

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

BOE TECHNOLOGY GROUP CO., LTD.
Petitioner,

v.

SAMSUNG DISPLAY CO., LTD.
Patent Owner.

Patent No. 11,626,066

Inter Partes Review No. IPR2025-01545

**PETITION FOR *INTER PARTES* REVIEW
UNDER 35 U.S.C. §§ 311-319 AND 37 C.F.R. § 42.100 *et seq.***

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Exhibit List for *Inter Partes* Review of USP 11,626,066

Exhibit Description	Exhibit #
U.S. Patent No. 11,626,066 to Lee	EX1001
Declaration of Thomas Credelle	EX1002
Prosecution history of U.S. Patent No. 11,626,066	EX1003
U.S. Patent No. 6,867,549 to Cok et al.	EX1004
U.S. Patent Pub. No. 2009/0033598 to Suh	EX1005
U.S. Patent No. 7,492,379 to Credelle et al.	EX1006
U.S. Patent Pub. No. 2004/0051724 to Elliott et al.	EX1007
K. Nishimura et al., “New Green and Red Phosphorescent Host Materials for Highly-efficient and Long-lifetime OLEDs,” <i>SID Digest</i> (2009)	EX1008
A. Lääperi et al., “OLED Lifetime Issues in Mobile Phone Industry,” <i>SID Digest</i> (2007)	EX1009
T. Tsujimura, <i>OLED Display</i> (2012) (excerpts from chapter 4)	EX1010
U.S. Patent Pub. No. 2003/0128225 to Credelle et al.	EX1011
U.S. Patent No. 11,626,067 to Lee	EX1012
U.S. Patent No. 7,215,347 to Phan	EX1013
U.S. Patent Pub. No. 2014/0191202 to Shim et al.	EX1014
Family Tree for U.S. Patent No. 11,626,066 to Lee	EX1015

U.S. Patent No. 10,832,616 to Lee	EX1016
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Declaration of Catherine Vassilkova authenticating EX1023, EX1024, and EX1025	EX1026
Prosecution history of U.S. Patent No. 10,832,616	EX1027
Comparison of U.S. Patent Pub. No. 2003/0128179 to U.S. Patent No. 7,492,379	EX1028

U.S. Patent No. 7,274,383 to Elliot	EX1029
U.S. Patent Pub. No. 2003/0128179 to Credelle	EX1030
I. Vogels, “The Visibility of a Local Deviation in Luminance and White-Point of a Display,” <i>SID Symp. Of Tech Papers</i> (2003).	EX1031
U.S. Patent Pub. No. 2008/0001525 to Chao et al.	EX1032
U.S. Patent No. 7,091,986 to Phan	EX1033
U.S. Patent Pub. No. 2011/0198598 to Kim et al.	EX1034
U.S. Patent Pub. No. 2007/0096637 to Kim	EX1035
U.S. Patent Pub. No. 2010/0033084 to Ko et al.	EX1036
U.S. Patent Pub. No. 2008/0128686 to Kwon	EX1037
U.S. Patent Pub. No. 2009/0194780 to Kwon	EX1038
U.S. Patent Pub No. 2011/0234550 to Hong et al.	EX1039

Petitioner BOE Technology Group Co., Ltd. (“Petitioner” or “BOE”) respectfully petitions for *inter partes* review of claims 1-5, 10-23, and 28-30 of U.S. Patent No. 11,626,066 (the “’066 patent” (EX1001)) in accordance with 35 U.S.C. §§ 311-319 and 37 C.F.R. § 42.100 *et seq.*

I. INTRODUCTION

The claims of the ’066 patent are directed to pixel arrangement structures for organic light emitting diode (OLED) displays and methods of manufacturing thereof. The pixel arrangement structure includes a plurality of green, blue, and red pixels (also referred to as first, second, and third pixels, respectively) defined by a pixel defining layer. A first green pixel has a center coinciding with a center of a virtual square having vertices at the centers of the different ones of the plurality of green pixels. At least two blue pixels and two red pixels are located within the bounds of the virtual square. This arrangement results in the red and blue pixels being spaced apart and alternately arranged in rows and in columns, effectively forming a checkerboard pattern. There are twice as many green pixels as blue pixels or red pixels.

A pixel arrangement having two green pixels for every red and blue pixel, known as an RGBG pixel arrangement, was well-known before the 2012 filing date of the ’066 patent. For example, U.S. Patent No. 6,867,549 to Cok et al. (“Cok” (EX1004)) disclosed an RGBG pixel arrangement structure for OLED

displays in 2004. Moreover, due to the rapid development of OLED technology, there were numerous materials that provided improved longevity and performance for OLED displays by 2012. A person of ordinary skill in the art (“POSITA”) would have been motivated to use such materials and optimize Cok’s pixel arrangement by using Cok’s own formula for determining pixel sizes based on OLED material properties. Further, a POSITA would have been motivated to implement the teachings of U.S. Patent Pub No. 2011/0234550 to Hong et al. (“Hong” (EX1039)) when optimizing the arrangement of Cok. Hong is directed to organic electroluminescent display devices and teaches spacing adjacent pixels apart by a same distance to prevent or reduce shadowing effects.

Furthermore, a POSITA would have been motivated to combine the teachings of Cok with U.S. Patent Pub. No. 2009/0033598 to Suh (“Suh” (EX1005)), which teaches a pixel defining layer to separate pixels of an OLED display. A POSITA would have understood that the pixel defining layer of Suh would allow for clear definition and separation of pixel areas. This would have been advantageous in accurately manufacturing pixels having the desired relative areas taught by Cok.

The combination of U.S. Patent No. 7,492,379 to Credelle et al. (“Credelle-379” (EX1006)) with Cok, Suh, and Hong, and, for some claims, U.S. Patent Pub. No. 2004/0051724 to Elliott et al. (“Elliott-724” (EX1007)), also teaches every

limitation of the challenged claims. Credelle-379 teaches an RGBG pixel arrangement. As described above, a POSITA would have been motivated to use improved OLED materials to improve the lifetime, as well as reduce power-consumption, of an OLED display. And a POSITA would have been motivated to use Cok's formula based on OLED material properties to adjust the pixel arrangements of Credelle-379, especially given that Credelle-379 explicitly contemplates adjusting the sizes and aspect ratios of its pixels. Further, Elliott-724, which is a parent application of Credelle-379, teaches that pixels can be hexagonal, which is compatible with Credelle-379's teaching that any pixel shape is desirable so long as it is manufacturable.

Petitioner thus respectfully submits the challenged claims are unpatentable for the reasons set forth in this Petition. This Petition is supported by the Declaration of Thomas Credelle (EX1002).

II. SUMMARY OF THE '066 PATENT

A. Background Of The '066 Patent

The '066 patent discloses pixel arrangement structures for an OLED display. As explained in the Background section of the patent, prior art OLED displays include "a plurality of pixels for emitting light of different colors" where a pixel is "a minimum unit for displaying [] images." (EX1001, 1:35-43.) A purported problem with OLED displays is "[w]hen reducing a gap between the neighboring

pixels to obtain a high aperture ratio of the pixels, deposition reliability may be deteriorated. On the other hand, when increasing the gap between the pixels to improve the deposition reliability, the aperture ratio of the pixels may be deteriorated.” (*Id.*, 1:51-56.)

The alleged innovation of the '066 patent is a pixel arrangement structure for an OLED display that purports to solve this problem. The patent proposes to improve the deposition process by forming “gaps of the first length L1 ... between adjacent pairs of the first pixels 100 and the second pixels 200, and between adjacent pairs of the first pixels 100 and the third pixels 300” and by forming “gaps of the third length L3 that is longer than the first length L1 ... between the neighboring ones of the first pixels 100.” (EX1001, 11:61-12:4.) It is not stated why or how this would improve the aperture ratio of the pixels.

As shown in FIG. 6 below, the pixels are arranged such that:

a center of one of the first pixels 100 is positioned at the center of the virtual square VS, a center of one of the second pixels 200 is positioned at the first vertex P1 [of the virtual square], and a center of one of the third pixels 300 is positioned at the second vertex P2 [of the virtual square] to both improve deposition reliability of the organic emission layer in the deposition process using the fine metal mask and improve an aperture of each of the first, second, and third pixels.

(*Id.*, 12:33-40.)

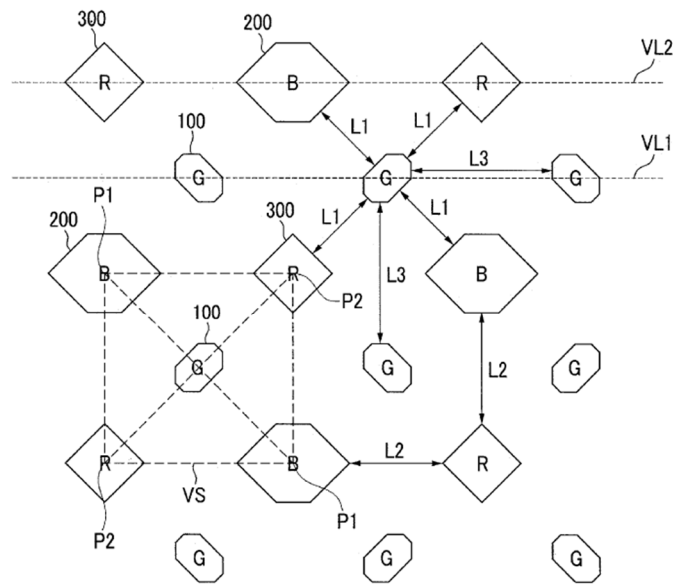


FIG. 6

Again, it is unclear why or how this arrangement would improve aperture ratio, particularly given the small areas of the pixels compared to the large distances between them, as shown by the figures of the '066 patent. (*Id.*, FIGS. 1-6.) Furthermore, these “improvements” are not recited in the independent claims. The independent claims recite that the first green pixel has a convex shape and a shortest distance between two green pixels is greater than a width of a red pixel. (*Id.*, Claims 1,15.) There is no indication in the specification as to why these recited spacings, shapes, or sizes of pixels affect the function or manufacturability of an OLED display.

B. Prosecution History Of The '066 Patent

The '066 patent was filed on June 24, 2022, as U.S. Application No. 17/005,753 and issued on April 11, 2023. The original application contained 25

claims with two independent claims. (EX1003, 1-32.)

On July 15, 2022, Patent Owner submitted a voluminous Information Disclosure Statement (IDS) with 267 references. (*Id.*, 112-128.) This IDS included Cok (EX1004), U.S. Patent Pub. No. 2011/0234550 to Hong et al. (EX1039), and U.S. Patent Pub. No. 2003/0128225 to Credelle (EX1011), the publication of the application that later became Credelle-379. (*Id.*)

On October 14, 2022, the Examiner issued a non-final rejection, rejecting claims 1-3, 5, 10, 14, 16-19, and 21 as anticipated or obvious in view of U.S. Patent No. 7,215,347 to Phan (“Phan-347” (EX1013)) or U.S. Patent Pub. No. US 2014/0191202 to Shim (“Shim” (EX1014)) in view of Phan-347. (*Id.*, 152-163.)

Patent Owner subsequently amended the independent claims to recite a pixel defining layer, that the two red and blue pixels were located “entirely” within the virtual square, and a limitation pertaining to the width of the red pixel, while removing the other limitations. (EX1003, 421-426.)

On February 21, 2023, the Examiner issued a Notice of Allowance. (*Id.*, 474-480.) While the Examiner did not provide reasons for allowability, in an interview summary, the Examiner indicated the added limitations overcame Phan-347. (EX1003, 445, 474-480.) On April 11, 2023, the '066 patent issued. On July 18, 2023, the USPTO issued a Certificate of Correction, correcting typographical errors. (*Id.*, 493.)

C. Level Of Ordinary Skill In The Art

A POSITA in the field of the '066 patent would have a bachelor's degree in electrical engineering or materials science and two years of experience working on display devices, including OLED displays, or an equivalent level of skill, knowledge, and experience. This POSITA would have been aware of and generally knowledgeable about OLED materials, display pixel design, layout, and operation. (EX1002, ¶43.)

III. CLAIM CONSTRUCTION

The '066 patent is the subject of co-pending litigation as identified in Section VI. The litigation has just begun, and a claim construction proceeding has not taken place or even been scheduled. Petitioner does not believe any claim construction is necessary for this Petition.¹ As set forth herein, the challenged claims are unpatentable under any reasonable interpretation of the claims.

¹ If trial is instituted, Petitioner reserves its right to address construction of any terms raised at trial, or in the related district court action. Petitioner believes that the '066 patent claims are invalid under at least 35 U.S.C. § 112. Because such issues cannot be raised in an IPR, Petitioner reserves the right to raise those issues in the related district court action.

IV. PRECISE REASONS FOR RELIEF REQUESTED

Pursuant to 37 C.F.R. § 42.104(b), Petitioner respectfully requests cancellation of claims 1-5, 10-23, and 28-30 of the '066 patent based on the references and statutory grounds as set forth below. All of the statutory citations are pre-AIA because Patent Owner may claim priority to a parent application filed on September 13, 2012, or an earlier date. If the Patent Owner does not claim priority, the analysis would be the same because the prior art relied upon in this Petition issued, filed, or were published years before the '066 patent's filing date.

Ground	35 U.S.C. §	Claims	Prior Art
1	103	1, 2, 4, 5, 10, 12-15, 17-20, 22, 23, 28-30	Cok (EX1004) in view of Suh (EX1005)
2	103	11	Cok in view of Suh and Hong (EX1039)
3	103	1, 2, 4, 5, 10, 12-15, 17-20, 22, 23, 28-30	Credelle-379 (EX1006) in view of Cok and Suh
4	103	3, 16, 21	Credelle-379 in view of Cok, Suh, and Elliott-724 (EX1007)
5	103	11	Credelle-379 in view of Cok, Suh, and Hong

Below, Petitioner discusses why the challenged claims are unpatentable under the statutory grounds raised, including how and where the prior art satisfies

each element of each challenged claim, as required by 37 C.F.R. § 42.104(b)(4).²

Petitioner's showing, including the accompanying Credelle Declaration (EX1002), establishes a reasonable likelihood that it will prevail on each ground of unpatentability for each challenged claim.

A. Ground 1: Cok In View Of Suh Renders Obvious Claims 1, 2, 4, 5, 10-13, 15, 17-23, 28, And 29

Cok was filed on December 10, 2002, published on June 10, 2004, and issued on March 15, 2005. (EX1004.) It qualifies as prior art to the '066 patent under at least §§ 102 (a), (b), and (e). Although the Examiner considered Cok during prosecution, it was provided in a voluminous IDS containing 267 references, and the Examiner never applied Cok in any rejection. (EX1003, 112-128.)

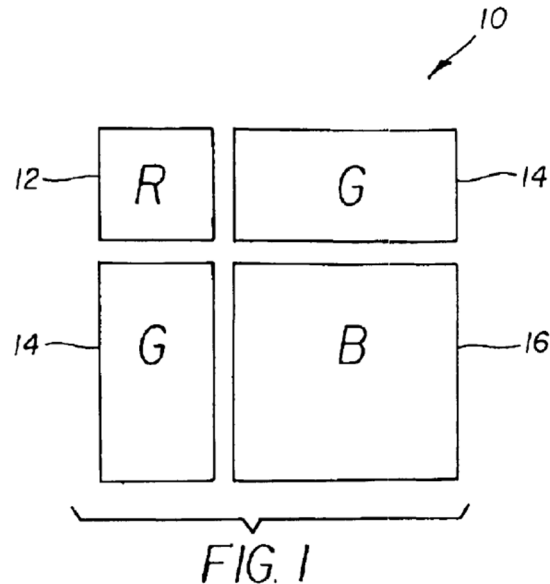
Suh was filed on May 2, 2008, and published on February 5, 2009. (EX1005.) Suh qualifies as prior art to the '066 patent under at least §§ 102(a), (b), and (e). Suh was not considered during prosecution.

1. Summary of Cok

Cok is directed to "OLED displays having repeated patterns of colored light emitting elements." (EX1004, 1:8-10.) It discloses OLED displays having

² Petitioner also shows how each claim preamble is satisfied, but does not concede that any preamble is limiting for any ground in the Petition.

repeated RGBG patterns, as shown below in FIG. 1, with each pattern including 2 green light emitting elements 14, one red light emitting element 12, and 1 blue light emitting element 16.



Cok explains that the lifetime and color quality (over time) of an OLED display can be improved by adjusting relative sizes of the red, blue, and green light emitting elements based on the properties of the materials used. (*Id.*, 4:31-45.) For example, Cok provides Equation (1) for determining the relative sizes of the pixels: $S = (A)/(E \cdot F)$, where S is the relative size of a first element to a second element, A is the relative rate of aging of the first element to the second element, E is the relative efficiency of the first element with respect to the second element, and F is the relative number of the first element with respect to the second element. (*Id.*, 3:42-55, 4:46-54.)

OLED displays are designed to achieve a desired white point “produced by a specific ratio of different colored light from the light emitting elements.” (*Id.*, 3:25-27.) Accordingly, Cok also provides Equation (2), which is an improved version of Equation (1), that takes into account a designed white point of an OLED display: $S = (A*W)/(E*F)$, where W is the relative contribution of a color to the white point. (*Id.*, 4:46-56.)

Cok further explains that:

[t]he size of one of the light emitting elements can be arbitrarily selected and the size of the other light emitting elements determined in relationship to it according to [the equation]. For example, for a pattern having red, green and blue light emitting elements, with two green elements, one red light emitting element, and one blue light emitting element, the green element can be selected first, then the sizes of the red and blue elements can be calculated according to equation (1) using $F=1/2$. The differently sized light emitting elements are then arranged in a specified pattern to define a pixel.

(*Id.*, 3:57-67.) Although FIG. 1 shows the red pixel being the smallest, “[d]ifferent materials may produce different relative sizes of pixel elements 12, 14, and 16,” and “the green light emitting elements may be smaller than both the red and blue light emitting elements.” (*Id.*, 4:16-21). Utilizing Cok’s formula optimizes the pixel arrangement by improving lifetime and color quality (over time) of an OLED display. (*Id.* 4:31-45.)

Cok is analogous art to the '066 patent at least because Cok is directed to the same problem (pixel arrangements) in the same field of endeavor (OLED displays) as the '066 patent. (EX1002, ¶58.)

2. Summary of Suh

Suh discloses an “OLED” display. (EX1005, Abstract.) Suh describes that for an OLED display to “display full colors, red (R), green (G), and blue (B) light emission layers may be patterned, respectively.” (*Id.*, [0006].) A laser induced thermal imaging (LITI) method may be used to finely pattern the organic layers and is advantageous because “[t]he LITI method can be used for a large area and is advantageous for high resolution.” (*Id.*) During the LITI method, “the light emission layers are patterned using a fine metal mask (FMM).” (*Id.*) As seen in FIG. 3 of Suh, “[t]he light emission layers 353 are formed as red light emission layers 353R, green light emission layers 353G, and blue light emission layers 353B by a laser induced thermal imaging (LITI) method using the FMM 370.” (*Id.*, [0031].)

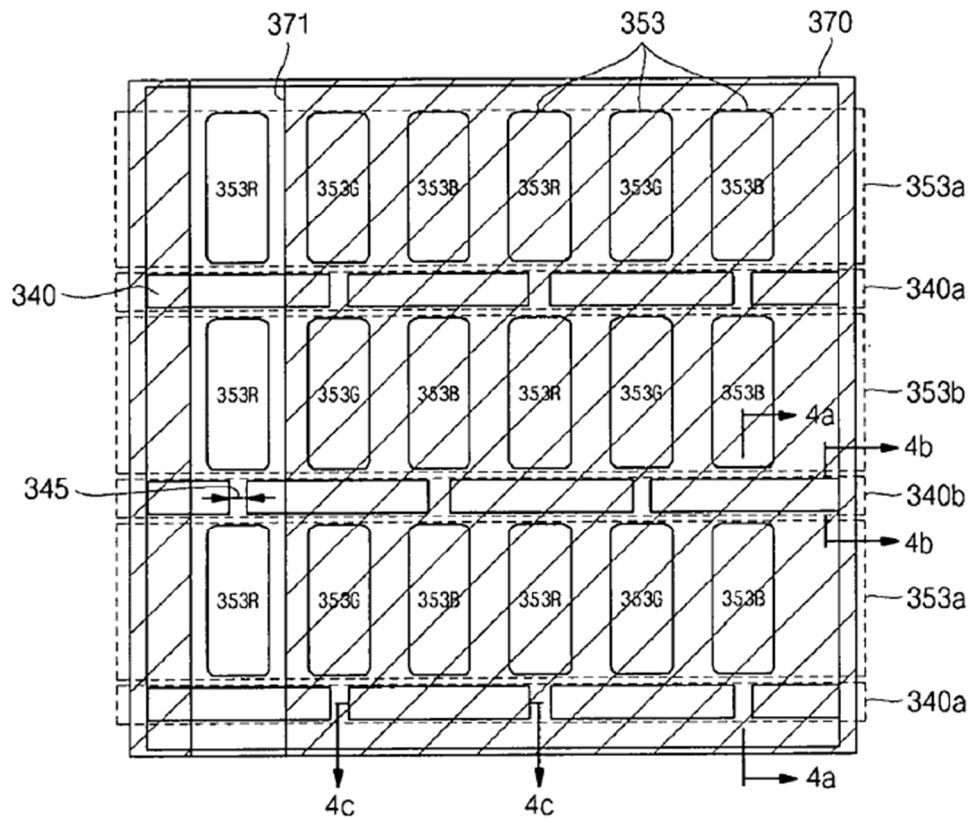
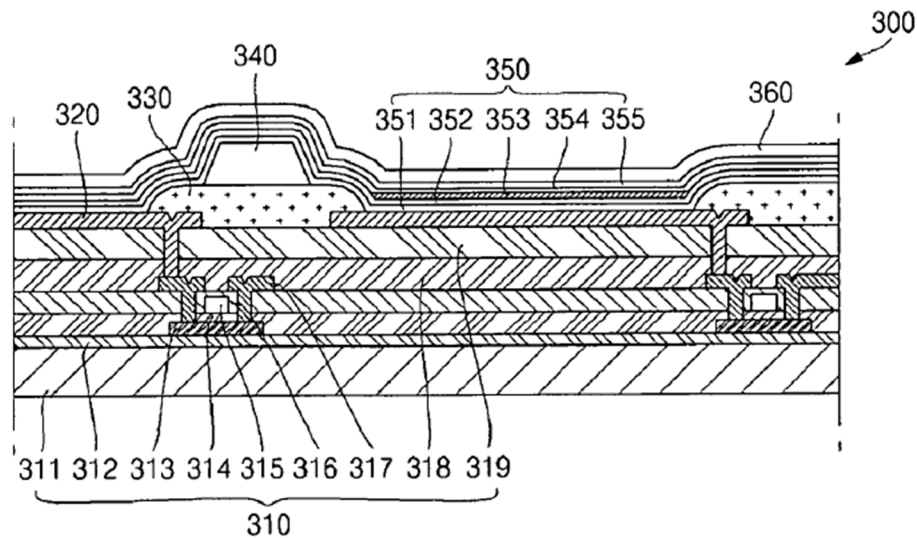
FIG. 3

FIG. 4A is a sectional view of the OLED panel 300 of FIG. 3, “include[ing] ... organic thin layers 350 formed on the anode electrodes 320, the pixel define layers 330, and the spacers 340.” (EX1005, [0035].)

FIG. 4A

As taught by Suh, “the pixel define layers 330 are formed in ... the non-light emitting region in order to increase the aperture ratio of pixels.” (*Id.*, [0048].)

Using a pixel define layer is advantageous because the “pixel define layers 330 make boundaries between the respective organic light emitting devices clearly distinguished so that light emitting boundary regions between the pixels become clear.” (*Id.*)

Suh is analogous art to the '066 patent at least because Suh is directed to the same problem (improving manufacturability of OLED displays) in the same field of endeavor (OLED displays) as the '066 patent. (EX1002, ¶62.)

3. Claim 1

a. Preamble³

Cok describes “[a]n organic light emitting diode (OLED) display.” (EX1004, 1:14-18; Abstract; EX1002, ¶63.)

b. 1[A]

Cok describes “an OLED display device for displaying a color image that includes an array of different colored independently controllable light emitting elements arranged in repeated patterns.” (EX1004, 2:14-18; Abstract.) Although Cok describes the individual light emitting elements as “light emitting elements,” a POSITA would have understood that these are merely terms referring to the same components as the claimed “pixels” in the ’066 patent. (EX1002, ¶64.)

c. 1[B]

Cok discloses OLED devices “utilize a current passed through thin-film layers of organic materials to generate light... The color of the light emitted by a light emitting element depends on the specific organic material used to make the OLED.” (EX1004, 1:13-19.) Cok also discloses that “a pixel pattern 10 in an OLED display device according to one embodiment of the present invention includes two green light emitting elements 14 having a first size (area), a red light

³ See the claims appendix for a full recitation of each claim.

emitting element 12 having a second smaller size, and a blue light emitting element 16 having a larger size,” and that pixel patterns are repeated within the OLED display device, such that there are a plurality of red, green, and blue light emitting elements. (EX1004, 2:14-19, 3:1-5, 4:7-13; EX1002, ¶65.) Suh also discloses “[t]he light emission layers 353 are formed as red light emission layers 353R, green light emission layers 353G, and blue light emission layers 353B.” (EX1005, [0031]; EX1002, ¶65.)

d. 1[C]

See limitation 1[B]. (EX1002, ¶66.)

e. 1[D]

See limitation 1[B]. (EX1002, ¶67.)

f. 1[E]

Suh discloses “the pixel define layers 330 are formed in a region corresponding to the transistor structure, that is, the non-light emitting region in order to increase the aperture ratio of pixels” and that the “pixel define layers 330 make boundaries between the respective organic light emitting devices clearly distinguished so that light emitting boundary regions between the pixels become clear.” (EX1005, [0048].) As discussed below, a POSITA would have been motivated to combine the pixel define layer of Suh with the pixel arrangement structure of Cok, because the pixel define layer of Suh allows for clear definition and separation of pixel areas, which is advantageous in accurately manufacturing

pixels having the desired relative areas taught by Cok. (EX1002, ¶68.)

Motivation to Combine Cok with Suh

A POSITA would have found it obvious to use the OLED structure (including the pixel define layer) taught by Suh with the pixel arrangement pattern of Cok. Both Cok and Suh are analogous art because they are in the same field as the '066 patent. *Wyers v. Master Lock Co.*, 616 F.3d 1231, 1237-39 (Fed. Cir. 2010). (*See also* EX1002, ¶69.)

Furthermore, the teachings of Cok are “advantageously practiced with both top-emitting and bottom-emitting OLED active matrix devices.” (EX1004, 5:53-55.) A POSITA would have known that using a pixel defining layer to define the pixels was beneficial in active matrix OLED devices. (EX1002, ¶70.) By the earliest priority date of the '066 patent, there were numerous publications describing the use of such pixel defining layers in OLED displays, including Patent Owner’s own patent applications. (*See* EX1005, [0048]; EX1034, [0059]-[0061]; EX1035, [0043]; EX1036, [0022], [0037], [0040]; EX1037, [0054]-[0056], [0078]; EX1038, [0013]; EX1002, ¶70.) Indeed, as discussed in the '066 patent, configurations such as insulation layers and pixel defining layers were known technologies in the art. (EX1001, 4:58-65; EX1002, ¶70.) Further, Suh discloses that the “[t]he pixel define layers 330 make boundaries between the respective organic light emitting devices clearly distinguished so that light emitting boundary

regions between the pixels become clear.” (EX1005, [0048].) A POSITA would have understood that clear boundaries also mean that the area of the pixel would be more defined such that the relative sizes of pixels in Cok can be accurately determined to adjust for color or aging differences. (EX1002, ¶70.)

A POSITA would have been motivated to make this combination. Doing so would have been a simple application of the structure taught by Suh to form the OLED display taught by Cok with predictable results because the two references describe the same, underlying OLED technology. (EX1002, ¶71.) Indeed, a POSITA would have viewed Suh as disclosing just one more way to manufacture the OLED display of Cok. (*Id.*)

Moreover, a POSITA would have recognized that the combination would provide benefits. (EX1002, ¶72.) The pixel define layer of Suh which defines the pixels and “make boundaries between the respective organic light emitting devices clearly distinguished” complements the teachings of Cok. (EX1005, [0048].) Cok teaches using particular relative dimensions for pixels based on a formula because “the light emitting elements will age at approximately the same rate, thus improving the lifetime of the device.” (EX1004, 4:31-36.) A POSITA would have understood that the pixel define layer of Suh would allow for clear definition and separation of pixel areas, which is advantageous in accurately manufacturing pixels having the desired optimized areas taught by Cok. (EX1002, ¶72.)

