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

DECLARATION OF THOMAS CREDELLE

I, Thomas Credelle, make this declaration in connection with the proceeding identified above.

I. INTRODUCTION

1. I have been retained as an expert witness on behalf of BOE Technology Group Co., Ltd. ("Petitioner" or "BOE") to provide expert opinions on the patentability of United States Patent No. 11,626,066 ("the '066 patent").

2. I am being compensated at my normal rate, plus reimbursement for expenses, for my analysis. My compensation does not depend on the content of my opinions or the outcome of this proceeding.

II. QUALIFICATIONS

3. In formulating my opinions, I have relied upon my knowledge, training, and experience in the relevant art. My qualifications are stated more fully in my curriculum vitae, which has been provided as Appendix A. Here, I provide a brief summary of my qualifications.

4. As shown in my curriculum vitae, I have devoted my career to the research and development and product engineering of flat panel displays and materials/optics/electronics for flat panel displays and touch sensors. I have over 20 years of involvement in active-matrix LCD R&D, starting in 1983 at RCA Labs and continuing at GE. I led the product development of active matrix LCDs for notebook computers at Apple in the early 1990s and had close collaboration with

many LCD developers in Asia. Later in my career, I made significant contributions to the design and implementation of new pixel architectures for LCDs and OLEDs while at Clairvoyante; both efforts involved Thin Film Transistor ("TFT") design modifications to achieve the desired goals of high pixel transmission and reduced circuit complexity. The contributions I made to advanced pixel architectures ("Pentile Matrix") and related circuit design optimization at Clairvoyante led to a decision by Samsung to acquire the IP (2007). More recently, I have testified in several patent litigation cases which required a detailed knowledge of TFT design, materials, and processing for both LCD and OLED.

5. After receiving my Master's in Electrical Engineering from MIT in 1970, I was employed by RCA at Sarnoff Labs in Princeton, NJ as a Member of the Technical Staff and later as a Group Manager in charge of all Active Matrix LCD research. During my time at RCA, I participated in research and development projects relating to optical materials and flat panel displays, including LCD devices. In 1983, I established the TFT LCD Program at Sarnoff Labs. As a Group Manager, I led a project that resulted in the development of the first poly

silicon TFT LCD at Sarnoff Labs. I received the Sarnoff Outstanding Achievement Award for Large Area Flat Panel TV Developments.

6. From 1986 to 1991, I was employed by GE as the Manager of TFT LCD Research and Development at the GE Research and Development Center in Schenectady, NY. My duties included contributing to and managing research and development efforts relating to TFT and LCD technology for avionics applications. While employed by GE, I led the team that built the world's first 1-million-pixel color LCD device. I also led the development of numerous other optical devices utilizing LCD technology.

7. From 1991 to 1994, I was employed by Apple Computer as the Manager of Display Engineering. In my role at Apple, I supervised all TFT-LCD design (in-house and at vendors), engineering, and qualification for the first PowerBook notebook computers introduced to market in the United States. A key part of my effort was the evaluation and development of active matrix LCDs with improved performance, such as viewing angle, contrast ratio and uniformity.

8. From 1994 to 1996, I was employed as the Director of Advanced Product Marketing by Allied Signal, where I was involved with the design and

engineering of optical films and custom focusing backlight designs for improving the viewing angle performance of LCD devices.

9. From 1996 to 1999, I was employed as the Director of Product Marketing for Motorola's Flat Panel Display Division, where I worked in the development of new flat panel technology. I also worked closely with Motorola groups responsible for integrating TFT-LCD technology into mobile phone products and materials development for OLED displays.

10. From 1999 to 2001, I served as the Vice President of Operations of Alien Technology Corporation. During my time at Alien Technology, I was involved with the design and architecture of drive electronics packaging technology suitable for flexible display devices.

11. From 2001 to 2007, I served as the Vice President of Engineering for Clairvoyante, Inc. My responsibilities as the VP of Engineering included managing research, development, engineering, and marketing of technologies for improving the resolution and power consumption of color flat panel displays, which required significant changes to the active matrix layout. During my time at Clairvoyante, I was therefore heavily involved with the design of the active matrix array and the LCD or OLED pixel circuit and driving circuitry. My work resulted

in the issuance of multiple patents relating to TFT-LCD and TFT-OLED display technology.

12. From 2007 to 2008, I served as the Senior VP of Engineering for Puredepth, Inc. My responsibilities included the design of hardware and software to create 3D images on TFTLCDs.

13. From 2012 through 2015, I served as the Vice President of Application Engineering and Device Performance for Innova Dynamics, Inc., a nanotechnology company developing materials to be used in LCDs and touch sensors. In that effort, I led the collaboration with major capacitive touch sensor makers to replace brittle Indium Tin Oxide ("ITO") transparent conductors with transparent silver nanowire conductors, which are compatible with flexible touch sensors. We successfully fabricated flexible capacitive touch sensors that could be bent without breaking.

14. In 2008, I founded TLC Display Consulting, a company that provides technical consulting in the areas of flat panel displays, liquid crystal displays, OLED, touch sensors, LEDs, and related electronics. I currently serve as the President of TLC Display Consulting.

15. I have been an active member of the Society for Information Display ("SID") for over 40 years, and am currently a Life Member. I was a member of the Society for Information Display's Program Committee for 15 years, and the

Director of the Society for Information Display's Symposium Committee for 10 years. In 1984, I was awarded the title of Fellow of the Society for Information Display in recognition of my achievements and contributions to flat panel display technology.

16. I am a named inventor on over 80 US patents relating to flat panel display, LCD, and OLED technology. I have also authored several articles relating to LCD technology and flat panel displays that were published by industry periodicals such as Information Display and peer reviewed journals such as the Society for Information Display's Digest of Technical Papers.

17. My curriculum vitae contains further details regarding my experience, education, publications, and other qualifications that allow me to render expert opinions in connection with this proceeding.

