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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MIANYANG BOE OPTOELECTRONICS TECHNOLOGY CO., LTD.;
WUHAN CHINA STAR OPTOELECTRONICS SEMICONDUCTOR DISPLAY
TECHNOLOGY CO., LTD.; TIANMA MICROELECTRONICS CO., LTD.;
AND VISIONOX TECHNOLOGY, INC.,
Petitioner,

v.

SAMSUNG DISPLAY CO., LTD.
Patent Owner.

Case IPR2023-00941
U.S. Patent No. 7,414,599

PATENT OWNER'S RESPONSE

PUBLIC VERSION

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Ex. 2002	U.S. Patent Publication No. 2004/0041750 (“Abe”)
Ex. 2003	U.S. Patent Publication No. 2004/0145547 (“Oh”)
Ex. 2004	Digital Integrated Circuits, A Design Perspective 2 nd ed. (2003)
Ex. 2005	Claim Construction Order, Inv. No. 337-TA-1351
Ex. 2006	Declaration of Jared Frisch
Ex. 2007	Declaration of Derek Andros
Ex. 2008	 Declaration of Andrew Wolfe, Ph.D.
Ex. 2009	Replay the Display, <i>Mass Production of AMOLED – Samsung’s Dramatic Success That Changed the History of Displays</i> , Samsung Display Newsroom (Feb. 17, 2003) (https://global.samsungdisplay.com/31098)
Ex. 2010	Society of Information Display, <i>Mobile Displays Technology and Applications</i> (Achintya K. Bhowmik et al.) (2008)
Ex. 2011	Dawson et al., <i>Design of an Improved Pixel for a Polysilicon Active-Matrix Organic LED Display</i> , Society of Information Display (1998)
Ex. 2012	Akimoto et al., <i>An Innovative Pixel-Driving Scheme for 64-Level Grey-Scale Full-Color Active Matrix OLED Displays</i> , Society of Information Display (2002)
Ex. 2013	Shirasaki et al., <i>Full Color Polymer OLED Display Driven by a-Si:H TFT Utilizing a New Current-Programmed Method</i> , International Display Workshop (2003)



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Ex. 2014	Chih-Lung, Lin, <i>Pixel Circuit with High Immunity to the Degradation of TFTs and OLED for AMOLED Displays</i> , IMD/IDMC/ASIA Display Digest (2008)
Ex. 2015	Yoo et. al., <i>302-ppi High-Resolution AMOLED using Laser-Induced Thermal Imaging</i> , Society of Information Display (2005)
Ex. 2016	Yoon Jeong-hyun, <i>Samsung Display Achieves the Highest Definition Quality With Tenacity. Full HD AMOLED “Revolution,”</i> BIZ Insight (2013) (including certified English translation)
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Ex. 2048	Curriculum Vitae of Andrew Wolfe, Ph.D.
Ex. 2049	Study of Leakage Current in n-channel and p-channel Polycrystalline Silicon Thin-film Transistors by Conduction and Low Frequency Noise Measurements, C.T. Angelis, et. al, J. Appl. Phys. 82, 4095-4101 (1997)
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Ex. 2051	Sourcely Plus AMOLED Display Claim Chart
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I. Introduction

Petitioner's challenge to claims 1–18 of U.S. Patent No. 7,414,599 (Ex. 1001, the “’599 Patent”), which is based solely on U.S. Patent Publication No. 2003/0132931 (Ex. 1002, “Kimura”), has no merit. Kimura is a lengthy reference presenting a multitude of pixel circuits. Rather than start with any circuit touted by Kimura, the Petition roots its arguments in a “baseline circuit [of] Kimura Fig. 33,” Pet. at 15, that Kimura recognizes is a flawed design that may emit light at unintended times, Kimura at ¶666. Petitioner then disregards Kimura's solution to this problem of spurious light emission, because Kimura's solution reinforces the non-obviousness of the '599 Patent's pixel circuits. Instead, Petitioner advances a series of inappropriate modifications inconsistent with Kimura's disclosures and that a POSITA would have had no motivation to make. For instance, changing Kimura's Figure 33 to an “all PMOS” circuit or using the same signal to control transistors 3307 and 3310, would leave intact the fundamental operational defect Kimura identified in its Figure 33 circuit.

In seeking to challenge claims 1–18, Petitioner proposes three sets of significant modifications to the “baseline circuit [of] Kimura Fig. 33.” Pet. at 15. In its institution decision, the Board correctly expressed skepticism of Petitioner's modifications. As Dr. Wolfe explains, there would have been no motivation for a POSITA to make these modifications, which in fact are contradicted by Kimura's

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teachings. Indeed, Petitioner's expert, Dr. Foty, has made crucial admissions in deposition that further undermine the Petition's theories.

First, in its challenge as to all claims, Petitioner seeks to convert the CMOS circuit of Figure 33 to an "all PMOS" redesign. Petitioner asserts that a single-transistor-species circuit would lead to certain manufacturing advantages over a CMOS circuit (which includes complementary NMOS and PMOS transistors). As the Board observed, however, this "theory appears incomplete because what is shown in Figures 33A–33E is merely a pixel circuit and does not include other components [including a CMOS driver circuit] which are fabricated on the same substrate." DI at 31. Petitioner's theory is unsupported by, and at odds with, the disclosures of Kimura, which emphasize the CMOS design and its improved manufacturability of CMOS circuits.

Although the Board determined that a theory of "general interchangeability of nMOS and pMOS transistors used as switching transistors" was "sufficiently persuasive" for institution purposes as justification for the "all PMOS" redesign, DI at 23, the evidence shows that the redesign advanced by Petitioner does not entail simple interchangeability. As Dr. Wolfe explains, and Dr. Foty admitted, there are important structural and operational differences between NMOS and PMOS thin-film transistors including in their leakage current, speed, and size. A POSITA would have understood that these differences matter in these pixel circuits, and they counsel



against the numerous changes demanded for Petitioner’s proposed redesign. Further, Kimura’s Figure 33 is designed as a *CMOS* circuit containing both NMOS and PMOS transistors, and a POSITA would appreciate that CMOS circuits confer advantages. Dr. Foty acknowledged in deposition that, contrary to Petitioner’s proposed single-transistor-species design, “[t]he reason we use CMOS is [it is] so advantageous as a circuit technology that [it is] worth paying the price literally and figuratively.” Ex. 2050 at 94:19–95:14.

Petitioner’s theory of an all-PMOS redesign suffers from a number of further flaws. For instance, Petitioner fails to account for additional changes that would be required by its proposed redesign, including to the drive circuitry, let alone explain how a POSITA would have made such changes. And Petitioner’s redesign would require changing the polarity of up to five different transistors from those taught by Kimura, to arbitrarily select one set of polarities from at least thirty-two possibilities (not to mention that once a POSITA began to consider changing transistors they would also have the option of changing the transistor type, e.g., to amorphous silicon). Petitioner has not shown, and could not show, a POSITA would have been motivated to choose its particular combination.

Second, in an attempt to satisfy the “initialization transistor” requirement of claims 2, 8, 16, and 18, “Petitioner proposes a modification to incorporate an additional transistor from Kimura’s embodiment of Figure[s] 16 and 17, into



Kimura’s Figure 33 embodiment to reset the capacitor voltage.” DI at 47. A POSITA would have had no reason to make any such modification. As the Board recognized in the institution decision, Petitioner bases this proposed modification on its improper conflation of Kimura’s “initialization” and “erasure” operations. DI at 49. The Board thus was correct to “question Petitioner’s accounting for the alleged obviousness of [these claims] over Kimura.” DI at 49 (claim 8); *see* DI at 56 (claims 16 and 18), 58 (claim 2). Moreover, as Dr. Wolfe explains, Petitioner’s theory has a number of other flaws. For instance, Petitioner does not even incorporate an additional transistor from Figures 16 and 17 in a manner consistent with Kimura’s teachings, and its modification would undesirably require adding another signal line for that transistor.

Third, claims 1–6 and 13–18 each require a shared light-emitting signal, and to challenge these claims Petitioner proposes tying the gates of transistors 3307 and 3310 of Figure 33 to the same signal line in order to control these transistors to turn on and off together. As the Board observed in its institution decision, Petitioner does not explain how the pixel circuit of Figure 33 would operate under this proposed modification. DI at 51–52. That is because Petitioner’s proposed modifications would, in fact, render the circuit inoperable. Indeed, Petitioner’s expert, Dr. Foty, conceded in deposition that turning on transistor 3307 at the same time as transistor 3310 during the operation shown in Figure 33B “would make no sense” and “would

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be a bad idea,” as it may cause “too much current through the electroluminescent element and damage it.” Ex. 2050 at 76:12–77:5. A POSITA would have had no reason to make such a modification. For this reason alone, Petitioner’s challenge as to claims 1–6 and 13–18 necessarily fails.

Given the crucial flaws in the Petition’s theories, including those noted above, it is unsurprising that Petitioner attempted to pivot to new theories. The Board properly denied Petitioner’s attempt, recognizing that Petitioner’s motion for “supplemental information” sought to materially alter the ground presented in the Petition, including as to each of Petitioner’s three proposed sets of modifications to Kimura. *See, e.g.*, Paper 27 at 10–11 (“All of the opinions in the proposed supplemental declaration of Dr. Foty with regard to additional modifications including adding another transistor, are new and not in any way addressed or referred to in the Petition or Dr. Foty’s first declaration.”); *id.* at 14 (“This change is significant, and substantially alters, if not completely eliminates, Petitioner’s initial reasoning to use transistor 1607 in Kimura’s Figures 16 and 17.”); *id.* at 10 (“Neither the Petition nor the first declaration of Dr. Foty proposed any modification of the Kimura’s Figure 33 embodiment, in connection with the shared light emitting signal feature of claim 13, beyond simply applying the same light emitting-signal to the gates of transistors 4 and 5.”). If anything, the technical flaws underlying the

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Petition's theories and Foty declaration highlight the challenges of the technology and the non-obviousness of the claimed inventions.

Additionally, robust evidence of objective indicia confirms the non-obviousness of the '599 Patent's claims and further undercuts Petitioner's theories. Before the '599 Patent's inventions, many companies and academic research groups had attempted to develop suitable pixel circuits to drive active matrix OLED displays, but without success. There were profound challenges in devising a pixel circuit for an AMOLED display providing uniform light output, adequate aperture ratio, and suitability for mass manufacture despite the differences in threshold voltages among thin-film transistors. The inventions of the '599 Patent were the first to solve these problems, satisfying a long-felt but previously unmet need in the industry. The importance of the inventions has been widely recognized. The inventors have been praised, including receiving awards from the Society of Information Display and from the President of Korea. Pixel circuits embodying the inventions have been adopted across flagship products using AMOLED displays, including all Samsung Galaxy smartphones and iPhones containing AMOLED displays. The pixel circuits embodying the inventions have also been widely copied, including by other display manufacturers that tried but failed to develop their own pixel circuits for AMOLED displays. These real-world facts further support the non-obviousness of the challenged claims.

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The Board should find that Petitioner has not shown any challenged claim of the '599 Patent to be unpatentable.

II. Claim Construction

On September 11, 2023, the Administrative Law Judge in related ITC Investigation No. 337-TA-1351 issued a claim construction order construing certain claim terms of the '599 Patent. Ex. 2005 at 13–15, 37–48. For purposes of this proceeding, Patent Owner does not believe any specialized constructions are necessary. Petitioner fails to show obviousness under any claim interpretation.

III. Level of Ordinary Skill in the Art

Patent Owner proposes that a POSITA with regard to the '599 Patent would have had a relevant technical degree in Electrical Engineering, Computer Engineering, Materials Science, Physics, or the like, and experience in active matrix display design and electroluminescence. *See* Ex. 2008, ¶¶45–49.

Petitioner has proposed a POSITA would have had “a Bachelor’s degree in electrical engineering or similar discipline, along with 2–3 years of circuit design/analysis experience,” and that “[l]ack of work experience can be remedied by additional education, and vice versa.” Petition at 13. For purposes of the preliminary response only, Patent Owner did not challenge Petitioner’s proposal, and the Board preliminarily adopted Petitioner’s proposed definition. DI at 12.

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However, Petitioner’s definition is incorrect, as it entails only general “circuit design” experience with no experience in active matrix display design and electroluminescence, the subject matter of the ’599 Patent. The ’599 Patent is directed to AMOLED displays and solving problems specific to those displays, including image quality and aperture ratio. Ex. 2008, ¶46. Important aspects and considerations of the pixel circuit design are unique to the context of active matrix display design and to electroluminescent displays. *Id.* For example, the operation of the driving transistor in the pixel circuit and the importance of compensating for deviations in threshold voltage to provide uniform light output across pixels are specialized to AMOLED displays.