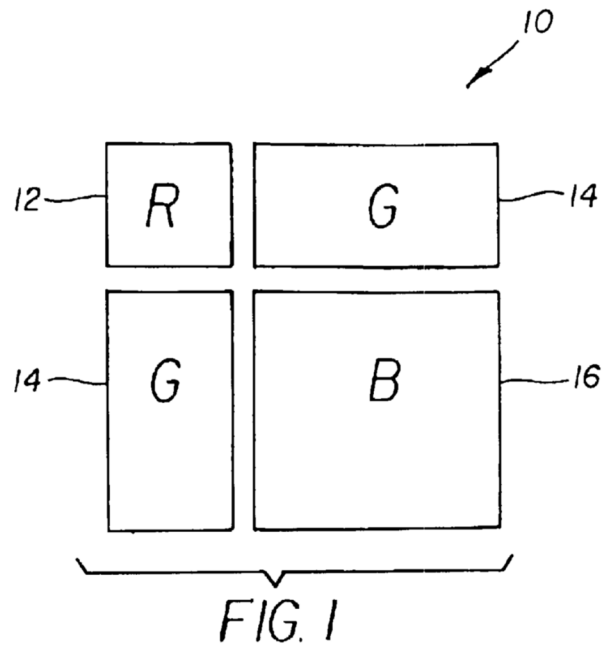
A POSITA would have reasonably expected the combination to succeed. (EX1002, ¶73.) Both references relate to OLED display technology. This combination would have been straightforward. (*Id.*)

g. 1[F]

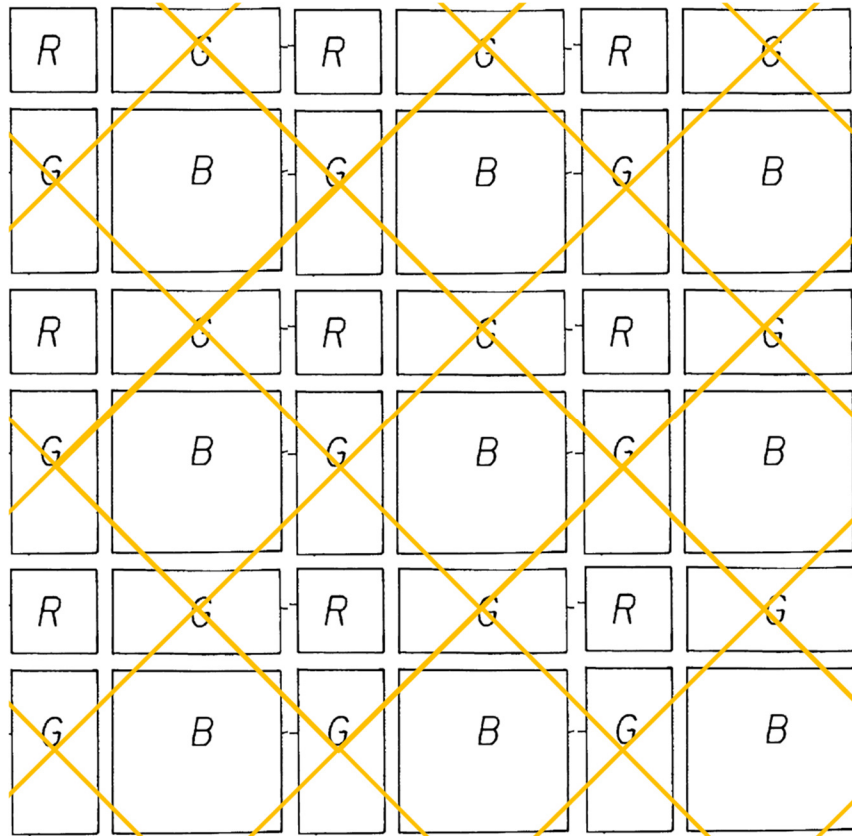
Suh discloses that the “pixel define layers 330 make boundaries between the respective organic light emitting devices clearly distinguished so that light emitting boundary regions between the pixels become clear.” (EX1005, [0048]; EX1002, ¶74.)

h. 1[G]

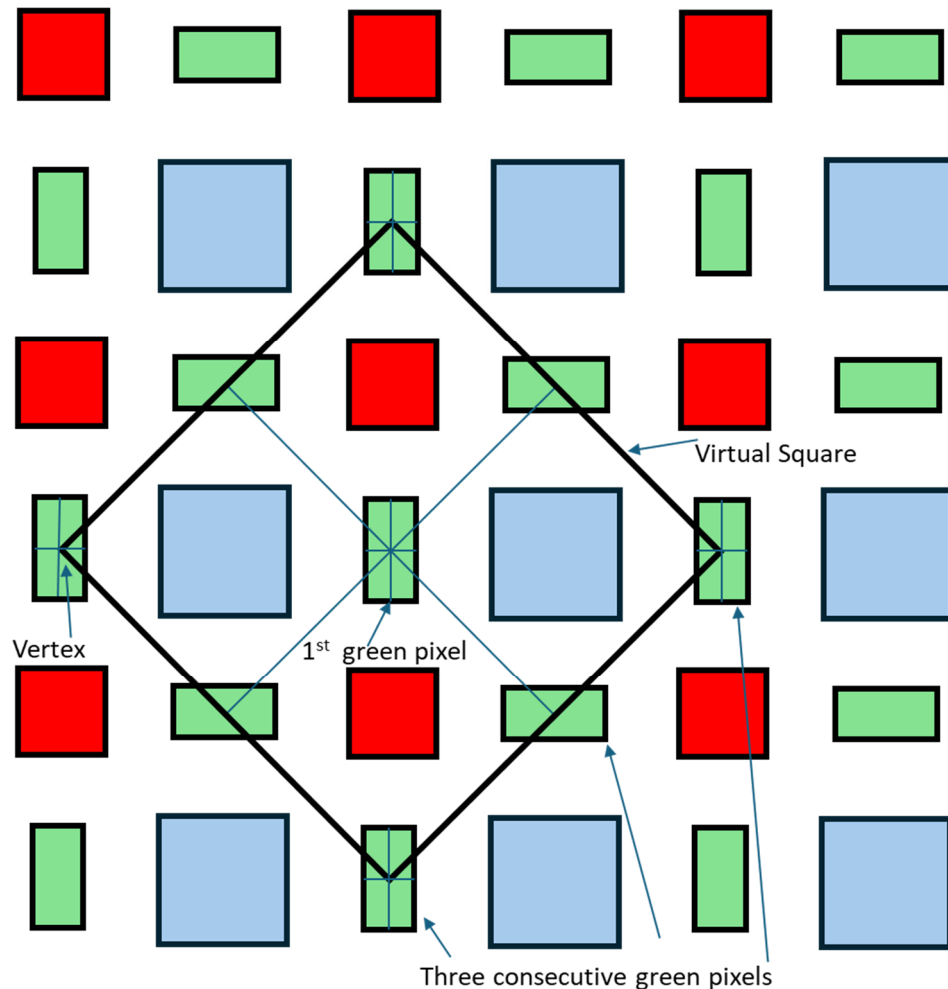
As discussed above, Cok discloses “an array of different colored independently controllable light emitting elements arranged in repeated patterns.” (EX1004, 6:1-4.) Further, “the repeated patterns are aligned with each other.” (*Id.*, 6:25-26.) One such pattern is the “square pixel arrangement” shown in FIG. 1, which includes “two green light emitting elements 14 having a first size (area), a red light emitting element 12 having a second smaller size, and a blue light emitting element 16 having a larger size.” (*Id.*, 4:8-13; EX1002, ¶75.) A POSITA would have recognized that in Cok’s square pixel arrangement unit, the red and blue pixels are squares, and the two green pixels are identical save for their orientation. (EX1002, ¶75.)



Cok teaches repeating such patterns to form an array. (EX1004, 6:1-4; 6:25-26.) This pattern is repeatable as shown below. (EX1002, ¶76.) The green pixels are positioned such that the centers of the green pixels are on an equal grid spacing, as shown by the orange grid below. (*Id.*) A POSITA would have recognized the units of the grid as forming squares based on the periodic symmetry in the positions of pixel centers provided by the RGBG pattern. (*Id.*)



As discussed below, a POSITA would have been motivated to modify FIG. 1 of Cok as follows, with a green pixel having a center coinciding with a center of a virtual square, each vertex of the virtual square coinciding with a center of a different one of the plurality of green pixels and each edge of the virtual square overlapping three consecutive green pixels. (EX1002, ¶77.)



Such a modification would also preserve aspects of Cok relied upon above because changing the sizes of the pixels would not change the basic structure or operation of the OLED display. (EX1002, ¶78.)

Motivation to Modify FIG. 1 of Cok in view of Cok Equation (2)

A POSITA would have been motivated to modify FIG. 1 of Cok, as above, in order to improve the lifetime and performance of an OLED display. (EX1002, ¶¶80-82.) Between the publication date of Cok in 2004 and the earliest claimed priority date of the '066 patent in 2012, there was “rapid[] develop[ment]” of

OLED technology, including in the organic materials used for the emission layers of an OLED display. (EX1008 (“Nishimura”), 310; EX1002, ¶80; *see also* EX1023, EX1026.) A POSITA would have known that such materials provided better longevity and performance for OLED displays. (EX1002, ¶80.)

For example, Nishimura (circa 2009) describes new phosphorescent host materials for red and green phosphorescent emitters that demonstrated lower driving voltages, higher efficiency, and longer lifetimes. (EX1008, 310-312.) Table 3 (below) of Nishimura shows the performance of OLED displays using older, fluorescent materials and newer green and red phosphorescent materials. (EX1002, ¶81.)

Table 3. Estimated results of 2.0" QVGA display performance. The power by TFT is not included.

	CIE _x	CIE _y	L/J (cd/A)	Voltage (V)	Power (mW)	Half lifetime (hr)
All fluorescence						
Blue	0.13	0.08	5.1	5	91	19,000
Green	0.21	0.69	37.1	5	67	126,000
Red	0.67	0.33	20.8	5	57	230,000
				total	215	
Blue:Fluorescence, G,R:Phosphorescence						
Blue	0.13	0.08	5.1	5	91	19,000
Green	0.24	0.71	77.5	5	32	25,000
Red	0.67	0.33	26.9	5	44	>600,000
				total	167	

Based on Table 3 above, a POSITA would have understood that the improved red and green phosphorescent materials resulted in an OLED display that consumed overall less power (167 mW) when driven at the same voltage (5 V).

(EX1002, ¶82.) A POSITA would have understood decreasing the power consumption of an OLED allows for OLEDs with higher efficiency and longer lifetimes. (EX1008, 310; EX1002, ¶82.) In view of this knowledge, a POSITA would have been motivated to use such improved materials to improve the lifetime, as well as reduce power-consumption, of an OLED display. (EX1002, ¶82.)

Cok discloses that “different materials may produce different relative sizes of pixel elements 12, 14, and 16. For example, for some combinations of materials, the green light emitting elements may be smaller than both the red and blue light emitting elements.” (EX1004, 4:16-21.) A POSITA would have turned to Cok’s formula for determining pixel size based on the OLED materials to be used, because the formula provides an optimized pixel arrangement with improved lifetime and color quality (over time). (*Id.*, 4:31-45; EX1002, ¶¶83-84.) Specifically, a POSITA would have looked to Cok’s Equation (2) (*i.e.*, the improved version of Equation (1) which considers a desired white point) to determine the relative sizes of red, blue, and green light emitting elements.⁴

⁴ Cok also refers to an Equation (3). (EX1004, 5:3.) But this equation is for displays where a usage pattern is known beforehand, and the display is intended to predominately display a particular color. (*Id.*, 4:57-61.) A POSITA would have

(EX1002, ¶83-84.) For the relative area of a red pixel compared to a green pixel, the equation would be $S[r \text{ to } g] = (A[r \text{ to } g] \times W[r]) / (E[r \text{ to } g] \times 0.5)$, and a POSITA would have used, *e.g.*, the yellow table below of Nishimura, for the values of E, W, and A given its improved materials. (EX1002, ¶85.)

Table 3. Estimated results of 2.0" QVGA display performance. The power by TFT is not included.

	CIE _x	CIE _y	L/J (cd/A)	Voltage (V)	Power (mW)	Half lifetime (hr)
All fluorescence						
Blue	0.13	0.08	5.1	5	91	19,000
Green	0.21	0.69	37.1	5	67	126,000
Red	0.67	0.33	20.8	5	57	230,000
				total	215	
Blue:Fluorescence, G,R:Phosphorescence						
Blue	0.13	0.08	5.1	5	91	19,000
Green	0.24	0.71	77.5	5	32	25,000
Red	0.67	0.33	26.9	5	44	>600,000
				total	167	

“E” Value

Nishimura shows the luminous flux L/J (also known as current efficiency) of the red, blue, and green materials. (EX1002, ¶86.) Based on the yellow table of Nishimura, a POSITA would have known that the relative luminance efficiency of

understood that a display that is optimized to display predominately a particular color would have a much more limited use case than a display that can efficiently produce a white color gamut. (EX1002, ¶84.)

red to green ($E[r \text{ to } g]$) can be calculated as $26.9 \text{ cd/A} / 77.5 \text{ cd/A} = 0.3471$. (*Id.*)

Similarly, a POSITA would have calculated the luminance efficiency of blue to green ($E[b \text{ to } g]$) as $5.1 \text{ cd/A} / 77.5 \text{ cd/A} = 0.0658$. (*Id.*)

“W” Value

Nishimura also shows the chromaticity coordinates ($CIEx$ and $CIEy$) of the red, blue, and green materials, which can be used to calculate how much of each color contributes to a desired white point. (EX1002, ¶¶87.) A POSITA would have chosen a white point of D65 since it was an industry standard for OLED displays. (EX1002, ¶¶90.) Based on the chromaticity coordinates in the yellow table, a POSITA would have converted the $CIEx$ and $CIEy$ values to tristimulus values, and balanced the intensities of the red, blue, and green pixels to achieve D65. (EX1002, ¶¶87-93.) After balancing the intensities, a POSITA would have also known that the contribution of red light to achieving a white point of D65 ($W[r]$) is 0.2813. (EX1002, ¶¶93.) Similarly, a POSITA would have also known that the contribution of blue light to the white point ($W[b]$) is 0.1059 (*Id.*)

“A” Value

A POSITA would have further understood that the half-lifetime for each color emitter could be used to determine an aging curve for each color emitter. (EX1002, ¶¶94.) As described by Cok, “A” represents “the relative rate of aging to a given minimum threshold of the first light emitting element with respect to the

second.” (EX1004, 3:45-47.) A POSITA would have chosen a minimum threshold as the time when an OLED screen was degraded to a visibly defective state due to pixel aging. (EX1002, ¶95.) For example, a POSITA would have known that a luminance drop between 9% - 15% caused significant distortion in an OLED display. (EX1002, ¶95; EX1009, FIG. 12; FIG. 13.) Accordingly, a POSITA would have chosen the minimum threshold as when the blue pixel (the pixel that ages the fastest) drops in luminance by 9%, which occurs at approximately 2,600 hours. (EX1002, ¶95.)

Based on the aging curves, a POSITA would have known that after aging approximately 2,600 hours, the luminescence of the red pixel at 2,600 hours was .9970, the luminescence of a green pixel would drop to .9305, and the luminescence of a blue pixel would drop to .9095. (EX1002, ¶96.) Accordingly, a POSITA would have calculated the aging factor of the red light emitting element compared to the green light emitting element ($A[r \text{ to } g]$) as $(1/.9970)/(1/.9305) = 0.9333$. (*Id.*) Similarly, a POSITA would have calculated the aging factor of the blue light emitting element compared to the green light emitting element ($A[b \text{ to } g]$) as $(1/.9095)/(1/.9305) = 1.023$. (*Id.*)

Calculation of “S”

Using those values in combination with Equation (2) of Cok, a POSITA would obtain the relative size of a red pixel compared to a green pixel ($S[r \text{ to } g]$) =

$(0.9333 \times 0.2813)/(0.3471 \times 0.5) = 1.513$. (EX1002, ¶97.) Similarly, a POSITA would obtain the relative size of the blue pixel to the green pixel ($S[b \text{ to } g]$) = $(1.023 \times .1059)/(.0658 \times 0.5) = 3.293$. (*Id.*)

Pixel Arrangement

As Cok does not teach absolute sizes, to achieve these area ratios, a POSITA would have begun, as taught by Cok (EX1004, 3:57-67), with choosing the size of one of the light emitting elements, and used the area ratios to determine the size of the other light emitting elements accordingly. (EX1002, ¶98.) Furthermore, in determining how to implement the area ratios with Cok's default RGBG pattern, the POSITA would have recognized that there were four possible options: 1) changing the size of each pixel, 2) maintaining the red pixels and adjusting the blue and green pixels relative to the red, 3) maintaining the green pixels and adjusting the red and blue pixels relative to the green, and 4) maintaining the blue pixels and adjusting the red and green pixels relative to the blue. (*Id.*) Depending on other design choices, the POSITA would have understood that all or only some of these four options would have been viable, but in any event would have found each to be obvious to try with a reasonable expectation of success. (*Id.*) Here, the POSITA would have found it especially suitable to maintain the area of the red pixel because it is most likely to avoid pixel overlap when adjusting pixel sizes while maintaining the positions of pixel centers (an important consideration, as explained

in the next paragraph). (*Id.*)

Considering an OLED display with a 0.16 mm pixel pitch (typical for displays in the 2000s), a POSITA would have determined that reasonable dimensions of the red light emitting element would be $60\text{ }\mu\text{m} \times 60\text{ }\mu\text{m}$ or an area of $3600\text{ }\mu\text{m}^2$, which is reasonable considering OLED efficiencies, display luminance targets, and manufacturing tolerances and design rules in the 2000s. (EX1002, ¶¶99.) Using the relative areas calculated above, a POSITA would have obtained an area of $2380\text{ }\mu\text{m}^2$ for the green light emitting element and an area of $7835\text{ }\mu\text{m}^2$ for the blue light emitting element. (*Id.*)

As discussed in Cok, a POSITA would have then arranged the differently-sized light emitting elements in the specified pattern of FIG. 1 of Cok. (EX1004, 3:65-67; EX1002, ¶¶100.) For example, a POSITA would have maintained the relative centers of the light emitting elements, such that the centers of each pixel line up as shown in the pattern of FIG. 1. (*Id.*) Further, a POSITA would have repeated the RGBG pattern as taught by Cok, of four pixels with equal spacing between the four-pixel pattern, because it is important for the accurate display of information that digital image data be displayed on a uniform, equal-spaced grid of RGBG patterns. (EX1002, ¶¶102-104.)

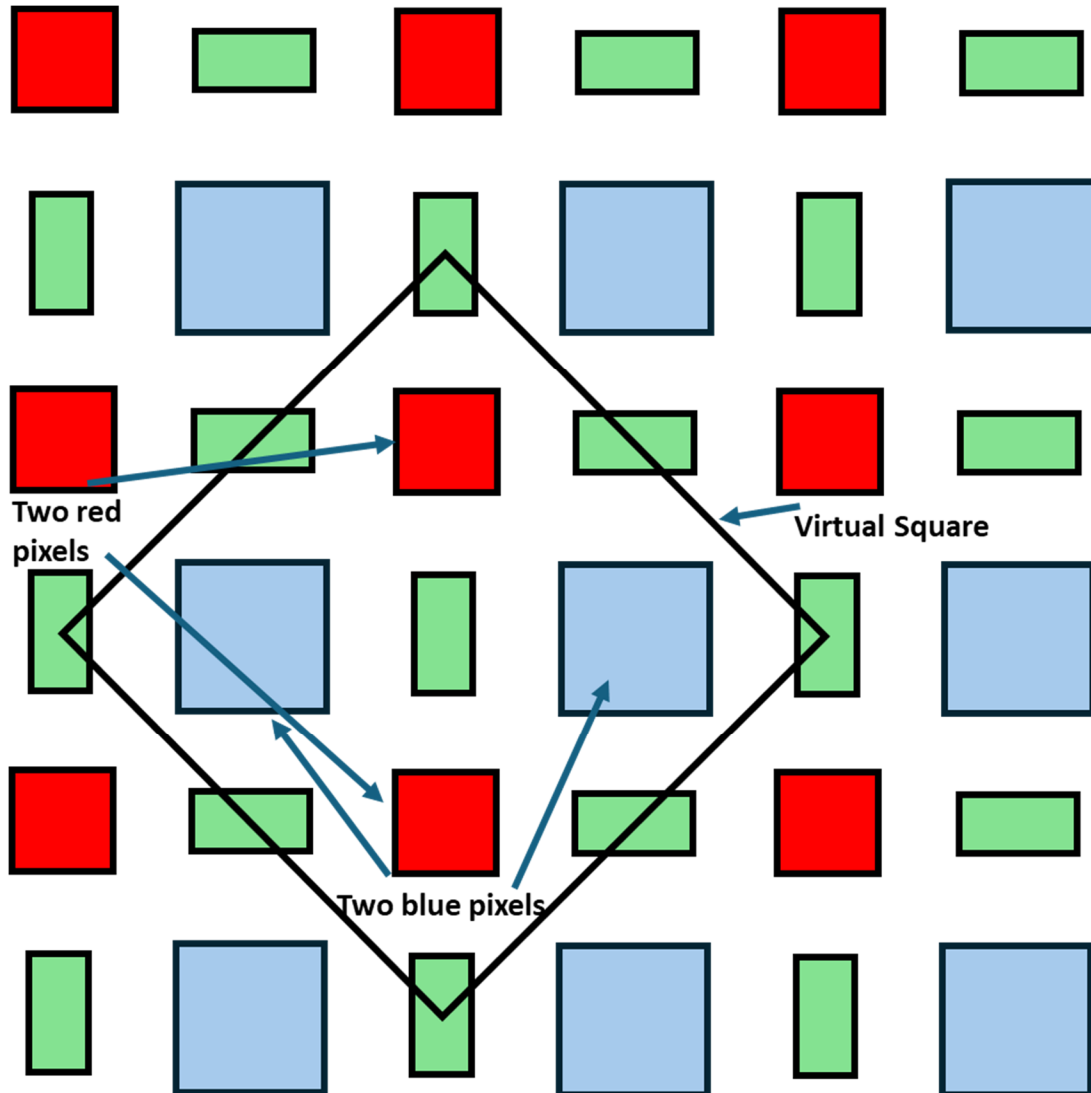
A POSITA would also have found it obvious to maintain the aspect ratios of the pixels shown in FIG. 1 because these aspect ratios are part of the specified

pattern of FIG. 1. (EX1004, 3:65-67; EX1002, ¶101.) A POSITA, when considering the teachings of Cok, would have identified two possible options: using the aspect ratios taught by FIG. 1 of Cok or further modify FIG. 1 of Cok to use different area ratios. (EX1002, ¶101.) Considering these finite options, it would have been obvious to try maintaining the aspect ratios shown in FIG. 1 of Cok when modifying the pixel sizes as taught by equation (2) of Cok. (*Id.*) A POSITA would have then repeated the resulting pattern to form the OLED display as shown above. (EX1004, 3:65-67; EX1002, ¶101.)

A POSITA would have reasonably expected to succeed in modifying Cok in the manner discussed above. (EX1002, ¶¶105-107.) Cok itself discloses that “different materials may produce different relative sizes of pixel elements 12, 14, and 16. For example, for some combinations of materials, the green light emitting elements may be smaller than both the red and blue light emitting elements.” (EX1004, 4:16-21.) Cok then provides an equation to determine those relative sizes. (*Id.*, 4:50.) The computed sizes result in a pixel arrangement, as shown above, that would have a reasonable expectation of success. (*Id.*)

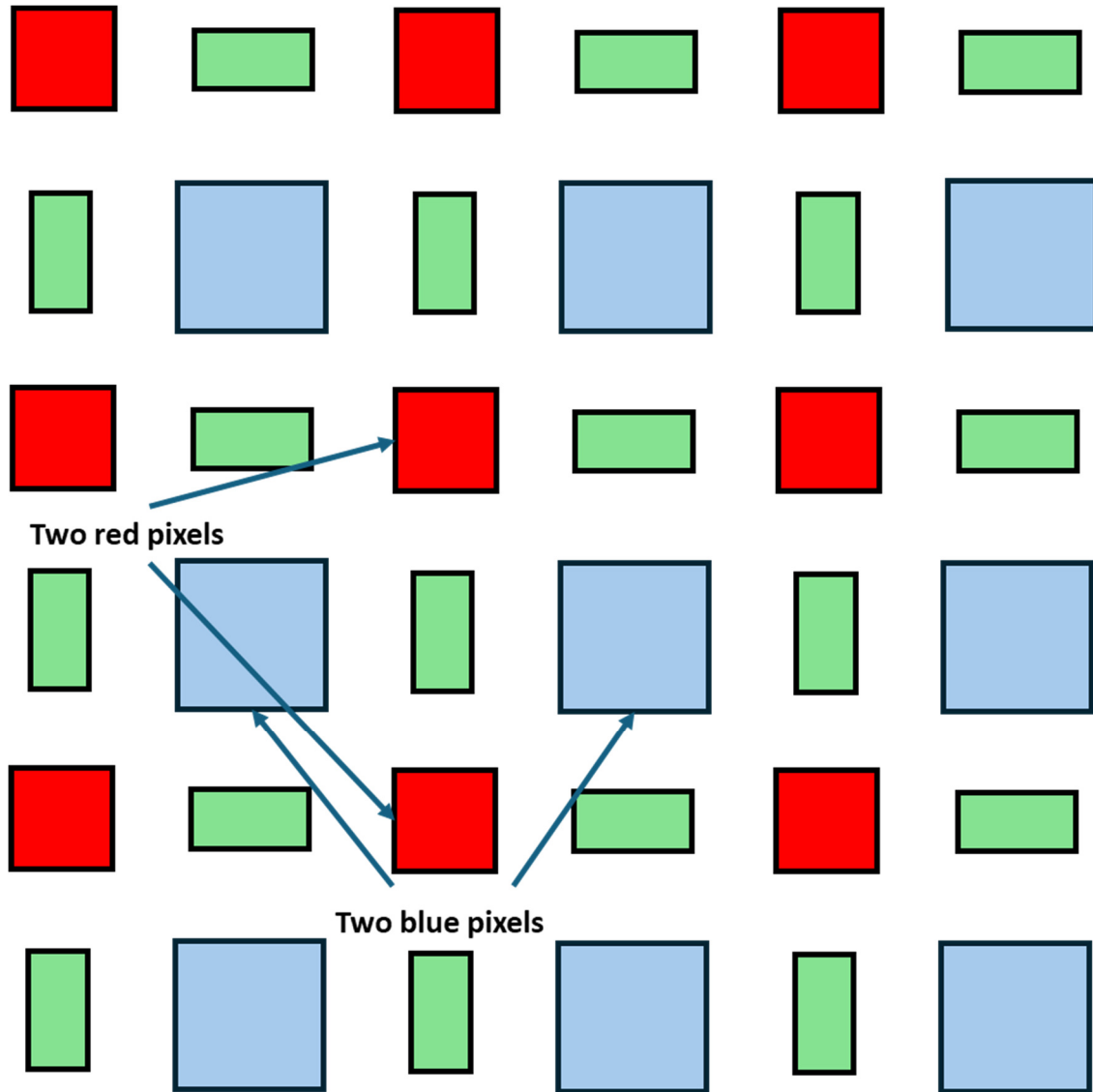
i. 1[H]

As shown below, two blue pixels and two red pixels are located entirely within boundaries of the virtual square. (EX1002, ¶108.)



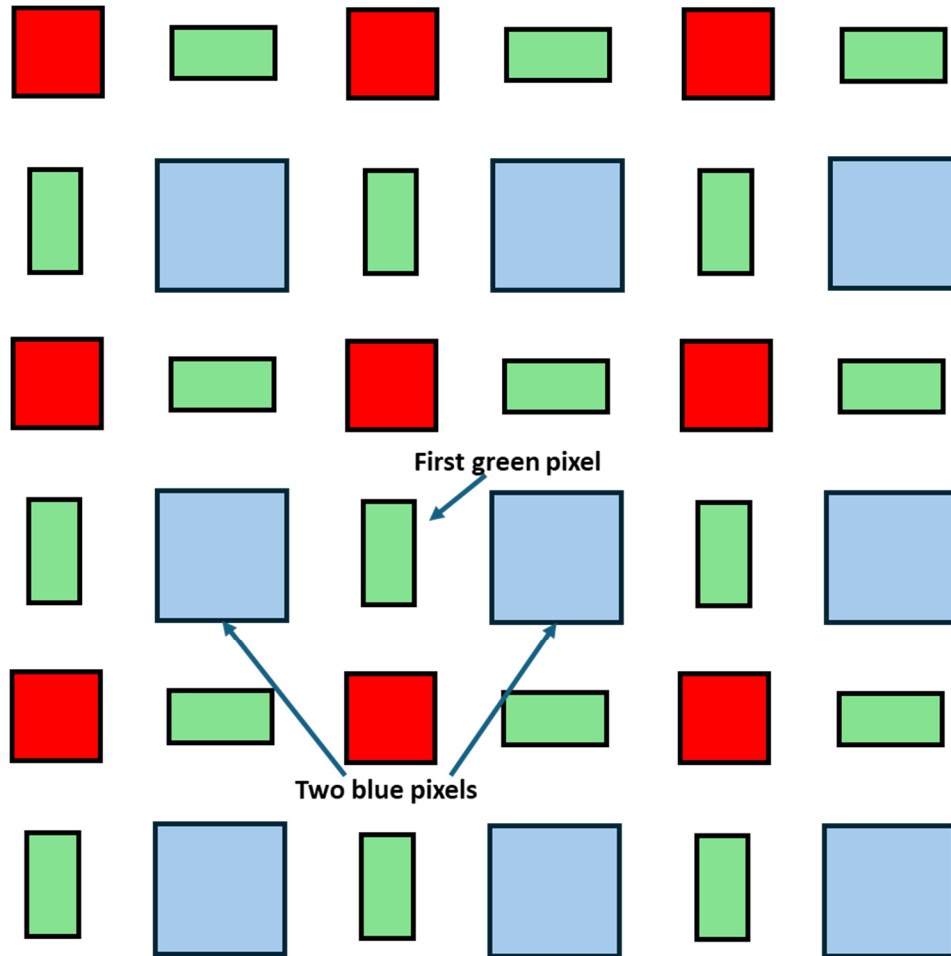
j. 1[I]

As shown below, the two blue pixels each have an area of $7835 \mu\text{m}^2$, which is larger than the area of each of two red pixels ($3600 \mu\text{m}^2$). (EX1002, ¶109.)