III. MATERIALS CONSIDERED

18. In preparing this declaration, I have reviewed, among other things, the '066 patent and file history. I have also considered each of the documents cited in this Declaration and the documents specifically identified below and in the Exhibit

list. In formulating my opinions, I have further relied upon my extensive experience in the relevant fields.

IV. OVERVIEW OF THE ORGANIC LIGHT-EMITTING DEVICE (OLED) DISPLAY DEVICE TECHNOLOGY AT THE TIME OF THE ’066 PATENT

19. Organic light-emitting devices (“OLEDs”) are a type of display technology. In contrast to light-emitting diodes (“LEDs”), OLEDs are made of organic compounds that emit light when electric current is applied. OLEDs have benefits over LEDs. For example, OLEDs are very thin, flexible, and transparent.

20. There are, however, shortcomings with OLED displays. For example, the manufacturing of OLED displays can be costly and complicated. An error during manufacturing can impact the quality of the OLED display by causing luminance errors such as aliasing, chromatic aberration, Moiré defects, Mura, etc.

21. The idea of arranging the red, green, and blue pixels of an OLED display in a non-standard arrangement (*e.g.*, an arrangement with red, blue, and green pixels in a non 1:1:1 ratio) and adjusting the relative sizes of sub-pixels was known by at least March 6, 2012 (which I have been informed is the earliest possible priority date for the ’066 patent). Further, arranging pixels of OLED displays to form equally spaced pixels vertically and horizontally (*e.g.*, in a “virtual square” arrangement) by arranging red, green, and blue pixels in alternating

patterns in both rows and columns to form a checkerboard pattern (as opposed to color stripes or delta arrangement) was also known by at least March 6, 2012.

22. Additionally, pixel arrangements with an unequal number of red, green, and blue pixels (*e.g.*, RGBG arrangements) were known by at least March 6, 2012. It was well known that the human eye is most sensitive to green light and less sensitive to red and blue light, both in terms of luminance and spatial resolution. Thus, RGBG pixel arrangements that have more green pixels than red or blue pixels were developed and commonly known by at least March 6, 2012. By providing more green pixels in a display than red and blue pixels and using sub-pixel rendering software, the display resolution seen by the human visual system is maintained and yet the manufacturing processes are simplified.

23. Numerous patent publications, including those discussed herein, disclose these ideas before the earliest priority date of the ’066 patent.

V. SUMMARY OF THE ’066 PATENT

A. Filing and Priority Dates

24. The ’066 patent was filed on June 24, 2022, as U.S. Application No. 17/005,753 and issued on April 11, 2023. The ’066 patent is a continuation of U.S. Patent Application Ser. No. 17/005,753, which became U.S. Patent No. 11,626,064 (’064 patent) and claimed priority to Korean Patent Application No. 10-2013-0044993, filed on April 23, 2013. The ’064 patent is a continuation of U.S. patent

application Ser. No. 13/872,018, which became U.S. Pat. No. 10,832,616 (the ’616 patent, EX1016) and also claimed priority to Korean Patent Application No. 10-2013-0044993, filed on April 23, 2013. The ’616 patent is a continuation in part of U.S. patent application Ser. No. 13/614,197, filed September 13, 2012, now U.S. Pat. No. 9,818,803, which claims priority to and the benefit of Korean Patent Application No. 10-2012-0022967, on March 6, 2012. (EX1015.) For the purposes of this declaration only, I am using the March 6, 2012, priority date. I am not opining on whether the claims are, in fact, entitled to that priority date.

B. Specification and Claims

25. The ’066 patent is titled “Pixel Arrangement Structure for Organic Light Emitting Diode Display.” The ’066 patent discloses “[a] pixel arrangement structure of an [] OLED display.” (EX1001, Abstract.) The OLED display may include a plurality of pixels, including blue, red, and green pixels. (EX1001, 3:1-3.) The pixels may be arranged to form virtual squares. (EX1001, 10:26-33.)

26. The ’066 specification explains that “reducing a gap between neighboring pixels to obtain a high aperture ratio of the pixels” may deteriorate deposition reliability, but increasing the gap to improve deposition reliability decreases the aperture ratio. (EX1001, 1:51-56.)

27. Figure 6, annotated below, shows a pixel arrangement structure. Independent claim 1 is directed to a pixel arrangement structure of an organic light

emitting diode (OLED) display, comprising a plurality of individually addressable pixels for displaying images, the individually addressable pixels being minimum addressable units of the OLED display and comprising:

- **"a plurality of red pixels"** comprising an organic emission layer for emitting red light;
- **"a plurality of blue pixels"** comprising an organic emission layer for emitting blue light; and
- **"a plurality of green pixels"** comprising an organic emission layer for emitting green light,
- 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,
- 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,