Petitioner’s definition does not accurately reflect the experience of those working in the field of the ’599 Patent. Ex. 2008, ¶¶47–49. Indeed, Petitioner’s misreading of the art appears to result from a lack of appreciation of active matrix display-related technology. For example, Kimura’s disclosures relating to “erasure” are specific to the display context, and describe how to “cut off” current from flowing to the OLED, to thereby cause the pixel to not emit light. *See, e.g.*, Kimura at ¶405 (describing erasure in the context of a combined digital gray scale and time gray scale method). Petitioner’s misunderstanding of Kimura’s teachings relating to erasure and initialization, *see, e.g.*, DI at 47, underscores how a proper understanding

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of active matrix and electroluminescent displays is critical to understand the content of the prior art.

Because Petitioner’s definition fails to include any experience with active matrix display design and electroluminescence, it fails to reflect the background and knowledge of a POSITA. Ex. 2008, ¶47. Patent Owner notes that, in the related ITC Investigation, the Administrative Law Judge agreed with and adopted Patent Owner’s proposal. Ex. 2005 at 12–13 (explaining, among other things, the ’599 Patent is “directed to active matrix display technologies for organic light-emitting diode displays” and “[i]t is therefore reasonable to expect one of skill to have specific experience with active matrix display circuitry and electroluminescence”).

IV. Petitioner Has Not Established a *Prima Facie* Case of Obviousness Based on Kimura.

A. A POSITA Would Not Have Been Motivated to Change Kimura Figure 33 to an “All-PMOS” Circuit (All Challenged Claims).

For its challenges to all claims, Petitioner relies on a theory that a “baseline” pixel circuit of Figure 33 of Kimura, a CMOS circuit, would be changed so as to convert it into an “all-PMOS” circuit. Pet. at 22.¹

¹ In the institution decision, the Board “disagree[d]” that “the all-pMOS modification is required in all of Petitioner’s theories of obviousness for all challenged claims,” stating that “[n]one of the independent claims includes any

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In the institution decision, the Board properly cast doubt on the only particularized reason Petitioner asserted to make such modifications. DI at 31–32. The Board preliminarily accepted, however, for purposes of institution, Petitioner’s contention that there is “general interchangeability of nMOS and pMOS transistors used as switching transistors.” *Id.* at 23. Kimura does not characterize all of the transistors Petitioner would change as switching transistors, and the evidence—including the explanations of Dr. Wolfe, and admissions of Dr. Foty—now demonstrates that a theory of “general interchangeability” is inappropriate to the pixel circuits at issue. Important differences in characteristics between NMOS and PMOS TFTs would be expected to affect the design and operation of AMOLED pixel circuits. Moreover, even if there were interchangeability for certain transistors,

limitation with regard to whether one or more recited transistors must be nMOS or pMOS.” DI at 19. Patent Owner respectfully submits that this overlooks the Petition’s unqualified statement that “Petitioner uses the modified ‘All-PMOS’ version of Fig. 33 *for the patentability analysis.*” Pet. at 22. Additionally, the Petition admits that independent claims 15 and 17 require that “all transistors ... must be PMOS based on the recited source/drain/gate connections,” Pet. at 72, 80, and that “[e]ven though claim 7 is not limited to PMOS devices, Kimura’s all-PMOS embodiment was used for consistency.” Pet. at 72.

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a theory of “general interchangeability” cannot substitute for a reason to make the modifications required to change Figure 33 from CMOS to Petitioner’s all-PMOS redesign, nor the wholesale changes to Kimura’s circuitry required for Petitioner’s proposal.

1. Petitioner’s “general interchangeability” theory does not provide rationale or motivation for its proposed modifications.

Initially, Kimura does not state that NMOS and PMOS transistors may be interchanged for all the transistors in Figure 33 (the “baseline circuit for Petitioner’s patentability analysis” (Pet. at 15)). Nor does Kimura provide any reason for doing so; on the contrary, Kimura designed this circuits as CMOS. Kimura’s discussion of switching between NMOS and PMOS transistors pertains to identified transistors in particular embodiments, which Kimura states “function as simple switching devices.” *See, e.g.*, Kimura at ¶0438; Ex. 2008, ¶60. Kimura specifies, in its embodiments, which transistors can have their polarity changed.

Yet even assuming *arguendo* that the discussion in Kimura ¶0438 applies “generally for all ‘switching transistors’ and transcends any particular embodiment,” as the Board preliminarily accepted, DI at 24, a theory of “general interchangeability” cannot support Petitioner’s “all-PMOS” redesign of Figure 33.

As a matter of law, while the obviousness analysis is “flexible,” there must still be “reasons to combine or modify the prior art,” as well as “articulated reasoning

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and evidentiary support,” as the PTO’s recent guidance makes clear. Updated Guidance for Making a Proper Determination of Obviousness, 89 Fed. Reg. 14449–453, 451–452 (Feb. 27, 2024). Petitioner has provided neither. A POSITA would have had no reason to take the CMOS circuit of Kimura’s Figure 33 and make numerous modifications that would be required to redesign it as an “all PMOS” circuit.

The Federal Circuit has specifically rejected obviousness arguments where, as here, the expert’s “testimony primarily consisted of conclusory references to her belief that one of ordinary skill *could* combine the references, not that they *would* have been motivated to do so.” *InTouch Technologies, Inc. v. VGO Communications, Inc.*, 751 F.3d 1327, 1352 (Fed. Cir. 2014). The court has likewise overturned an obviousness determination where “the Board focused on what a skilled artisan would have been *able* to do, rather than what a skilled artisan would have been *motivated* to do at the time of the invention.” *Polaris Industries, Inc. v. Arctic Cat, Inc.*, 882 F.3d 1056, 1068–69 (Fed. Cir. 2018).

Petitioner’s theory fails under these principles. Lacking any credible motivation for a POSITA to make the required changes to Kimura’s Figure 33, Petitioner attempts to rely on a theory of “a simple and obvious design choice.” Pet. at 21. However, a “design choice” theory cannot support Petitioner’s “all-PMOS” redesign.

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First, “a finding of obviousness based on design choice is precluded where the difference between the claimed feature and prior art results in a functional difference.” *Lumenis Be Ltd. v. BTL Healthcare Technologies A.S.*, IPR2021-01275, Paper 8 at 30 (Feb. 8, 2022) (citing *In re Gal*, 980 F.2d 717, 719 (Fed. Cir. 1992)); *Unified Patents Inc. v. Velos Media, LLC*, IPR2019-00749, Paper 7, at 11–12 (Oct. 15, 2019) (same). A POSITA would have understood there were material differences between NMOS transistors and PMOS transistors relevant to, and that would affect the design and operation of, a pixel circuit for an AMOLED display. Ex. 2008, ¶¶63–68. Kimura discloses pixel circuits comprised of polysilicon thin-film transistors. *See, e.g.*, Kimura at ¶357; Ex. 2008, ¶63. In polysilicon TFTs, it was known that NMOS transistors were less susceptible to leakage current relative to PMOS transistors. Ex. 2008, ¶63; *see, e.g.*, Ex. 2049, Study of Leakage Current in n-channel and p-channel Polycrystalline Silicon Thin-film Transistors by Conduction and Low Frequency Noise Measurements, C.T. Angelis, et al., J. Appl. Phys. 82, 4095–4101 (1997) (“The substantially lower leakage current observed in the n-channel polysilicon TFT is explained by the development of positive fixed charges at the interfaces near the drain junction which suppress the electric field.”); Ex. 2050 (Foty Tr.) at 98:14–20. NMOS TFTs were further known to have higher mobility, and therefore to be faster, than PMOS TFTs. Ex. 2008, ¶64; Ex. 2050 at 92:20–93:20 (acknowledging a roughly 2:1 higher electron mobility in NMOS transistors). And at this time a

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POSITA would have understood that NMOS TFTs had the advantage of being smaller than comparable PMOS TFTs. Ex. 2008, ¶65; Ex. 2050 at 93:21–94:18. These and other differences (which the Petition wholly ignored) preclude any theory of “a simple and obvious design choice.”

For example, the difference in leakage current may present significant operational issues if transistor 3309 in Figure 33 were modified to be PMOS (i.e., the transistor in Kimura that Petitioner claims corresponds to the “third” transistor of the ’599 Patent). As Dr. Wolfe explains, the “third” transistor controls charge flow to the capacitor that holds the programmed data for the pixel to maintain the intended brightness level. Ex. 2008, ¶70. Kimura discloses that this transistor is NMOS. Kimura Fig. 33A. Nowhere does Kimura suggest that this transistor (or a transistor arranged in this way) may be modified from NMOS to PMOS. Ex. 2008, ¶70. On the contrary, the potential for greater leakage current in a PMOS transistor would be particularly significant for this “third” transistor, as any leakage could alter the stored brightness level, where Kimura was attempting to ensure emission at an intended brightness level. *Id.*

In addition, the faster speed of NMOS transistors would need to be taken into account with respect to the circuit’s timing. Their difference in size would also influence the overall size (i.e., area) of the circuit, an important issue in display design. As Dr. Foty acknowledged, a reduction in circuit area allows for a larger



aperture ratio. Ex. 2050 at 39:6–18; Ex. 2008, ¶65. A POSITA would have had no motivation to make unnecessary circuit modifications that would increase the circuit area, thus lowering the display’s aperture ratio.

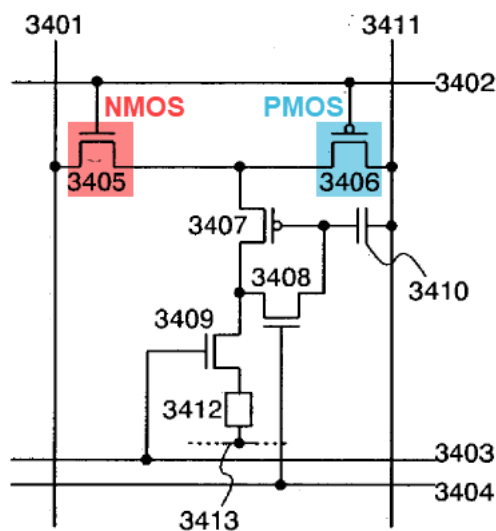
Petitioner all but ignores these considerations. It merely asserts in a footnote, without explanation, that “[o]f course, an all-PMOS implementation requires active-low signaling, but that was well-known to a POSITA and would have been trivial to implement.” Pet. at 21, n.5. As Dr. Wolfe explains, a POSITA would have considered relevant differences between PMOS and NMOS transistors, and the benefits of having both in a circuit, and would not have been motivated to make the significant modifications to Kimura’s Figure 33 on which Petitioner’s theory depends. Ex. 2008, ¶61.

Notably, while Kimura is explicit about polarity of transistors, Petitioner only cites one PMOS teaching in Kimura that relates to the circuit of Figure 33, arguing that “Kimura expressly discloses replacing the **first or fourth transistor** in Fig. 33 with PMOS.” Pet. at 20–21 (citing Kimura at ¶659 and Fig. 34A) (emphasis in original). But even this disclosure refutes Petitioner’s “all PMOS” theory and highlights that the selection of an NMOS or PMOS transistor in relation to the other transistors is no simple “design choice.” Kimura teaches that one of these transistors can be PMOS *provided that the other is NMOS* and that the *combination of two different polarities* allows a gate signal line to be removed:

[T]he TFT 3306 and the TFT 3307 are controlled so as to turn on and off at mutually opposite timings, and therefore the polarity of one of the TFTs may be made opposite to the polarity of the other TFT, and both of the TFTs can thus be controlled by the same gate signal line 3402, as shown in FIG. 34A.

Kimura at ¶659. Crucially, it is a *combination* of NMOS and PMOS for TFTs 3306 and 3307 in Figure 33 (the alleged “first” and “fourth” transistors) that allows a single gate signal line to control them. Ex. 2008, ¶71. This is illustrated in Figure 34A, where NMOS TFT 3405 and PMOS TFT 3406 are controlled by a single gate line, 3402:

Fig.34A



Kimura Fig. 34A
(annotated)

If anything, this disclosure demonstrates that a POSITA would *not* be motivated to make *both* of those transistors—much less all of the transistors—

[REDACTED]

PMOS, because doing so would sacrifice the ability to reduce the number of gate signal lines. As Petitioner points out, “Kimura itself [teaches that] reducing the number of control lines improves aperture ratio.” Pet. at 65 (citing Kimura at ¶¶429, 421–422). Further, by controlling both transistors with a single signal line, Kimura would reduce power consumption, an advantage Petitioner’s changes would sacrifice. Ex. 2008, ¶66. Accordingly, a POSITA would not be motivated to replace both the first and fourth transistors with PMOS transistors, and Kimura would if anything discourage the POSITA from doing so. *See, e.g., Polaris Indus. v. Arctic Cat Inc.*, 882 F.3d 1056, 1069 (Fed. Cir. 2018) (“[E]ven if a reference is not found to teach away, its statements regarding preferences are relevant to a finding regarding whether a skilled artisan would be motivated to combine that reference with another reference.”); *Apple Inc. v. Samsung Elecs. Co.*, 839 F.3d 1034, 1051 n.15 (Fed. Cir. 2016) (en banc).