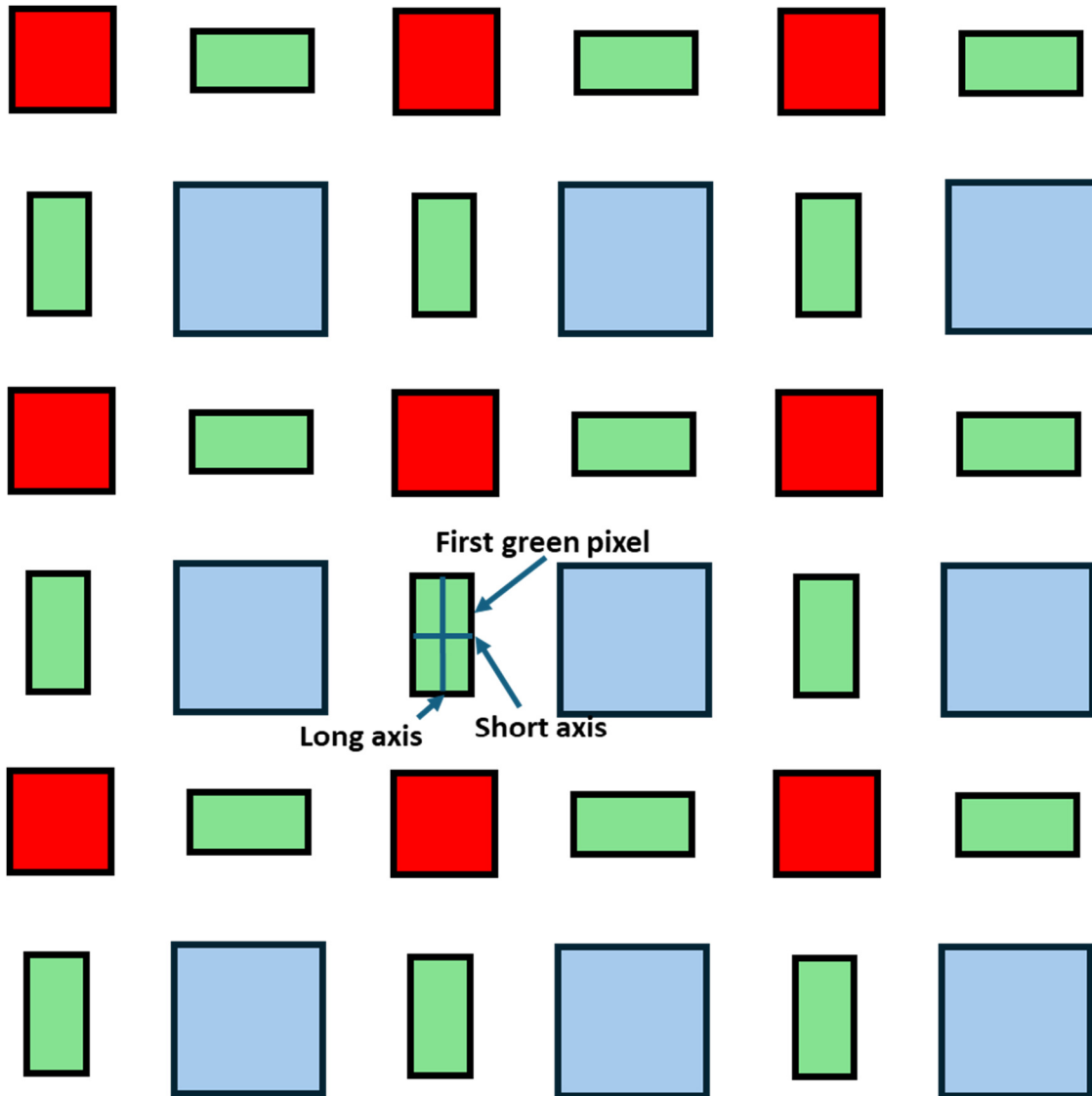
k. 1[J]

The two blue pixels each have an area of $7835 \mu\text{m}^2$, which is larger than the area of the green pixel ($2380 \mu\text{m}^2$), as shown below. (EX1002, ¶110.)



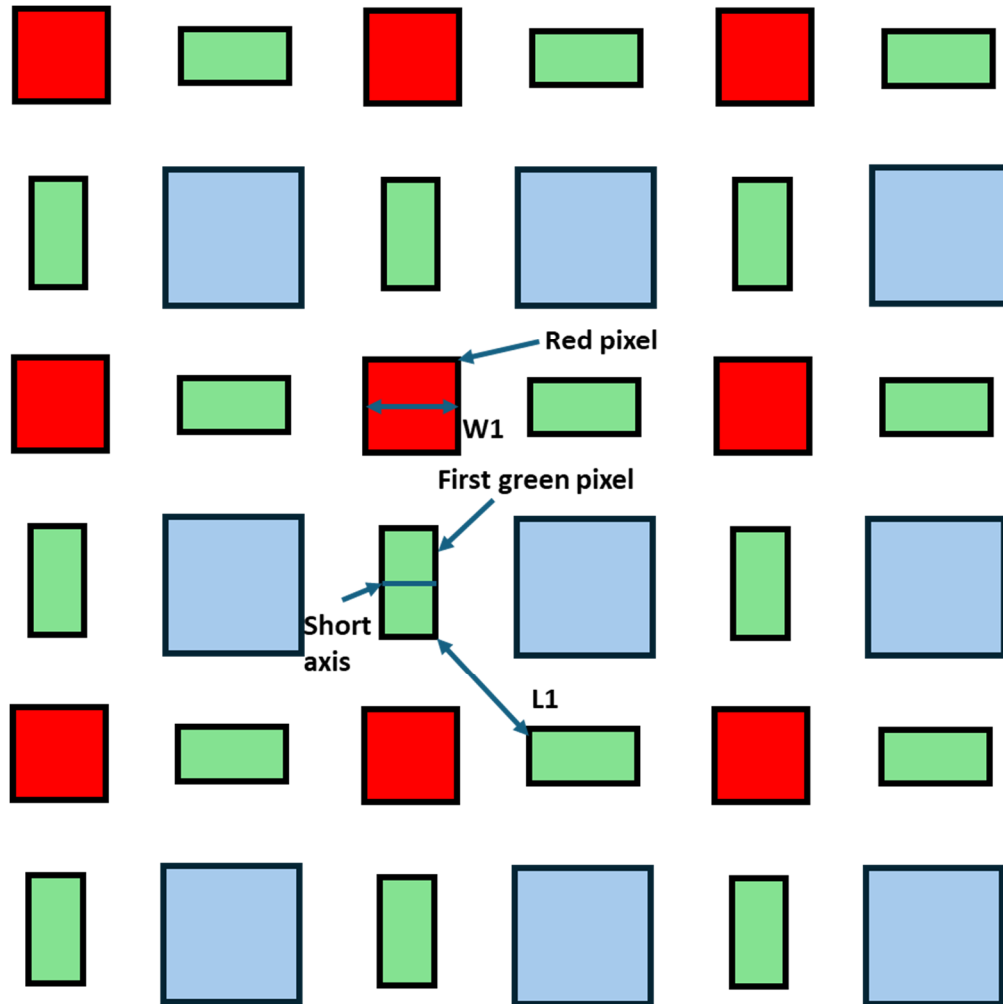
I. 1[K]

As shown below, the green pixel has a convex shape such that a line along the long axis of the green pixel ($68.986\text{ }\mu\text{m}$) has a greater length than a line along a short axis of the green pixel ($34.493\text{ }\mu\text{m}$). (EX1002, ¶111.)



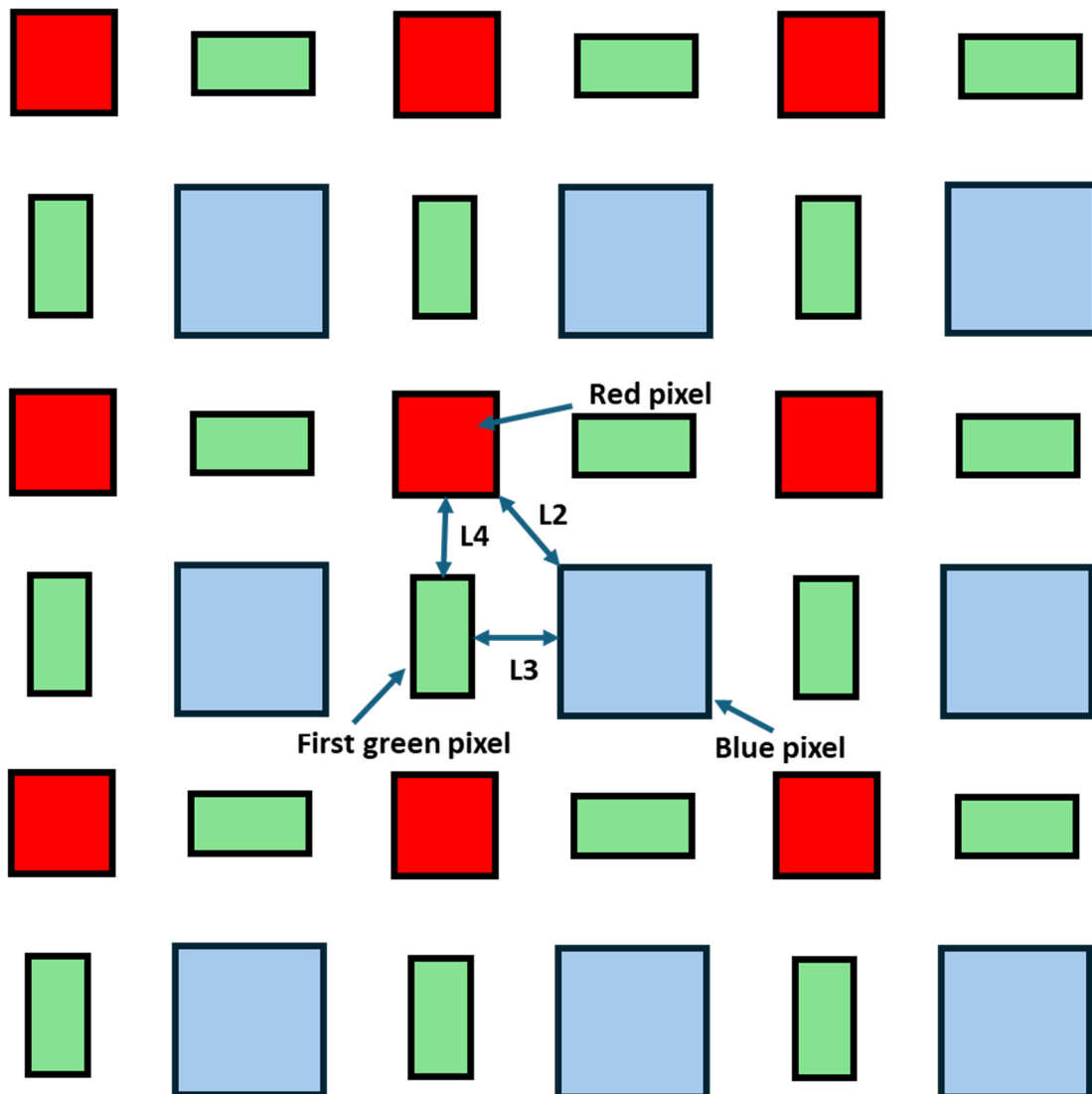
m. 1[L]

A shortest distance L1 (86.829 μm) between two nearest green pixels is greater than a width W1 (60.000 μm) of a first red pixel along a direction parallel to the short axis of the first green pixel, as shown below. (EX1002, ¶¶112-120.)



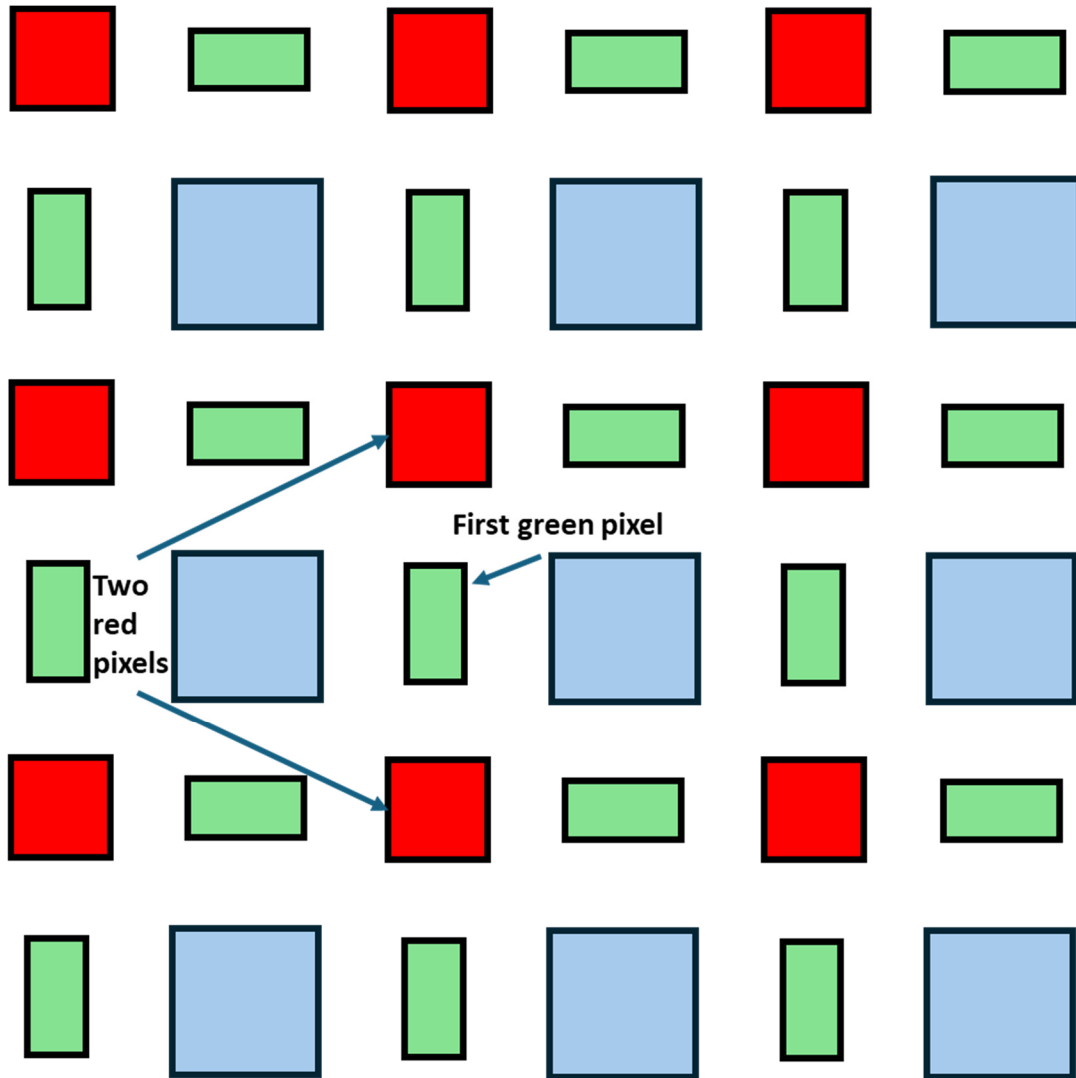
4. Claim 2

As shown below, a shortest distance L2 (54.984 μm) between one of the two blue pixels and one of the two red pixels is greater than a shortest distance L3 (51.633 μm) between the first green pixel and the one of the two blue pixels or a shortest distance L4 (48.644 μm) between the first green pixel and the one of the two red pixels. (EX1002, ¶121-124.)



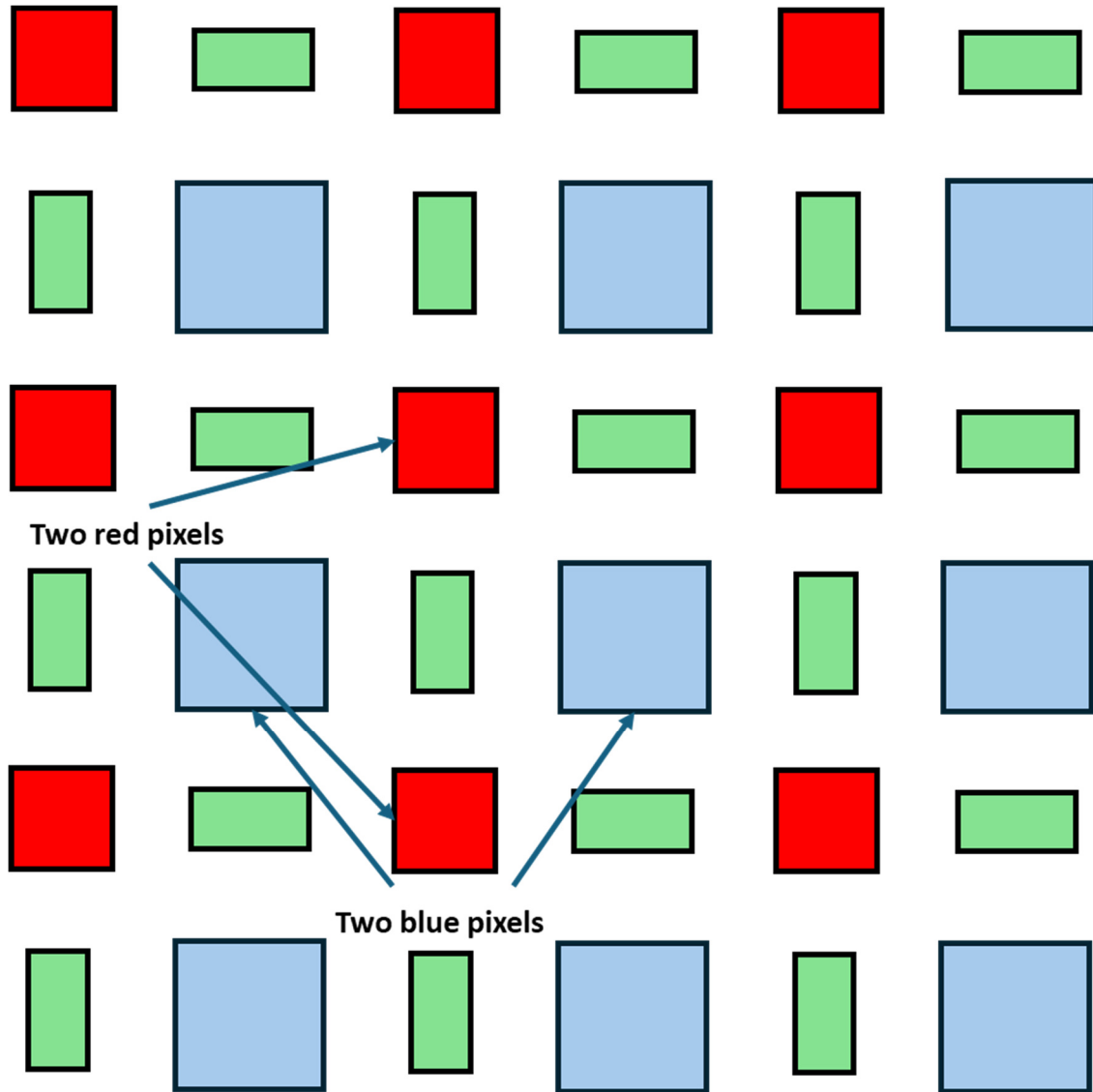
5. Claim 4

As shown below, the two red pixels each have an area of $3600\text{ }\mu\text{m}^2$, which is larger than the area of the green pixel ($2380\text{ }\mu\text{m}^2$). (EX1002, ¶125.)



6. Claim 5

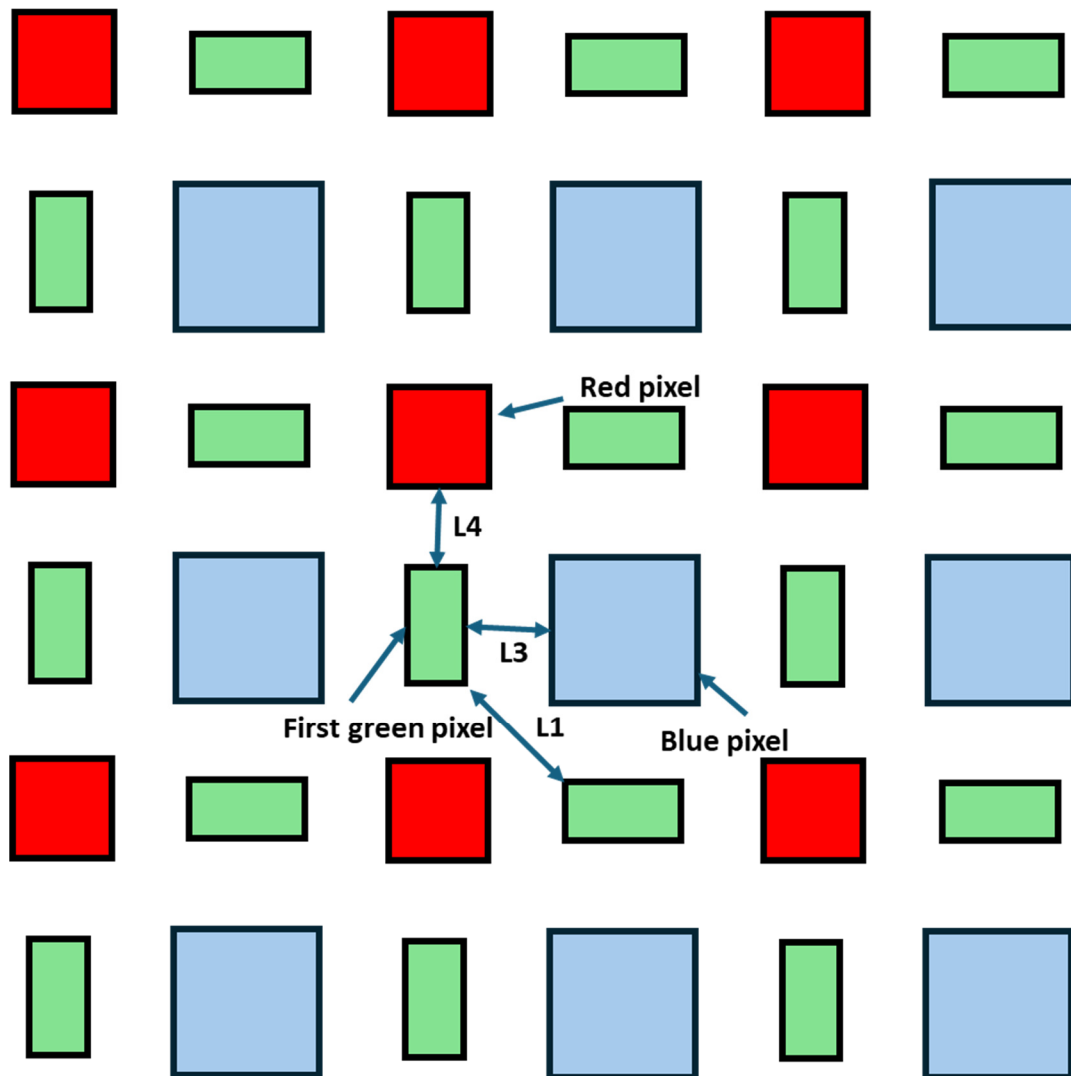
As shown below, the two blue pixels and the two red pixels have polygonal (e.g., “quadrangle”) shapes. (EX1002, ¶126.)



7. Claim 10

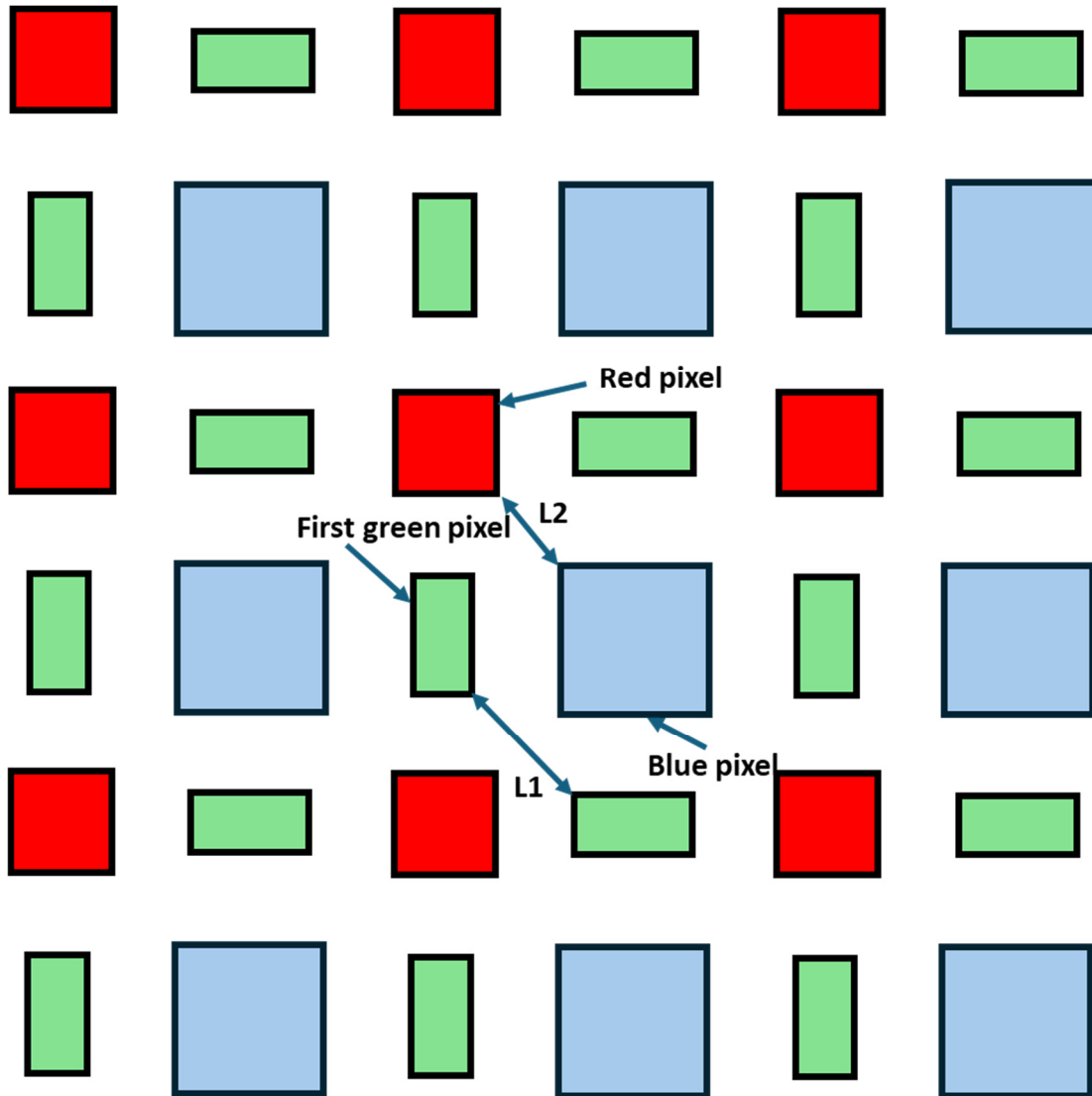
As shown below, a shortest distance L1 ($86.829\text{ }\mu\text{m}$) between the first green pixel and an adjacent green pixel is greater than a shortest distance L3 ($51.633\text{ }\mu\text{m}$) between the first green pixel and one of the two blue pixels or a shortest distance L4 ($48.644\text{ }\mu\text{m}$) between the first green pixel and one of the two red pixels.

(EX1002, ¶127.)



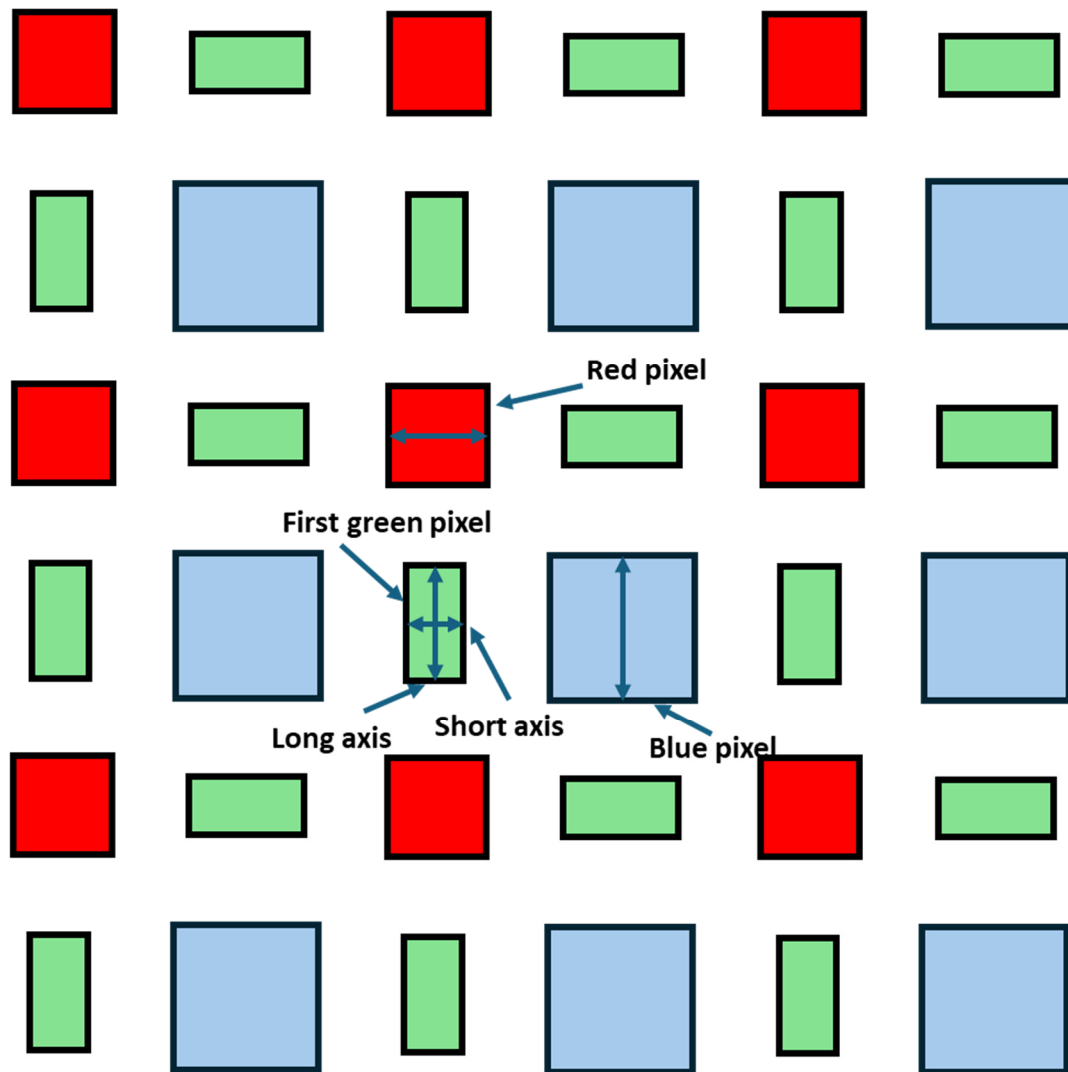
8. Claim 12

As shown below, a shortest distance L1 ($86.829\text{ }\mu\text{m}$) between two nearest green pixels not equal to a shortest distance L2 ($54.984\text{ }\mu\text{m}$) between one of the two blue pixels and one of the two red pixels. (EX1002, ¶128.)