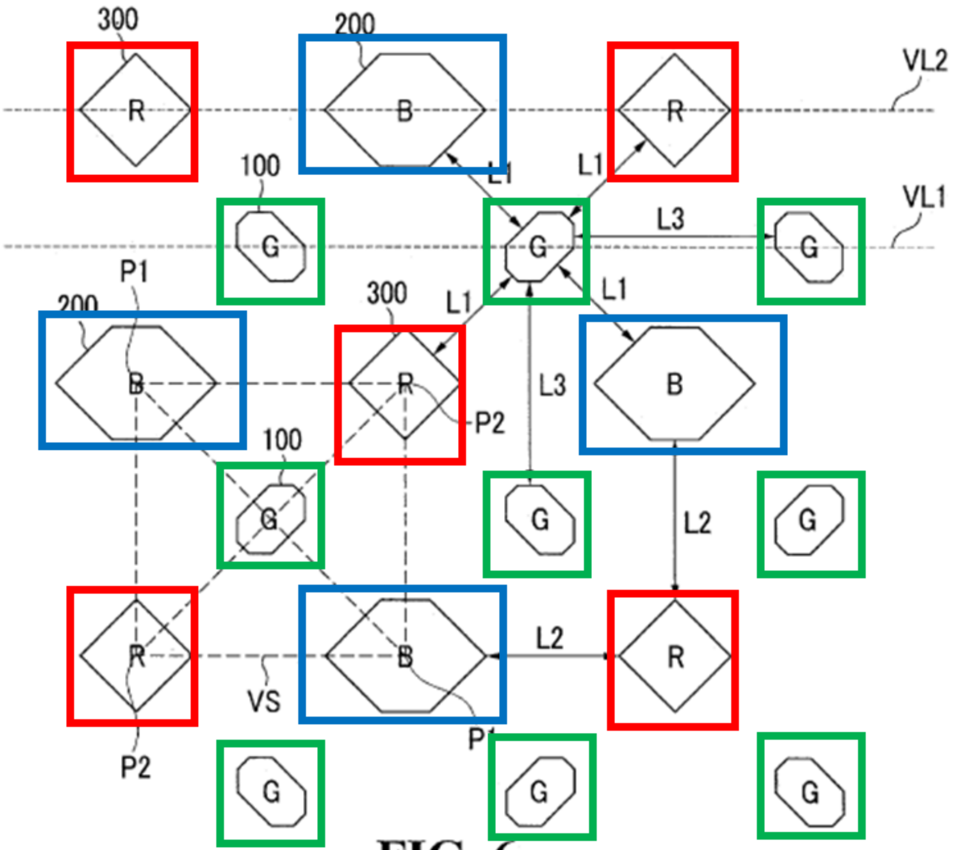

FIG. 6

- 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,"**

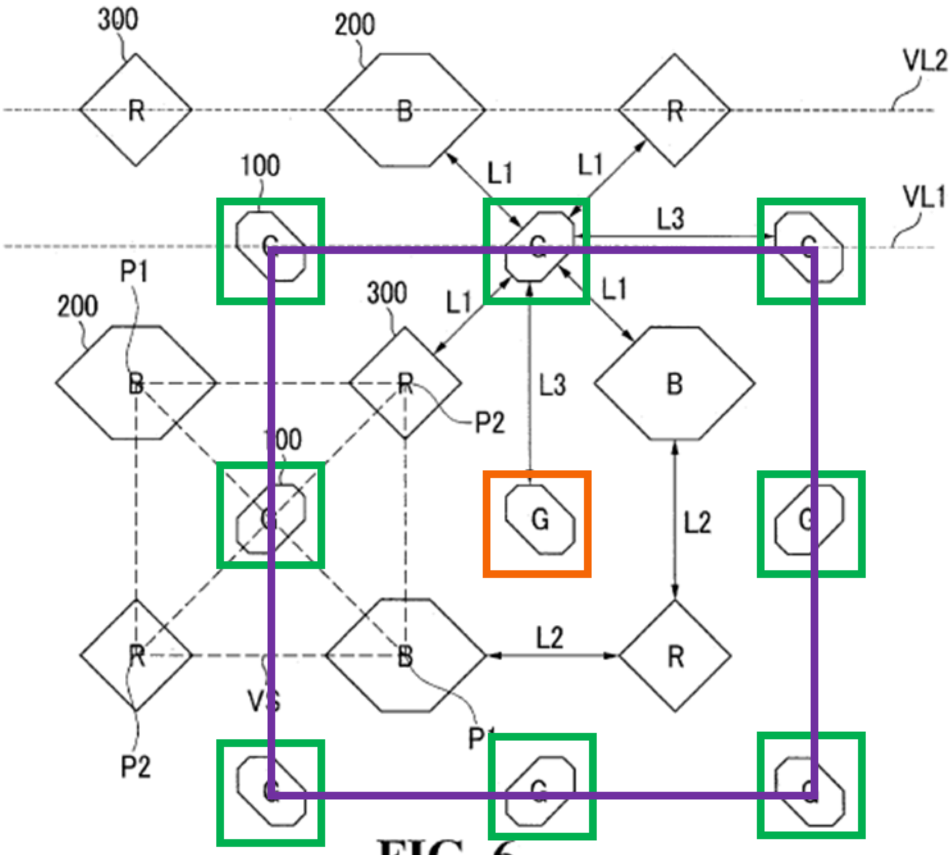

FIG. 6

- 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,"

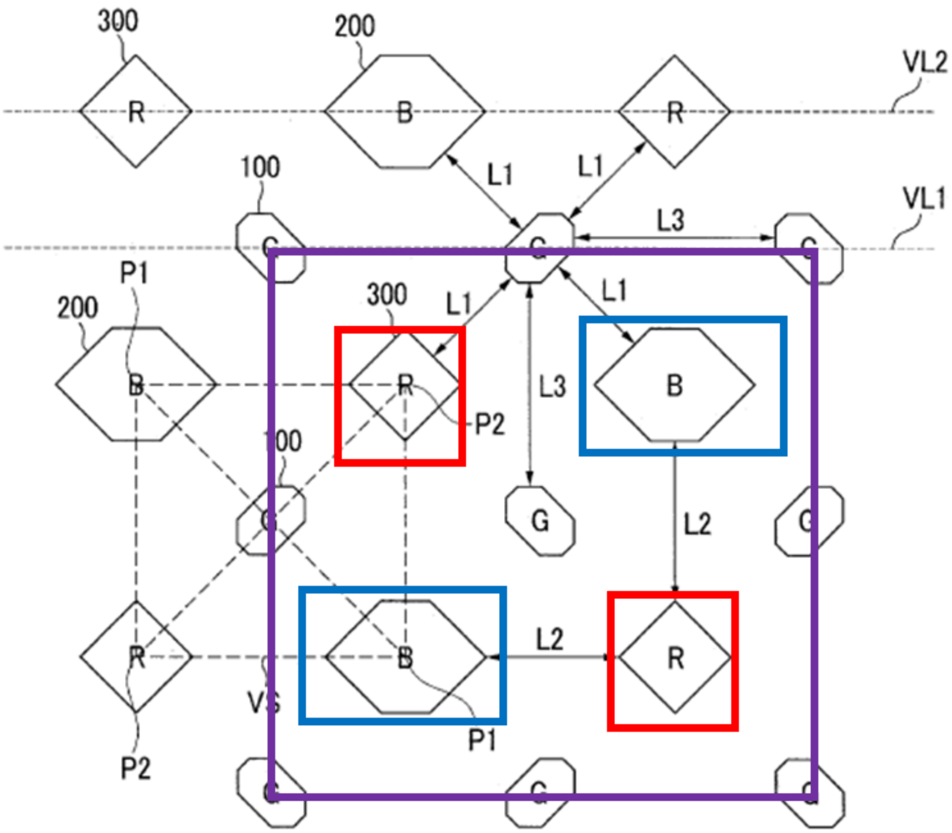

FIG. 6

- wherein each of the **"at least two blue pixels"** has a larger area than each of the **"at least two red pixels,"**
- wherein each of the **"at least two blue pixels"** has a larger area than that of **"the first green pixel,"**