Thus, relevant structural and operational differences between NMOS and PMOS transistors in the pixel circuits at issue preclude reliance on a “simple design choice” theory. *See, e.g., In re Gal*, 980 F.2d 717, 719–20 (Fed. Cir. 1992) (reversing Board finding of “obvious design choice” where the claimed structure and the function it performs are different from the prior art).

Second, Petitioner’s proposed modification does not involve a simple “design choice” between two, or even a small number of, options. It is not limited to the

[REDACTED]

polarity of a particular transistor, but instead requires extensive modifications to Kimura’s disclosed embodiments and abandoning the CMOS design. Ex. 2008, ¶¶61–73. Petitioner disregards the host of other changes that would be necessary to drive circuitry, signaling, and the pixel circuit’s timing. *See, e.g., Philip Morris Products S.A. v. International Trade Commission*, 63 F.4th 1328, 1346–48 (Fed. Cir. 2023) (affirming non-obviousness where challenger failed to demonstrate the claimed invention was one of only three design choices, and the modification entailed a “multitude of design considerations”).

Moreover, Petitioner’s theory does not involve a choice between two alleged alternatives (NMOS versus PMOS) for one switching transistor, but many possibilities.² Petitioner’s theory would require taking a CMOS circuit and changing each of the four distinct NMOS transistors in the circuit (or five where Petitioner seeks to further add an “initialization” transistor) to PMOS transistors. If one were choosing polarities without regard for function (as Petitioner proposes), there would be a minimum of sixteen distinct permutations for this set of four transistors in Kimura’s Figure 33 (and thirty-two permutations for the set of five)—and that does

² *Cf. Uber Technologies, Inc. v. X One, Inc.*, 957 F.3d 1334, 1340 (Fed. Cir. 2020) (proposed combination implementing one of *only two* available, predictable solutions presented a “simple design choice”).

[REDACTED]

not include the driving transistor. Since the driving transistor's polarity could also be changed, there would be double the number of options.³ The number of options belies a simple “design choice” theory. *See, e.g., Manufacturing Resources Int’l, Inc. v. Samsung Elecs. Co.*, IPR2023-01202, Paper 10 at 22 (Feb. 8, 2022) (design choice rationale inapplicable where variety of possible options available). And Kimura does not teach any embodiment of its invention that includes an all-PMOS design. Ex. 2008, ¶58.

Third, Petitioner's theory disregards that Kimura's Figure 33 embodiment is specifically designed as a CMOS circuit, not a circuit having only one polarity of transistor. Petitioner's theory is not a mere matter of changing a particular transistor from NMOS to PMOS, but eliminating the CMOS design of the circuit entirely. As discussed, Kimura teaches specific advantages of its CMOS configuration. And as Dr. Foty admitted in deposition, there were known, significant benefits of using CMOS. Ex. 2050 at 94:19–95:14 (“The reason we use CMOS is it is so advantageous as a circuit technology that it is worth paying the price literally and figuratively”). A

³ A POSITA inclined to modify the transistors could also change the *type* of thin-film transistor and would have numerous options. *E.g.*, Ex. 2050 (Foty Tr.) at 47:20–50:9 (stating transistors of amorphous silicon, organic materials, gallium arsenide, or indium phosphide could be used).

[REDACTED]

POSITA would not have discarded these advantages, and would not have been motivated to do so. Ex. 2008, ¶¶72–78. Certainly, this would not have been a mere “design choice.”

Therefore, Petitioner may not rely on a theory of a purportedly “simple and obvious design choice,” and the extensive modifications required for its proposed redesign would be no such thing. Petitioner’s theory of an “all PMOS” redesign of Figure 33 must fail because Petitioner can muster no credible explanation for why a POSITA would choose the specific permutation of polarities that Petitioner selected to arrive at the claims.

2. Petitioner’s only purported reasons for a POSITA to attempt an “all-PMOS” configuration fail.

As the Board observed in its institution decision, the single paragraph in the Petition relating to purported manufacturing benefits stemming from using a single species of transistor is “incomplete,” and “Petitioner has not asserted, much less explained, the interchangeability of a CMOS pair of nMOS and pMOS transistors with either two nMOS transistors or two pMOS transistors.” ID at 31. Petitioner then attempted to materially change its flawed theory under the guise of supplemental information, which the Board rejected. Paper 27 at 15–16 (“Patent Owner correctly notes that Dr. Foty’s proposed supplemental declaration does not answer our questions, and that Petitioner ‘does not even attempt to explain how [Dr. Foty’s] new opinions are relevant to the Board’s questions, which they are not.’”).



The Petition argues that “it would have been ‘advantageous’ to ‘manufactur[e] all TFTs [] of the same type,’” citing only a passing statement in a reference unrelated to Kimura. Pet. at 21 (quoting Ex. 1004 at 12:30–49); *see also id.* at 53 (advancing similar argument for the “sixth” initialization transistor appearing in certain claims). This argument fails for a number of reasons.

First, Petitioner’s logic is circular. For the sixth transistor, e.g., it argues: “*Given that all other transistors in the All-PMOS implementation are PMOS devices, a POSITA would have been motivated to implement the initialization transistor as a PMOS device.*” Pet. at 53 (emphasis added). This assumes a contrived scenario in which a POSITA is only permitted to consider an alleged “manufacturing advantage” of an all-PMOS design *after* having already changed all of the other NMOS transistors in Figure 33 to PMOS transistors (for no reason). If anything, Petitioner’s logic would suggest converting Figure 33 into an “all-NMOS” circuit, as Figure 33 has four-NMOS transistors versus just one PMOS transistor. Ex. 2008, ¶73.

Second, Petitioner’s theory of an alleged manufacturing benefit to an all-PMOS circuit has no support. Indeed, it is inconsistent with Kimura’s disclosures. Kimura is directed to active matrix devices formed using CMOS technology—i.e., circuitry that by its definition requires *both* PMOS and NMOS transistors. *See, e.g.*, Ex. 1011 at 5; Kimura at ¶¶547, 582. As Dr. Wolfe explains, a POSITA would not look to a reference teaching an improved CMOS process, like Kimura, only to

[REDACTED]

abandon its CMOS design and teachings and implement a single-species modification. Ex. 2008, ¶76.

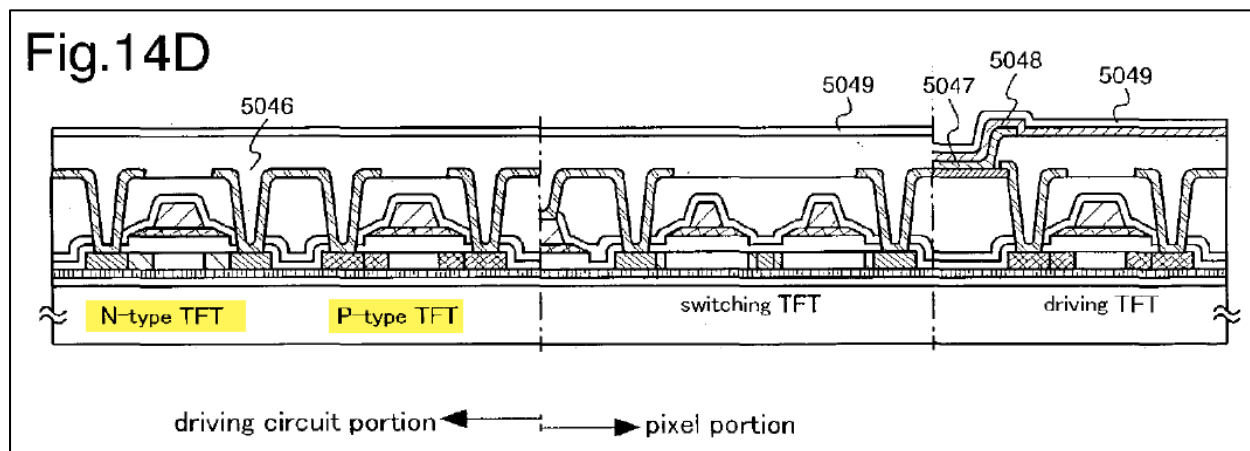
Kimura includes extensive disclosures of using CMOS circuits, including detailed and specific manufacturing instructions to form pixel circuits and driver circuits that are both CMOS. Indeed, as noted above, Kimura expressly teaches that its process is directed to optimizing CMOS manufacturing. Kimura’s opening paragraph states that it is directed to “*active matrix* light emitting device[s],” Kimura at ¶1 (emphasis added), and Kimura explains that its “active matrix” devices necessarily include CMOS circuitry:

In this specification, a substrate in which [i] a driver circuit ***including a CMOS circuit*** and [ii] a pixel part having a switching TFT and a drive TFT are formed on the same substrate ***is called an active matrix*** substrate as a matter of convenience.

Kimura at ¶502 (emphasis added).⁴ Accordingly, Kimura teaches that its disclosed pixel circuits (the “pixel part”)—including the embodiments relied upon by Petitioner—are used alongside CMOS driver circuits (e.g., for driving the signal line

⁴ Petitioner itself emphasizes Kimura’s teaching that the baseline pixel circuit of Figure 33 is part of “an ‘***active matrix***’” substrate. Pet. at 81 (emphasis in original) (citing Kimura at ¶¶1, 476).

voltages), as part of the same substrate. Ex. 2008, ¶¶74–78. This can be seen in Figure 14D:



Kimura Fig. 14D (annotated)

Because the CMOS driver circuit and pixel circuits are formed together on the same active matrix substrate, the pixel circuits are (like the driver circuit) formed in a process that involves making both NMOS and PMOS transistors. Ex. 2008, ¶¶74–78. Indeed, Kimura includes detailed process steps for manufacturing its active matrix substrate consisting of both the driver circuit and pixel circuit, which results in the creation of both NMOS and PMOS TFTs. Kimura at ¶¶502–615, Figs. 13–15. Kimura explains that, by following its disclosed processing steps, “as shown in Fig. 14D, the driver circuit portion including the *CMOS circuit composed of the N-channel TFT and the P-channel TFT* and the pixel part including the switching TFT and the drive TFT can be formed on the same substrate.” *Id.* at ¶547; *see id.* at ¶582. Even more, Kimura teaches that following its disclosed CMOS processing steps

[REDACTED]

entails a manufacturing advantage—“the process is shortened and it can contribute to the reduction in manufacturing cost and the improvement of a yield.” *Id.* at ¶571.

Petitioner ignores that the “active matrix substrate” of Kimura, including the driver circuitry, is CMOS. Petitioner’s theory of a purported manufacturing benefit is based wholly on citation to a passing statement in an unrelated reference, Exhibit 1004. This reference is inapplicable to Kimura. Ex. 2008, ¶77. Petitioner does not even explain how it would be applicable to Kimura. Petitioner simply calls this unrelated reference “Kimura ’798,” but there is no relation between it and the Kimura reference on which Petitioner primarily relies. Petitioner fails to mention that this “Kimura” of Exhibit 1004 is by a different inventor (Matsumi Kimura) at a different company than the “Kimura” of Exhibit 1002 (Hajime Kimura). Ex. 2050 at 27:16–28:21 Nothing in the Kimura reference that underlies the Petition’s obviousness ground (Exhibit 1002) teaches or suggests that there would be benefits in modifying its circuits to use “all TFTs [] of the same type.” In fact, none of the pixel circuits in Kimura use an all-PMOS configuration (setting aside Figures 22–23, which depict the prior art).

Moreover, the circuits in Exhibit 1004 are unrelated to those of Kimura. Exhibit 1004 merely mentions briefly “advantageousness in manufacturing” for its own circuits, not for all circuits. Exhibit 1004 does not discuss any advantages that

[REDACTED]

would allegedly apply to the different circuits of Kimura, nor does Petitioner identify any such disclosure.

Thus, even assuming there could be any “advantage[] in manufacturing when all TFTs are of the same type” in designs like those of the unrelated reference of Exhibit 1004 (Ex. 1004 at 12:30–49), any such advantage would not apply to Kimura’s Figure 33. Ex. 2008, ¶77. Kimura’s active matrix substrates include both NMOS and PMOS transistors in the driver portion, and thus even an all-PMOS redesign of Figure 33 (which is solely the pixel portion of the substrate) would not result in a substrate containing “all TFTs ... of the same type” (Ex. 1004 at 12:30–49).