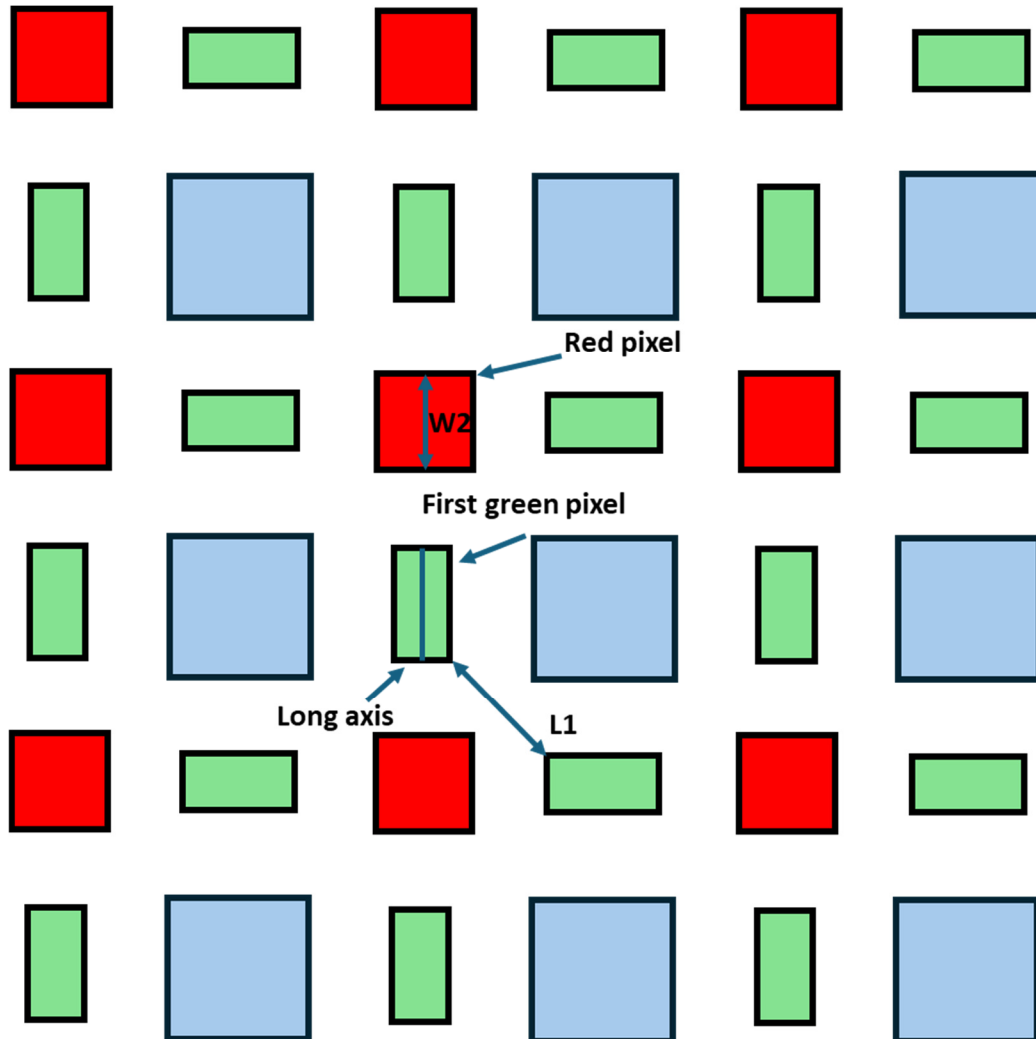
9. Claim 13

A width of the first green pixel along the short axis (34.493 μm) is different from a width of one of the red pixels along the first direction (60.000 μm), or a width of the first green pixel along the long axis (68.986 μm) is different from a width of one of the two blue pixels along a second direction parallel to the long axis (88.515 μm), as shown below. (EX1002, ¶129.)



10. Claim 14

A shortest distance L1 (86.829 μm) between the two nearest green pixels is greater than a width W2 (60.000 μm) of the first red pixel along a second direction parallel to the long axis of the first green pixel, as shown below. (EX1002, ¶130.)



11. Claim 15

a. Preamble

Cok discloses “OLED displays.” (EX1004, 1:8-10.) Suh describes how to make such OLED displays by teaching, for example, “[i]n the OLED, in order to

display full colors, red (R), green (G), and blue (B) light emission layers may be patterned, respectively. In order to pattern the light emission layers, ... laser induced thermal imaging (LITI) method may be used ...in the LITI method, the light emission layers are patterned using a fine metal mask (FMM).” (EX1005, [0006].)

Motivation to Use the Manufacturing Process of Suh

A POSITA would have found it obvious to use the manufacturing methods taught by Suh with the pixel arrangement pattern of Cok. Both Cok and Suh are analogous art because they are in the same field as the '066 patent. *Wyers*, 616 F.3d at 1237-39. (*See also* EX1002, ¶132.)

A POSITA would have been motivated to make this combination. Doing so would have been a simple application of the method and structure taught by Suh to form the OLED display taught by Cok with predictable results because the two references describe the same, underlying OLED technology. (EX1002, ¶133.) Indeed, a POSITA would have viewed Suh as disclosing just one more way to manufacture the OLED display of Cok. (*Id.*)

Moreover, a POSITA would have recognized that the combination would provide benefits. (EX1002, ¶134.) Using the LITI method and associated fine metal mask of Suh would have improved the OLED display because the LITI method “is advantageous for high resolution” such that organic layers could be

“finely patterned.” (EX1005, [0006].) Cok teaches using particular relative dimensions for pixels because “the light emitting elements will age at approximately the same rate, thus improving the lifetime of the device.” (EX1004, 4:31-36.) A POSITA would have understood that the LITI method of Suh would allow for forming pixels with clear definition and high resolution, which is advantageous in accurately manufacturing pixels having the desired relative areas taught by Cok. (EX1002, ¶134.)

A POSITA would have reasonably expected the combination to succeed. (EX1002, ¶135.) Both references relate to OLED display technology. This combination would have been straightforward. (*Id.*)

b. 15[A]

Cok teaches that OLED “devices utilize a current passed through thin-film layers of organic materials to generate light [and] [t]he color of the light emitted by a light emitting element depends on the specific organic material used to make the OLED.” (EX1004, 1:13-19.) Suh teaches “[t]he light emission layers 353 are formed as red light emission layers 353R, green light emission layers 353G, and blue light emission layers 353B by a laser induced thermal imaging (LITI) method using the FMM 370.” (EX1005, [0031]; EX1002, ¶¶136-137.)

c. 15[B]

Suh teaches “[t]he light emission layers 353 are formed in the regions

corresponding to the pixels 301 [and] are formed as red light emission layers 353R, green light emission layers 353G, and blue light emission layers 353B by a laser induced thermal imaging (LITI) method using the FMM 370.” (EX1005, [0031]; EX1002, ¶¶138-140.)

d. 15[C]

See limitation 15[A]. (EX1002, ¶141.)

e. 15[D]

See limitation 15[B]. (EX1002, ¶142.)

f. 15[E]

See limitation 15[A]. (EX1002, ¶143.)

g. 15[F]

See limitation 15[B]. (EX1002, ¶144.)

h. 15[G]

See limitation 1[A]. (EX1002, ¶145.)

i. 15[H]

See limitation 1[E]. (EX1002, ¶146.)

j. 15[I]

See limitation 1[F]. (EX1002, ¶147.)

k. 15[J]

See limitation 1[G]. (EX1002, ¶148.)

l. 15[K]

See limitation 1[H]. (EX1002, ¶149.)

m. 15[L]

See limitation 1[I]. (EX1002, ¶150.)

n. 15[M]

See limitation 1[J]. (EX1002, ¶151.)

o. 15[N]

See limitation 1[K]. (EX1002, ¶152.)

p. 15[O]

See limitation 1[L]. (EX1002, ¶153.)

12. Claim 17

See claim 4. (EX1002, ¶154.)

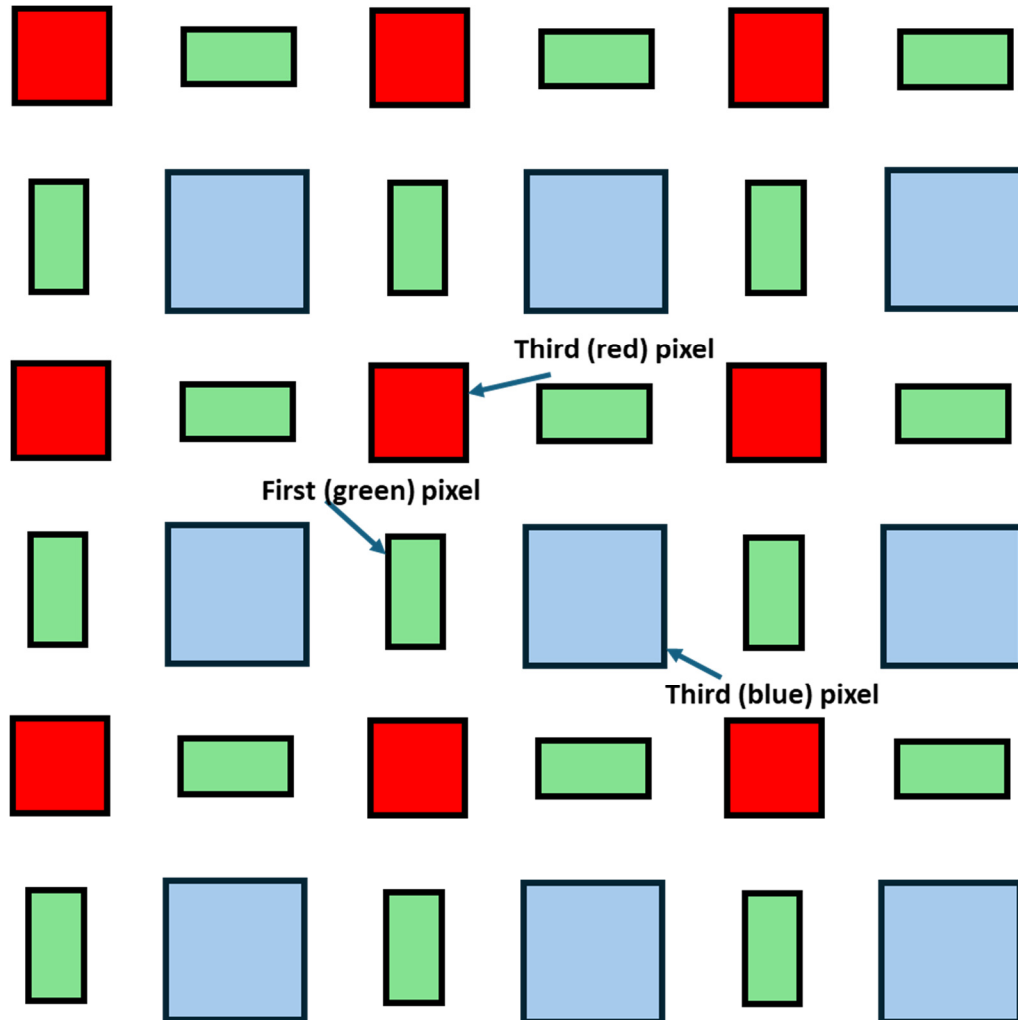
13. Claim 18

See claim 5. (EX1002, ¶155.)

14. Claim 19

Cok discloses OLED displays “utilize a current passed through thin-film layers of organic materials to generate light. ... The color of the light emitted by a light emitting element depends on the specific organic material used to make the OLED.” (EX1004, 1:13-19.) Cok also discloses “a pixel pattern 10 in an OLED display device ... includes two green light emitting elements 14 ..., a red light emitting element 12 ..., and a blue light emitting element 16,” and that there are a plurality of green light emitting elements, red light emitted elements, and blue light emitting elements. (2:14-19, 3:1-5, 4:7-13; EX1002, ¶156.)

As shown below, the first pixels emit green light, the second pixels emit blue light, and the third pixels emit red light. (EX1002, ¶158.)



15. Claim 20

See claim 2. (EX1002, ¶159.)

16. Claim 22

See claim 4. (EX1002, ¶160.)

17. Claim 23

See claim 5. (EX1002, ¶161.)

18. Claim 28

See claim 12. (EX1002, ¶162.)

19. Claim 29

See claim 13. (EX1002, ¶163.)

20. Claim 30

See claim 14. (EX1002, ¶164.)

B. Ground 2: Cok in view of Suh and Hong Renders Obvious Claim 11

Hong was filed on August 13, 2010, published September 29, 2011, and later issued as U.S. Patent No. 8,363,072 on January 29, 2013. It qualifies as prior art to the '066 patent under at least §§ 102(a) and (e). Although the Examiner considered the patent that issued from Hong (U.S. Patent No. 8,363,072) during prosecution, it was provided in a voluminous IDS containing 267 references, and the Examiner never applied Hong in any rejection. (EX1003, 112-128.)

1. Summary of Hong

Hong is directed to organic electroluminescent display devices and methods of fabricating such devices. Hong describes that regions between adjacent two sub-pixel regions in a display do not emit a predetermined colored light due to overlapping, which is referred to as a shadowing effect. (EX1039, [0010].) As described by Hong, “[t]o prevent the shadowing effect, the adjacent organic patterns 60 may be spaced apart by a first distance d1.” (*Id.*) For example, as

illustrated by FIG. 5, “the first and second organic patterns 200a and 200b are spaced apart from each other by a first distance d1 for preventing a shadowing effect along a diagonal direction with respect to the first and second directions, and the second and third organic patterns 200b and 200c are spaced apart from each other by the first distance d1 along the diagonal direction.” (EX1039, [0048].)

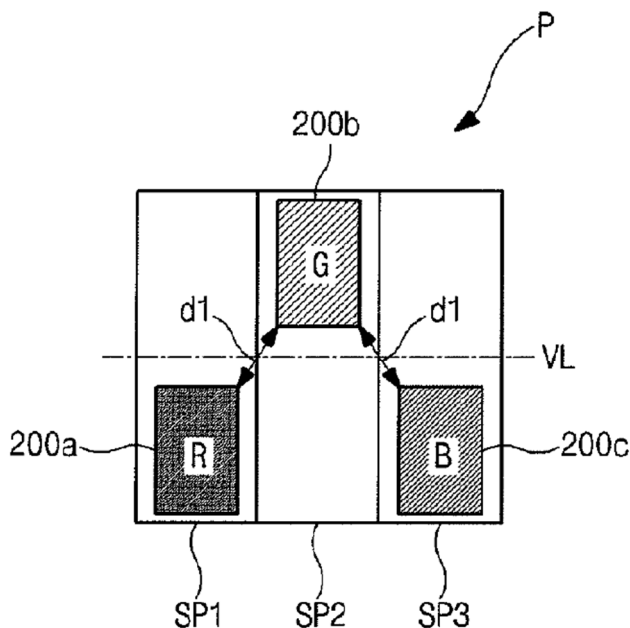


FIG. 5

Although FIG. 5 shows all sub-pixels having the same size, Hong describes that “first, second and third organic patterns may be formed to have different areas based on an emission efficiency.” (EX1039, [0074].) For example, if the green pixel is the most efficient and the blue is the least efficient, “the area of the first [red] organic pattern 250a may be greater than the area of the second [green] organic pattern 250b and may be smaller than the area of the third [blue] organic

pattern 250c so that the lights emitted from the first, second and third organic patterns 250a, 250b and 250c can have the same brightness as each other.” (*Id.*)

Hong describes how the device is fabricated using a shadow mask. (EX1039, [0072].) The shadow mask (or shadow masks) includes a plurality of open portions 350, through which organic material is deposited during a vacuum thermal evaporation process to form subpixels. (*Id.*) Hong describes that “[s]ince the shadow mask 300 is formed of a metallic material, the shadow mask 300 may expand due to heat to cause deformation such as warpage while the ... organic patterns ... are formed through a vacuum thermal evaporation method.” (*Id.*) Such “deformation of the shadow mask 300 causes a shadowing effect.” (*Id.*)

Hong is analogous art to the ’066 patent at least because Hong is directed to the same problem (pixel arrangements) in the same field of endeavor (OLED displays) as the ’066 patent. (EX1002, ¶168.)

2. Claim 11

Claim 1 is met by Cok in view of Suh as set forth above. Claim 11 is met by Cok in view of Suh with further modification in view of Hong to provide for equal distances between adjacent red-green and blue-green pixel pairs. As an initial matter, a POSITA would have recognized that a pixel arrangement that repeats Cok’s RGBG pattern would already apply this condition. (EX1004, Fig. 1; EX1002, ¶169.)

But to the extent a POSITA would not have understood this element to be disclosed by or obvious from Cok, the POSITA would nevertheless have found it obvious to provide even spacing between adjacent green-red and green-blue pairs of pixels based on the teachings of Hong. (EX1002, ¶170.) As illustrated in FIG. 5 of Hong below, the distance between the first (*e.g.*, green) pixel and the second (*e.g.*, blue) pixel as well as a shortest distance between the first (*e.g.*, green) pixel and the third (*e.g.*, red) pixel is a same first length $d1$ in order to prevent shadowing. (EX1039, [0048]; EX1002, ¶170.)

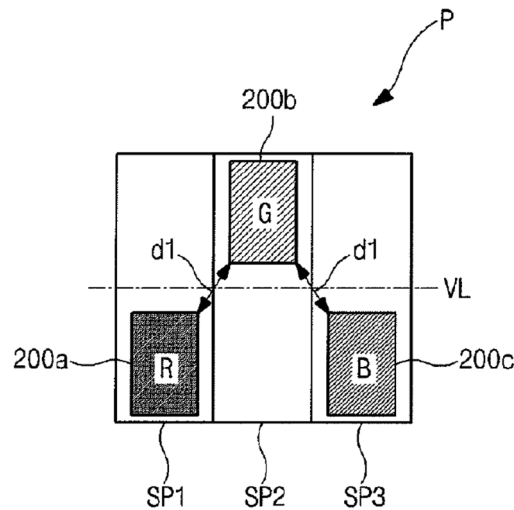
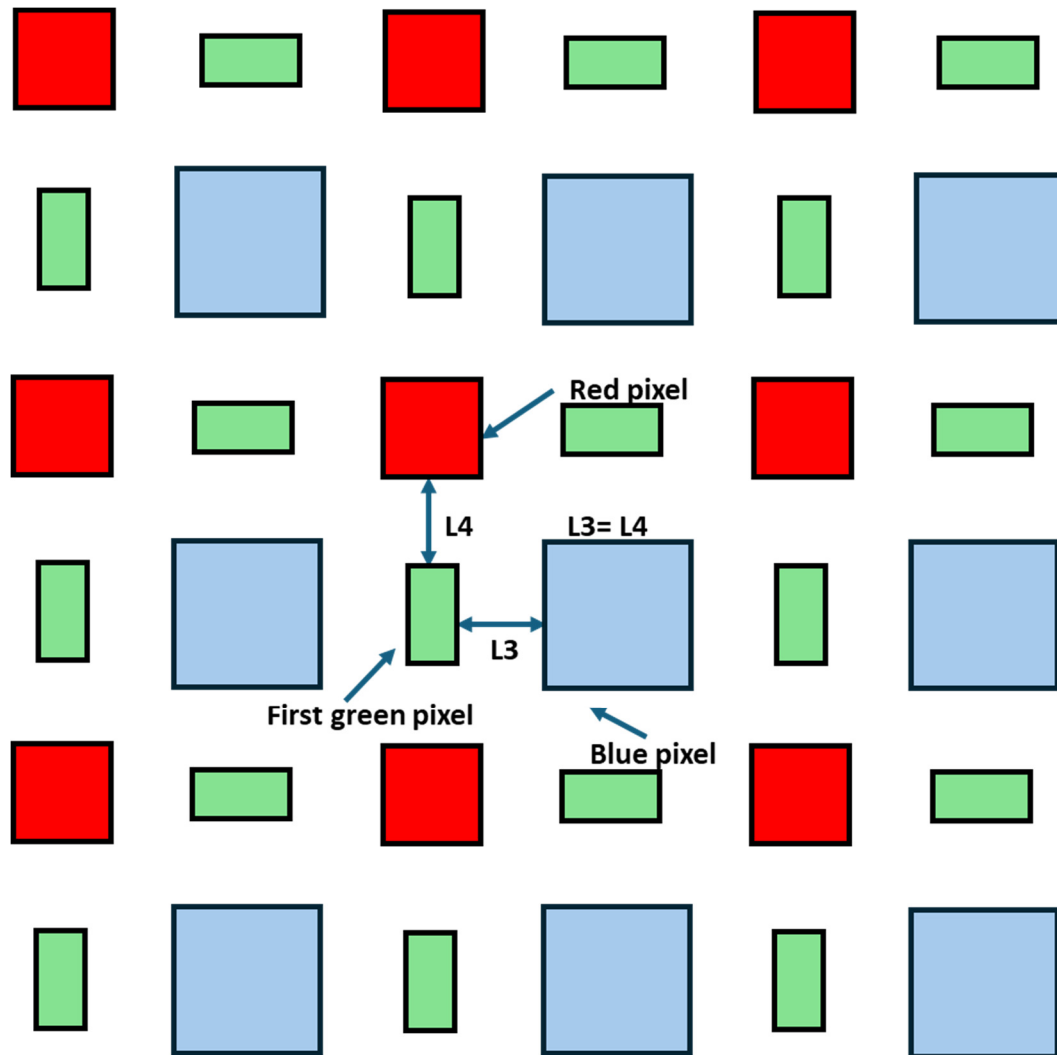


FIG. 5

In accordance with this teaching, a POSITA would have been motivated to modify Cok as shown below, such that the distance between the first (*e.g.*, green) pixel and the second (*e.g.*, blue) pixel as well as a shortest distance between the first (*e.g.*, green) pixel and the third (*e.g.*, red) pixel is a same first length $d1$ in

order to prevent shadowing. (EX1002, ¶171.)



Motivation to Combine Cok with Hong

A POSITA would have found it obvious to modify the pixel arrangement pattern of Cok in view of Hong's teachings. (EX1002, ¶172.) Both Cok and Hong are analogous art because they are in the same field as the '066 patent. *Wyers*, 616 F.3d at 1238-39; EX1002, ¶172.

A POSITA would have been motivated to make this combination in order to

improve the manufacturability and performance of an OLED display. (EX1002, ¶172.) Doing so would have been a simple application of the spacing taught by Hong to form the OLED display taught by Cok with predictable results because the two references describe the same, underlying OLED technology. (*Id.*) Indeed, a POSITA would have viewed Hong as disclosing just one more way to space the pixels in the OLED display of Cok. (*Id.*)

Furthermore, modifying the device of Cok to have the spacings of Hong would be advantageous to prevent or reduce shadowing. (EX1002, ¶173.) For example, as described by Hong, spacing the green pixels from the blue pixels and the green pixels from the red pixels “by a first distance d_1 ” can prevent a shadowing effect along the direction of the space between the pixels. (EX1039, [0048]; EX1002, ¶173.) Applying this teaching to Cok, a POSITA would have sought to prioritize equal spacing between green-red and green-blue pairs of adjacent pixels when resizing the pixels to achieve the area ratios discussed above under claim 1. (EX1002, ¶173.)

Additionally, a POSITA would have recognized that such a spacing would improve the manufacturability of an OLED display by preventing or reducing shadowing caused by the deposition process. (EX1002, ¶174.) Cok is silent with respect to manufacturing an OLED display, and thus a POSITA would have looked to Suh and Hong to supply those details. (*Id.*) As discussed above, Hong teaches

the use of a shadow mask for patterning the pixels, which is analogous to the fine metal mask of Suh. (EX1039, [0072]; EX1005 [0006]; EX1002, ¶174.) Such a shadow mask, because it is made of metal, is susceptible to thermal expansion, such that the shadow mask may warp while the pixels are being formed during a vacuum thermal evaporation method, as taught by Hong, or a laser induced thermal evaporation, as taught by Suh. (EX1039, [0072]; EX1005 [0006], [0031]; EX1002, ¶174.)

A POSITA would have understood that shadowing or color mixing can occur even if multiple masks are used because all masks will experience deformations such as warpage. (EX1002, ¶174.) The POSITA would have also recognized that the equal spacing taught by Hong can minimize the effects of such warpage and thermal deformation. (*Id.*) This is at least because a POSITA would have known that thermal expansion in any direction is proportional to the original length of the material in that direction and that the error in position can occur in any direction. (*Id.*)

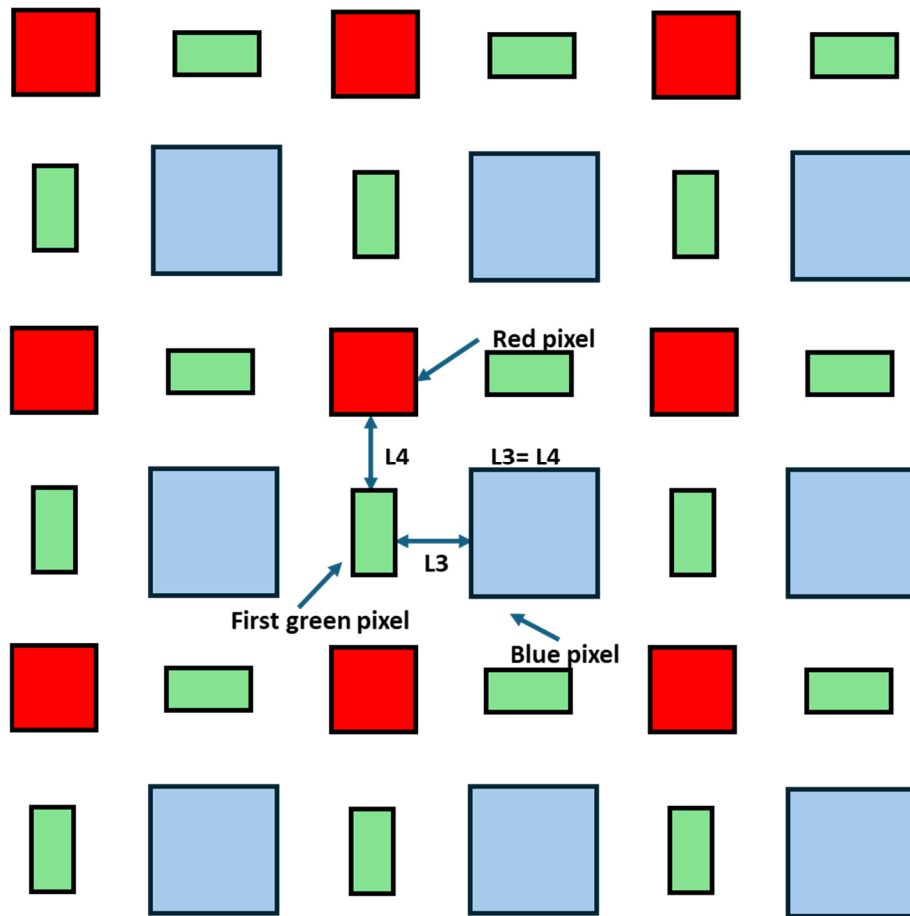
Because the direction and extent mask deformations are unknown, a POSITA would have understood that keeping the spacings between the green-blue pixel pairs and the green-red pixel pairs the same will result in the least amount of shadowing. (EX1002, ¶175.) Thus, the POSITA would have been motivated to maintain an equal minimum distance between the green-blue pixel pairs and the

green-red pixel pairs, such that the shadowing effect will be reduced equally in any direction. (EX1002, ¶176.)

Accordingly, the POSITA would have recognized that adopting Hong's teaching of equal distances between the green-blue pixel pairs and the green-red pixel pairs would mitigate the adverse effects of thermal expansion. (EX1002, ¶176.) If the distances between the green-blue pixel pairs and the green-red pixel pairs are equal, any expansion that occurs will affect all patterns consistently, thus maintaining the integrity of the design and reducing the likelihood of shadowing. (*Id.*)

A POSITA would have reasonably expected the combination to succeed. (EX1002, ¶177.) All three references relate to OLED display technology. A POSITA would have viewed Hong as disclosing just one more way to space Cok's pixels. (*Id.*) The combination of Cok and Hong, with its resulting pixel arrangement above, would have been straightforward. (*Id.*)

For example, to achieve the equal spacing disclosed in Hong, a POSITA would have slightly modified the dimensions of the green and blue pixels to be 30.000 μm x 60.000 μm and 90.000 μm x 90.000 μm , respectively, to arrive at the arrangement shown below, such that L3 (53.137 μm)=L4 (53.137 μm). (EX1002, ¶178.)



Such a modification would still achieve the limitations of claim 1. (EX1002, ¶179.) For example, the two blue pixels still have a larger area ($8100 \mu\text{m}^2$) than the red pixels ($3600 \mu\text{m}^2$) and the green pixels ($1800 \mu\text{m}^2$), and L1 ($96.360 \mu\text{m}$) is still greater than a width of a first red pixel of the plurality of red pixels along a first direction ($60.000 \mu\text{m}$). (*Id.*)

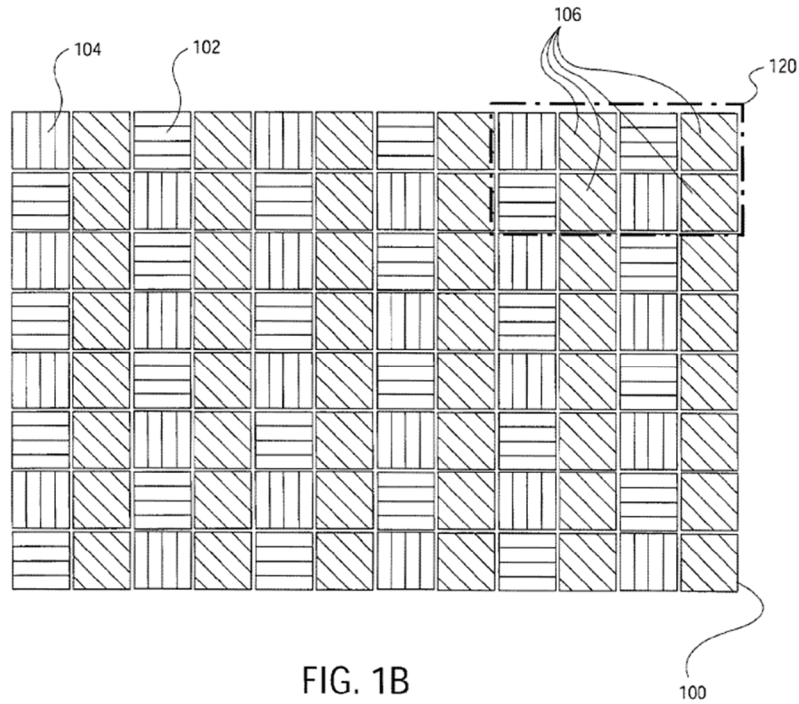
C. Ground 3: Credelle-379 In View Of Cok And Suh Renders Obvious Claims 1, 2, 4, 5, 10-13, 15, 17-23, 28, And 29

Credelle-379 was filed on October 22, 2002, published on July 10, 2003, and issued on February 17, 2009. Credelle-379 qualifies as prior art to the '066 patent

under at least §§ 102(a), (b), and (e). Although Credelle-379, as a published application (EX1011), was considered by the Examiner, it was provided in a voluminous IDS containing 267 references, and was never applied in any rejection. (EX1003, 112-128, 179-195.)