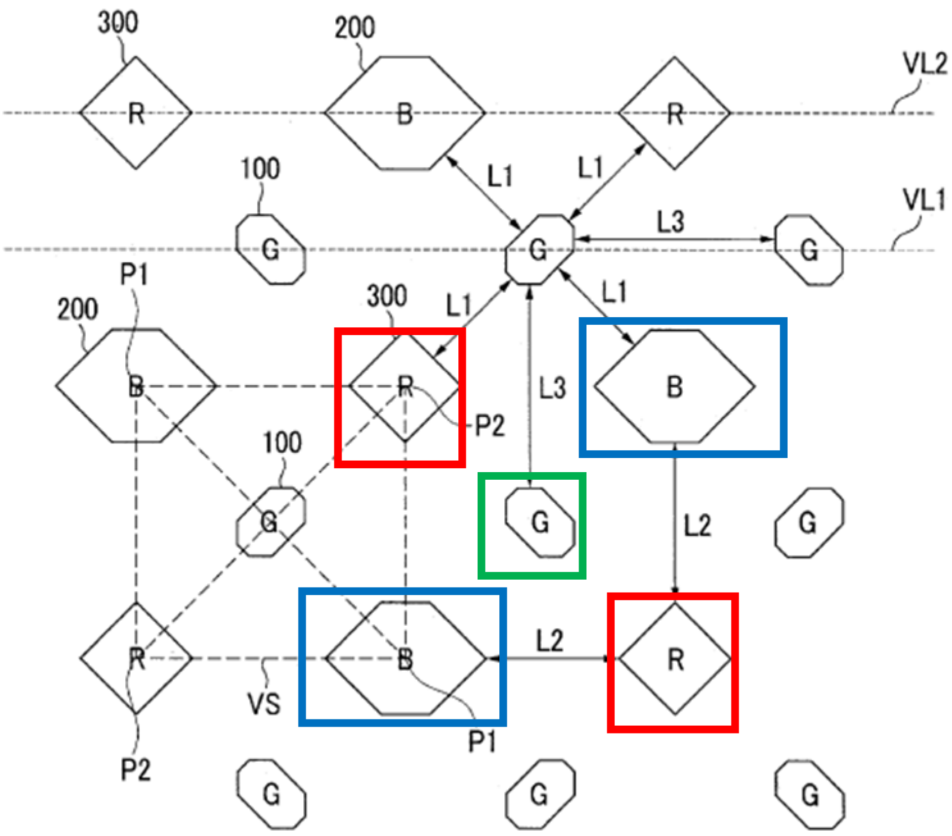

FIG. 6

- 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

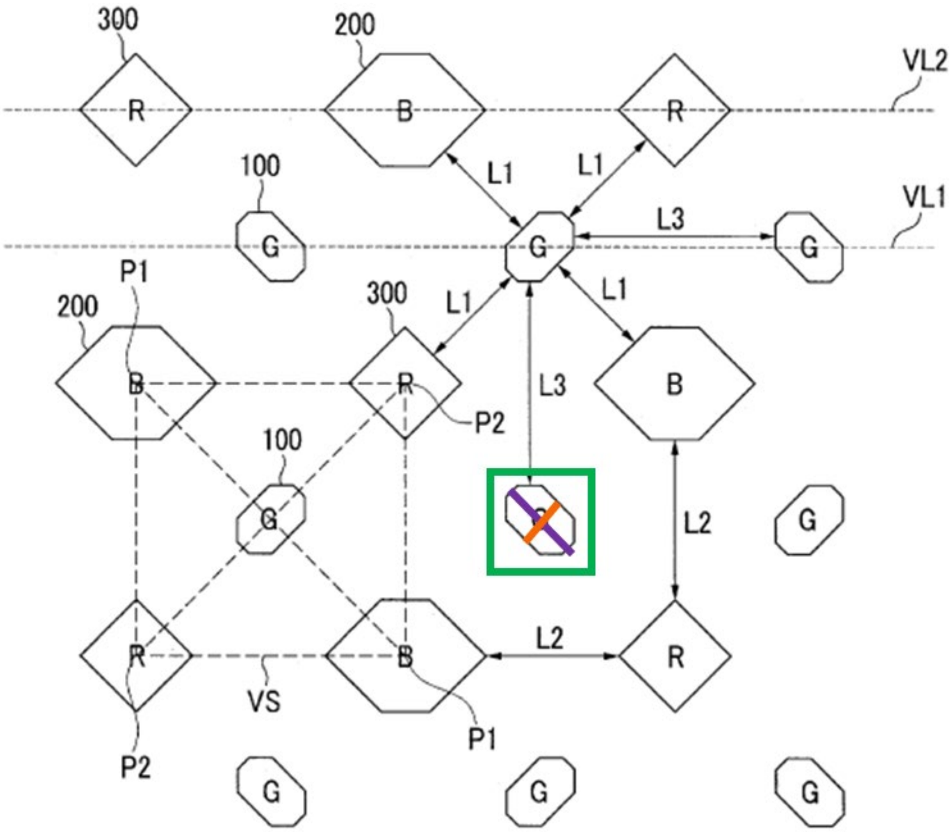

FIG. 6

- 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.