3. A POSITA would have had no reason to modify Kimura Figure 33 in ways that would not solve its disclosed problem of unwanted light emission.

Although Petitioner relies on Figure 33 of Kimura as the “baseline circuit for Petitioner’s patentability analysis” (Pet. At 15), Petitioner provides no reason why a POSITA would choose to start with this design without making changes to solve its fundamental flaw: that this design would lead to light output at undesired times and thus undermine the goal of the pixel circuit. Kimura itself notes this flaw in the Figure 33 pixel circuit and even attempts to correct it in different embodiments. *See* Kimura at ¶¶665–666. Petitioner’s expert, Dr. Foty, noted this flaw in the Figure 33 embodiment, Ex. 1003 at ¶155, yet Petitioner’s proposed “all PMOS” pixel circuit

[REDACTED]

would not address it. A POSITA would have had no motivation to make modifications that would result in an indisputably flawed pixel circuit design.

The only plausible explanation for Petitioner’s theory is Dr. Foty’s admission that his analysis of Kimura involved starting with the claims of the ’599 Patent and then looking backwards through Kimura. *See, e.g.*, Ex. 2050 34:2–34:16 (“Q. And so you were starting with the claimed circuit of the ’599 patent and then looking for which of the embodiments of Kimura you thought most closely resembled that?...A. That would be a relatively fair assessment.”). Dr. Foty conceded he did not even consider the majority of Kimura’s embodiments in forming his opinions. *Id.* at 110:14–111:2 (“Q. Is it fair to say if an embodiment didn’t appear in your declaration, it was one of the ones you didn’t consider?...A. I believe that’s a relatively fair assessment.”).

B. Kimura Does Not Teach or Suggest the Claimed “Initialization Transistor” (Claims 2, 8, 16, 18).

Dependent claims 2, 8, 16, and 18 of the ’599 Patent require that the pixel circuit contain, among its other elements, a specific initialization transistor that discharges the data signal voltage stored in the capacitor in response to a scan signal (scan[n-1]) just before the current scan signal (scan[n]).⁵ *See* Ex. 2008, ¶79.

⁵ This is the “fourth” transistor in claim 2 and “sixth” transistor in claims 8, 16 and 18.

[REDACTED]

Petitioner's arguments regarding the claimed "initialization transistor" are fundamentally flawed, including in that they rest on the erroneous premise that Kimura's "erasure" means the same thing as "initialization," when in fact Kimura discloses those as separate and distinct operations. *See* DI at 49. Petitioner's failed attempt to change theories after this was pointed out, through its denied motion for "supplemental information," only underscores that the ground presented in the Petition lacks merit.

As Petitioner recognizes, the five-transistor pixel circuit of Kimura's Figure 33 (and the all-PMOS modification Petitioner posits) does not disclose or suggest the claimed initialization transistor. To challenge claims 2, 8, 16, and 18, Petitioner advances a different and contrived set of additional modifications to the circuit of Figure 33 that a POSITA would have had no reason to make. Petitioner's proposal requires taking an NMOS "initialization transistor" that Petitioner purports to find in the unrelated embodiment of Figures 16–17 (and taking nothing else from that embodiment, which has a significantly different structure than Figure 33), replacing that NMOS transistor with a PMOS transistor, and placing it in a different location with different connections in the theoretical all-PMOS version of Figure 33. *Ex. 2008*, ¶80. Indeed, Dr. Foty admitted in deposition that these modifications would require at least one additional signal line be added to the pixel circuit. *Ex. 2050* at 117:21–118:14. As Dr. Wolfe explains, a POSITA would not have had any reason

[REDACTED]

to make these changes, and Petitioner’s proposed modifications are inconsistent with Kimura’s teachings regarding the Figure 16–17 embodiment. Ex. 2008, ¶¶85–96.

1. Petitioner’s rationale for adding an “initialization transistor” to Kimura Figure 33 hinges on its misunderstanding of “erasure.”

As the Board noted, the Petition’s theory for the “initialization transistor” claims is premised on a fundamental technical flaw, stemming from Petitioner’s error in portraying “erasure” in Kimura as being synonymous with “initialization.” *See* ID at 47–48 (“The record evidence does not support Petitioner’s assertion that the fifth transistor, when used as an erasure transistor, resets the capacitor voltage to a default initialization value.”). In Kimura, “erasure” means “forcibly plac[ing] [the EL device] in a non-light-emitting state.” Kimura at ¶410. And an “erasure TFT” is a transistor that permits “electric current supplied to the EL device [to] be cut off at an arbitrary timing.” Kimura at ¶658. Kimura does not use “erasure” to refer to “reset[ting] the capacitor voltage to a default initialization value” (i.e., initialization) as Petitioner mistakenly asserts. Pet. at 18; Ex. 2008, ¶84.

Petitioner’s flawed reading of “erasure” in Kimura is the basis for its proposal to combine Figures 16–17 with Figure 33. First, it leads Petitioner to inaccurately assert that Figure 36 (for which Kimura discusses “erasure” but does not discuss any “initialization”) reflects the addition of an “initialization transistor” to Figure 33. Pet. at 19. This, in turn, is the rationale for Petitioner’s assertion that a POSITA might



seek to use the “initialization transistor” of Figures 16–17 as an alternative. *See id.* at 19, 51. Finally, Petitioner’s flawed reading of “erasure” is the sole premise for Petitioner’s faulty reasoning that Kimura’s discussion of an *erasure transistor* in connection with Figure 33 would make the *initialization* approach of Figures 16–17 “readily applicable to the baseline circuit of Fig. 33.” *Id.* at 52–53. Ex. 2008, ¶¶81–96. Petitioner’s flawed reading is unsurprising given its expert’s admission that he had not considered Kimura’s embodiment of Figure 21, which introduces the concept of “erasure” and makes clear it is wholly different than “initialization.” Ex. 2050 at 86:6–11 (“Q. I want to turn to Figure 21 of Kimura...A. I have that on my paper. I will just note as preface obviously this was not an embodiment I considered in my analysis.”).

Beginning with Figure 36, Petitioner asserts that this embodiment includes “a dedicated initialization transistor (labelled sixth transistor) ... where, during initialization, the capacitor discharges through the sixth transistor instead of the light emitting element.” Pet. at 19. Contrary to Petitioner’s assertion, Kimura does not identify any “initialization transistor” (or an initialization phase) with respect to the Figure 36 embodiment. Ex. 2008, ¶¶91–92. Nothing in Kimura discloses or suggests an initialization transistor for this pixel circuit.



Petitioner points to TFT 3612 as the purported “initialization transistor” of Figure 36. *See* Pet. at 19.⁶ Nothing in Kimura teaches or suggests that this transistor is used for initialization. On the contrary, Kimura describes TFT 3612 as preventing unwanted light emission, consistent with the purpose of this embodiment:

A TFT 3612 is therefore added as shown in FIG. 36A. *Electric current* flowing in the TFT 3609 during input of the image signal *flows through the TFT 3612 and to an electric power source line 3617*. An electric current path to the EL device 3615 is cut off by a TFT 3611, and therefore the EL device 3615 does not emit light. *Light emission* by the EL device during unnecessary periods *can thus be prevented by using this type of structure*.

Kimura at ¶666 (emphases added). Moreover, Kimura describes TFT 3612 as preventing unwanted light emission “during input of the image signal”—i.e., during the programming phase. Kimura does not characterize this transistor, or any other transistor found in Figure 36, as relating to an “initialization” phase or operation. Ex. 2008, ¶¶91–92.

⁶ On page 19, the Petition includes an annotated version of Figure 36B in which Petitioner (incorrectly) labels the transistor on the lower left as a “dedicated initialization transistor (labelled sixth transistor).” This is TFT 3612 as shown in Figure 36A.



Yet it is on the mistaken premise that Figure 36 adds an “initialization transistor” to Figure 33 (when in fact the Figure 36 circuit has no initialization transistor) in order to address the issue of unwanted light emission, that Petitioner proposes combining Figure 33 with a different “initialization transistor”—that of Figures 16–17. *See* Pet. at 51. Not only is Petitioner’s premise wrong, but when Kimura is read correctly, it is clear that the circuit of Figures 16–17 is not even directed to the same problem as Figure 36 (i.e., unwanted light emission). Ex. 2008, ¶¶95. Figures 16–17 present wholly different and unrelated pixel circuits. For these circuits, Kimura does not express any potential issue of, or need to prevent, unwanted light emission during programming (*see* Kimura at ¶¶420–430). Ex. 2008, ¶¶95.

Contrary to Petitioner’s suggestion, the initialization approach of Figures 16–17 is not “readily applicable” to the circuit of Figure 33 (let alone Petitioner’s theorized all-PMOS modification thereof). Pet. at 52. Once again, Petitioner’s theory is premised on the erroneous assumption that “erasure TFT” means the same thing “initialization TFT,” as is illustrated in the following passage from the Petition:

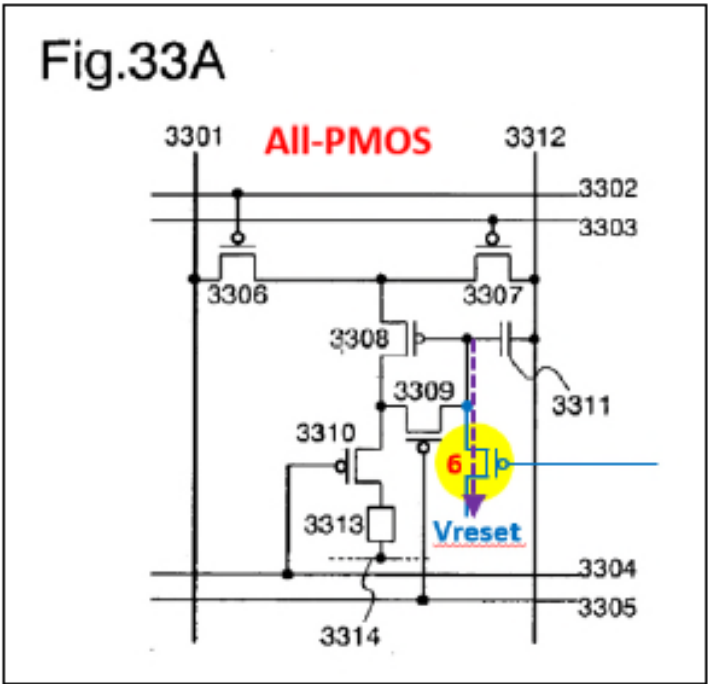
Such an approach is readily applicable to the baseline circuit of Fig. 33.... Indeed, when discussing Fig. 33, *Kimura expressly teaches that “the erasure [transistor] can be placed in any location*, provided that it is a location at which electric current supplied to the EL device can be cut off at an arbitrary timing.” EX1002, [0658]. *Thus, a POSITA*



would have been motivated to place the initialization transistor discussed in Figs. 16-17 in the same location (*i.e.*, directly connected to the capacitor) in Fig. 33.

Pet. at 52–53 (emphasis added). Petitioner assumes an “initialization transistor” (as in Figures 16–17) can be placed in any location suitable for an “erasure transistor” (as in Figure 33), when in fact they perform different functions. Ex. 2008, ¶82.

Additionally, as the passage of Kimura Petitioner cites above makes clear, Kimura’s “erasure” transistor must be placed where it can “cut off” the “electric current supplied to the EL device.” Kimura at ¶658. Yet Petitioner proposes adding an “initialization” transistor in a location that would *not* allow it to cut off current flow to the EL device. Ex. 2008, ¶86. As shown below, Petitioner and Dr. Foty propose to add the “initialization” transistor to a location in the pixel circuit that is *not* along the current path to the EL device 3313. *Id.*



But as Dr. Foty admitted in deposition, when Kimura describes “cut[ting] off” current flow, it means preventing current from flowing to the EL element. Ex. 2050 at 112:11–113:7. He further admitted that the additional transistor he proposes adding would not “cut off” current flow to the EL element. Ex. 2050 at 120:1–15 (Q... “[T]here’s no current path through Transistor 6 that also leads through the EL element. Right? A. Yes. That’s the point of the modification, to have that capacitor be drained without having it go through the electroluminescent element.”); *see also* Ex. 2008, ¶¶86–87. Thus, Petitioner’s proposed modification is inconsistent with even the disclosure of Kimura on which Petitioner purports to rely.

Petitioner’s theory suffers from still further problems. As Dr. Foty admitted, the Petition’s proposed modification would also require adding at least one

[REDACTED]

additional signal line connected to the drain of the added Transistor 6 to allow charge to be “evacuated” through the transistor. Ex. 2050 at 116:20–118:17, 136:9–138:3. Petitioner fails to explain why a POSITA would have made these modifications that require adding at least one additional signal line, particularly when a POSITA would want to reduce the number of signal lines. Ex. 2008, ¶¶88–90.