1. Summary of Credelle-379

Credelle-379 discloses “improved color pixel arrangements” which can be used in Active Matrix OLED displays. (EX1006, 1:45-46, 10:52-54.) Credelle-379 discloses arrangements of sub-pixel emitters comprising repeated octal groupings 120, as shown below in FIG. 1B (below), where “the colors are assigned as red 104, blue 102, and ... green 106.” (*Id.*, 4:22-23.) Each octal pattern 120 includes “twice as many green 106 as there are of the other two colors, red 104 and blue 102.” (*Id.*, 4:23-24.)



Credelle-379 describes various ways the pixel arrangement of FIG. 1B can be altered. For example, FIG. 1C shows the sub-pixels adjusted in size and aspect ratio, with the green sub-pixels 106 reduced in size compared to the blue and red sub-pixels 102 and 104. (*Id.*, 4: 11-14.)

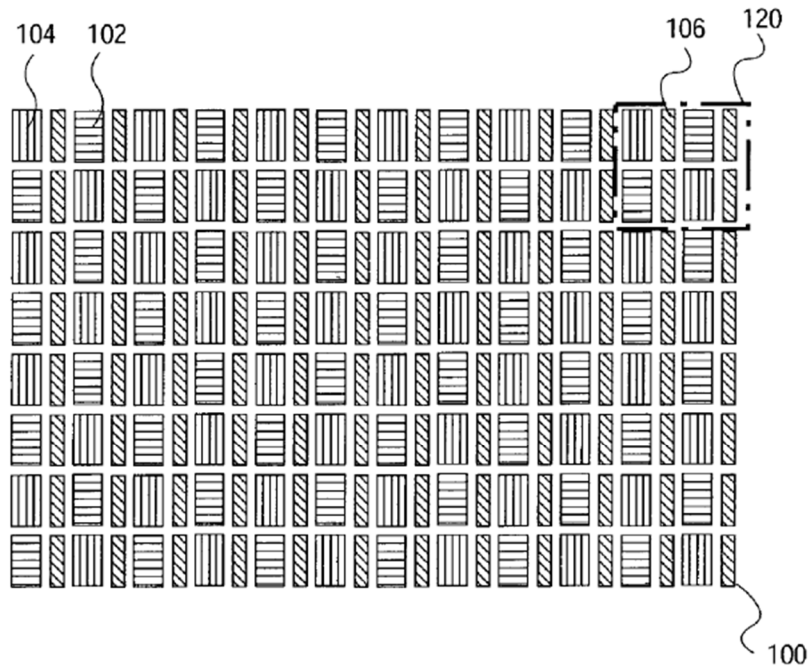


FIG. 1C

Credelle-379 also discloses that the sub-pixels are spaced apart from one another, as seen in FIGS. 1B, 1C, and FIG. 12. The pixel array in FIG. 12 also teaches that the pixels are arranged in a grid with equal spacing between the centers of the pixels. For example, FIG. 12 of Credelle-379 shows the distance between the center of a blue pixel and the center of a red pixel is 160 μm for a typical display in the 2000s.

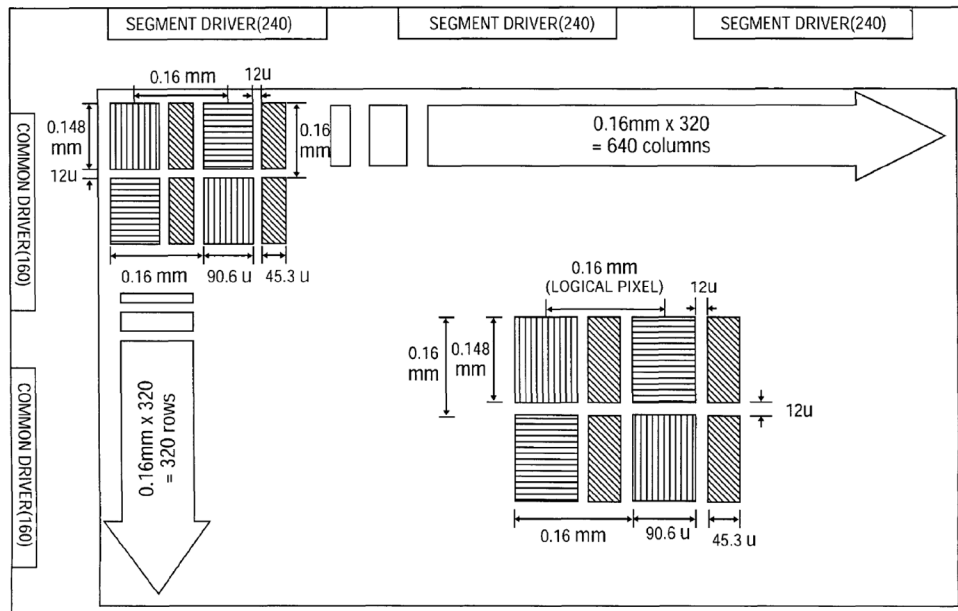
FIG. 12

FIG. 12 shows a spacing of 12 μm between the edges of the sub-pixels, but Credelle-379 explains that “[a]lthough various sub-pixel dimensions are also disclosed in FIG. 12, it should be appreciated that other dimensions would also suffice and that FIG. 12 is merely offered for illustrative purposes.” (*Id.*, 10:39-44.)

As seen in FIGS. 1B and 1C, the sub-pixels are spaced apart, and when the sizes and aperture ratios of the sub-pixels are altered, the spacings between the sub-pixels are also altered to achieve the desired repeat group 120 shape. (*Id.*, FIGS. 1B and 1C.) For example, Credelle-379 discloses that “the sub-pixel aspect ratios may be adjusted so that the display array 100 consists of square repeat cell groups 120. This will put the majority color sub-pixel emitter 106 on a square grid.” (*Id.*, 4:27-32.)

Credelle-379 also discloses that “so too may the exact positions of the subpixels be varied under the scope of the present invention. For example, FIGS. 8A and 8B depict a similar octal subpixel grouping wherein one or both of the majority stripes 106 are offset (relatively or otherwise) from the other subpixels 102 and 104. Other vertical offsets are also possible.” (*Id.*, 4:59-65.)

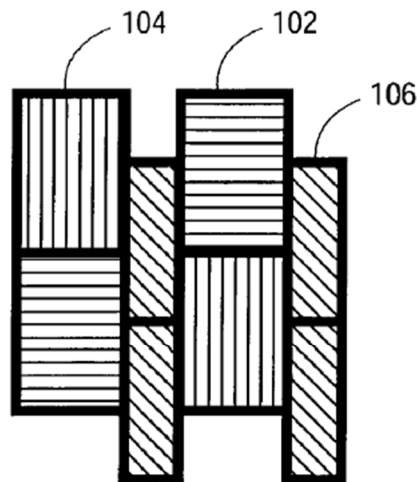


FIG. 8A

Although the figures show rectangular sub-pixels, Credelle-379 explains that “[i]t should be appreciated that other shapes to the subpixels are also possible and ... are desirable if manufacturable.” (*Id.*, 4:52-57.)

Credelle-379 is analogous art to the '066 patent at least because Credelle-379 is directed to the same problem (pixel arrangements) in the same field of

endeavor (displays, including OLED displays) as the '066 patent. (EX1002, ¶187.)

2. Claim 1

a. Preamble

Credelle-379 discloses “improved color pixel arrangements,” which can be used for display technologies such as “Active Matrix Organic Light Emitting Diode Display (AMOLED).” (EX1006, 1:44-46, 5:55-57, 13:26-33; EX1002, ¶188.)

b. 1[A]

Credelle-379 discloses “improved color pixel arrangements,” which can be used in AMOLED displays. (EX1006, 1:44-46, 5:55-57, 13:26-33; EX1002, ¶189.) Although Credelle-379 describes the individual light emitting elements as “sub-pixels,” a POSITA would have understood that these are merely terms referring to the same components as the claimed “pixels” in the '066 patent. (*Id.*, 2:34-37; EX1002, ¶189.) A POSITA would have known that a characteristic of AMOLEDs is that each sub-pixel is individually addressable. (EX1002, ¶189.)

a. 1[B]

Credelle-379 discloses “color pixel arrangements” for OLED displays. (EX1006, 1:45-46, 10:52-54.) As seen in FIGS. 1B, 1C, and 8A, the arrangements include a plurality of red, blue, and green pixels. (EX1006, FIGS. 1B, 1C, 8A.) Suh describes that for an OLED display to “display full colors, red (R), green (G),

and blue (B) light emission layers may be patterned, respectively” and that “[t]he light emission layers 353 are formed as red light emission layers 353R, green light emission layers 353G, and blue light emission layers 353B,” where the emission layers are organic. (EX1005, [0005], [0006], [0031]; EX1002, ¶190.)

Motivation to Combine Credelle-379 with Suh

A POSITA would have been motivated to combine the teachings of Credelle-379 and Suh. Credelle-379 teaches color pixel arrangements for OLED displays but is silent regarding the structure of said OLED displays. (EX1006, 1:45-46, 10:52-54.) The POSITA would have thus turned to Suh to fill in the details regarding the structure and manufacturing process of OLED displays. (EX1002, ¶191.)

A POSITA would have reasonably expected the combination to succeed. Both references relate to OLED display technology. Given these disclosures and the knowledge of a POSITA, the combination would have been straightforward. (EX1002, ¶192.)

Credelle-379 and Suh are analogous art because they are in the same field as the '066 patent. *Wyers* at 1238-39; *see also* EX1002, ¶193.

b. 1[C]

See claim 1, limitation 1[B]. (EX1002, ¶194.)

c. 1[D]

See claim 1, limitation 1[B]. (EX1002, ¶195.)

d. 1[E]

Suh discloses “the pixel define layers 330 are formed ... in order to increase the aperture ratio of pixels” and that the “pixel define layers 330 make boundaries between the respective organic light emitting devices clearly distinguished so that light emitting boundary regions between the pixels become clear.” (EX1005, [0048].) A POSITA would have been motivated to combine the pixel define layer of Suh with the pixel arrangement structure of Credelle-379 because the pixel define layer of Suh allows for clear definition and separation of pixel areas. (EX1002, ¶196.)

Motivation to Combine the OLED Structure of Credelle-379 with Suh

A POSITA would have been motivated to use the manufacturing methods and OLED structure taught by Suh with the pixel arrangement pattern of Credelle-379. Doing so would have been a simple application of the method and structure taught by Suh to form the OLED display taught by Credelle-379 and Cok with predictable results given that the references describe the same, underlying OLED technology. (EX1002, ¶¶197-198.)

Furthermore, Credelle-379 discloses “improved color pixel arrangements,” which can be used for display technologies such as AMOLED.” (EX1006, 1:44-

46, 5:55-57, 13:26-33.) A POSITA would have known that using a pixel defining layer to define the pixels was beneficial in AMOLED devices. (EX1002, ¶199.) By the earliest priority date of the '066 patent, there were numerous publications describing the use of such pixel defining layers in OLED displays. (*Id.*)

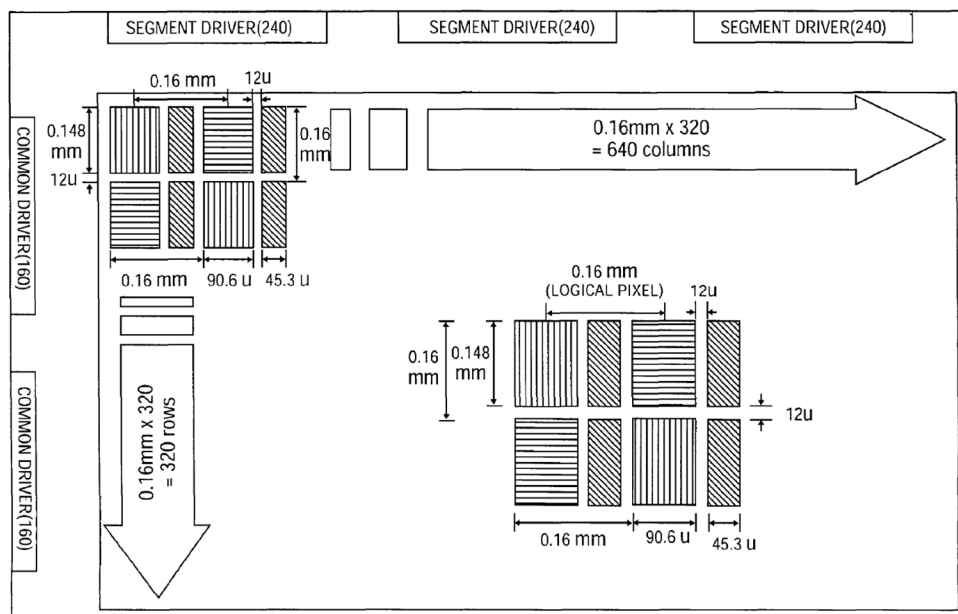
Moreover, a POSITA would have recognized that the combination would provide benefits. The pixel define layer of Suh define the pixels and “make boundaries between the respective organic light emitting devices clearly distinguished so that light emitting boundary regions between the pixels become clear.” (EX1005, [0048]; EX1002, ¶200.) A POSITA would have understood that the pixel define layer of Suh would allow for clear definition and separation of pixel areas, which is advantageous in accurately manufacturing pixels having the desired sizes and shapes. A POSITA would also have understood that *clear boundaries* also mean that the area of the pixel would be more defined such that the relative sizes of pixels could be more precisely set to balance for color or aging effects. (EX1002, ¶200.)

A POSITA would have reasonably expected the combination to succeed. Both references relate to OLED display technology. Given these disclosures and the knowledge of a POSITA, the combination would have been straightforward. (EX1002, ¶201.)

e. 1[F]

Credelle-379 teaches that the plurality of red pixels, the plurality of blue pixels, and the plurality of green pixels are spaced apart from each other in FIG. 12, showing explicit spacing between the pixels for an exemplary display. (EX1006, FIG. 12; EX1002, ¶202.)

FIG. 12



f. 1[G]

Credelle-379 in view of Cok discloses this element. Credelle-379 teaches the pixel arrangement shown in FIG. 1C, below. The green pixels are positioned such that the centers of the green pixels are on an equal grid spacing, as shown by the red square (*e.g.*, a virtual square) below. (EX1002, ¶203.)

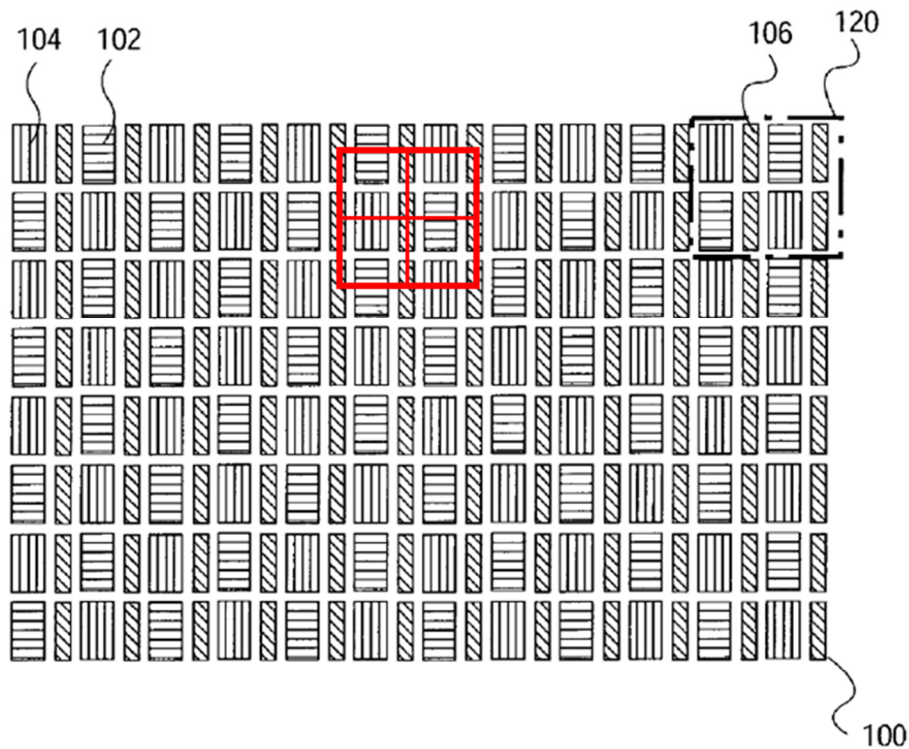
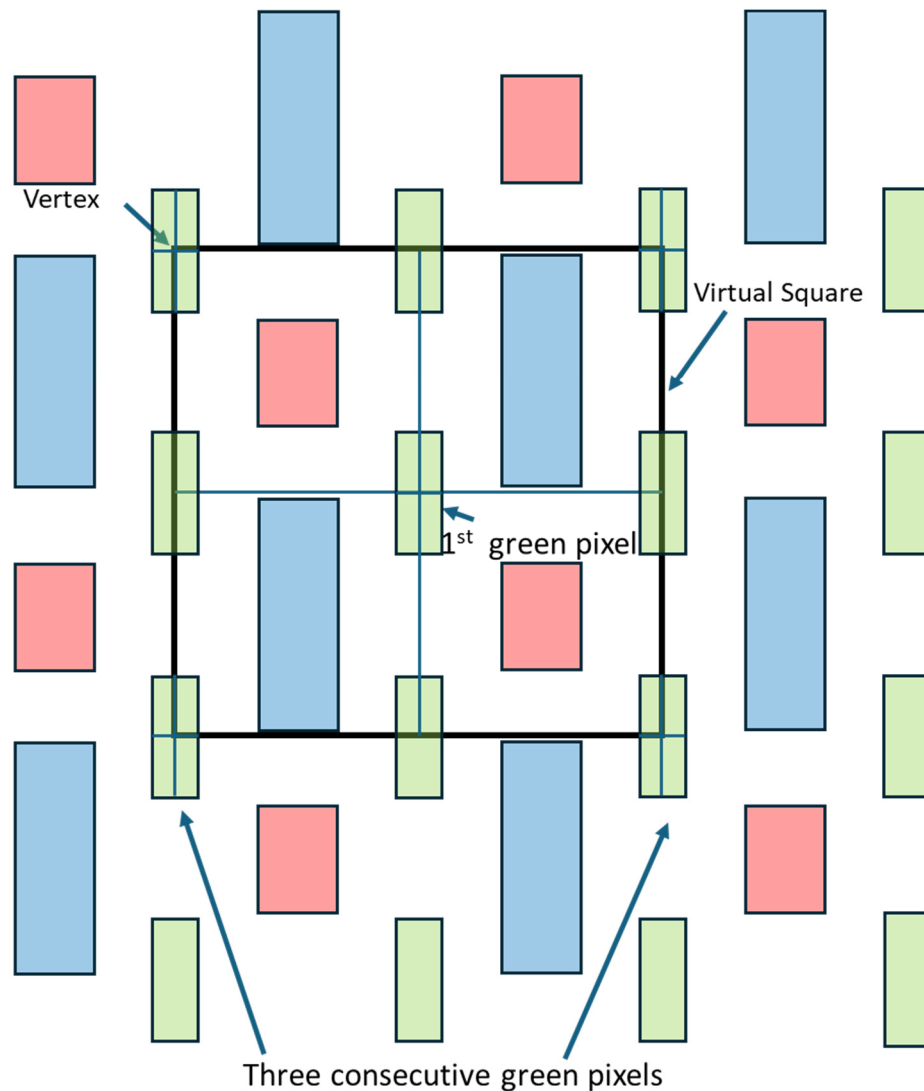


FIG. 1C

Credelle-379 teaches that the relative sizes, aspect ratios, spacings, and positions of the pixels can be altered. (EX1006, 4:27-32, 4:52-57, 4:59-65, 10:39-45, FIGS. 1B, 1C, 8A, and 8B.) As discussed below, a POSITA would have been motivated to modify FIG. 1C of Credelle-379 as follows, with a green pixel of Credelle-379 (*i.e.*, a “first green pixel”) having a center coinciding with a center of a virtual square, each vertex of the virtual square coinciding with a center of a different one of the plurality of green pixels and each edge of the virtual square

overlapping three consecutive green pixels. (EX1002, ¶205.)



Motivation to Combine Credelle-379 with Cok

A POSITA would have been motivated to modify FIG. 1C of Credelle-379 in order to improve the lifetime and performance of an OLED display. (EX1002, ¶206.) For example, a POSITA would have known of the improved materials as described in Nishimura and would have been motivated to use such improved materials to improve the lifetime and reduce power-consumption of an OLED

display. (EX1002, ¶206.)

Cok discloses that “[d]ifferent materials may produce different relative sizes of pixel elements 12, 14, and 16. For example, for some combinations of materials, the green light emitting elements may be smaller than both the red and blue light emitting elements.” (EX1004, 4:16-21.) A POSITA would have looked to Cok’s Equation (2) to determine the relative sizes of red, blue, and green light emitting elements in Credelle-379 given that the resulting pixel arrangement would be optimized for providing improved lifetime and color quality (over time). (EX1002, ¶207; EX1004, 4:31-45.) Based on Cok’s formula, a POSITA would have understood the relative area of a red pixel compared to a green pixel to be 1.513 and the relative area of a blue pixel compared to a green pixel to be 3.293. (EX1002, ¶207.)

For example, considering an OLED display with a 0.16 mm pixel pitch, a POSITA would have reasonably chosen a rectangular green light emitting element to have dimensions of 30 μm x 80 μm or an area of 2400 μm^2 . (EX1002, ¶208.) A green pixel size of 30 μm x 80 μm is also reasonable. (*Id.*) Using the relative areas calculated above, a POSITA would have obtained an area of 3631 μm^2 for the red pixel and an area of 7902 μm^2 for the blue pixel. (*Id.*)

Further, a POSITA would have understood that vertically offsetting the green pixels as taught by FIG. 8A of Credelle-379 would create an array with

improved visual properties and improved manufacturability. (EX1002, ¶209.)

A POSITA would also have maintained the spacing between the centers of the blue and red pixels, and correspondingly, the spacing between the centers of the green pixels, as 160 μm . (EX1002, ¶¶210, 212.) Combining the above calculated area ratios with FIG. 1C of Credelle-379 and vertically offsetting the green sub-pixels as shown in FIG. 8A of Credelle-379, a POSITA would arrive at the arrangement of pixels shown above. (*Id.*)

A POSITA would have found it obvious to use Cok's formula for adjusting the pixel arrangement of Credelle-379. Both Credelle-379 and Cok are analogous art because they are in the same field as the '066 patent. *Wyers*, 616 F.3d at 1238-39; *see also* EX1002, ¶213.

Making this combination would have been a simple substitution of one set of dimensions (the relative areas obtained by Equation (2) of Cok) for another (the relative areas of Credelle-379 FIG. 1C) with predictable results given that the two references describe the same, underlying OLED technology. (EX1002, ¶214.) Indeed, a POSITA would have viewed Cok as disclosing just one more way to dimension Credelle-379's sub-pixels given improvements in OLED materials. (*Id.*)

Moreover, a POSITA would have recognized that the combination would provide benefits. First, utilizing Cok's formula would have improved the overall

lifetime of an OLED display. (EX1004, 4:31-36; EX1002, ¶215.) Second, utilizing Cok’s formula would have improved the color quality (over time) of an OLED display “[b]ecause the differently colored light emitting elements age at approximately the same rate, [such that] the color shift experienced by prior-art OLED display devices will not occur.” (EX1004, 4:36-45; EX1002, ¶215.)

Additionally, as found by the Board—and unrebutted by Patent Owner—during the original examination of U.S. Patent No. 10,832,616 (EX1016), a parent application of the ’066 patent (*see* EX1015), “an artisan would have been motivated at the time of the invention to combine [Credelle-179’s] system with Kim’s different sub-pixel sizes because the different sub-pixel sizes can correct white balance and color coordinate.” (EX1027, 121.) Although the Examiner’s analysis refers to Credelle-179, which taught different shapes and vertical offsets and not explicitly different sizes, the same analysis applies even more strongly to Credelle-379, which explicitly contemplates altering pixel size in addition to altering shapes and vertical offsets. (EX1027, 121; EX1006, 4:27-32, 4:50-58, 4:59-65, 10:39-44, FIGS. 1B, 1C, 8A, and 8B; EX1002, ¶216.)

A POSITA would have reasonably expected the combination to succeed. (EX1002, ¶217.) Both references already teach using RGBG pixel arrangements in an OLED display. (EX1006, FIGS. 1B, 1C, 8A, 8B; EX1004, FIG. 1, FIG. 3.) And Credelle-379 itself discloses that the relative sizes, aspect ratios, spacings, and

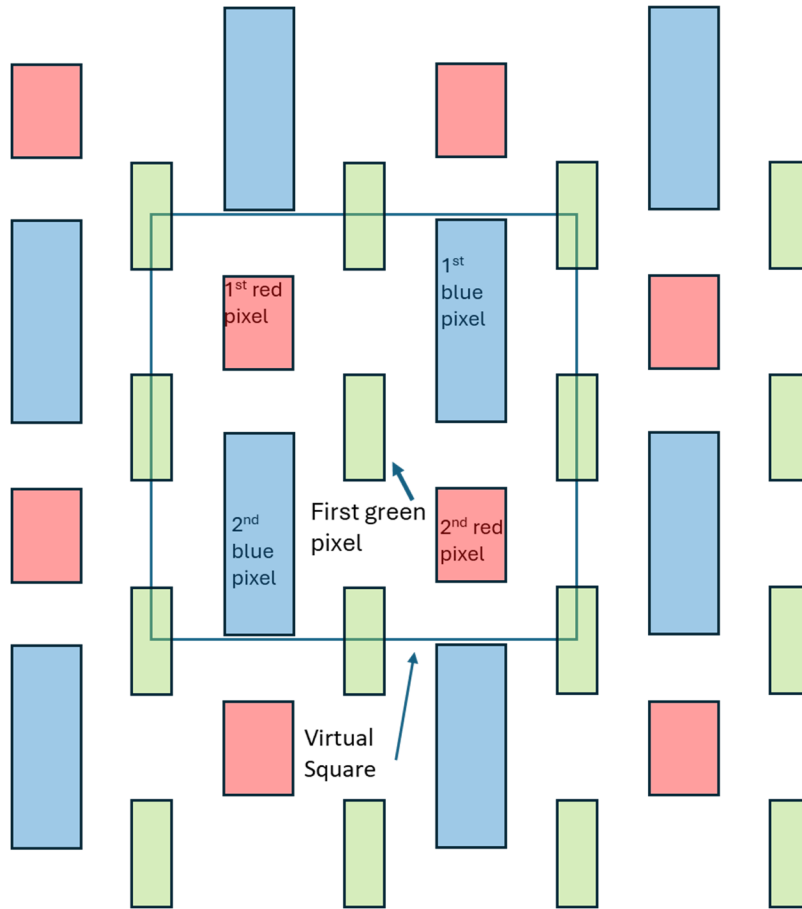
positions of the pixels can be altered. (EX1002, ¶217.) The combination of Credelle-379 and Cok would have been straightforward. (*Id.*)

As taught by Credelle-379, the modification has adjusted aspect ratios. Upon determining the sizes of the red and blue pixels based on the size of the green, a POSITA would have next determined what dimensions to use for the red and blue pixels to achieve their respective desired areas. (EX1002, ¶218.) Credelle-379 teaches that the red and blue pixels have twice the width of the green pixels. (EX1006, 9:32-42, FIG. 12.) Thus, a POSITA would have been motivated by the teachings of Credelle-379 to dimension the red and blue pixels such that they have twice the width of the green pixel. (EX1002, ¶218.) Thus, given a green pixel having dimensions of 30.0 μm x 80.0 μm and the calculated areas above, the red pixel would have dimensions of 60.0 μm x 60.5 μm and the blue pixel would have dimensions of 60.0 μm x 131.7 μm . (EX1002, ¶218.)

Such a modification would also preserve the aspects of Credelle-379 in view of Suh relied upon above for limitations 1[A]-1[F] because changing the sizes of the pixels would not change the basic structure or operation of the OLED display. (EX1002, ¶219.)

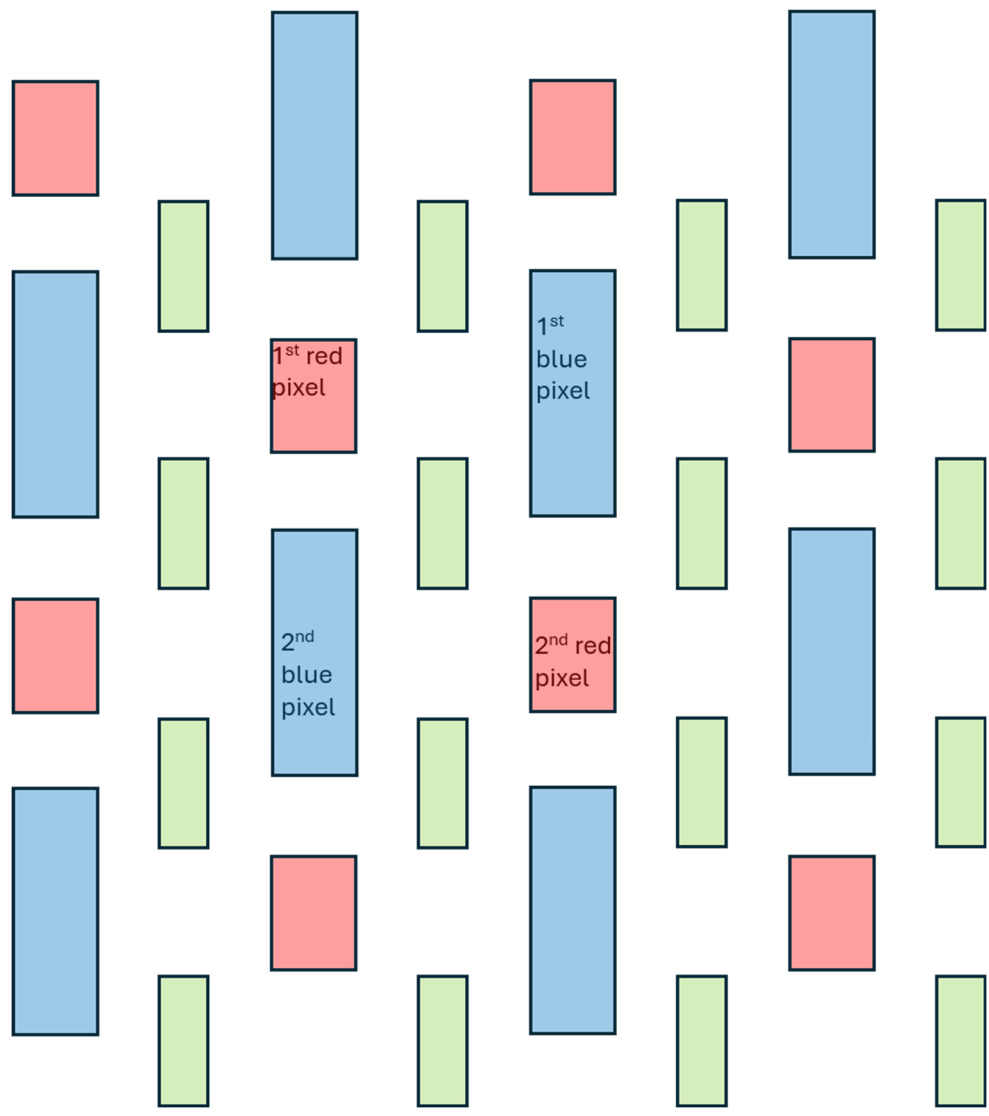
g. 1[H]

As shown below, two blue pixels and two red pixels are located entirely within boundaries of the virtual square. (EX1002, ¶220.)