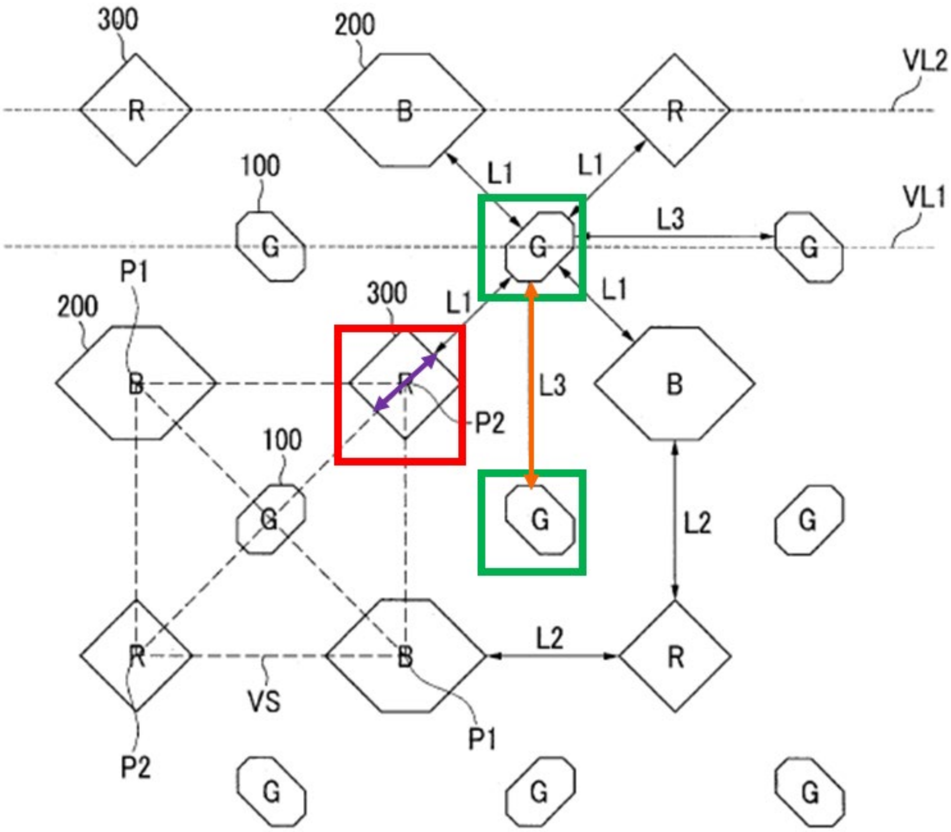

FIG. 6

28. Independent claim 15 recites elements similar to independent claim 1, except claim 15 is a method claim, recites first, second, and third pixels instead of red, blue, and green pixels, and also recites forming the pixels using a fine metal mask.

29. Claims 2-14 and 16-30 are dependent claims. Claims 2, 6, 10, 11, 12, 14, 20, 24, 28, and 30 are directed to spacing in between the pixels. Claims 4, 8, 13, 17, 22, 26, and 29 relate to the relative sizes of the pixels. Claims 3, 5, 7, 9, 16,

18, 21, 23, 25, and 27 relate to the shapes of the pixels. Claim 19 relates to the colors emitted by the pixels.

C. Prosecution History

30. I understand that during prosecution of the ’066 patent, Patent Owner submitted a voluminous Information Disclosure Statement (IDS) with 267 references. (EX1003, 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.*)

31. On October 14, 2022, the Examiner issued a non-final rejection, provisionally rejecting claims 1-7, 9-19, 21-23 and 25 for nonstatutory double patenting over claims of co-pending Application No. 17/808,983 (now U.S. Patent No. 11,626,067 (EX1012)) in view of U.S. Patent No. US 7,215,347 to Phan (“Phan-347” (EX1013)). (EX1003, 142-151.)

32. Further, the Examiner rejected claims 1-3, 5, 10, 14, 16-19, and 21 as anticipated or obvious in view of Phan-347 or U.S. Patent Pub. No. US 2014/0191202 to Shim (“Shim” (EX1014)) in view of Phan-347. (*Id.*, 152-163.)

33. On January 17, 2023, Patent Owner amended the independent claims to recite a pixel defining layer and that the two red and blue pixels were located “entirely” within the virtual square, and added the limitation pertaining to the

width of the red pixel, while removing the other limitations pertaining to distances between the pixels. (EX1003, 421-426.) The Patent Owner argued that the amended independent claims were patentable over the co-pending application and that neither Phan-347 nor Shim disclosed a pixel defining layer or the limitation pertaining to the width of the red pixel. (*Id.*, 431-434.)

34. 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.)

35. I understand that during prosecution of the ’616 patent (a parent application of the ’066 patent), the Examiner rejected the claims as lacking novelty and as being obvious in light of a multitude of prior art references, including U.S. Patent No. 7,274,383 to Elliott[1] (“Elliott-383” (EX1029)); U.S. Patent Pub. No. 2008/0001525 to Chao et al. (“Chao” (EX1032)); Cok; U.S. Pub. No.

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[1] Although the patent refers to “Elliot” with one “t,” other patent publications to the same inventor utilize two “t”s. For consistency, Elliott is used with two “t”s throughout the Declaration.

2009/0302331 to Smith et al.; U.S. Patent Pub. No. 2003/0128179 to Credelle ("Credelle-179" (EX1030)); U.S. Patent Pub. No. 2006/0274090 to Koyama; U.S. Patent No. 6,882,364 to Inuiya et al.; and U.S. Patent Pub. No. 2004/0183764 to Kim et al. Neither Elliott-383 nor Chao teach an RGBG pixel arrangement, a difference from both the '066 and the '616 patents.

VI. RELEVANT LEGAL STANDARDS AND DEFINITIONS

A. Anticipation

36. It is my understanding that the claims of a patent are anticipated by a prior art reference if each and every element of the claim is found either explicitly or inherently in a single prior art reference or system. I understand that inherency requires a showing that the missing descriptive matter in the claim is necessarily or implicitly present in the allegedly anticipating reference and that it would have been so recognized by a POSITA. In addition, I understand that an enabling disclosure is a disclosure that allows a POSITA to make the invention without undue experimentation. Although anticipation typically involves the analysis of a single prior art reference, I understand that additional references may be used to show that the primary reference has enabling disclosure, to explain the meaning of

a term used in the primary reference, and/or to show that a characteristic is inherent in the primary reference.