Accordingly, Petitioner’s purported motivations for adding an “initialization transistor” to Figure 33, which are rooted in its misunderstanding of “erasure” and are suffused with further flaws, cannot withstand scrutiny. When Kimura is properly interpreted, a POSITA would have had no reason to make Petitioner’s contrived modifications.⁷

2. Petitioner fails to explain why a POSITA would disregard Kimura’s solution to the problem and make the series of changes Petitioner’s theory demands.

Petitioner’s theory for adding an “initialization transistor” to Kimura Figure 33 notes that the design of Figure 33 “is less desirable” because of “undesired light emission.” Pet. at 51. Kimura acknowledges this shortcoming in Paragraph 665:

⁷ Petitioner contends a POSITA “would have been motivated to implement the initialization transistor as a PMOS device,” “[g]iven that all other transistors in the All-PMOS implementation are PMOS devices.” Pet. at 53. This is wrong for the reasons discussed in Sections IV.A.1 and IV.A.2 above.



In the structures shown FIGS. 33 to 35, there are cases in which *electric current flows in the EL device to cause light emission*, before or after threshold voltage acquisition, that is *during a period that is not the normal light emitting period....* [T]his therefore causes errors to develop between the actual brightness and the target brightness.

Kimura at ¶665. However, Kimura provides its solution to this problem in the very next paragraph—namely, the circuit of Figure 36:

A TFT 3612 is therefore added as shown in FIG. 36A ... An electric current path to the EL device 3615 is cut off by a TFT 3611, and therefore the EL device 3615 does not emit light. Light emission by the EL device during unnecessary periods can thus be prevented by using this type of structure.

Kimura at ¶666 (emphasis added). Indeed, Petitioner elsewhere acknowledges that “Kimura solves this problem ... as shown in Fig. 36B.” Pet. at 19. Ex. 2008, ¶95.

But Figure 36 is a materially different circuit than claims 2, 8, 16, and 18 of the ’599 Patent and does not satisfy the claim requirements. As discussed, Kimura does not state or suggest that Figure 36 involves initialization, let alone that its TFT 3612 serves as an initialization transistor. Further, claims 2, 8, 16, 18 of the ’599 Patent require that the initialization transistor be controlled by “a scan signal just before the current [or associated] scan signal”—in other words, controlled by the



previous scan line,⁸ while in Kimura’s Figure 36 TFT 3612 is not controlled by the previous scan line. Petitioner does not contend otherwise. As shown above, TFT 3612 is controlled by line 3606, which Kimura does not teach or suggest is the previous scan signal line for the circuit. Thus, even if TFT 3612 *could* be viewed as an “initialization transistor” (which it cannot), Figure 36 still would not meet the claims. Ex. 2008, ¶¶91–96.

Rather than accept the non-obviousness of the claims, Petitioner theorizes that a POSITA seeking to overcome the undesired light emission of Figure 33 could (1) reject (for no stated reason) the solution actually taught by Kimura in Figure 36, (2) then scour the many varied embodiments within Kimura’s 85-page disclosure looking for ideas, (3) land upon the pixel circuit of Figures 16–17 even though it does not have the “undesired light emission” problem and Kimura does not connect it in any way to the circuits of Figures 33 and 36, (4) notice that this different circuit design contains TFT 1607, (5) take only that NMOS TFT and not the circuit’s other features, (6) replace it with a PMOS transistor, (7) implement and connect that TFT in a location and manner inconsistent with the circuit of Figures 16–17, and (8) add

⁸ See ’599 Patent at Fig. 3 (showing line “scan[n-1]” that controls the initialization transistor T34).

[REDACTED]

at least one additional signal line to accommodate the added transistor. Ex. 2008, ¶¶91–96.

This is dubious. A POSITA would have had no reason to take this tortured path necessary for Petitioner’s proposal. Why would an artisan even turn to Figures 16–17 to try find “[a]nother solution” to Figure 33, when Kimura already provides its solution in Figure 36? Petitioner offers no reason, and does not even attempt to argue that its alternative provides any benefit over Figure 36. Ex. 2008, ¶¶91–96. On the contrary, it would require adding another signal line, among other drawbacks.

Finally, Petitioner is wrong in asserting that Figures 16–17 represent “[a]nother solution taught by Kimura.” Pet. at 19, 51. Kimura never portrays Figures 16–17 as a solution to the light-emission problem of Figure 33. Kimura does not even discuss unwanted light emission in connection with Figures 16–17 or suggest it would be an issue with their circuit design. And nowhere does Kimura teach or suggest that the embodiment of Figures 16–17 should be combined with Figure 33, or vice-versa. They are portrayed as entirely separate embodiments. Petitioner offers no valid reason why a POSITA would have looked to the circuit of Figures 16–17 much less taken all the other steps that would be necessary to modify Figure 36 as it proposes. *See In re Kotzab*, 217 F.3d 1365, 1371 (Fed. Cir. 2000) (obviousness “cannot be predicated on the mere identification in [a prior art reference] of individual components of claimed limitations. Rather, particular findings must be

[REDACTED]

made as to the reason the skilled artisan, with no knowledge of the claimed invention, would have selected these components for combination in the manner claimed”). Ex. 2008, ¶¶91–96.

C. Kimura Does Not Teach or Suggest that the “Current Light-Emitting Signal’ Control the Fourth and Fifth Transistors (Claims 13–18) or Fifth and Sixth transistors (Claims 1–6).

A crucial feature of claims 1–6 and claims 13–18, which led to allowance of the claims, is that the current light-emitting signal is used to control the gates of both of two specified transistors in the pixel circuit (the “fifth” and “sixth” transistors in claims 1–6, and in the numbering of claims 13–18 the “fourth” and “fifth” transistors). Ex. 2001 at 426-440, 445. Petitioner fails in its attempt create a circuit from Kimura that would meet these limitations, underscoring the non-obviousness of these claims and the ’599 Patent’s circuit design.⁹ *See, e.g.*, Pet. at 63.

The Petition’s theory for the shared “current light-emitting signal” limitations requires implementing a shared signal line in Kimura’s Figure 33 embodiment, as the Board observed in denying Petitioner’s motion to submit supplemental information and rejecting Petitioner’s attempt to shift to a different theory:

⁹ For simplicity, the remainder of this section refers to these as the “fourth” and “fifth” transistors. But the discussion is equally applicable to the “fifth” and “sixth” transistors (respectively) of claim 1 and its dependent claims.



The Petition explains that although the Figure 33 embodiment of Kimura shows the fourth and fifth transistors controlled by different signals, the Figure 36 embodiment of Kimura uses shared light-emitting signal to control the fourth and fifth transistors. Pet. 64–65. On the basis of the use of a shared light emitting signal in the Figure 36 embodiment to control the fourth and fifth transistors, Petitioner concludes that it would have been obvious to use a shared light emitting signal in the Figure 33 embodiment to control the fourth and fifth transistors. *Id.* No other modification to the Figure 33 embodiment was proposed by Petitioner to account for this feature.

Paper 27 at 7–8. As the Board explained, “[n]either the Petition nor the first declaration of Dr. Foty proposed any modification of the Kimura’s Figure 33 embodiment, in connection with the shared light emitting signal feature of claim 13, beyond simply applying the same light emitting-signal to the gates of transistors 4 and 5.” Paper 27 at 10.

A POSITA would have had no motivation to make the Petition’s proposed modification, nor a reasonable expectation of success in doing so. As Dr. Wolfe explains, and Dr. Foty admitted in deposition, Petitioner’s proposed modification would result in an inoperable circuit. Ex. 2008, ¶97; Ex. 2050 at 71:21–72:15, 72:21–73:7. Petitioner has not shown, and could not show, that any of claims 1–6 and claims 13–18 would have been obvious to a POSITA.

1. Using a shared gate signal for the “fourth” and “fifth” transistors in Figure 33 would render the modified circuit inoperable.

As the Board intimated, the Petition and supporting declaration of Dr. Foty fail to establish that its modification of Figure 33 would yield an operable circuit that satisfies the shared “current light-emitting signal” limitations of claims 1–6 and claims 13–18. *See, e.g.*, DI at 51 (“If the fourth and fifth transistors in the Figure 33 embodiment were to be controlled by the same shared signal, such that they have to be turned on and off together, they would produce outputs and make current connections and disconnections inconsistent with what the other components in the pixel circuit of the Figure 33 embodiment expect from them.”); *id.* at 51–52 (“It is questionable whether the Figure 33 embodiment, after being modified to make the fourth and fifth transistor always turn on and off together, as Petitioner proposes based on the Figure 36 embodiment, would still meet all the requirements of the first, second, third, fourth, and fifth transistor, as recited in claim 7. Based on the present record, we find that Petitioner has not provided an adequate explanation as to this potential discrepancy.”). As discussed below, Petitioner’s proposed modification would not work.

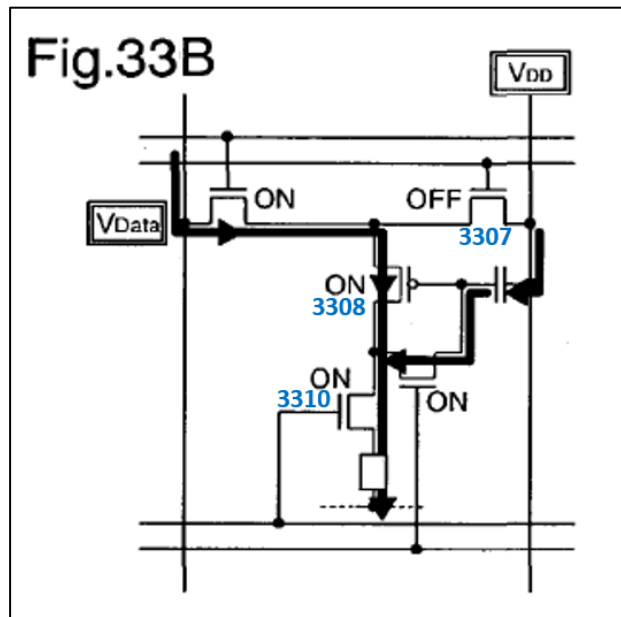
Following the institution decision, Petitioner moved to submit “supplemental information” in an effort to change theories. The Board denied Petitioner’s motion, pointing out that it was improperly attempting to materially change from the

[REDACTED]

Petition's theory and to "proceed[] in a new direction." Paper 27 at 8–9; *see id.* at 10–11 ("All of the opinions in the proposed supplemental declaration of Dr. Foty with regard to additional modifications including adding another transistor, are new[.]").

The Petition's theory is that a POSITA would modify Kimura's Figure 33 embodiment to control the fourth and fifth transistors with a shared light emitting signal. A POSITA would have not reason to make such a modification, nor a reasonable expectation of success, as such a modification would disrupt the operation of the circuit. It is telling that Petitioner was unable to explain how the modified circuit it presented in the Petition would operate. As Dr. Wolfe explains, Petitioner's proposed modification would result in an inoperable circuit. Ex. 2008, ¶97.

The operation of the circuit in Figure 33 would be frustrated if, as the Petition proposes, the alleged fourth and fifth transistors shared a light emitting signal. Ex. 2008, ¶97. Dr. Foty acknowledged this during deposition. Ex. 2050 at 71:21–72:15, 72:21–73:7. For example, as shown below, Figure 33B of Kimura depicts an operation stage in which transistor 3307 is OFF, while transistor 3310 is ON.



Kimura Fig. 33B (annotated)

In this stage, transistor 3308 is turned ON in preparation for a subsequent stage shown in Fig. 33C. *E.g.*, Ex. 2050 at 72:12–18 (“This will pull the node connected to the gate of Transistor 3308 low, which will turn the transistor on. You’re preparing it for the programming step which is coming in 33C.”); Kimura at ¶¶655–656. As Dr. Foty admitted, the operation stage shown in Fig. 33B is necessary to the operation of the circuit, including to place the circuit in a state required for the subsequent stage. Ex. 2050 at 72:21–73:7 (“And you can’t do the programming step unless 3308 is on and can function as is shown in 33B.”); *see* Ex. 2008, ¶¶98–100.

However, under Petitioner’s proposed modification of Figure 33, in which the gates of transistors 3307 and 3310 are controlled by the same signal, those transistors would always both be ON or OFF together, because in Petitioner’s proposed

[REDACTED]

modification both of these transistors are PMOS. Accordingly, the operation stage shown in Figure 33B would be impossible, because it requires transistor 3307 to be OFF while transistor 3310 is ON. Ex. 2008, ¶101.