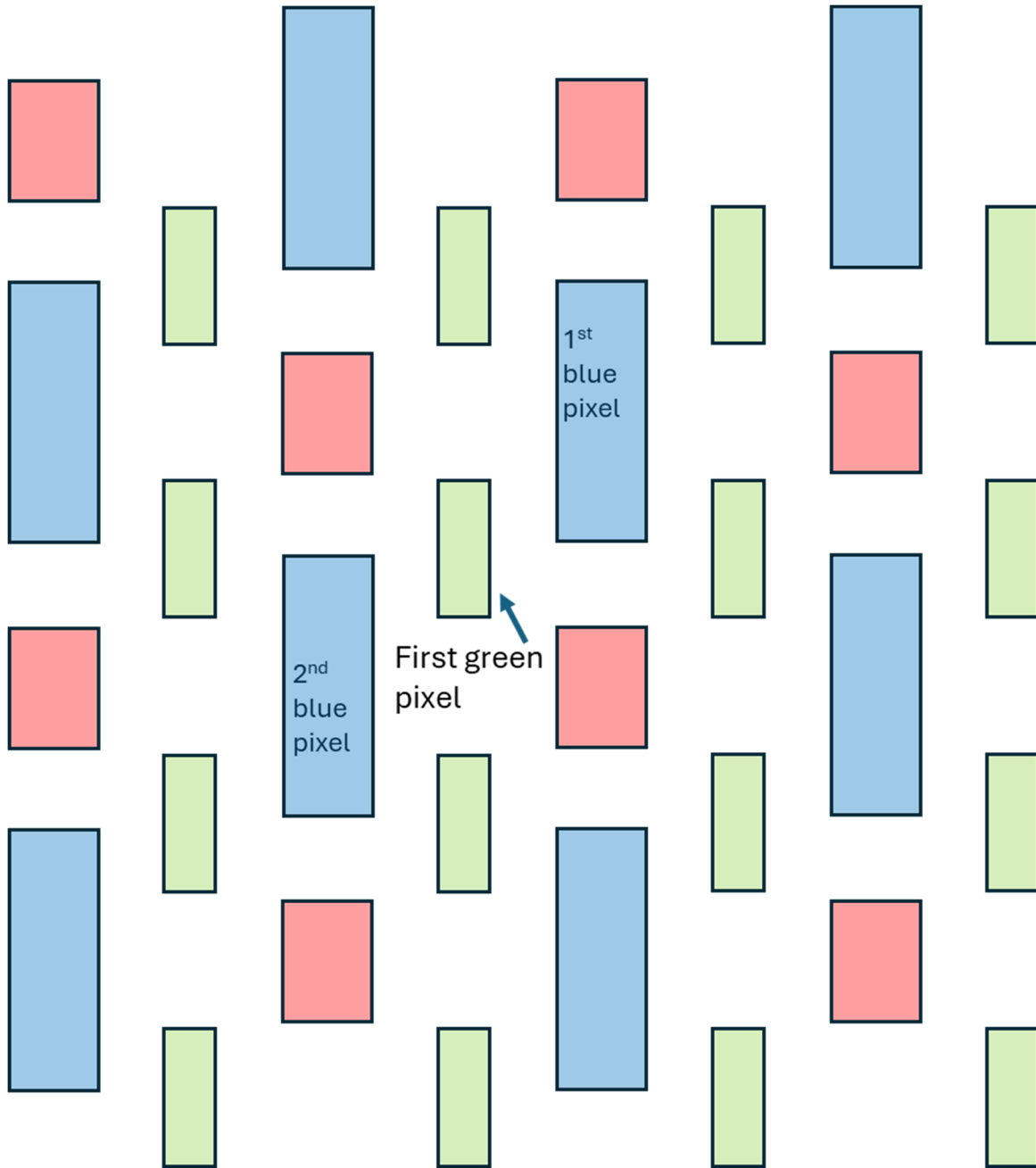
h. 1[I]

As shown below, the two blue pixels each have an area ($7902 \mu\text{m}^2$) larger than the area of each of two red pixels ($3631 \mu\text{m}^2$). (EX1002, ¶221.)



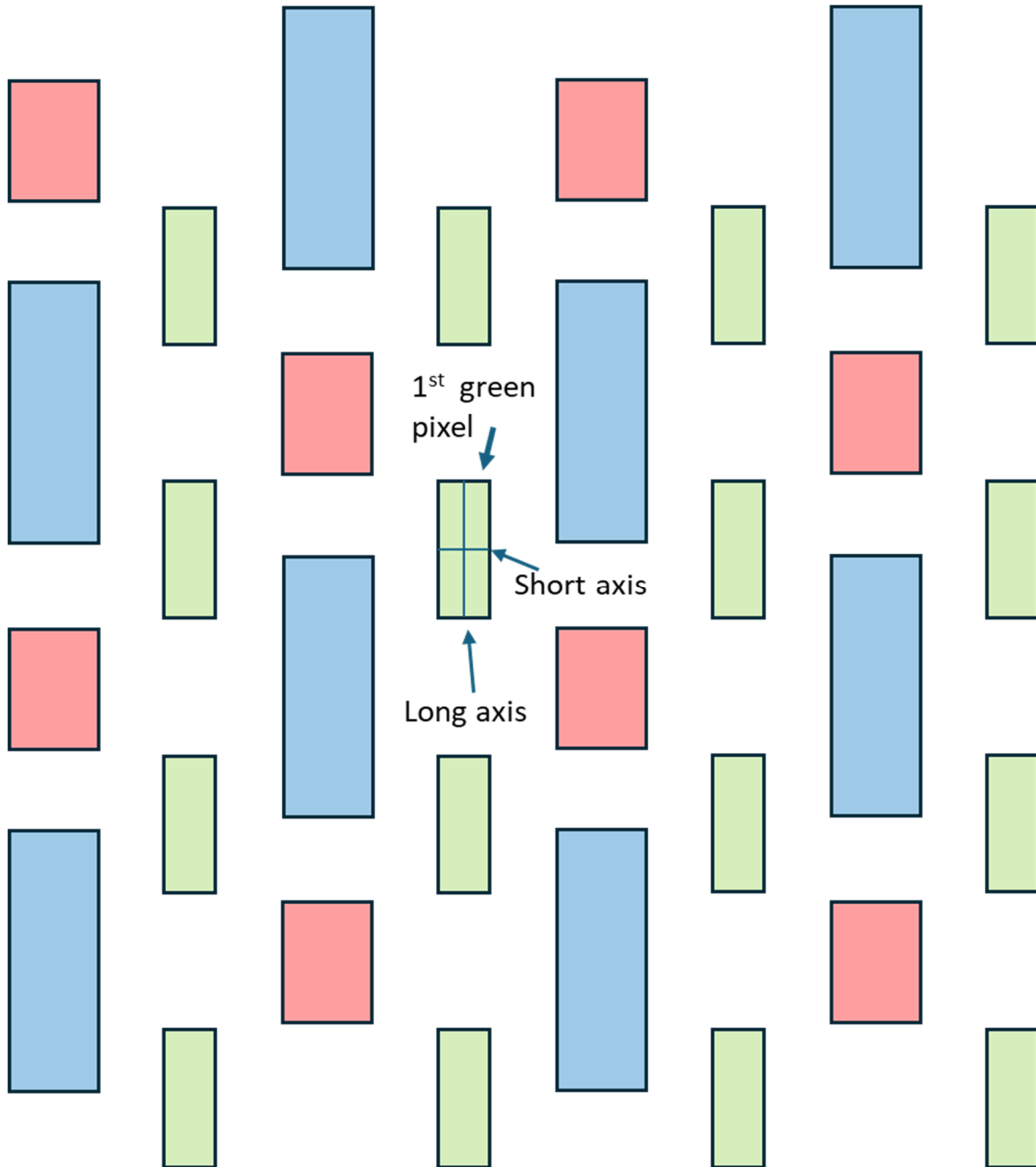
i. 1[J]

The two blue pixels each have an area ($7902 \mu\text{m}^2$) larger than the area of the green pixel ($2400 \mu\text{m}^2$), as shown below. (EX1002, ¶222.)



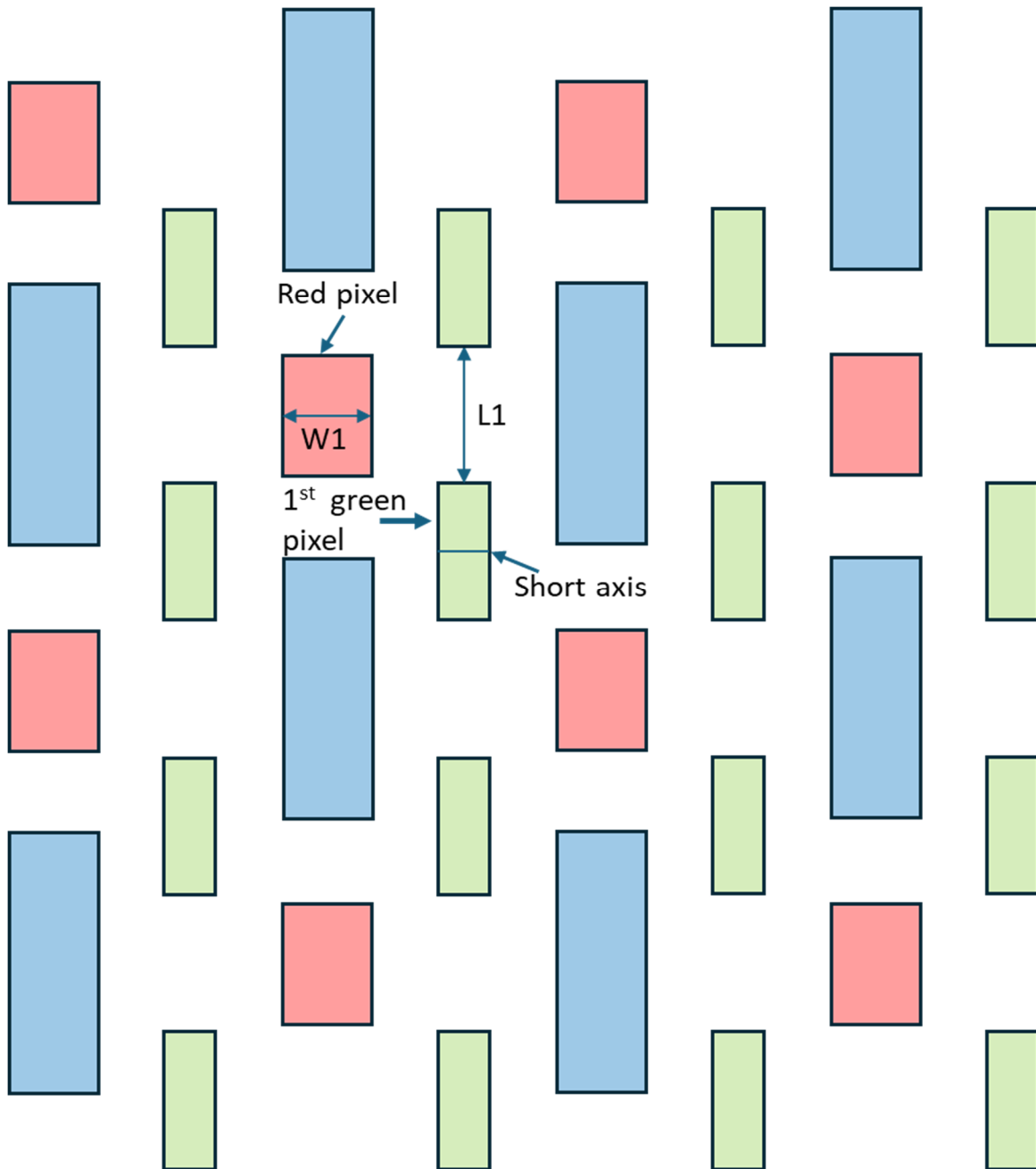
j. 1[K]

As shown below, the green pixel has a convex shape such that a line along the long axis of the green pixel ($80.0\text{ }\mu\text{m}$) has a greater length than a line along a short axis ($30.0\text{ }\mu\text{m}$). (EX1002, ¶223.)



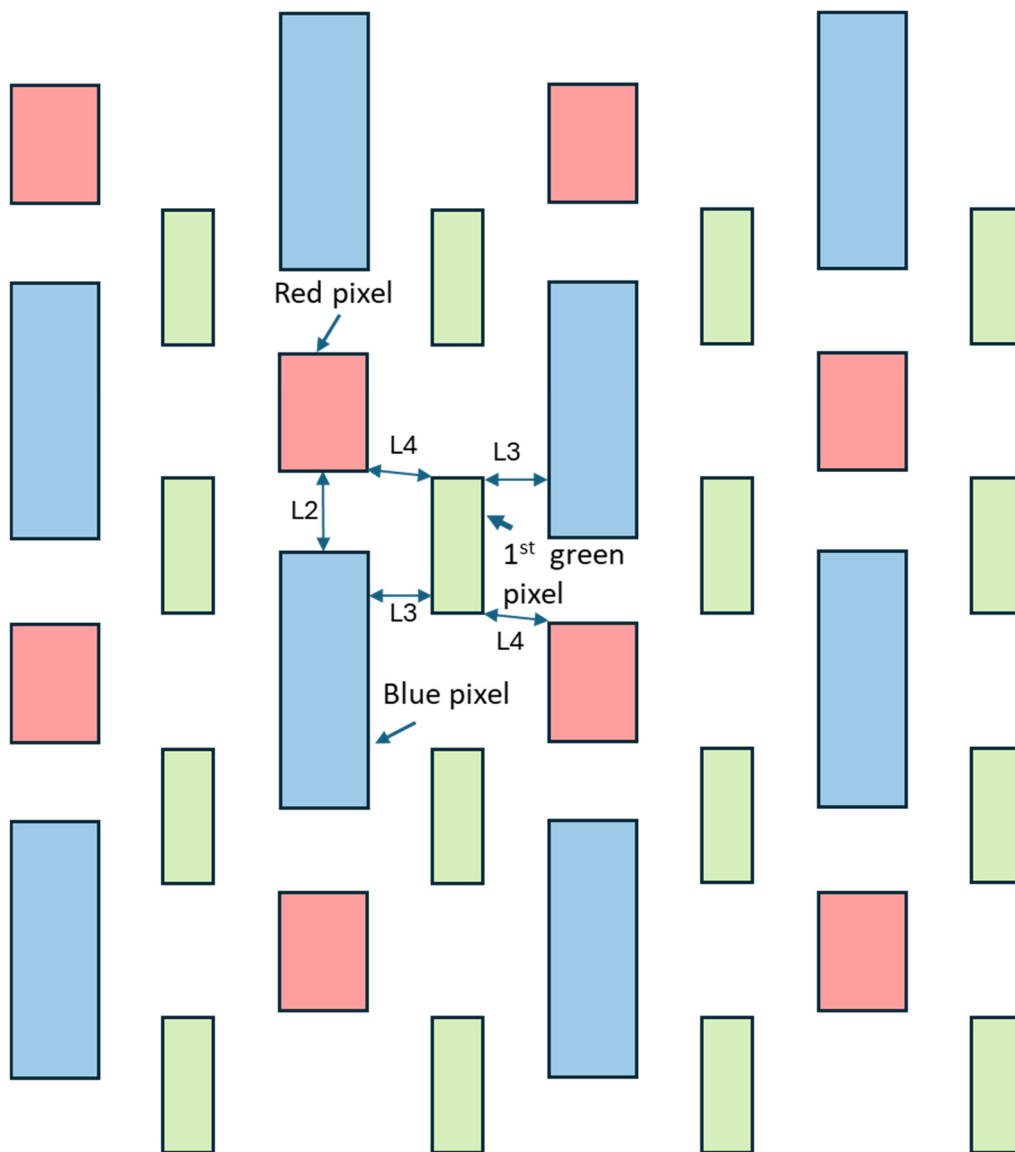
k. 1[L]

A shortest distance $L1$ ($80.0\text{ }\mu\text{m}$) between two nearest green pixels is greater than a width W ($60.0\text{ }\mu\text{m}$) of a first red pixel along a direction parallel to the short axis of the first green pixel, as shown below. (EX1002, ¶¶224-228.)



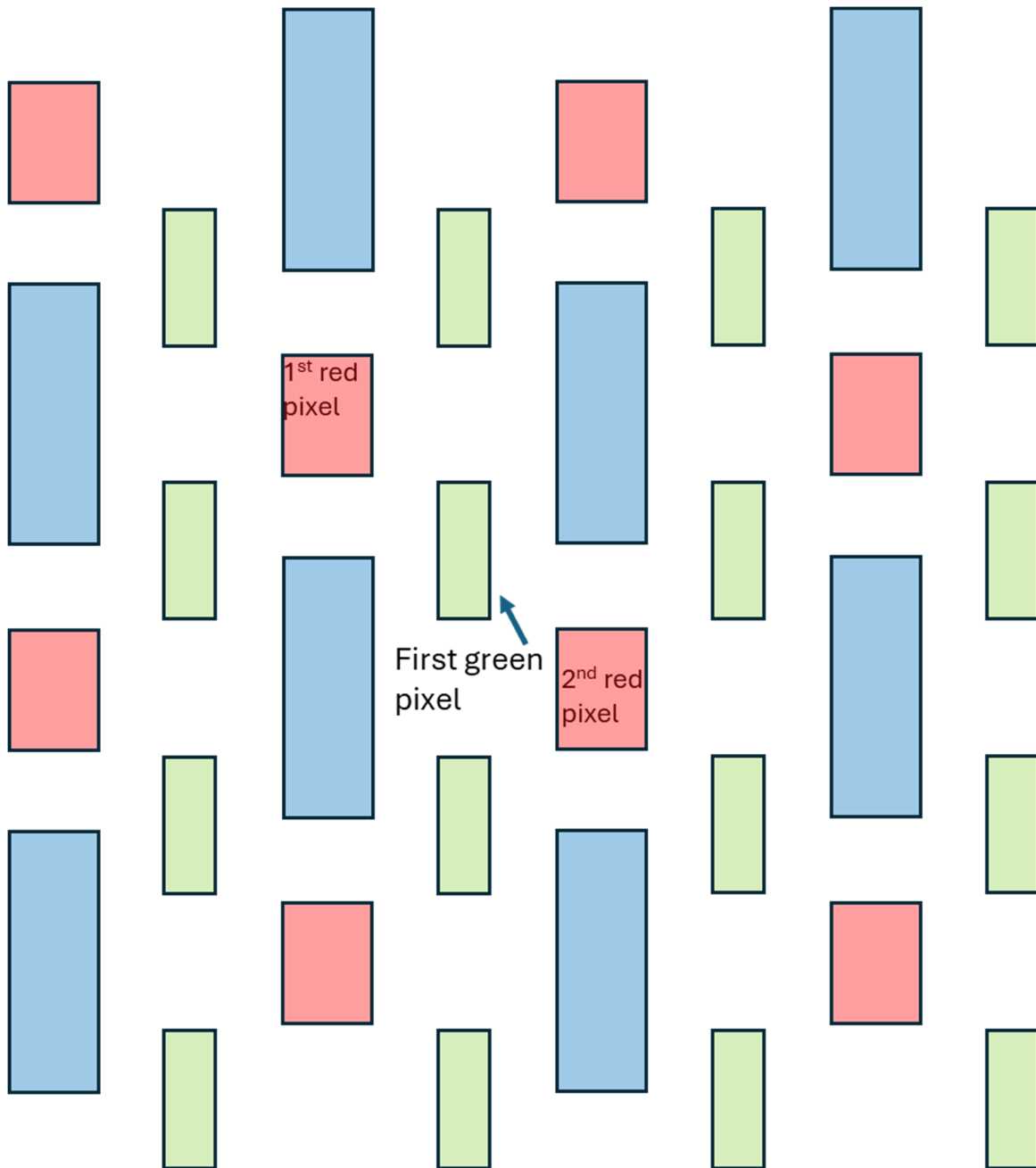
3. Claim 2

As shown below, a shortest distance L2 ($63.9\text{ }\mu\text{m}$) between one two blue pixels and one red pixels is greater than a shortest distance L3 ($35.0\text{ }\mu\text{m}$) between the first green pixel and the one of the at least two blue pixels or a shortest distance L4 ($36.3\text{ }\mu\text{m}$) between the first green pixel and the one of the at least two red pixels. (EX1002, ¶¶229-237.)



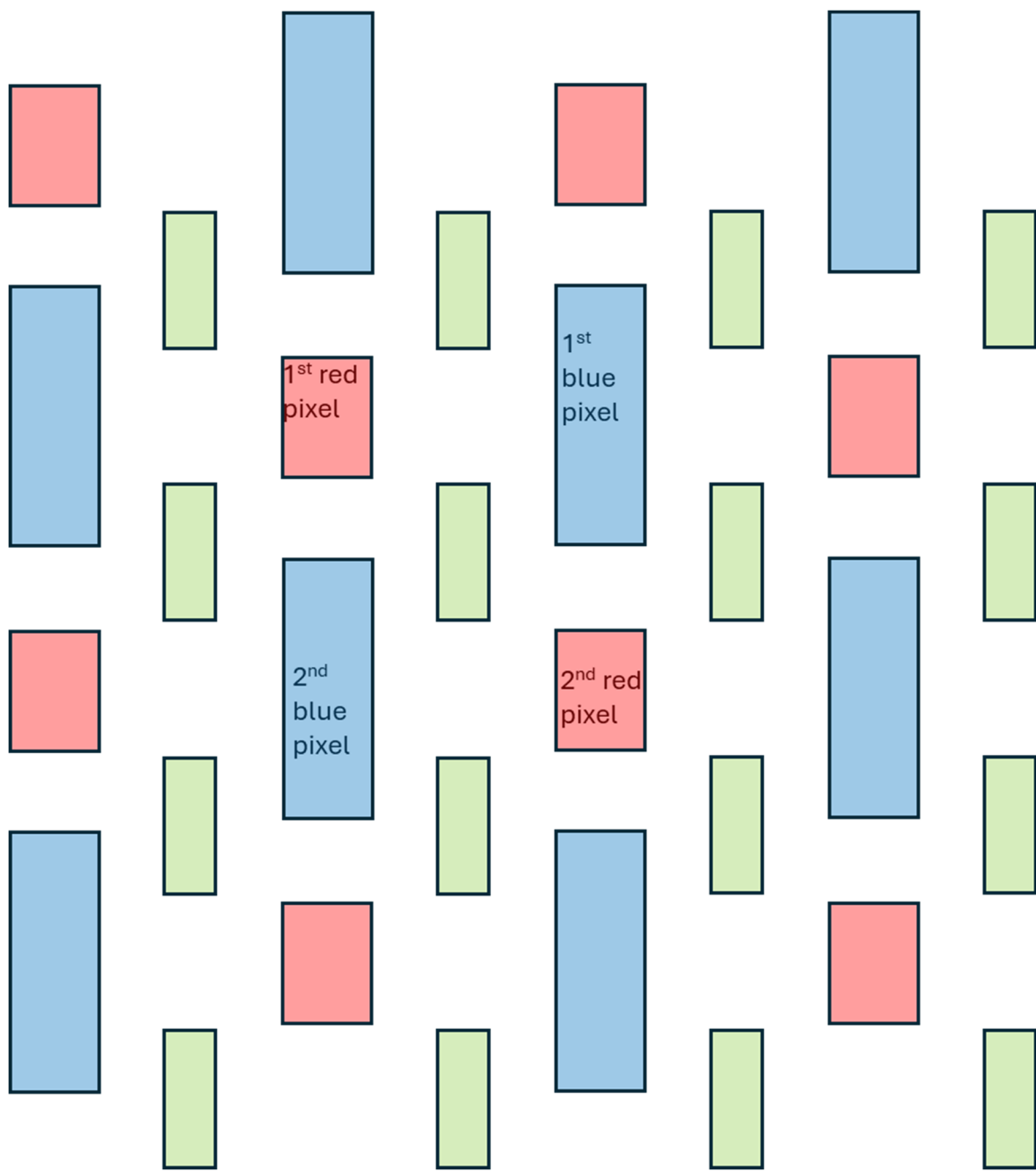
4. Claim 4

As shown below, the two red pixels each have an area ($3631 \mu\text{m}^2$) larger than the area than the green pixel ($2400 \mu\text{m}^2$). (EX1002, ¶238.)



5. Claim 5

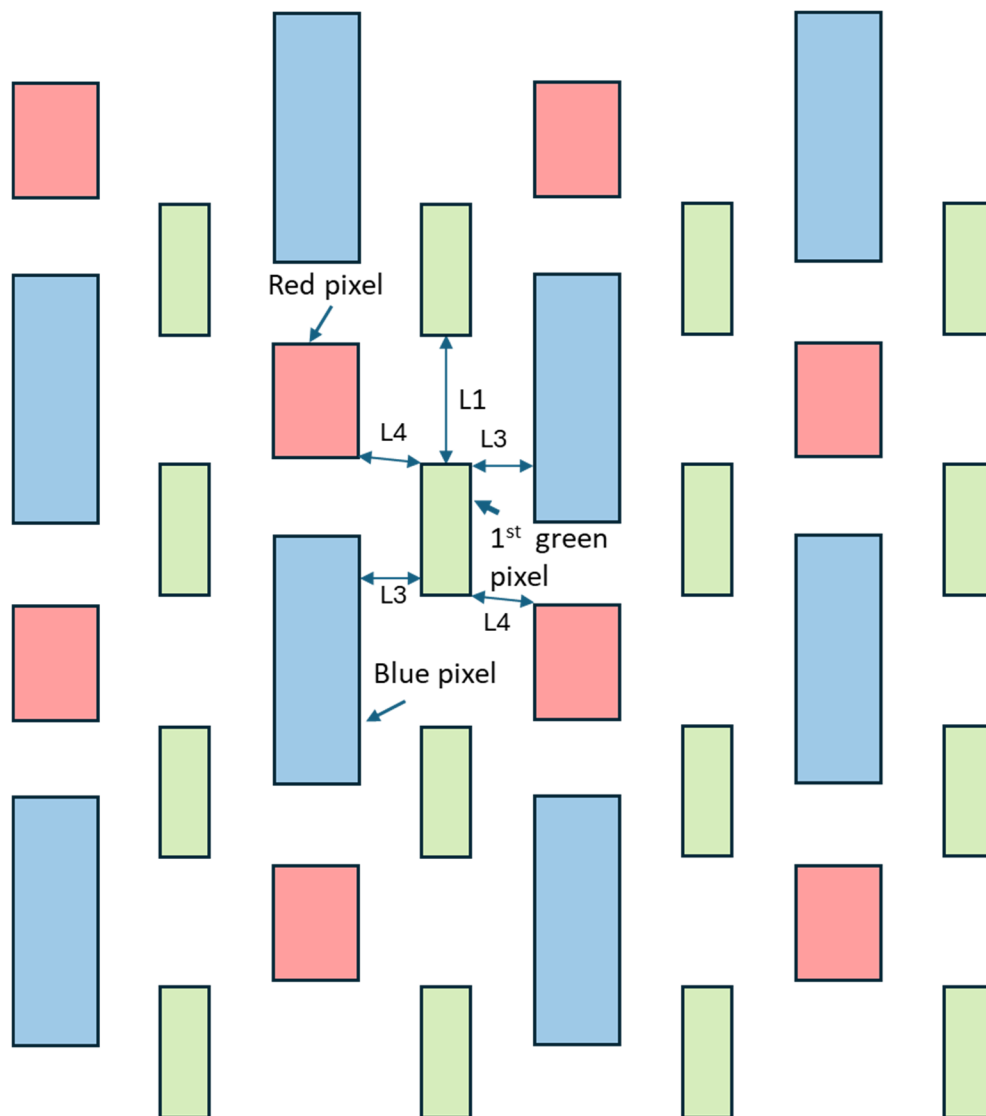
As shown below, the two blue pixels and the two red pixels have polygonal (e.g., “quadrangle”) shapes. (EX1002, ¶239.)



