π -stacking. Petitioner’s

argument that one skilled in the art would have added bulky side chains to prevent excessive π -stacking is a substantially new argument that is improper in a reply. Petitioner's new argument is driven by the uncontroverted recognition that strong π -stacking causes the charge transport axis to be parallel to the substrate, which is undesirable in OLEDs where the charge transport axis between anode and cathode is perpendicular.

Similarly, Petitioner's argument that one skilled in the art would have modified the compounds of Heil to improve oxidative stability, independent of any motivation to increase π -stacking, is an improper new argument. As explained by Dr. Schwartz in his declaration submitted with the Petition, both oxidative stability and an increase in carrier mobility are *the result of* the "strongly π -stacked" interaction in the solid state. Ex. 1003 ¶ 53; *see also* Pet. 48–49.

Further, even if considered, Petitioner's newly articulated motivation to combine argument is not persuasive. Petitioner states that the "important point is that an N/O configuration, if placed in the Heil structure, would be more environmentally stable than an N/N configuration shown by Heil in its example compound 4." Reply 10. "This conclusion is independent of potential use as an OFET material or as an OLED material." *Id.*; *see also id.* at 15–16 (stating the "important teaching of Kawaguchi is that the . . . modification of the indolocarbazole DPh-IC with the N/N arrangement to the benzofuranocarbazole Ar-BFCs with the N/O arrangement – provides improved oxidative stability" and "that teaching is true regardless of the end utility for the compound"). However, the claims at issue are directed to a material for use in an OLED device, and the use of the material is relevant to the motivation-to-combine analysis.

Moreover, Petitioner has not provided sufficient evidence that one of ordinary skill in the art could have modified the compounds of Heil to provide NR¹ and O divalent bridging atoms with a reasonable expectation of success that such a modified compound would be suitable for use in an OLED. Petitioner states that one skilled in the art would have had a reasonable expectation of success that the modified compounds having N/O or N/S as bridging atoms would “be characterized by retention of the improved OLED properties of Heil” because Kawaguchi’s N/N type compound DPh-IC was known to be a useful OLED material. Reply 7 (citing Exs. 1032, 1033). However, the issue is not whether one skilled in the art would have expected the starting compounds of Kawaguchi, such as DPh-IC, to be useful as OLED materials. Rather, the issue is whether one skilled in the art, looking at the modifications taught in Kawaguchi and potentially applying them to Heil, would have expected Kawaguchi’s asymmetric OFET compounds to be useful as an OLED material. Given that the claimed invention is directed to materials for OLED devices, and that the modifications disclosed in Kawaguchi to the DPh-IC compound would result in strong π -stacking, which Petitioner acknowledges is useful in OFETs but not in OLED compounds (Reply 6; Ex. 1033 ¶ 59), Petitioner has not shown that one skilled in the art would have been motivated to make the asserted modifications.

Nor has Petitioner established that one skilled in the art would have been motivated to add bulky side chains to decrease π -stacking with a reasonable expectation of success of arriving at the claimed invention. Petitioner’s declarant states that “it would have been obvious to a [person of ordinary skill in the art to] restore luminescence by adding a bulky side

group” as discussed in Exhibits 1031 and 1030. Ex. 1033 ¶ 65; *see also* Reply 10 (stating one of ordinary skill in the art would have known that the addition of one or more bulky side chains converts an OFET material to an OLED material). Petitioner also states that “[m]ere routine experimentation would be required in determining the side chain appropriate for OLED characteristics, bearing in mind the preferred heteroaryl R¹ moiety” of Heil. Reply 13.

However, Petitioner has not provided sufficient evidence to support its claim that “mere routine experimentation” is required to determine which side chains would convert the modified compounds as taught by Heil and Kawaguchi from an OFET material to an OLED material. Petitioner states Dr. Anthony, Patent Owner’s declarant, “admitted that Kawaguchi’s compounds can be used for OLEDs” and that “a potential OLED can be tuned by the [person of ordinary skill in the art] to avoid π -stacking.” *Id.* at 16. During the oral hearing, Petitioner stated that Dr. Anthony agreed that one of ordinary skill in the art “would have known that there are these opportunities to fine-tune with bulky side groups. And that as such is a reasonable expectation of success that a skilled artisan would have had just based on their own knowledge.” Tr. 45:21–46:2. However, nowhere does Dr. Anthony state that Kawaguchi’s compounds *having asymmetric* heteroatoms can be used as OLEDs. *See, e.g.*, Ex. 1027, 28–29. Rather, Dr. Anthony merely stated that DPh-IC, which has symmetrical heteroatoms, can be used as an OLED material. Nor did Dr. Anthony state that one skilled in the art would have had a reasonable expectation that a modified asymmetric compound would work in an OLED. *See* Tr. 23:14–22.