The result of Petitioner's proposed modification would be that either (a) both transistors 3307 and 3310 would be OFF during the stage shown in Fig. 33B, or both transistors 3307 and 3310 would be ON during that stage. Either possibility would result in an inoperable pixel circuit. Ex. 2008, ¶101.

If both transistors 3307 and 3310 were controlled to be OFF, the operation shown in Fig. 33B could not take place. As shown in Fig. 33B, transistor 3310 must be ON in order for transistor 3308 to turn ON. *See also* Ex. 1003 (Foty Dec) at ¶133. Thus, as Dr. Wolfe explains, if both transistors 3307 and 3310 were controlled to be OFF, the stage shown in Fig. 33B could not occur; it would instead collapse into the stage shown in Fig. 33C (in which both transistors 3307 and 3310 are OFF). Ex. 2008, ¶¶102–103. In other words, the stage of the pixel circuit's operation shown in Figure 33B—which Dr. Foty concedes is necessary to turn transistor 3308 back ON for the subsequent programming step to be performed—would not occur. Ex. 2008 at ¶103.

Similarly, if both transistors 3307 and 3310 were controlled to be ON, the operation of the circuit would be disrupted. This would allow VDD to be input through transistor 3307 while VData is input to the circuit through transistor 3306.

[REDACTED]

Providing both signals during this stage would disrupt the pixel circuit's operation and cause numerous potential issues. Ex. 2008, ¶¶104–105. As discussed, Kimura recognized its Figure 33 design was prone to unwanted light emission outside of the light-emission stage. The additional current flowing to the OLED in Petitioner's proposed modification would cause additional such unwanted light emission during a non-emission stage, exacerbating the problem. Ex. 2008, ¶105. Providing VDD in addition to VData would also lead to potential compensation issues. *Id.* Dr. Foty acknowledged in deposition that providing both VDD and VData to the circuit during this operation stage “would make no sense,” “would be a bad idea,” and might lead to “too much current through the electroluminescent element and damage it.” Ex. 2050 71:21–72:15.

Simply put, as Dr. Wolfe explains, the embodiment of Figure 33 would not operate correctly under Petitioner's proposed modifications. Ex. 2008, ¶¶97-105. A POSITA would have had no motivation to make those modifications, and would not have had any reasonable expectation of success in making them. *Id.*

D. Petitioner Has Not Shown Any Challenged Claim to Be Prima Facie Obvious.

Independent claims 1, 14, 15, and 17, and dependent claim 13, require, among other things, a shared current light-emitting signal. For the reasons discussed in Section IV.C, the Petition's obviousness theory as to these limitations fails. Further, Petitioner's theory is premised on an “all PMOS” redesign of Kimura's Figure 33

[REDACTED]

that a POSITA would have had no motivation to make, and fails for the reasons discussed in Section IV.A as well. For each of these reasons, Petitioner has not shown obviousness any of these claims, or their dependent claims. And because a POSITA would not have made an “all PMOS” redesign, as the Petition’s theory would require, Petitioner has not shown claim 7 or any of its dependent claims to be obvious.

Dependent claims 2, 16, and 18 further require a specific initialization transistor, as does dependent claim 8. The Petition fails to show obviousness of these claims for the additional reasons discussed in Section IV.B. Moreover, the Petition’s theories for these claims would require multiples sets of modifications that are internally inconsistent. Yet the claims must be read as a whole. For example, Petitioner contends a POSITA would make the shared current light-emitting signal modification to reduce the number of necessary signal lines, yet Dr. Foty has admitted Petitioner’s proposed modification to add an initialization transistor would require adding at least one more signal line. Ex. 2008 ¶88. The Petition wholly failed to justify making its multiple sets of modifications in a single circuit.

Finally, claims 3–5, 9–11, 13, and 15–18 require that specified transistors in the pixel circuit be PMOS (either explicitly or impliedly through recitation of their connections). For reasons discussed in Section IV.A, a POSITA would have had no motivation to change the allegedly corresponding transistors in Kimura’s Figure 33

[REDACTED]

to PMOS. Additionally, claims 5 and 11 specifically require the “third” transistor to be PMOS. Kimura never discloses or suggests that such a transistor could be PMOS and does not refer to it as a “switching” transistor. A POSITA would have had no motivation to change that transistor to PMOS, and would have been discouraged by the greater susceptibility of leakage current of PMOS polysilicon TFTs. Ex. 2008 ¶¶106–107.

V. Objective Evidence Confirms the Non-Obviousness of the Challenged Claims.

Petitioner’s obviousness theories are further undercut by extensive real-world, objective evidence of non-obviousness, including failure of others, long-felt need, skepticism, praise, and copying of Samsung Display’s patented pixel circuits. *See* Ex. 2008, ¶¶108–170.

The Federal Circuit has “stressed that objective considerations of non-obviousness must be considered in *every* case,” *WBIP, LLC v. Kohler Co.*, 829 F.3d 1317, 1328 (Fed. Cir. 2016) (emphasis in original),¹⁰ because they “play an important role as a guard against the statutorily prescribed hindsight reasoning in the

¹⁰ Samsung Display moved for additional discovery to seek materials from Mianyang BOE relied upon in parallel litigation as evidence supporting objective indicia as to the ’599 Patent. Paper 26. The Board denied this motion. Paper 30.

[REDACTED]

obviousness analysis,” *Lectrosonics, Inc. v. Zaxcom, Inc.*, IPR2018-01129, Paper 33 at 71 (Jan. 24, 2020) (precedential) (quoting *WBIP*, 829 F.3d at 1328).

In the years since Samsung Display first successfully mass-produced AMOLED displays for mobile devices—implementing the inventions of the ’599 Patent—they have become a transformative technology. Ex. 2009 at 2. AMOLED displays employing the pixel circuits of the ’599 Patent have been widely adopted across flagship mobile devices such as the Samsung Galaxy and Apple iPhone. But it was not until Samsung Display developed the pixel circuits claimed in the ’599 Patent that these AMOLED displays could be commercialized, despite many years of earlier research efforts by the display industry and repeated attempts to devise a suitable pixel circuit.

The ’599 Patent succeeded where many others had failed—including Kimura’s assignee, Semiconductor Energy Laboratory—solving the longstanding technical problem of delivering a pixel circuit for AMOLED displays that achieved high display uniformity and adequate pixel aperture ratio, and could be readily manufactured. The importance of its inventions has been validated by industry praise, widespread industry adoption of Samsung Display’s patented pixel circuits, and slavish copying of these patented circuits.

**A. The '599 Patent's inventions satisfied longstanding needs,
overcame skepticism, and succeeded where others had failed.**

Long-felt need, skepticism, and failure of others support the non-obviousness of the challenged claims. “Evidence of a long felt but unresolved need tends to show non-obviousness because it is reasonable to infer that the need would have not persisted had the solution been obvious.” *WBIP*, 829 F.3d at 1332. Further, “[i]f industry participants or skilled artisans are skeptical about whether or how a problem could be solved ... it favors non-obviousness.” *Id.* at 1335. Moreover, “[e]vidence that others tried but failed ... may carry significant weight in an obviousness inquiry.” *In re Cyclobenzaprine Hydrochloride Extended-Release Capsule Patent Litigation*, 676 F.3d 1063, 1081 (Fed. Cir. 2012).

At the time of the inventions, AMOLED display technology, and in particular a suitable pixel circuit to drive such a display, had long been the subject of significant research by numerous companies (including Samsung Display) and research groups, but suitable pixel circuits for AMOLED displays had yet to be attained. *See generally* Ex. 2010; Ex. 2008, ¶¶110–150. As explained in the “Advances in AMOLED Technologies” chapter in a 2008 textbook on mobile displays, a significant hurdle for mass-producibility of AMOLED displays was luminance non-uniformity, because unavoidable imperfections in the low-temperature polysilicon manufacturing process for TFTs would yield AMOLED panels having TFTs with nonuniform electrical characteristics. *See* Ex. 2010 at 26–31 (“[P]ixel-to-pixel level

[REDACTED]

device variation is the key issue that makes the AMOLED panel a concern for certain applications.”). “Since the OLED is a current-driven device, the brightness uniformity over the panel [wa]s susceptible to variations in device characteristics of TFTs.” *Id.* at 35. Non-uniformity due to pixel circuits was viewed as a “major bottleneck[]” to “commercialization activities.” *Id.* at 52 (emphasis added).

This longstanding need was well recognized by the industry. Ex. 2008, ¶¶110–122, 127–129. For example, researchers from Sarnoff, Planar, Eastman Kodak, and Princeton University explained in a 1998 Society of Information Display (“SID”) paper that “thin film transistors” used in AMOLED displays “suffer[ed] from significant initial output characteristic non-uniformity ... mak[ing] it difficult to create a uniform current source at each pixel.” Ex. 2011 at 1. In 2002, just before the inventions of the ’599 Patent, Hitachi researchers observed in a SID paper that “[s]everal pixel-driving methods have been proposed for suppressing inter-pixel non-uniformity ... caused by a deviation in poly-Si TFTs performance,” and despite these efforts, “challenges remain[ed] with active matrix OLED displays,” with “inter-pixel uniformity [being] one of the most important for ... picture quality.” Ex. 2012 at 1. The ’599 Patent itself discusses the problem of non-uniformity, including in its Background of the Invention. *See* ’599 Patent at 1:15–3:40 (describing, *inter alia*, “display nonuniformity ... problem[s],” “image quality degradation” issues, “difficult[ies] [in] manufactur[ing] transistors in the AMOLED,” and “difficult[ies]

[REDACTED]

to obtain a uniform driving current due to deviation of the threshold voltage of TFT”).

Many tried but failed to make suitable pixel circuits for AMOLED displays. As the “Advances in AMOLED Technologies” chapter explains, “[t]o overcome the non-uniformity issues for ... AMOLED displays, several compensation approaches have been proposed” over the years. Ex. 2010 at 36–37 (explaining “compensation means that the driving TFT in a pixel has to be compensated for parameters such as threshold voltage and/or mobility, so that the output current becomes independent of the parameters”).

For example, companies and research groups proposed a number of pixel circuits using voltage-programmed methods (i.e., where the data signal entered into a pixel circuit is a specific *voltage*, as opposed to a specific *current*), including a 4-transistor/2-capacitor circuit proposed in 1998 by Sarnoff; a 4-transistor/1-capacitor circuit proposed in 2003 by IDT; a 3-transistor/1-capacitor circuit proposed in 2003 by IBM; and a 5-transistor/1-capacitor circuit proposed in 2005 by Toppoly. *See id.* at 37–44. As Dr. Wolfe explains, he is not aware of any of these pixel circuits having been implemented in any mass-produced AMOLED display. Ex. 2008, ¶¶113–116, 124.

In addition, pixel circuits designed for current-programmed methods (which use current as the input data signal), as opposed to the voltage-programmed pixel

[REDACTED]

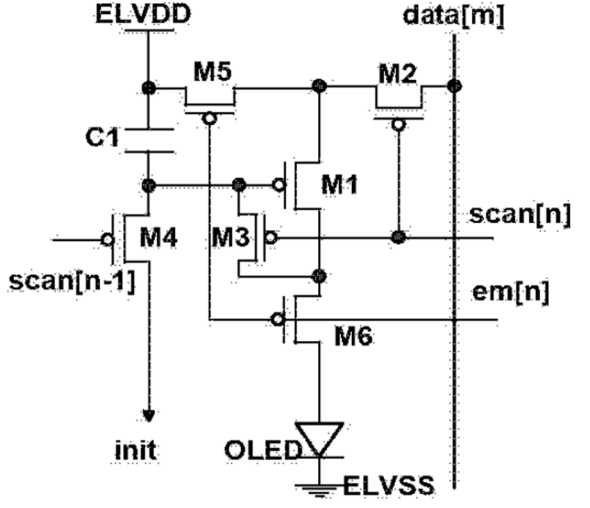
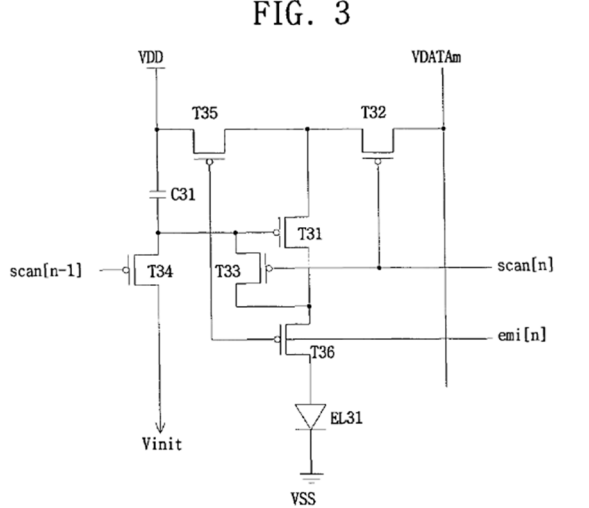
circuits of the '599 Patent, were proposed. This includes a 4-transistor/1-capacitor circuit proposed in 1998 by Sarnoff, which was criticized for suffering several issues, such as requiring a “quick-test procedure ... [that] is not suitable for current-driven AMOLEDs ... [and] not practical for mass production.” Ex. 2010 at 44–45. Another example of a current-programmed pixel circuit included a 4-transistor/1-capacitor “current-mirror type” pixel circuit proposed in 2001 by Sony. *Id.* at 45. The '599 Patent also explains that prior art current-programmed pixel circuits in general were inadequate, including due to data instability and prolonged data line charge times. *See* '599 Patent at 1:51–2:10. Dr. Wolfe is not aware of any of these current-programmed circuits having been used in any mass-produced AMOLED display. Ex. 2008, ¶¶117–120, 124.