6. Claim 10

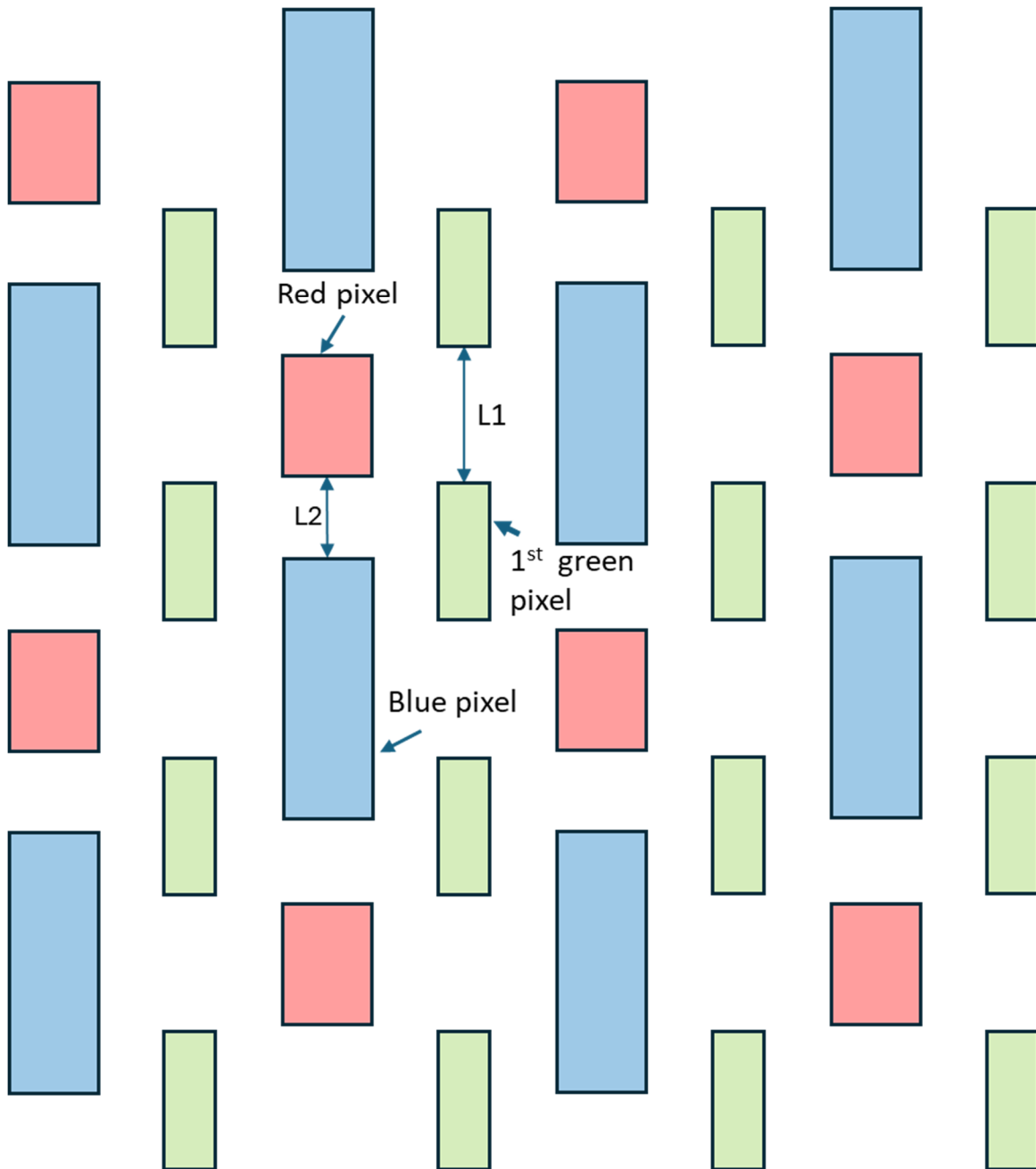
As shown below, a shortest distance L1(80.0 μm) between the first green pixel and an adjacent green pixel is greater than a shortest distance L3 (35.0 μm) between the first green pixel and one of the two blue pixels or a shortest distance L4 (36.3 μm) between the first green pixel and one of the two red pixels.

(EX1002, ¶240.)



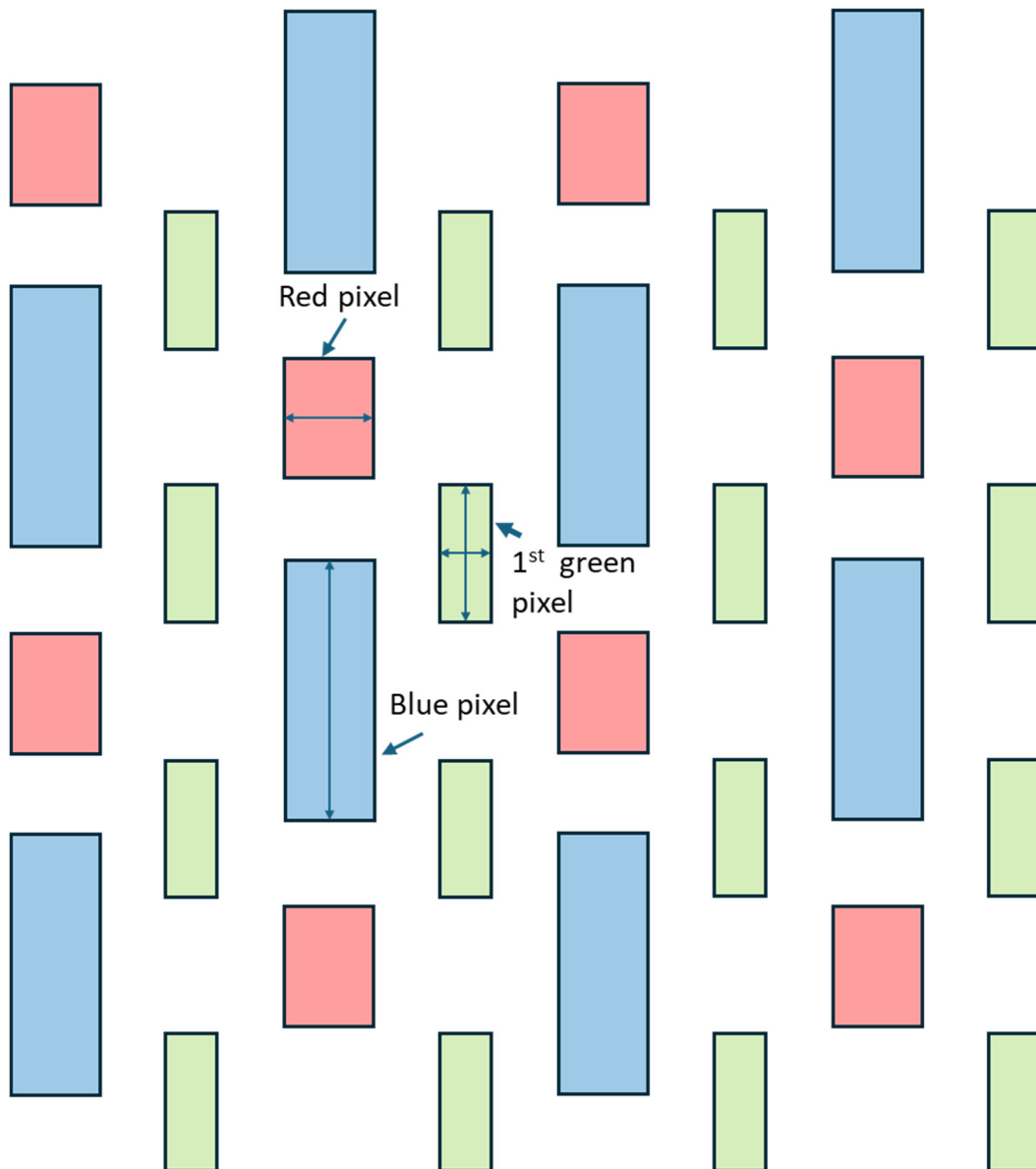
7. Claim 12

As shown below, a shortest distance L1 (80.0 μm) between the first green pixel and an adjacent green pixel is not equal to a shortest distance L2 (63.9 μm) between one of the two blue pixels and one of the two red pixels. (EX1002, ¶241.)



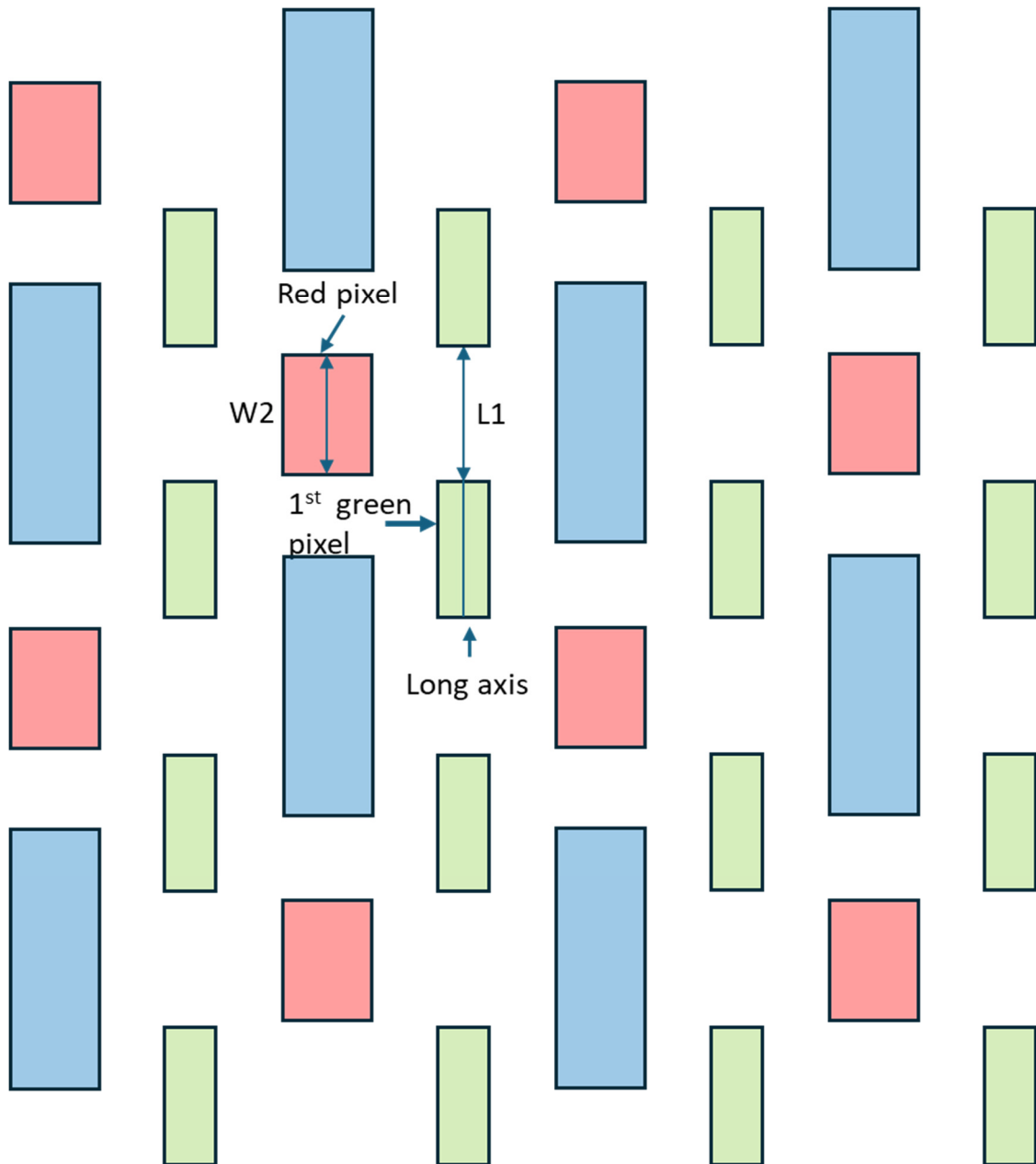
8. Claim 13

As shown below, a width of the first green pixel along the short axis (30.0 μm) is different from a width of one of the red pixels along the first direction (60.0 μm), or a width of the first green pixel along the long axis (80.0 μm) is different from a width of one of the two blue pixels (131.7 μm) along a second direction parallel to the long axis. (EX1002, ¶242.)



9. Claim 14

A shortest distance between the two nearest green pixels L1 (80.00 μm) is greater than a width W (60.5 μm) of the first red pixel along a second direction parallel to the long axis of the first green pixel, as shown below. (EX1002, ¶243.)



10. Claim 15

a. Preamble

Credelle-379 discloses “improved color pixel arrangements” which can be implemented in OLED devices. (EX1006, 1:45-46, 10:52-54.) Suh describes how to make such OLED displays by teaching, for example, “[i]n the OLED, in order to display full colors, red (R), green (G), and blue (B) light emission layers may be patterned, respectively. In order to pattern the light emission layers, ... laser induced thermal imaging (LITI) method may be used ...in the LITI method, the light emission layers are patterned using a fine metal mask (FMM).” (EX1005, [0006].)

Motivation to Use the Manufacturing Process of Suh

A POSITA would have found it obvious to use the manufacturing methods taught by Suh with the pixel arrangement pattern of Credelle-379. Both Credelle-379 and Suh are analogous art because they are in the same field as the '066 patent. *Wyers*, 616 F.3d at 1238-39. (See also EX1002, ¶¶245.)

A POSITA would have been motivated to use the method of manufacturing taught by Suh to manufacture the device of Credelle-379 because the LITI method and associated fine metal mask “is advantageous for high resolution” such that organic layers could be “finely patterned.” (EX1002, ¶¶244-247.) Moreover, a POSITA would have recognized that the combination would provide benefits. A POSITA would have understood that the LITI method of Suh would allow for

forming pixels with clear definition and high resolution, which is advantageous in accurately manufacturing pixels having a desired shape and size. (*Id.*)

A POSITA would have reasonably expected the combination to succeed. (EX1002, ¶248.) Both references relate to OLED display technology. This combination would have been straightforward. (*Id.*)

b. 15[A]

Suh teaches “[t]he light emission layers 353 are formed as red light emission layers 353R, green light emission layers 353G, and blue light emission layers 353B by a laser induced thermal imaging (LITI) method using the FMM 370.” (EX1005, [0031]; EX1002, ¶249.)

c. 15[B]

Suh teaches “The light emission layers 353 are formed in the regions corresponding to the pixels 301 (refer to FIG. 2) [and] are formed as red light emission layers 353R, green light emission layers 353G, and blue light emission layers 353B.” (EX1005, [0031]; EX1002, ¶¶250-251.)

d. 15[C]

See limitation 15[A]. (EX1002, ¶252.)

e. 15[D]

See limitation 15[B]. (EX1002, ¶253.)

f. 15[E]

See limitation 15[A]. (EX1002, ¶254.)

g. 15[F]

See limitation 15[B]. (EX1002, ¶255.)

h. 15[G]

See limitation 1[A]. (EX1002, ¶256.)

i. 15[H]

See limitation 1[E]. (EX1002, ¶257.)

j. 15[I]

See limitation 1[F]. (EX1002, ¶258.)

k. 15[J]

See limitation 1[G]. (EX1002, ¶259.)

l. 15[K]

See limitation 1[H]. (EX1002, ¶260.)

m. 15[L]

See limitation 1[I]. (EX1002, ¶261.)

n. 15[M]

See limitation 1[J]. (EX1002, ¶262.)

o. 15[N]

See limitation 1[K]. (EX1002, ¶263.)

p. 15[O]

See limitation 1[L]. (EX1002, ¶264.)

11. Claim 17

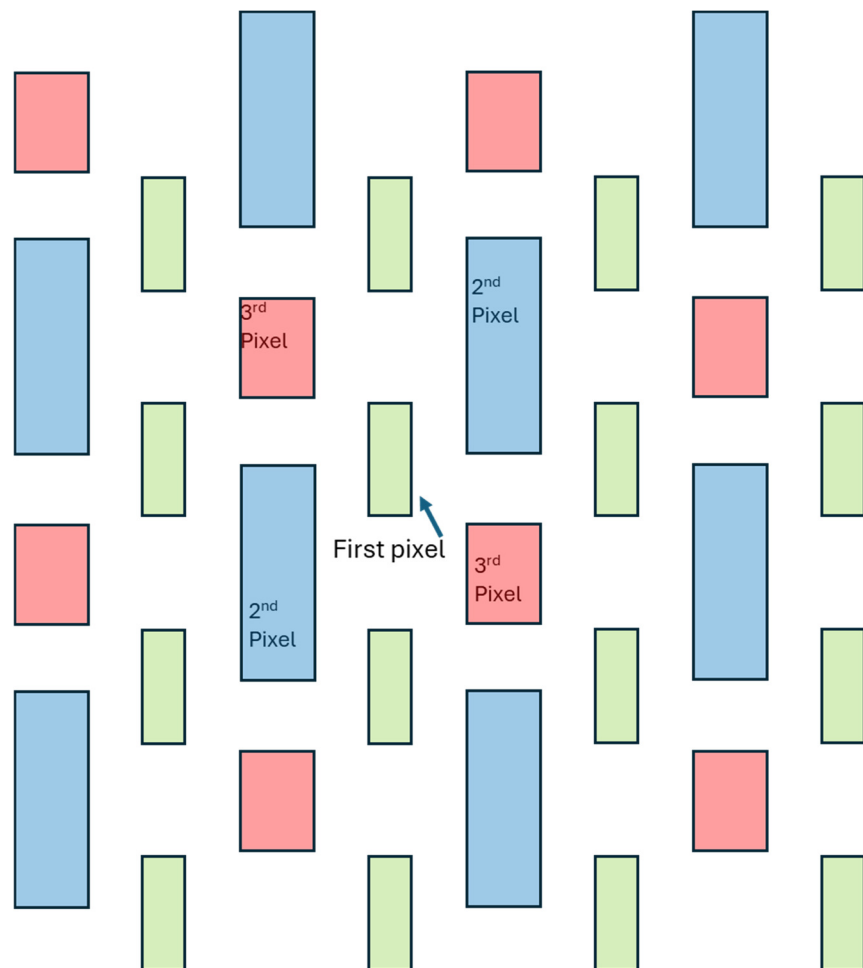
See claim 4. (EX1002, ¶265.)

12. Claim 18

See claim 5. (EX1002, ¶266.)

13. Claim 19

FIGS. 1B, 1C, and 8A of Credelle-379 show a plurality of red, blue, and green pixels. (EX1006, FIGS. 1B, 1C, 8A.) As shown below, the first pixels emit green light, the second pixels emit blue light, and the third pixels emit red light. (EX1002, ¶267.)



14. Claim 20

See claim 2. (EX1002, ¶268.)

15. Claim 22

See claim 4. (EX1002, ¶269.)

16. Claim 23

See claim 5. (EX1002, ¶270.)

17. Claim 28

See claim 12. (EX1002, ¶271.)

18. Claim 29

See claim 13. (EX1002, ¶272.)

19. Claim 30

See claim 14. (EX1002, ¶273.)

D. Ground 4: Credelle-379, Cok, Suh, And Elliott-724 Render Obvious Claims 3, 16, And 21

Elliott-724 was filed on September 13, 2002, and published on March 18, 2004. Elliott-724 qualifies as prior art to the '066 patent under at least § 102(a), (b), and (e). Elliott-724 is a parent application of Credelle-379 and was not considered during prosecution of the '066 patent.

1. Summary of Elliott-724

Elliott-724 discloses “[s]ubpixel arrangements” and that OLED displays will be “improved using this teaching.” (EX1007, [0041], [0075], [0116].) As shown

in FIG. 19, some sub-pixels are made hexagonal. (*Id.*, FIG. 19.)

Elliott-724 is analogous art to the '066 patent at least because Elliott-724 is directed to the same problem (pixel arrangements) in the same field of endeavor (OLED displays) as the '066 patent. (EX1002, ¶275.)

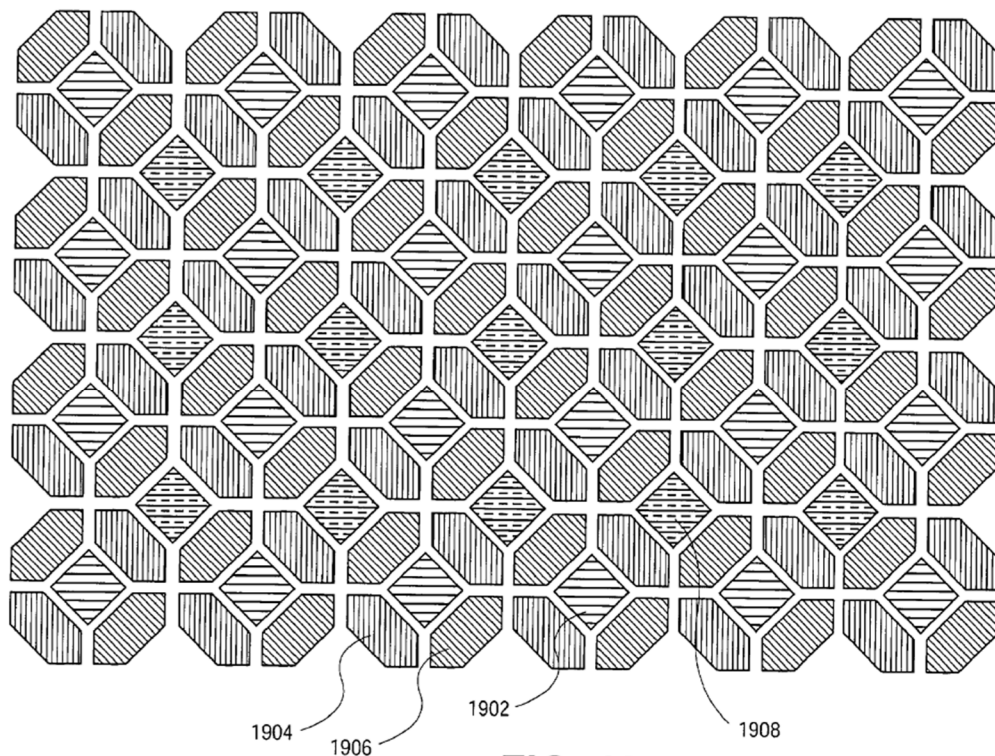


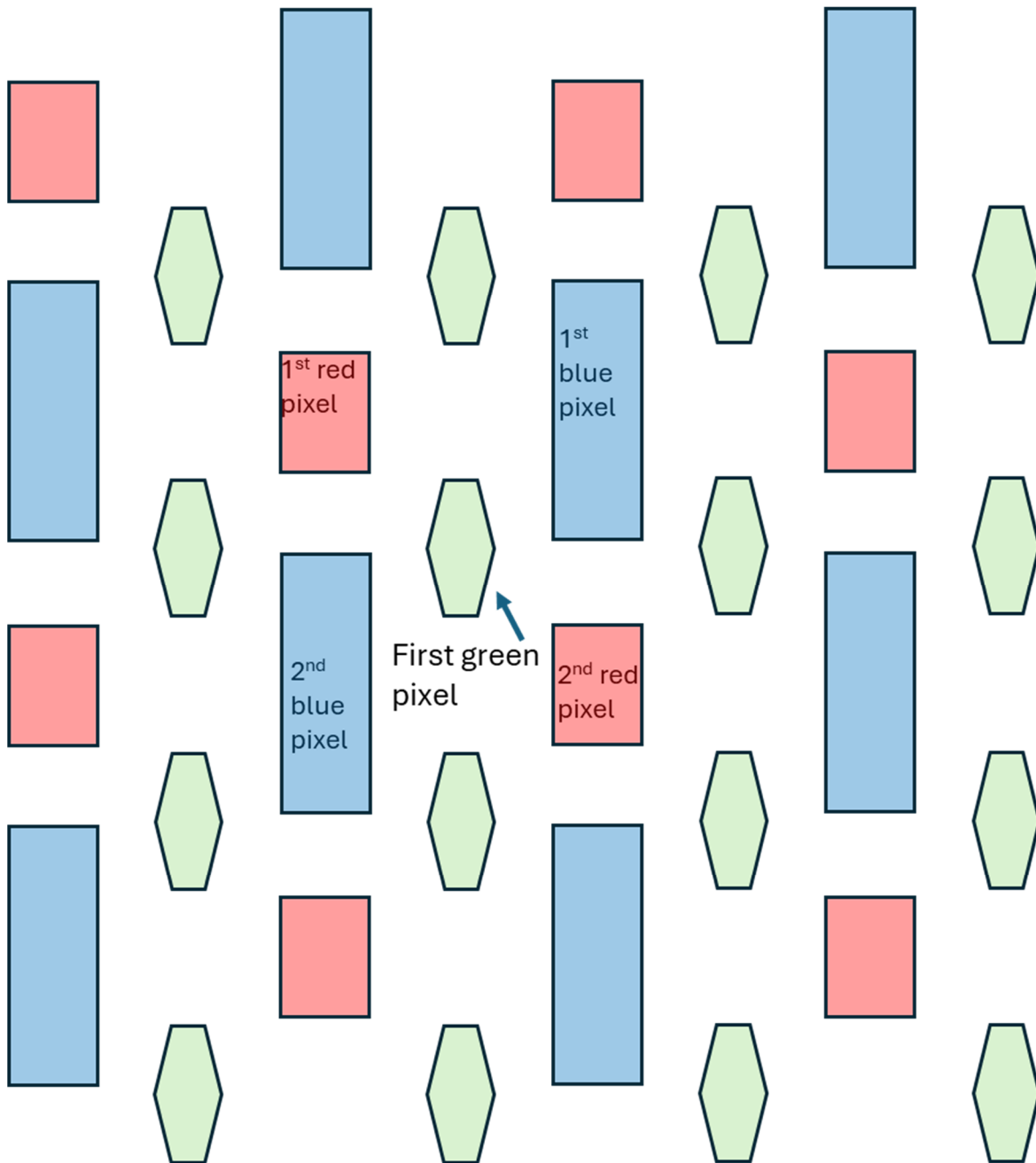
FIG. 19

2. Claim 3

Credelle-379 discloses “[i]t should be appreciated that other shapes to the subpixels are also possible and ... are desirable if manufacturable.” (EX1006, 4:50-56.) Further, Elliott-724, which is a parent application of Credelle-379, teaches in FIG. 19 that sub-pixels can be made hexagonal. (EX1007, FIG. 19.)

Accordingly, Credelle-379 in view of Cok and Suh, when further

considering that Elliott-724 teaches hexagonal sub-pixels are manufacturable, teaches that sub-pixels can be made hexagonal. (EX1002, ¶277.) A POSITA would have been motivated to substitute the green sub-pixels with hexagonal sub-pixels having the same area, such that the first green pixel has a different shape (*e.g.*, hexagonal) than the one of the at least two blue pixels and the one of the at least two red pixel (*e.g.*, rectangular), as shown below. (*Id.*)



Motivation to Combine Credelle-379 with Elliott-724

A POSITA would have found it obvious to combine the hexagonal sub-pixels of Elliott-724 with Credelle-379 in view of Cok and Suh. (EX1002, ¶278.)

Like Credelle-379, Cok, and Suh, Elliott-724 is analogous art because it is in the

same field as the '066 patent. *Wyers* at 1238-39; *see also* EX1002, ¶278.

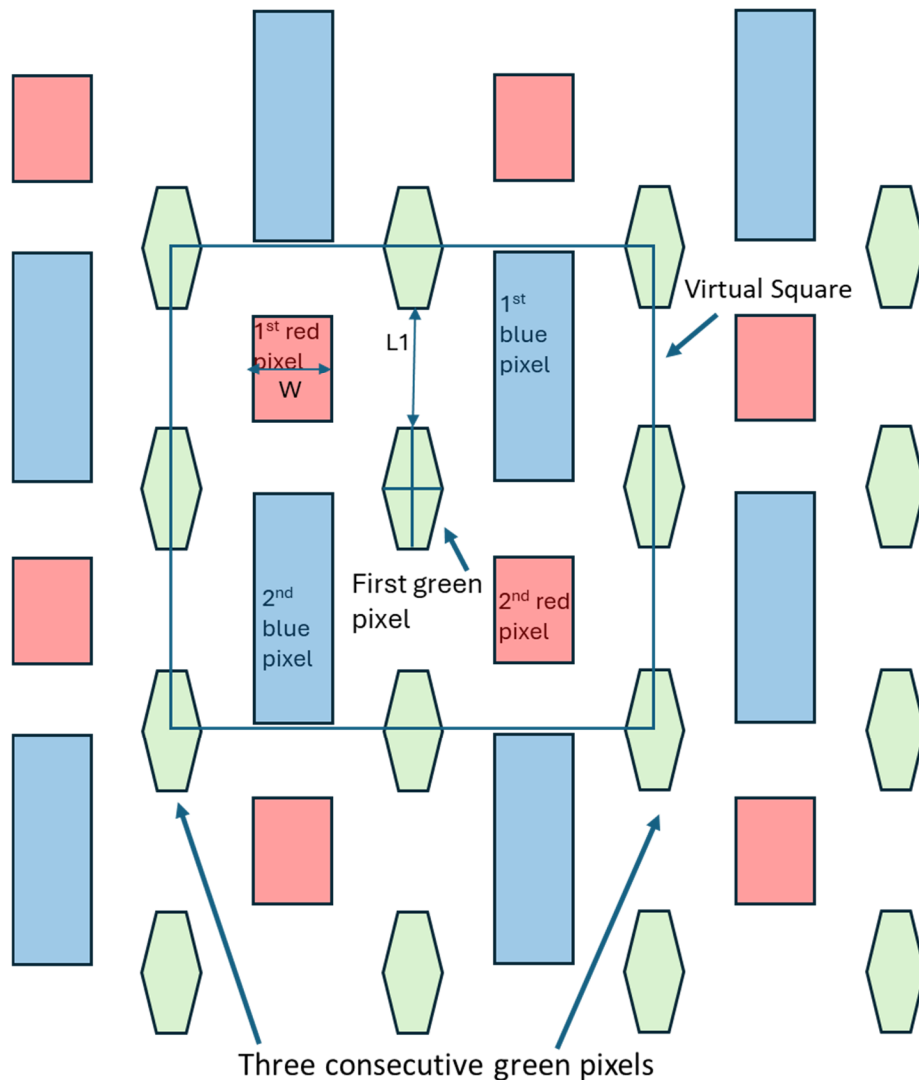
Credelle-379 itself discloses “[i]t should be appreciated that other shapes to the subpixels are also possible and ...are desirable if manufacturable.” (EX1006, 4:51-56.) And, given that Elliott-724 is the parent application of Credelle-379 and is incorporated by reference, a POSITA would have been motivated to use the hexagonal pixel shapes taught by Elliott-724 for the sub-pixels of Credelle-379. (EX1006, 1:13-21; EX1002, ¶279.) Further, it would have been obvious to try making the green pixels hexagonal, while maintaining the shapes of the red and blue pixels, because doing so would have been one of a finite number of identified, predictable solutions with a reasonable expectation of success—specifically, eight possibilities based on whether each of the red, green, and blue pixels is modified to have a hexagonal shape. (EX1002, ¶279.)