B. Obviousness

37. I understand that a claim is unpatentable if the differences between the claimed subject matter and the prior art are such that the subject matter as a whole would have been obvious at the time the claimed subject matter was made to a POSITA to which the subject matter pertains. I understand that a patent claim may be obvious to a POSITA in view of the prior art teachings of a single reference or a combination of references.

38. To assess obviousness, I understand that I am to consider the scope and content of the prior art, the differences between the prior art and the claim, the level of ordinary skill in the art, and any secondary considerations to the extent they exist.

39. It is also my understanding that there are principles that may be used as further guidance in an obviousness analysis (especially when considering combinations of references), which include considering whether:

- the claimed subject matter is simply a combination of prior art elements according to known methods to yield predictable results;
- the claimed subject matter is a simple substitution of one known element for another to obtain predictable results;

- the claimed subject matter uses known techniques to improve similar devices or methods in the same way;
- the claimed subject matter applies a known technique to a known device or method that is ready for improvement to yield predictable results;
- the claimed subject matter would have been "obvious to try" choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success;
- there is known work in one field of endeavor that may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to a POSITA;
- there existed at the time of conception and reduction to practice a known problem for which there was an obvious solution encompassed by the patent's claims; and
- there is some teaching, suggestion, or motivation in the prior art that would have led a POSITA to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed subject matter.

40. I understand that there are secondary considerations that may tend to show that a claimed invention would not have been obvious to a POSITA. These include, for example, commercial success, long-felt but unsolved needs, failure of

others, and unexpected results. I further understand that there must be a relationship, or nexus, between any secondary considerations and the novelty of the claimed invention.

C. Prior Art

41. I am informed and understand that prior art includes patents and printed publications that existed before the effective filing date of the claimed invention. The effective filing date is the earliest claimed priority date or the earliest filing date of the application that describes the subject matter. A patent or published patent application is prior art if it was filed before the earliest filing date of the claimed invention, absent a few exceptions. I am informed that a patent or published patent application is entitled to have its effective filing date as the filing date of its provisional application if the disclosure of the provisional application provides support for the claim(s) of the patent or published patent application.

VII. LEVEL OF ORDINARY SKILL IN THE ART FOR THE ’066 PATENT

42. I am informed and understand that various factors can be considered in determining a person of ordinary skill in the art (POSITA). I am informed and understand that those factors include: (1) the educational level of the inventors; (2) the type of problems encountered in the art; (3) prior art solutions to those

problems; (4) the rapidity with which innovations are made; (5) sophistication of the technology; and (6) education level of active workers in the field.

43. A person of ordinary skill in the art (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. I believe this level of skill was utilized in previous *inter partes* reviews of related patents.

44. I agree with this level of ordinary skill for the ’066 patent. Based on my experience, I understand and know of the capabilities of a person of this skill level as of the time the ’066 priority application was filed in 2012. I am familiar with how a POSITA would have understood and used the terminology found in the ’066 patent at the time of the filing of the priority application, and with the state of the art at that time.

VIII. CLAIM CONSTRUCTION

45. I have been informed that claim construction requires consideration of the words of the claims themselves, the specification, the prosecution history, and extrinsic evidence concerning relevant scientific principles, the meaning of technical terms, and the state of the art. I have also been informed that the

specification is usually definitive, as it is the single best guide to the meaning of a disputed term.

46. I have been informed that, in the context of this proceeding, Petitioner has not proposed any terms for construction. Instead, Petitioner believes each of the terms of the ’066 patent carries its ordinary and customary meaning, which is the meaning that the term would have to a POSITA. I agree with Petitioner and apply the ordinary and customary meaning of the terms in my analysis below.

IX. PRIOR ART

47. I understand that each of the references discussed herein qualifies as prior art against the ’066 patent (that is, they were published well before whatever priority date the patent is entitled to):

48. U.S. Patent No. 6,867,549 (“Cok,” EX1004) was filed on December 10, 2002, published on June 10, 2004, and issued on March 15, 2005.

49. U.S. Patent Pub. No. 2011/0234550 (“Hong,” EX1039) 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.

50. U.S. Patent Pub. No. 2009/0033598 (“Suh,” EX1005) was filed on May 2, 2008, and published on February 5, 2009.

51. U.S. Patent No. 7,492,379 (“Credelle-379,” EX1006) was filed on October 22, 2002, published on July 10, 2003, and issued on February 17, 2009. It

claims priority to U.S. Provisional Application No. 60/346,738 filed January 7, 2002, and is a continuation-in-part of U.S. patent application 2004/0051724 filed on September 13, 2002.

52. U.S. Patent Pub. No. 2004/0051724 ("Elliott-724" EX1007) was filed on September 13, 2002, and published on March 18, 2004.

X. ANALYSIS AND OPINION

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

1. Summary of Cok

53. Cok describes "OLED displays having repeated patterns of colored light emitting elements." (EX1004, 1:8-10.) For example, Cok describes OLED displays having 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.

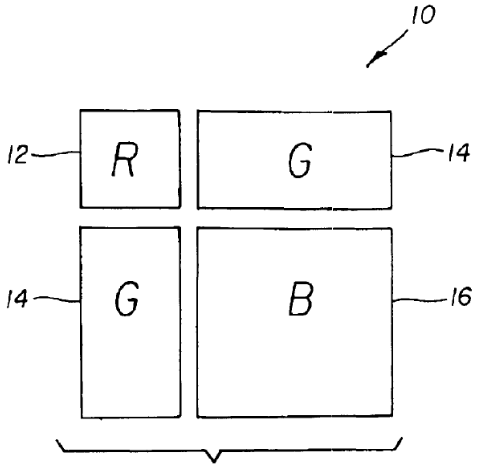


FIG. 1

54. 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*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.)

55. 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.)