Compounding the display uniformity problem was the difficulty of achieving adequate pixel aperture ratios. Ex. 2008, ¶¶112–123, 129, 144–149. Even though it was known that aperture ratio was important to the “lifetime” and “luminance” of displays, Ex. 2010 at 28, in an effort to compensate for display non-uniformity, companies and research groups proposed increasingly complicated pixel circuits involving “more TFTs and capacitors” at the expense of aperture ratio, *id.* at 30–31. The industry expressed skepticism that even pixel circuits with fewer circuit elements than the '599 Patent would be too complicated and too large. Ex. 2008 at ¶¶144–149. For example, researchers at Casio and Kyushu University noted in a

[REDACTED]

2003 International Display Workshop paper that pixel circuits “need[ing] more than four TFTs ... for each pixel” were considered “too complicated” and “too busy in pixel ar[e]a to achieve ... large aperture ratio.” Ex. 2013 at 1. Similarly, in referencing a proposal for a 5-transistor/1-capacitor pixel circuit, researchers at the National Cheng Kung University in Taiwan criticized it as “us[ing] an excess of components ... reducing the aperture ratio of the display.” Ex. 2014 at 1. Given the concerns about pixel circuit size reducing aperture ratio, the larger relative size of PMOS transistors was a perceived disadvantage. Ex. 2008, ¶¶63–64, 147. Samsung Display’s introduction and mass-production of its pixel circuits implementing the ’599 Patent’s inventions, which used only PMOS transistors, went against the grain.

The inventions of the ’599 Patent satisfied the long-felt need for pixel circuits that provide display uniformity and adequate aperture ratios and were suitable for mass-production of AMOLED displays. *See* ’599 Patent at 3:44–48. As described in a 2005 SID paper by Samsung SDI (a predecessor to Samsung Display and original assignee of the ’599 Patent), the ’599 Patent’s pixel circuit (referred to in the paper as the “6 TFTs and 1 capacitor structure,” and reproduced below next to Figure 3 of the ’599 Patent) was found to be “suitable to realize a high image quality and high resolution for AMOLED panel[s]” and “compensate[s] the V_{th} variation of the driving TFT in the pixels.” Ex. 2015 at 1; *see* Ex. 2008, ¶¶125, 130–143.

6T1C Pixel Circuit 2005 SID Paper (Ex. 2015)	'599 Patent, Figure 3
	

Ex. 2015 at 1. The same paper noted that “[a]lthough many groups [had been] developing compensation circuits,” it was “difficult to integrate such circuits in ... higher pixel density display[s] due to restricted pixel area[s].” *Id.* at 1.

As explained in the 2005 SID paper, the '599 Patent's pixel circuit made possible the successful manufacture of a “full color VGA AMOLED display with the highest resolution to date” with “40% aperture ratio, making it the world's highest density AMOLED display reported to date,” and a “V_{th} compensating pixel circuit to improve image quality.” Ex. 2015 at 3. Thus, the inventions of the '599 Patent succeeded in overcoming the technical challenges that had caused a “major bottleneck[.]” and led many others to fail, and innovated a pixel circuit that achieved display uniformity and sufficient aperture ratio to allow AMOLEDs to be used in mobile devices. Ex. 2010 at 52.

[REDACTED]

Implementing pixel circuits of the '599 Patent, Samsung Display successfully mass-produced AMOLED displays, with work beginning in 2005 (shortly after the '599 Patent's inventions) and commercial production commencing in 2007. Ex. 2009 at 2 (“Samsung began its attempt at producing [AMOLEDs] in 2005 ... [and] became the world’s first company to successfully mass-produce AMOLED in September 2007.”); Ex. 2016 at 6 (“[T]he company persevered to uphold the principle of ‘Samsung smartphone is AMOLED itself’ and it finally overcame all the barriers.”); Ex. 2017 at 5 (“Samsung Display has emerged as an unparalleled powerhouse in the current small and medium-sized OLED display market thanks to its endeavors to walk down the uncharted path that no other competitors had taken before.”).

The '599 Patent's innovative pixel circuit has been used ubiquitously in AMOLED displays for mobile devices. Ex. 2008, ¶135. For example, the AMOLED display used in the Samsung Galaxy S21 product practices all challenged claims of the '599 Patent. Ex. 2008, ¶¶136–143; Ex. 2018 (Galaxy S21 Claim Chart). [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

. Wolfe explains tha

- [Preamble]/[1a]: “a pixel circuit in an organic light emitting device, comprising a first transistor for delivering a data signal voltage...,” *i.e.*, transistor T2;
- [1b]: “a second transistor for generating a driving current depending on the data signal voltage delivered through the first transistor,” *i.e.*, transistor T1;
- [1c]: “a third transistor for detecting and self-compensating threshold voltage deviation in the second transistor,” *i.e.*, transistor T3;
- [1d]: “a fifth transistor for providing a power supply voltage for the second transistor in response to a current light-emitting signal,” *i.e.*, transistor T5;

-
- [1e]: “a sixth transistor ... for providing the driving current for the electroluminescent element through the second transistor in response to the current light-emitting signal,” *i.e.*, transistor T6;
 - [1f]: “a capacitor for storing the data signal voltage delivered to the second transistor,” *i.e.*, capacitor [REDACTED] and
 - [1g]: an electroluminescent element that “emits light corresponding to the driving current generated through the second transistor,” *i.e.*, OLED.

See Ex. 2008, ¶137 (discussing Ex. 2018 (chart mapping claims 1–18 to Galaxy S21 Display)).

Dr. Wolfe has not seen any indication that alternative pixel circuits proposed over the years by others have been successfully implemented in commercialized AMOLED displays for mobile devices. Rather, a broad array of products, including AMOLED displays for successful mobile devices such as the Galaxy series, have adopted the pixel circuits claimed in the '599 Patent.

B. The success of Samsung Display’s patented pixel circuits has been validated by specific industry recognition for the inventors.

Industry recognition further supports the non-obviousness of the challenged claims. “Evidence that the industry praised a claimed invention ... weighs against an assertion that the same claim would have been obvious.” *WBIP*, 829 F.3d at 1334.

[REDACTED]

The named inventors have received recognition for their innovative achievement of developing the pixel circuits of the '599 Patent. Ex. 2008, ¶¶150–154. For example, Dr. Oh-Kyong Kwon was awarded the Korea Best Scientist and Engineer Award by the President of South Korea specifically for “develop[ing] pixel circuits ... for AMOLED displays that can be accurately controlled to very low current levels, which were *considered practically impossible, enabling the mass production* of AMOLEDs for mobile devices.” Ex. 2021 at 1 (emphasis added). As one article described:

Pixel circuit research is also one of Professor Kwon’s major achievements. The *existing pixel circuit structure had uneven luminance and low yield*. Professor Kwon talked about the development process, saying, “We solved the problem by ... [developing a] *pixel circuit that can compensate for the deviation in the characteristics of the TFT for current control*.” He then replied, “Through research on pixel circuit structure, we have been able to *increase the resolution* of displays even with low current levels.”

Ex. 2022 at 2 (emphases added). Dr. Ho Kyoong Chung was awarded, *inter alia*, the Order of Science and Technology Merit and the Order of Industrial Service Merit by the President of South Korea and Karl Ferdinand Braun Prize by the Society for Information Display, including “for his contributions to the large-scale commercialization and technical development of AMOLED displays.” Ex. 2023. This praise is directed to the benefits of the claimed inventions, which improved

[REDACTED]

display uniformity with adequate aperture ratio and allowed mass-producibility of AMOLED displays. 33

C. Widespread copying of Samsung Display’s patented pixel circuits confirm the non-obviousness of the ’599 Patent.

The widespread copying of Samsung Display’s pixel circuits embodying the inventions of the ’599 Patent further supports non-obviousness. The Federal Circuit recently emphasized the importance of copying evidence, noting that “a determination of copying [is] strong evidence of non[-]obviousness.” *Volvo Penta of the Americas, LLC v. Brunswick Corp.*, 81 F.4th 1202, 1213 (Fed. Cir. 2023). Copying “may be demonstrated either through internal documents ... direct evidence such as disassembling a patented prototype, photographing its features, and using the photograph as a blueprint to build a virtually identical replica, ... or access to ... the patented product.” *Iron Grip Barbell Co. v. USA Sports, Inc.*, 392 F.3d 1317, 1325 (Fed. Cir. 2004).

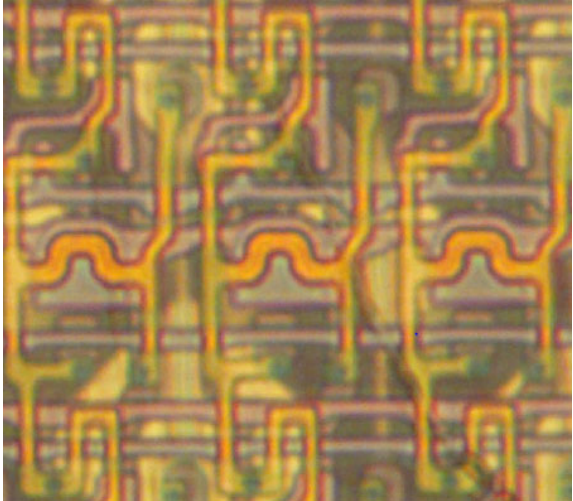
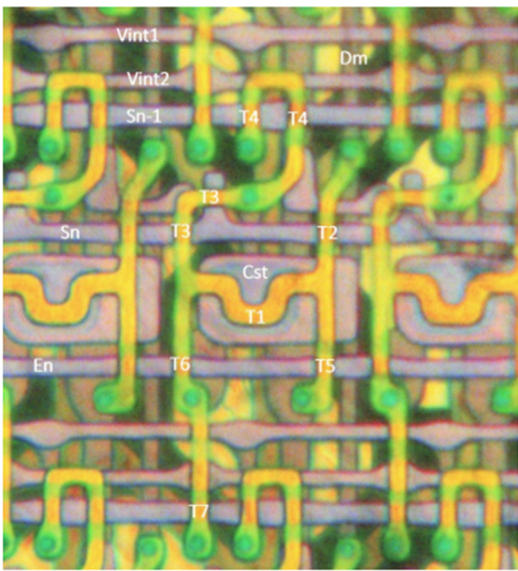
Although Samsung Display’s motion for additional discovery to seek Petitioner Mianyang BOE’s internal documents germane to the issue of copying was denied, Paper 30, widespread copying of Samsung Display’s patented pixel circuits after Samsung Display’s successful commercialization of AMOLED displays in flagship products such as Galaxy phones and iPhones is evident from teardown photographs of commercially available AMOLED display products. These teardowns show not just that other companies are infringing, but that they have



fashioned near identical replicas of Samsung Display’s pixel circuits down to the physical layout and shapes of the circuit elements.

As Dr. Wolfe explains, the pixel circuits in these AMOLED products are so strikingly similar, including in their physical layout, to the patented pixel circuits in Samsung Display’s products that they can only be reasonably explained by the deliberate copying of Samsung Display’s commercially available AMOLED products by persons with access to those products or Samsung Display confidential technical information. Ex. 2008 at ¶¶155–160. This indicates the makers of these replica products “had access to, and borrowed from” Samsung Display’s patented pixel circuit technology. *Institut Pasteur v. Focarino*, 738 F.3d 1337, 1346, 1348 (Fed. Cir. 2013).

For example, following Samsung Display’s successful mass-production of AMOLED displays (including for iPhones), Petitioner Mianyang BOE copied Samsung Display’s pixel circuits in commercializing AMOLED displays for products such as the iPhone. Ex. 2008 at ¶¶156–157. The pixel circuit in Mianyang BOE’s AMOLED display for the iPhone 12 is a replica of Samsung Display’s patented pixel circuit (*see* Ex. 2047 at ¶¶31–50), as illustrated below in the side-by-side annotated comparison of teardown images of pixel circuits in a Samsung Display AMOLED display (Galaxy S21) (Ex. 2020 at 5) and a Mianyang BOE AMOLED display (iPhone 12) (Ex. 2047 at ¶35).