Making this combination would have been a simple substitution of one pixel shape for another with predictable results given the two references describe the same, underlying OLED technology. (EX1002, ¶280.) Indeed, a POSITA would have viewed Elliott-724 as disclosing just one more way to shape Credelle-379’s sub-pixels. (*Id.*)

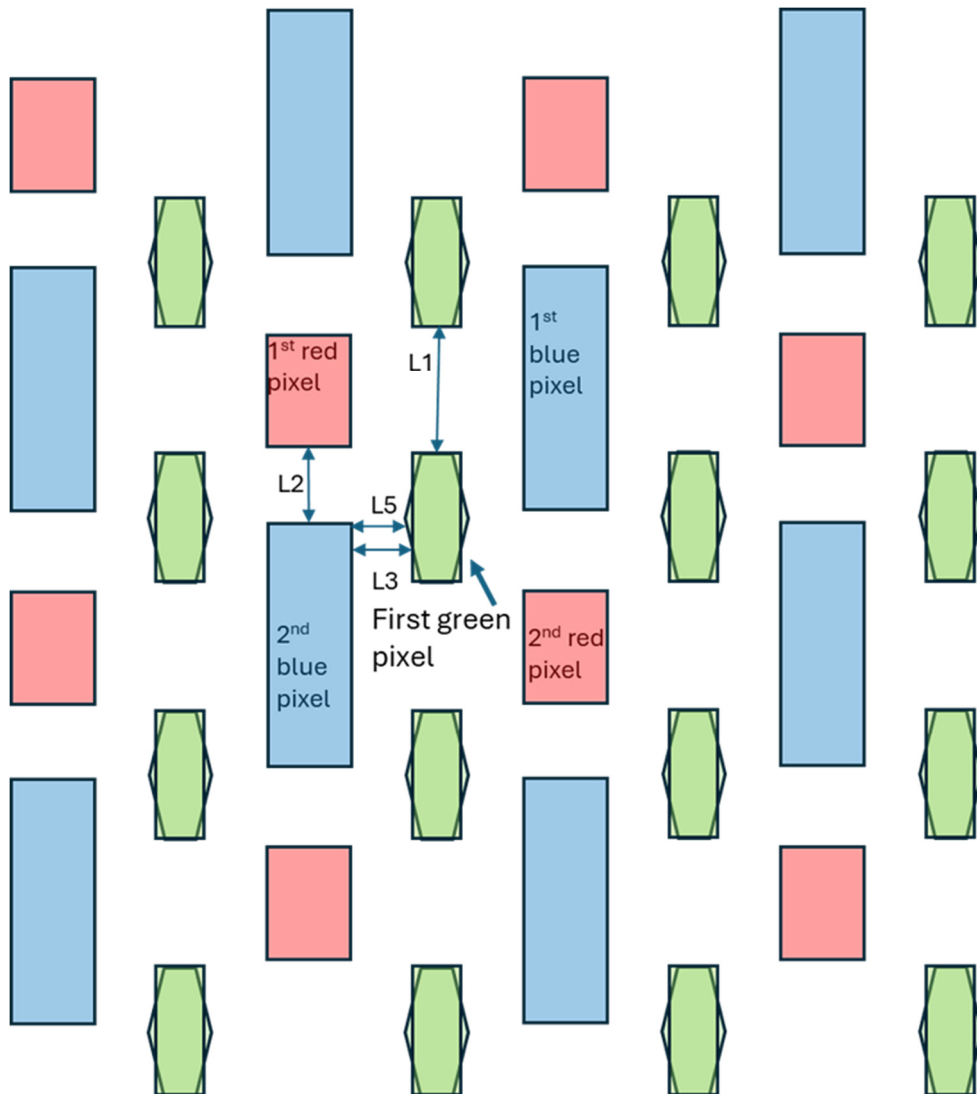
Moreover, a POSITA would have reasonably expected the combination to succeed. (EX1002, ¶281) All references relate to OLED display technology. Further, Elliott-724 is the parent application of Credelle-379 and is incorporated by

reference. (EX1006, 1:13-21.) Credelle-379 discloses “[i]t should be appreciated that other shapes to the subpixels are also possible ... and are desirable if manufacturable,” thereby contemplating the hexagonal pixel shapes shown in Elliott-724. (EX1006, 4:51-56.) Given these disclosures and the knowledge of a POSITA, the combination would have been straightforward. (EX1002, ¶281.)

Such a modification would still satisfy all the limitations of claim 1 from which claim 3 depends, as shown below. (EX1002, ¶282.)



As shown below, such a modification would still satisfy all the limitations of claim 2 from which claim 3 depends. (EX1002, ¶283.) L5 represents the shortest distance between the blue pixel and the hexagonal green pixel. (*Id.*) As shown below, given the convexity of the side of the green pixel, L5 is less than L3. (*Id.*) Accordingly, L2 is greater than L5. (*Id.*)



3. Claim 16

See claim 3. (EX1002, ¶284.)

4. Claim 21

See claim 3. (EX1002, ¶285.)

E. Ground 5: Credelle-379, Cok, Suh, and Hong Render Obvious Claim 11

1. Claim 11

Claim 1 is met by Credelle-379 in view of Cok and Suh as set forth above.

Claim 11 is met by Credelle-379 in view of Cok, Suh, and Hong. For example, as illustrated by FIG. 5, Hong teaches a pixel arrangement layout where the distance between the first (*e.g.*, green) pixel and the second (*e.g.*, blue) pixel as well as a shortest distance between the first (*e.g.*, green) pixel and the third (*e.g.*, red) pixel is a same first length $d1$ in order to prevent shadowing. (EX1039, [0048]; EX1002, ¶¶286-287.)

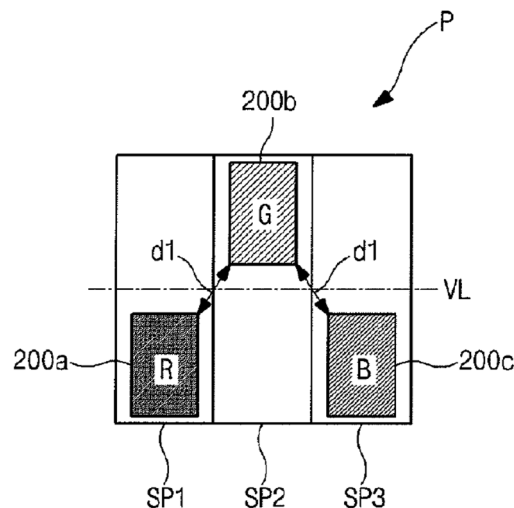
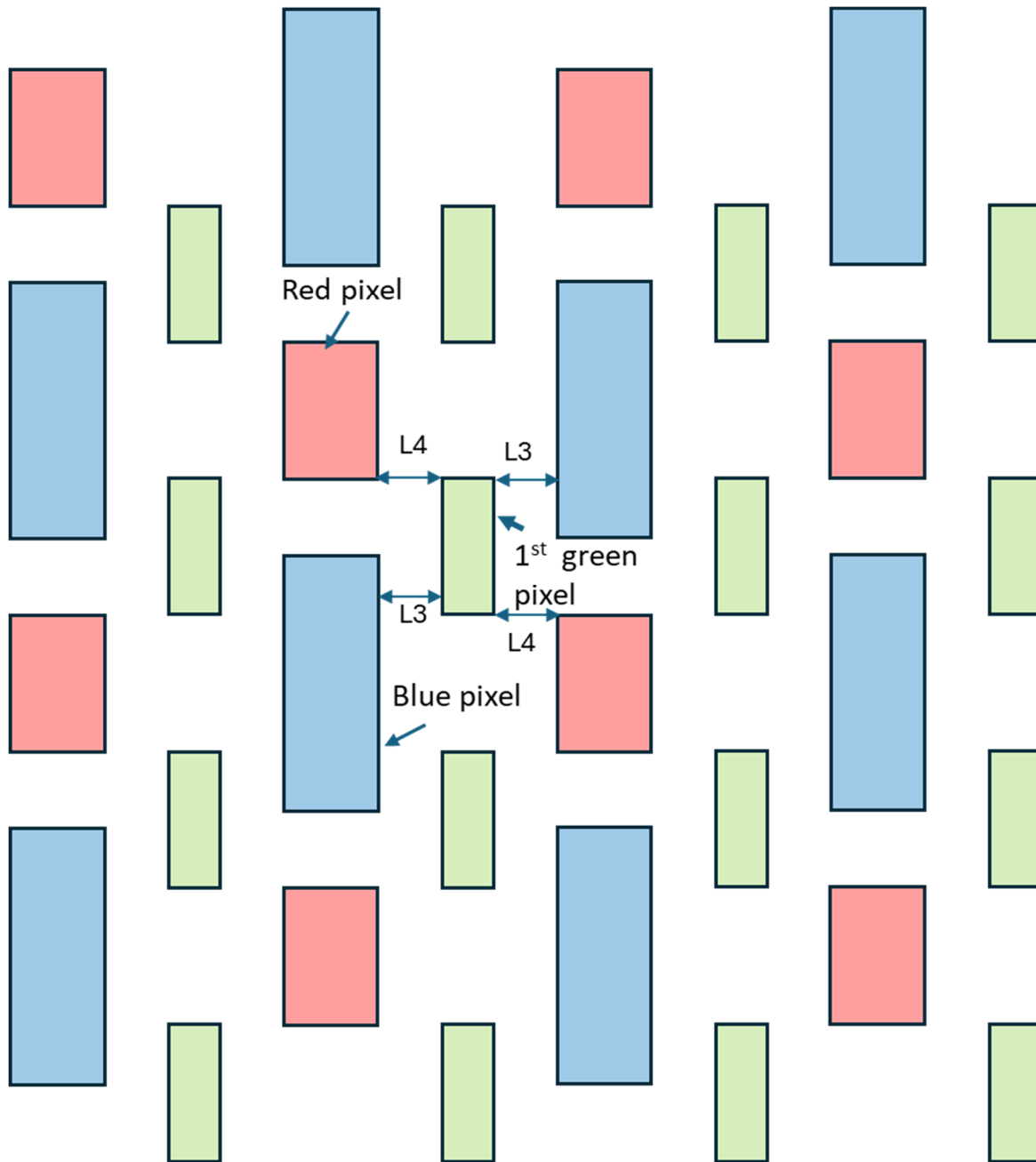


FIG. 5

Thus, a POSITA would have been motivated to modify Credelle-379 as shown below, such that $L3 = L4$ (35.0 μm) in order to prevent shadowing.

(EX1002, ¶287.)



Motivation to Combine Credelle-379 with Hong

A POSITA would have found it obvious to use the spacing of Hong with the pixel arrangement pattern of Credelle-379. A POSITA would have been motivated

to make this combination in order to improve the manufacturability and performance of an OLED display. (EX1002, ¶289.) Doing so would have been a simple application of the spacing taught by Hong to form the OLED display taught by Credelle-379 with predictable results because the two references describe the same, underlying OLED technology. (*Id.*)

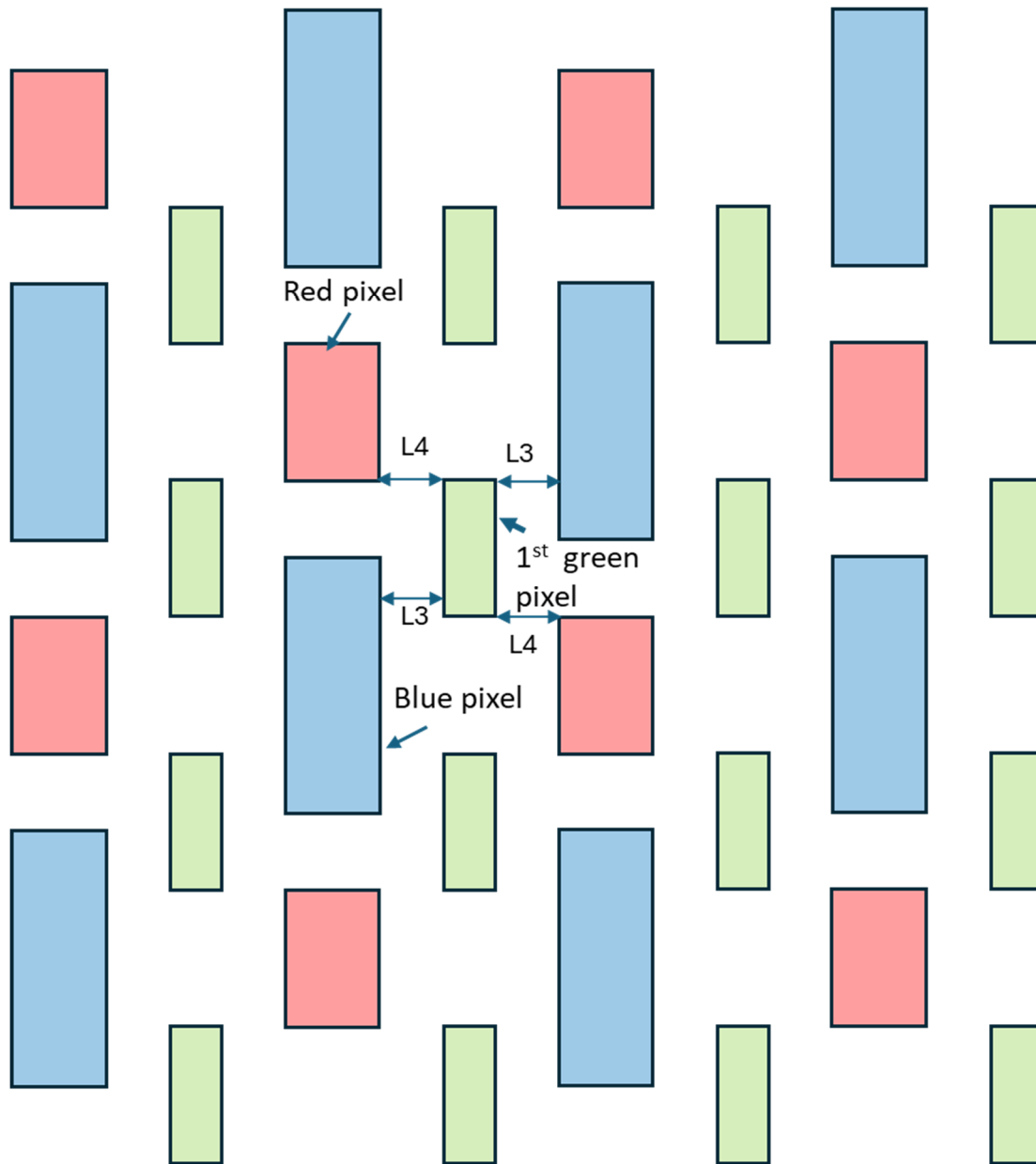
Furthermore, modifying the device of Credelle-379 to have the spacings of Hong would be advantageous because spacing the green pixels from the blue pixels and the green pixels from the red pixels “by a first distance d_1 ” can prevent a shadowing effect along the direction of the space between the pixels. (EX1039, [0048]; EX1002, ¶290.)

Additionally, a POSITA would have recognized that such a spacing would improve the manufacturability of an OLED display by preventing or reducing shadowing caused by the deposition process. (*Id.*) Credelle-379 is silent with respect to manufacturing an OLED display, and thus a POSITA would have looked to Suh and Hong to supply those details. (*Id.*) As discussed above, Hong teaches the use of a shadow mask for patterning the pixels, which is analogous to the fine metal mask of Suh. (EX1039, [0072]; EX1005 ¶6; EX1002, ¶290.) Such a shadow mask is susceptible to thermal expansion and may warp while the pixels are being formed. (EX1039, ¶72; EX1005 [0006], [0031]; EX1002, ¶290.) The POSITA would have also recognized that the equal spacing taught by Hong can

minimize the effects of such warpage and thermal deformation. (EX1002, ¶¶290-291.)

Thus, the POSITA would have been motivated to maintain an equal minimum distance between the green-blue pixel pairs and the green-red pixel pairs. (EX1002, ¶292.) Accordingly, the POSITA would have recognized that adopting Hong's teaching of equal distances between the green-blue pixel pairs and the green-red pixel pairs would mitigate the adverse effects of thermal expansion. (*Id.*) If the distances between the green-blue pixel pairs and the green-red pixel pairs are equal, any expansion that occurs will affect all patterns consistently, thus maintaining the integrity of the design and reducing the likelihood of shadowing. (*Id.*)

A POSITA would have reasonably expected the combination to succeed. (EX1002, ¶293.) All four references relate to OLED display technology. The combination of Credelle-379, Cok, Suh, and Hong, with its resulting pixel arrangement above, would have been straightforward. (*Id.*) For example, to achieve the equal spacing disclosed in Hong, a POSITA could have slightly modified the dimensions of the red pixels to be 60.00 μm x 80.00 μm , to arrive at the arrangement shown below, such that $L3=L4$ (35.0 μm). (*Id.*)



Such a modification would still achieve the limitations of claim 1. (EX1002, ¶294.) For example, the two blue pixels still have a larger area ($7902 \mu\text{m}^2$) than the red pixels ($4800 \mu\text{m}^2$) and the green pixels ($2400 \mu\text{m}^2$), and the shortest distance L1 between two nearest ones of the plurality of green pixels ($80.0 \mu\text{m}$) remains unchanged and is still greater than a width of a first red pixel of the

plurality of red pixels along a first direction (60.0 μm). (*Id.*)

V. REMAINING ISSUES

Petitioner is not fully addressing discretionary issues in the Petition per USPTO guidance. (*See FAQs for Interim Processes for PTAB Workload Management*, USPTO, <https://www.uspto.gov/patents/ptab/faqs/interim-processes-workload-management> (last visited September 23, 2025).) As noted above, Cok, Hong, and the published application (EX1011) of Credelle-379 were considered by the Examiner in a voluminous IDS with 267 references⁵ but were not relied upon by the Examiner in any rejection. (EX1003, 112-128, 179-195.)

Further, the Board previously determined there was a reasonable likelihood that similar claims of three family members were unpatentable in three separate proceedings. (EX1018, EX1020, EX1022.) Such findings were found to “counsel against discretionary denial.” *Tesla, Inc v. Intellectual Ventures II LLC*, IPR2025-00217, Paper 10 at 2 (June 13, 2025). In two of these proceedings, the Board found similar claims to be unpatentable with respect to U.S. Patent No. 7,091,986 to Phan (“Phan-986,” EX1033). (EX1018, 50-51; EX1020, 23.)

Finally, a schedule has not yet been issued and no trial date has been set in the corresponding district court litigation. A Final Written Decision is expected to

⁵ Neither Suh nor Elliott-724 was considered during prosecution of the '066 patent.

issue around March 2027, whereas the trial date for the district court case (which has not been set) will likely be after. As discussed above, the prior art teaches every element of the challenged claims, and the claims are unpatentable. Thus, the merits of the Petition weigh strongly in favor of institution.

VI. NOTICES AND STATEMENTS

Pursuant to 37 C.F.R. § 42.8(b)(1), BOE Technology Group Co., Ltd., is the real party-in-interest for Petitioner.

Pursuant to 37 C.F.R. § 42.8(b)(2), Petitioner identifies the following related litigation matter: the '066 patent is asserted in *Samsung Display Co. Ltd. v. BOE Technology Group Co., Ltd.*, No. 2-25-cv-00426 (E.D. Tex.). Petitioner and Patent Owner are also involved in two additional related litigation matters in the same court, i.e., No. 2-25-cv-00412 and -00430.

The '066 patent is related to U.S. Patent No. 9,818,803 (EX1017), its parent, and U.S. Patent Nos. 10,854,683 (EX1019) and 11,594,578 (EX1021). These three patents were subject to three respective IPRs, i.e., IPR2023-00987, IPR2023-00988, and IPR2023-01075, resulting in three final written decisions. (EX1018, EX1020, and EX1022.) In addition, the '803 and '578 patents were the subject of an International Trade Commission proceeding (Inv. No. 337-TA-1351).

Finally, Petitioner is contemporaneously seeking *inter partes* review of U.S. Patent No. 10,832,616, a parent of the '066 patent. The proceeding is IPR2025-

01544.

Pursuant to 37 C.F.R. § 42.8(b)(3), Petitioner identifies the following counsel (and a power of attorney accompanies this Petition).

Lead Counsel	First Backup Counsel
Mehran Arjomand Registration No. 48,231 MORRISON & FOERSTER LLP 707 Wilshire Boulevard, Suite 6000 Los Angeles, CA 90017-3543 Email: MArjomand@mofo.com Tel: (213) 892-5200 Fax: (213) 892-5454	Alex S. Yap Registration No. 60,609 MORRISON & FOERSTER LLP 707 Wilshire Boulevard, Suite 6000 Los Angeles, CA 90017-3543 Email: AYap@mofo.com Tel: (213) 892-5200 Fax: (213) 892-5454

Pursuant to 37 C.F.R. § 42.8(b)(4), service information for lead and back-up counsel is provided above. Petitioner consents to electronic service by email to BOE-Samsung-IPR@mofo.com.

Pursuant to 37 C.F.R. § 42.104(a), Petitioner certifies that the '066 patent is available for *inter partes* review and that Petitioner is not barred or estopped from requesting an *inter partes* review challenging the patent claims on the grounds identified in this Petition.

The USPTO is authorized to charge any required fees, including the fee as set forth in 37 C.F.R. § 42.15(a) and any excess claim fees, to Deposit Account No. **03-1952** referencing Docket No. **37294-00000.07**.

VII. CONCLUSION

Petitioner respectfully requests the Board initiate *inter partes* review of the challenged claims and ultimately cancel them.

Dated: September 23, 2025

Respectfully submitted,

By /Mehran Arjomand/
Mehran Arjomand, Reg. No. 48,231
MORRISON & FOERSTER LLP
707 Wilshire Boulevard, Suite 6000
Los Angeles, CA 90017-3543
Email: MArjomand@mofo.com
Tel: (213) 892-5200

Attorney for Petitioner

Certification of Word Count (37 C.F.R. § 42.24)

I hereby certify that this Petition for *Inter Partes* Review has 13,493 words (as counted by the “Word Count” feature of the Microsoft Word™ word-processing system), exclusive of “a table of contents, a table of authorities, mandatory notices under § 42.8, a certificate of service or word count, or appendix of exhibits or claim listing.”

Dated: September 23, 2025

By /Mehran Arjomand/
Mehran Arjomand

Certificate of Service (37 C.F.R. § 42.6(e)(4) and 42.205(a))

I hereby certify that the attached Petition for *Inter Partes* Review and supporting materials were served as of the below date by Priority Mail Express on the Patent Owner at the correspondence address indicated for U.S. Patent No. 11,626,066.

Lewis Roca Rothgerber Christie LLP
PO BOX 29001
Glendale, CA

A copy of the attached Petition for *Inter Partes* Review and supporting materials were also served via e-mail on the following litigation counsel:

aa@rothfirm.com
charles.sanders@lw.com
kevin.wheeler@lw.com
alex.grabowski@lw.com
cassandra.baloga@lw.com
brian.kim@lw.com
jake.vannette@lw.com
au@rothfirm.com
ca@rothfirm.com
efindlay@findlaycraft.com
shene@findlaycraft.com
taustin@cov.com
jfrisch@cov.com
jychang@cov.com
shong@cov.com
jlerner@cov.com
rhaslam@cov.com
bbieluch@cov.com
dwcho@cov.com
kylee@cov.com

Dated: September 23, 2025

/Mehran Arjomand/

Mehran Arjomand

VIII. CLAIMS APPENDIX**Claim 1**

[Preamble] An organic light emitting diode (OLED) display, comprising:

1[A] a plurality of individually addressable pixels for displaying an image, the individually addressable pixels being minimum addressable units of the OLED display and comprising:

1[B] a plurality of red pixels comprising an organic emission layer for emitting red light;

1[C] a plurality of blue pixels comprising an organic emission layer for emitting blue light; and

1[D] a plurality of green pixels comprising an organic emission layer for emitting green light,

1[E] wherein the OLED display comprises a pixel defining layer defining areas of the plurality of red pixels, the plurality of blue pixels, and the plurality of green pixels,

1[F] wherein each of the plurality of red pixels, the plurality of blue pixels, and the plurality of green pixels are spaced apart from each other,

1[G] wherein a first green pixel of the plurality of green pixels has a center coinciding with a center of a virtual square, each vertex of the virtual square coinciding with a center of a different one of the plurality of green pixels and each edge of the virtual square overlapping three consecutive green pixels,

1[H] wherein at least two blue pixels of the plurality of blue pixels and at least two red pixels of the plurality of red pixels are located entirely within boundaries of the virtual square,

1[I] wherein each of the at least two blue pixels has a larger area than each of the at least two red pixels,

1[J] wherein each of the at least two blue pixels has a larger area than

that of the first green pixel,

1[K] wherein the first green pixel has a convex shape such that a line bisecting the first green pixel along a long axis thereof has a greater length than a line bisecting the first green pixel along a short axis thereof, and

1[L] wherein a shortest distance between two nearest ones of the plurality of green pixels is greater than a width of a first red pixel of the plurality of red pixels along a first direction parallel to the short axis of the first green pixel.

Claim 2

The OLED display of claim 1, wherein a shortest distance between one of the at least two blue pixels and one of the at least two red pixels is greater than a shortest distance between the first green pixel and the one of the at least two blue pixels or a shortest distance between the first green pixel and the one of the at least two red pixels.

Claim 3

The OLED display of claim 2, wherein the first green pixel has a different shape than the one of the at least two blue pixels and the one of the at least two red pixels.

Claim 4

The OLED display of claim 2, wherein the one of the at least two red pixels has an area that is larger than that of the first green pixel.

Claim 5

The OLED display of claim 2, wherein the one of the at least two blue pixels and the one of the at least two red pixels have polygonal shapes with at least four sides.

Claim 10

The OLED display of claim 1, wherein a shortest distance between the first green pixel and an adjacent one of the plurality of green pixels is greater than a shortest distance between the first green pixel and one of

the at least two blue pixels or a shortest distance between the first green pixel and one of the at least two red pixels.

Claim 11

The OLED display of claim 1, wherein a shortest distance between the first green pixel and one of the at least two blue pixels is equal to a shortest distance between the first green pixel and one of the at least two red pixels.

Claim 12

The OLED display of claim 1, wherein a shortest distance between the first green pixel and an adjacent one of the plurality of green pixels is not equal to a shortest distance between one of the at least two blue pixels and one of the at least two red pixels.

Claim 13

The OLED display of claim 1, wherein a width of the first green pixel along the short axis of the first green pixel is different from a width of one of the at least two red pixels along the first direction, or a width of the first green pixel along the long axis of the first green pixel is different from a width of one of the at least two blue pixels along a second direction parallel to the long axis of the first green pixel.

Claim 14

The OLED display of claim 1, wherein a shortest distance between the two nearest ones of the plurality of green pixels is greater than a width of the first red pixel along a second direction parallel to the long axis of the first green pixel.

Claim 15

[Preamble] A method for manufacturing an organic light emitting diode (OLED) display, comprising:

15[A] depositing, using a fine metal mask, organic light-emitting material configured to emit a first color of light;

15[B] forming a plurality of first pixels to emit the first color of light;

15[C] depositing, using a fine metal mask, organic light-emitting material configured to emit a second color of light;

15[D] forming a plurality of second pixels to emit the second color of light;

15[E] depositing, using a fine metal mask, organic light-emitting material configured to emit a third color of light; and

15[F] forming a plurality of third pixels to emit the third color of light,

15[G] wherein the plurality of first pixels, the plurality of second pixels, and the plurality of third pixels are individually addressable pixels for displaying an image, the individually addressable pixels being minimum addressable units of the OLED display,

15[H] wherein the OLED display comprises a pixel defining layer defining areas of the plurality of first pixels, the plurality of second pixels, and the plurality of third pixels,

15[I] wherein each of the plurality of first pixels, the plurality of second pixels, and the plurality of third pixels are spaced apart from each other,

15[J] wherein a first one of the plurality of first pixels has a center coinciding with a center of a virtual square, each vertex of the virtual square coinciding with a center of a different one of the plurality of first pixels and each edge of the virtual square overlapping three consecutive first pixels,

15[K] wherein at least two second pixels of the plurality of second pixels and at least two third pixels of the plurality of third pixels are located entirely within boundaries of the virtual square,

15[L] wherein each of the at least two second pixels has a larger area than each of the at least two third pixels,

15[M] wherein each of the at least two second pixels has a larger area than that of the first one of the plurality of first pixels,

15[N] wherein the first one of the plurality of first pixels has a convex shape such that a line bisecting the first one of the plurality of first

pixels along a long axis thereof has a greater length than a line bisecting the first one of the plurality of first pixels along a short axis thereof, and

15[O] wherein a shortest distance between two nearest ones of the plurality of first pixels is greater than a width of one of the third pixels along a first direction parallel to the short axis of the first one of the plurality of first pixels.

Claim 16

The method of claim 15, wherein the first one of the plurality of first pixels has a different shape than one of the at least two second pixels and one of the at least two third pixels.

Claim 17

The method of claim 15, wherein one of the at least two third pixels has an area that is larger than that of the first one of the plurality of first pixels.

Claim 18

The method of claim 15, wherein one of the at least two second pixels and one of the at least two third pixels have polygonal shapes with at least four sides.

Claim 19

The method of claim 15, wherein the plurality of first pixels comprises an organic emission layer for emitting green light, the plurality of second pixels comprises an organic emission layer for emitting blue light, and the plurality of third pixels comprises an organic emission layer for emitting red light.

Claim 20

The method of claim 19, wherein a shortest distance between one of the at least two second pixels and one of the at least two third pixels is greater than a shortest distance between the first one of the plurality of first pixels and the one of the at least two second pixels or a shortest distance between the first one of the plurality of first pixels and the one of the at least two third pixels.

Claim 21

The method of claim 20, wherein the first one of the plurality of first pixels has a different shape than the one of the at least two second pixels and the one of the at least two third pixels.

Claim 22

The method of claim 20, wherein the one of the at least two third pixels has an area that is larger than that of the first one of the plurality of first pixels.

Claim 23

The method of claim 20, wherein the one of the at least two second pixels and the one of the at least two third pixels have polygonal shapes with at least four sides.

Claim 28

The method of claim 15, wherein a shortest distance between the first one of the plurality of first pixels and an adjacent one of the plurality of first pixels is not equal to a shortest distance between one of the at least two second pixels and one of the at least two third pixels.

Claim 29

The method of claim 15, wherein a width of the first one of the plurality of first pixels along the short axis of the first one of the plurality of first pixels is different from a width of one of the at least two third pixels along the first direction, or a width of the first one of the plurality of first pixels along the long axis of the first one of the plurality of first pixels is different from a width of one of the at least two second pixels along a second direction parallel to the long axis of the first one of the plurality of first pixels.

Claim 30

The method of claim 15, wherein a shortest distance between the two nearest ones of the plurality of first pixels is greater than a width of the one of the third pixels along a second direction parallel to the long axis of the first one of the plurality of first pixels.