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=½. 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. For example, for some combinations of materials, the green light emitting elements may be smaller than both the red and blue light emitting elements." (*Id*., 4:16-21.) Thus, Cok recognizes that different materials can be used, and its equations determine relative pixel size based on OLED material properties. Utilizing Cok's formula optimizes the pixel arrangement by improving lifetime and color quality (over time) of an OLED display. (*Id*., 4:31-45.)

57. Additionally, Cok provides Equation (3), which can be used if the usage pattern of a display device is known beforehand, and is known to predominately display a particular color: $S = (A*W*U)/(E*F)$, where U is the known relative usage of a color in the display. (*Id*., 4:47-5:6.)

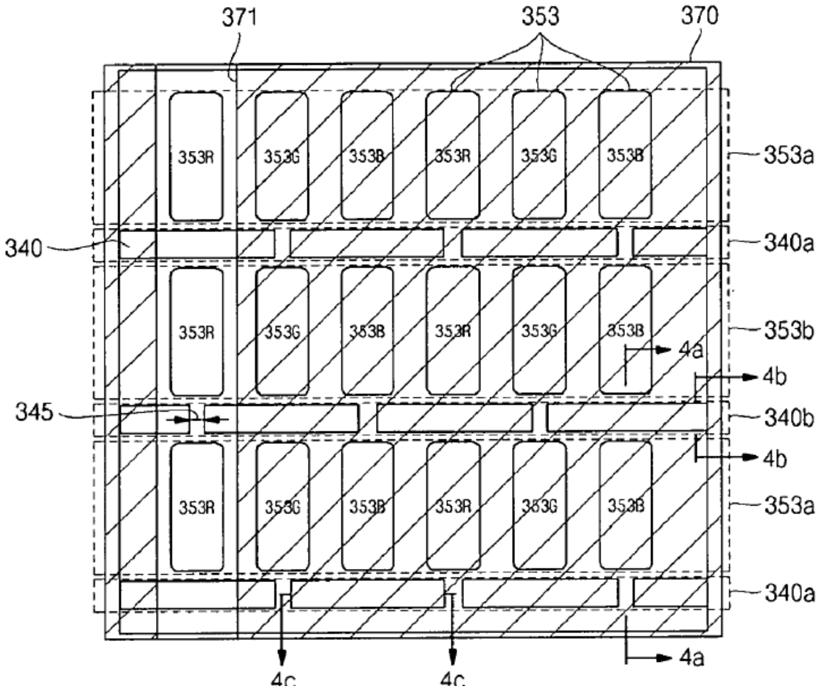
58. Cok is directed to the same problem (pixel arrangements) in the same field of endeavor (OLED displays) as the '066 patent.

2. Summary of Suh

59. Suh discloses an "OLED in which separation regions of spacers in odd and even rows are formed so that a fine metal mask (FMM) between light

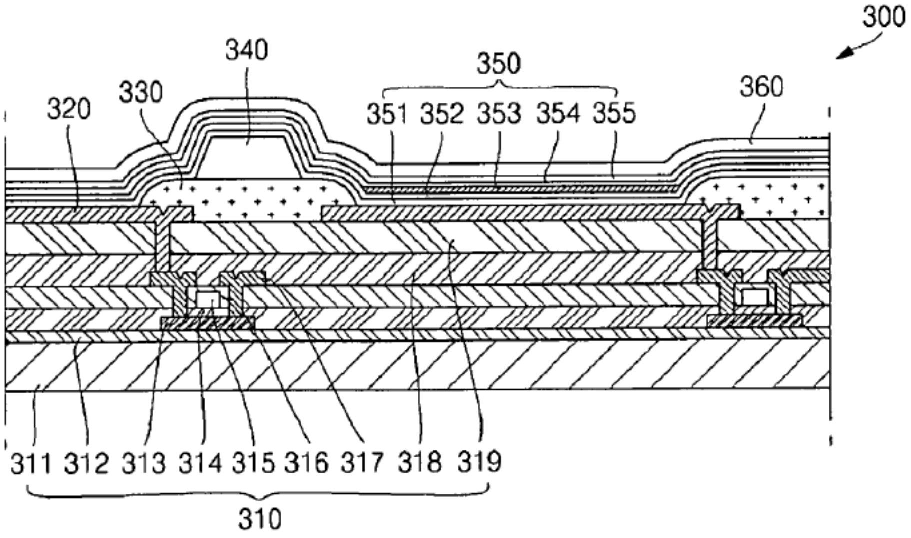
emission layers may move without being caught in the spacers." (EX1005, Abstract.) Suh describes that for an OLED display to "display full colors, red (R), green (G), and blue (B) light emission layers may be patterned, respectively." (*Id.,* ¶ [0006].) A laser induced thermal imaging (LITI) method may 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



60. FIG. 4A is a sectional view of the OLED panel of FIG. 3. As seen in FIG. 4A, the OLED panel 300 "includes … organic thin layers 350 formed on the anode electrodes 320, the pixel define layers 330, and the spacers 340, and a cathode electrode 360 formed on the organic thin layers 350." (EX1005, ¶ [0035].)

FIG. 4A



61. 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 to define the pixels 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.*)

62. Suh is directed to the same problem (improving manufacturability of OLED displays) in the same field of endeavor (OLED displays) as the '066 patent.

3. Claim 1

a. Preamble: "An organic light emitting diode (OLED) display, comprising:"

63. Cok teaches the preamble. Cok describes "[a]n organic light emitting diode (OLED) display."

b. 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:"

64. Cok teaches "a plurality of individually addressable pixels for displaying images, the individually addressable pixels being minimum addressable units of the OLED display." For example, Cok teaches "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.

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

65. Cok teaches this element. 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 "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 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 (emphasis added).) 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] (emphasis added).)

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

66. Cok teaches this element as set forth for limitation 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 "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 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 (emphasis added).) 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] (emphasis added).)

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

67. Cok teaches this element as set forth for limitation 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 "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 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 (emphasis added).) 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] (emphasis added).)

f. 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,”

68. Cok in view of Suh discloses this element. Suh discloses that “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.