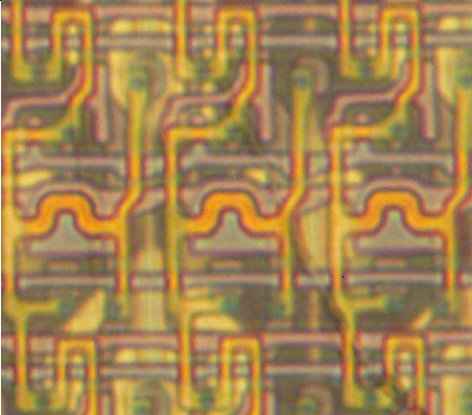
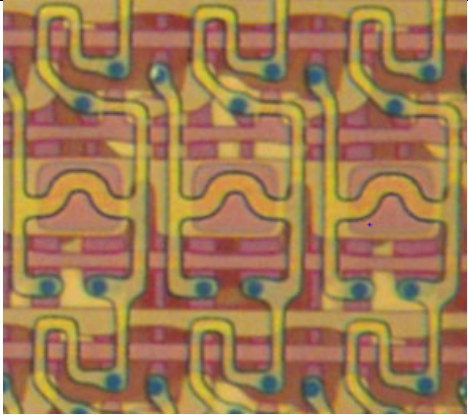
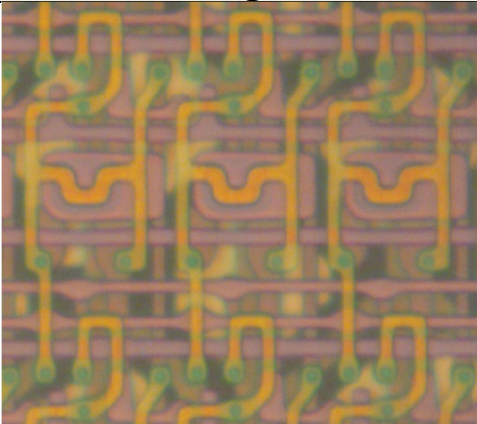
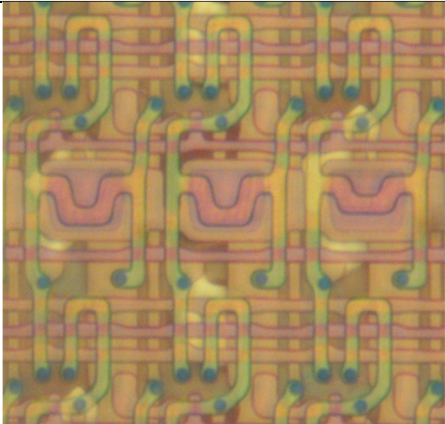
Samsung Display AMOLED (Galaxy S21)	Mianyang BOE AMOLED (iPhone 12)
 Ex. 2020 at 5	 Ex. 2047 at ¶35

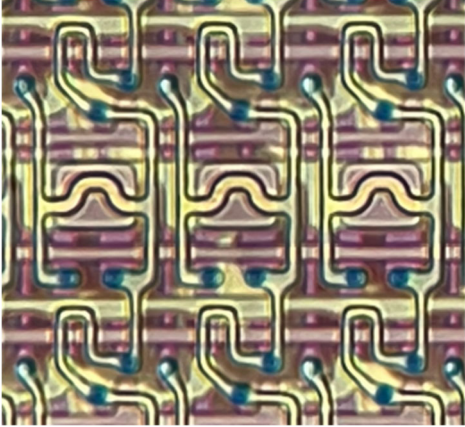
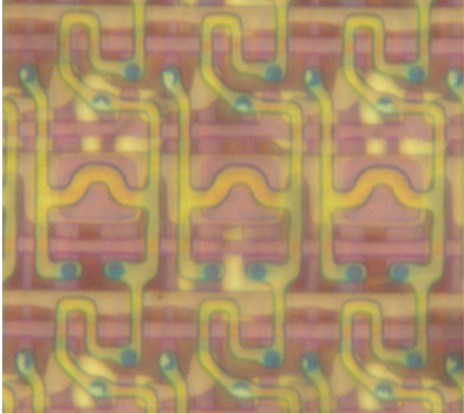
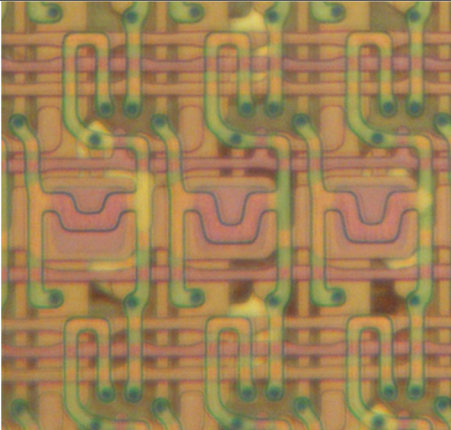
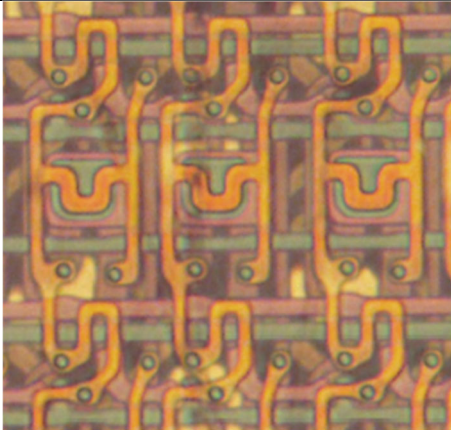
Further, Mianyang BOE’s patent filings demonstrate it tried to develop its own AMOLED pixel circuits, including using 5 transistors and 1 capacitor (Ex. 2024) or 4 transistors and 1 capacitor (Ex. 2025). Yet in order to commercialize AMOLED displays for mobile devices, Mianyang BOE resorted to copying Samsung Display’s patented pixel circuits. Ex. 2008 at ¶157.

The widespread copying is further apparent from samples of AMOLED displays sold by numerous vendors of replacement AMOLED displays for mobile phones. Again, these pixel circuits not only infringe the challenged claims (*see, e.g.*, Ex. 2051 (chart mapping claims 1–18 to Sourcely Plus AMOLED Display); Ex. 2052 (chart mapping claims 1–18 to Injured Gadgets AMOLED Display))), they are so strikingly similar to those of Samsung Display, down to their physical layouts and



shapes of circuit elements, that they show copying. Ex. 2008, ¶¶158–159. Exemplary teardown images of such replica products are shown below.

Galaxy S21 Pixel Circuit (Samsung Display AMOLED)  Ex. 2020 at 5	MobileSentry  Ex. 2026 at 5
Mengtor  Ex. 2027 at 4	Phone LCD Parts  Ex. 2028 at 4

Mobile Defenders	Injured Gadgets
 Ex. 2029 at 5	 Ex. 2030 at 5
Parts4LCD	SourcelyPlus
 Ex. 2041 at 4	 Ex. 2038 at 5

D. There is a direct and specific nexus between the objective indicia and the claimed inventions.

A strong nexus exists between the objective evidence of failure of others, long-felt need, skepticism, industry praise, and copying and the claimed inventions. For objective indicia of non-obviousness to be accorded substantial weight, its proponent must establish a nexus between the evidence and the claimed invention. *ClassCo, Inc., v. Apple, Inc.*, 838 F.3d 1214, 1220 (Fed. Cir. 2016). “[T]here is no nexus unless the evidence presented is ‘reasonably commensurate with the scope of

[REDACTED]

the claims.” *Id.* (citation omitted). Nexus can be proven “by showing that the evidence of secondary considerations is the ‘direct result of the unique characteristics of the claimed invention.’” *Fox Factory, Inc. v. SRAM, LLC*, 944 F.3d 1366, 1373–74 (Fed. Cir. 2019). As the Federal Circuit emphasized last year in *Volvo Penta*, “a nexus analysis need not be limited to a discussion of only novel features. It is instead important to consider ‘the invention as a whole,’ rather than on a ‘limitation-by-limitation’ basis.” 81 F.4th at 1212.

The challenged claims of the ’599 Patent recite pixel circuits whose specific arrangement of and connections among transistors and a capacitor provide for display uniformity by self-compensating for threshold voltage deviations in the driving transistor, while maintaining a compact structure and a limited number of lines that provide for adequate aperture ratio. As Dr. Wolfe explains, compensation is achieved through a structure in which a threshold voltage compensation transistor connects the gate and drain of the driving transistor such that the driving transistor is connected in the form of a diode. *See, e.g.*, ’599 Patent at 3:43–4:27; Ex. 2008, ¶¶161–165. The driving current supplied to the OLED “correspond[s] to the data signal voltage applied to the data line regardless of the threshold voltage of current driving transistor T31,” making it “possible to finely control the current flowing into the organic EL element.” ’599 Patent at 7:28–8:32; Ex. 2008, ¶¶164–165.



At the same time, the '599 Patent allows high aperture ratios to be achieved in AMOLED displays by requiring fewer control or scan lines for each pixel row. Ex. 2008, ¶¶166–170. For example, the emission transistors (T35 and T36 in Figure 3 of the '599 Patent), share a single emission control line. *E.g.*, '599 Patent at 6:52–7:1, Fig. 3, cl. 1 (“current light-emitting signal” turns on/off “a fifth transistor” and “a sixth transistor”), cl. 7. The switching transistor and threshold voltage compensation transistor (T32 and T33 in Figure 3), also share a single scan line. *E.g.*, *id.* at 6:19–51, Fig. 3, cl. 7 (“current scan signal” turns on/off “a third transistor” and “a first transistor”). In addition, the initialization transistor (T34 in Figure 3), is turned ON and OFF by the scan signal of the previous pixel row, further reducing the number of scan lines. *E.g.*, *id.* Fig. 3, cls. 2, 16. The claimed inventions’ novel design allowed for a smaller footprint and greater aperture ratio, and improved manufacturability, with compensation, which was significant to AMOLED displays for mobile devices. Ex. 2008, ¶¶166–169. The '599 Patent accomplishes this in a pixel circuit that may be composed entirely of PMOS TFTs. *E.g.*, '599 Patent at Fig. 3, 6:19–7:11.

The '599 Patent made commercialization of AMOLED displays possible by providing a unique and elegant pixel circuit that was suitable for mobile devices and achieved display uniformity and adequate aperture ratios. As explained above, these unique advantages flowed from practicing the claimed inventions.

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Moreover, the objective evidence is commensurate with the scope of the challenged claims. A pixel circuit having the unique benefits of '599 Patent's claimed invention was unattainable in the prior art, as exemplified by the failures of numerous sophisticated companies and research groups over the years to develop a suitable AMOLED pixel circuit when it was a recognized "bottleneck[]" to "commercialization activities," Ex. 2010 at 52. Further, it was not until Samsung Display "shatter[ed] th[e] bias" through the inventive pixel circuits claimed in the '599 Patent that it "[became] the world's first company to successfully mass-produce AMOLED [displays] in September 2007." Ex. 2009 at 2. The inventors received recognition and praise for successfully resolving longstanding challenges associated with display uniformity and aperture ratios in AMOLED displays. Samsung Display's patented pixel circuits have also been the subject of copying by other display manufacturers.

VI. Conclusion

For the foregoing reasons, Patent Owner respectfully submits that the Board should find the challenged claims patentable.

Date: March 8, 2024

Respectfully submitted,

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CERTIFICATE OF WORD COUNT

Pursuant to 37 C.F.R. § 42.24(d), I certify that the foregoing Patent Owner's Response contains 13,996 words based on the word count indicated by the word-processing program used to generate the paper and excluding those portions exempted by 37 C.F.R. §§ 42.24(a) and (b).

Date: March 8, 2024

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CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. § 42.6, I hereby certify that the foregoing Patent Owner's Response, together with exhibits 2008–2043 and 2046–2052, was served by electronic mail on the following counsel of record for Petitioner:¹

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¹ As discussed in Patent Owner's Motion to Seal and for Entry of Protective Order (being filed concurrently with this document), in order to ensure compliance with the restrictions on disclosure of NCT Information outside of the United States, Patent Owner is filing the unredacted confidential Patent Owner's Response and confidential exhibits as "Board and Filing Party Only." Patent Owner is serving these confidential materials on Counsel for Petitioner who are located in the United States and have signed acknowledgment letters pursuant to paragraph 4 of the Proposed PO.