Based on all of the evidence of record, we are not persuaded that Petitioner has established that one of ordinary skill in the art, looking at Heil and Kawaguchi, would have been motivated to select an O atom for one X and select NR¹ for the other X of Heil's formula (2a) to arrive at a compound of formula (1) or (2) of claim 1. As such, we conclude that Petitioner has failed to carry its burden of demonstrating, by a preponderance of the evidence, that claim 1 is unpatentable.

Petitioner's obviousness analysis for dependent claims 3, 4, and 14–26 does not address the deficiencies discussed above regarding independent claim 1 from which they depend. Pet. 51. As a result, Petitioner has not demonstrated, by a preponderance of the evidence, that claims 3, 4, and 14–26 are unpatentable. *See, e.g., Ortho-McNeil Pharm., Inc. v. Mylan Labs., Inc.*, 520 F.3d 1358, 1365 (Fed. Cir. 2008) (“[D]ependent claims are nonobvious if the independent claims from which they depend are nonobvious.”).

D. Asserted Obviousness of Claims 1, 3, 4, 15, 16, and 22–26 over Kai and Kawaguchi

Petitioner's obviousness analysis for combining Kai and Kawaguchi relies on the same asserted motivation for one of ordinary skill to combine Heil and Kawaguchi. Pet. 53–54 (stating motivation to modify Kai is provided by the improved stability and electronic coupling of Kawaguchi's asymmetric, strongly π -stacked compounds (citing Ex. 1003 ¶¶ 53–56)). For the same reasons stated in Section III.C.2 above with respect to Heil and Kawaguchi, Petitioner has not persuasively shown why one of ordinary skill in the art would have been motivated to modify the compounds of Kai in view of Kawaguchi to arrive at the claimed invention. *See* PO Resp. 56–65.

Accordingly, we conclude that Petitioner has failed to carry its burden of demonstrating, by a preponderance of the evidence, that the subject matter of claim 1 is unpatentable over the teachings of Kai and Kawaguchi.

We also note that during oral argument, Petitioner attempted to introduce new argument by asserting the branched chains of Kai's organic compounds would have interfered with π -stacking, and therefore the modified compounds of Kai would have resulted in a less solidly stacked compound. *See, e.g.*, Tr. 20:18–22:2. However, this argument was not presented in the briefing and has not been considered. *See* Office Patent Trial Practice Guide, 77 Fed. Reg. 48,756, 48,768 (Aug. 14, 2012) (“A party may . . . only present arguments relied upon in the papers previously submitted. No new evidence or arguments may be presented at the oral argument.”).

Petitioner's obviousness analysis for dependent claims 3, 4, 15, 16, and 22–26 does not address the deficiencies discussed above regarding independent claim 1 from which they depend. Pet. 55–57. As a result, Petitioner has not demonstrated, by a preponderance of the evidence, that claims 3, 4, 15, 16, and 22–26 are unpatentable.

*E. Asserted Obviousness of Dependent Claim 21
over Kai, Kawaguchi, and Heil*

Claim 21 depends from claim 1. Petitioner's obviousness analysis for dependent claim 21 does not address the deficiencies discussed above regarding independent claim 1. Pet. 58–59. As a result, Petitioner has not demonstrated, by a preponderance of the evidence, that claim 21 is unpatentable.

F. Patent Owner's Motion to Exclude

Patent Owner seeks to exclude Exhibits 1028, 1029, 1030, 1031, and 1032 and portions of Dr. Schwartz's reply declaration (Exhibit 1033) that were submitted in support of Petitioner's Reply. Paper 26. We need not reach the merits of Patent Owner's Motion to Exclude Evidence because, as explained above, even if the disputed evidence is considered, Petitioner has not met its burden of showing unpatentability by a preponderance of the evidence. Accordingly, Patent Owner's Motion to Exclude Evidence is dismissed as moot.

IV. CONCLUSION

For the foregoing reasons, based on a review of the complete record developed during trial, we conclude that Petitioner has not proven, by a preponderance of the evidence, that claims 1, 3, 4, and 14–26 are unpatentable.

V. ORDER

Accordingly, it is:

ORDERED that:

(1) The subject matter of claims 1, 3, 4, and 14–26 has not been shown to be unpatentable under 35 U.S.C. § 103(a) over Heil and Kawaguchi;

(2) The subject matter of claims 1, 3, 4, 15, 16, and 22–26 has not been shown to be unpatentable under 35 U.S.C. § 103(a) over Kai and Kawaguchi; and

(3) The subject matter of claim 21 has not been shown to be unpatentable under 35 U.S.C. § 103(a) over Kai, Kawaguchi, and Heil; and

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FURTHER ORDERED that Patent Owner's Motion to Exclude Evidence (Paper 26) is dismissed as moot.

This is a Final Written Decision under 35 U.S.C. § 318(a). Parties to the proceeding seeking judicial review of the Decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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