69. 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 in the same field as the ’066 patent. Like the ’066 patent, Cok is directed to “OLED displays having repeated patterns of colored light

emitting elements." (EX1004, 1:6-10.) Similarly, Suh is directed to "organic light emitting display[s]." (EX1005, ¶ [0005].)

70. 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 OLED displays, particularly in active matrix OLED devices. 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].) Indeed, as discussed in the '066 patent, configurations such as insulation layers and pixel defining layers were technologies known in the art. (EX1001, 4:58-65.) 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.

71. 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. Indeed, a POSITA would have viewed Suh as disclosing just one more way to manufacture the OLED display of Cok with more precise pixel sizes.

72. Moreover, a POSITA would have recognized that the combination would provide benefits. 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.

73. A POSITA would have reasonably expected the combination to succeed. Both references relate to OLED display technology. This combination would have been straightforward.

g. 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,"

74. Cok in view of Suh discloses this element. Suh discloses 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].)

h. 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,"

75. 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 (reproduced below), 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.)

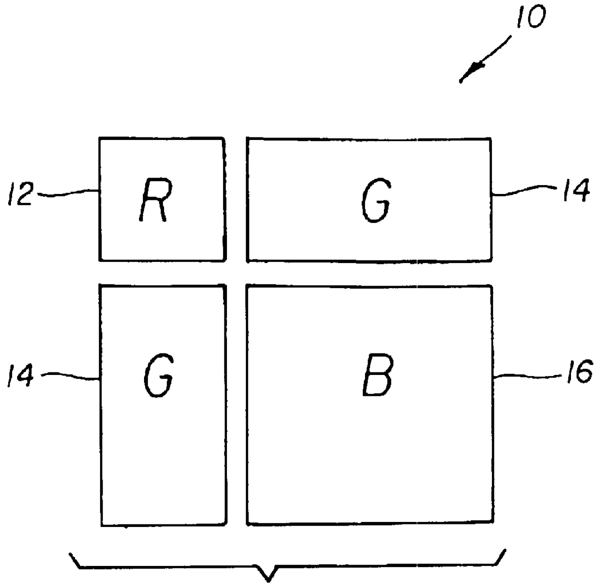
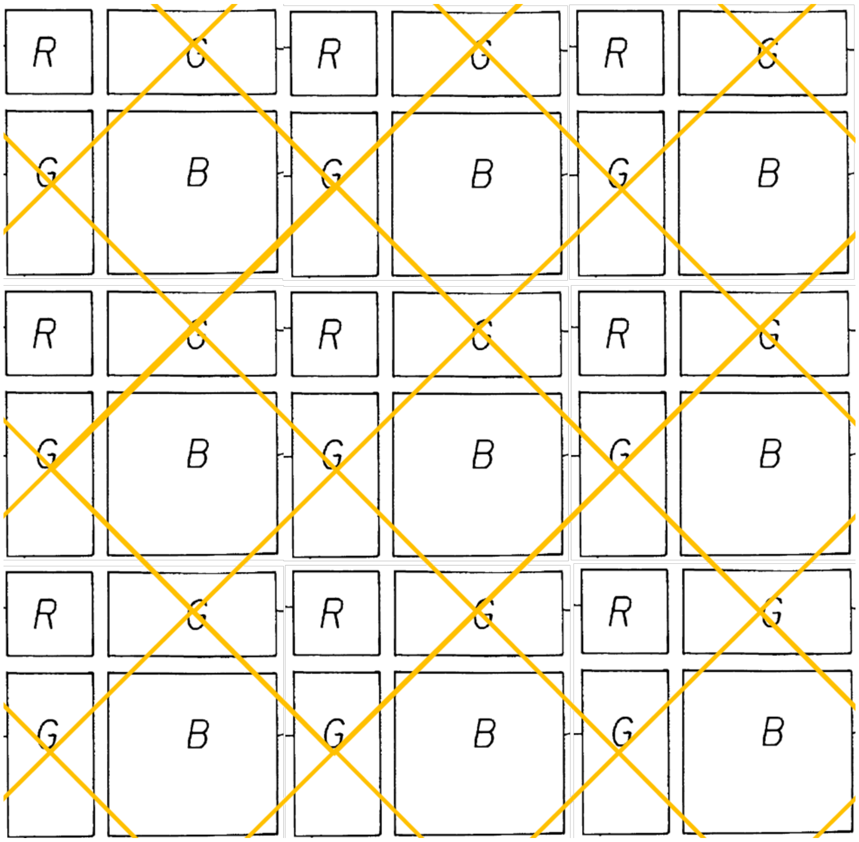


FIG. 1

I note that a POSITA would have understood that each green pixel would not only have the same area, as Cok states, but also the same dimensions (*i.e.*, side lengths). This is because Cok describes the RGBG arrangement as forming a square (a "square pixel arrangement"). As such, the width of the red pixel (W_R), the width of the upper-right green pixel (W_{G1}), and the spacing between the red pixel and the upper-right green pixel must sum to the same value as the height of the red pixel (H_R), the height of the lower-left green pixel (H_{G2}), and the spacing between the red pixel and the lower-left green pixel. In addition, as shown, the width of the red pixel is the same as the width of the lower-left green pixel (W_{G2}) and the height of the red pixel is the same as the height of the upper-right green pixel (H_{G1}). Further, the POSITA would understand that the shortest distance between the lower-left green pixel and the red pixel as well as the shortest distance between the upper-right green pixel and the red pixel is a same first length E due to the equal spacing between the four-pixel pattern, as explained in detail below with respect to paragraph 102. Thus, Cok's disclosure that Figure 1 shows a square indicates that $W_{G1} + W_{G2} + E = H_{G1} + H_{G2} + E$. Meanwhile, Cok's disclosure that the green pixels are each of a "first size (area)" indicates that $W_{G1}*H_{G1} = W_{G2}*H_{G2}$. Given these constraints, a POSITA would have understood that $W_{G1} = H_{G2}$ and $H_{G1} = W_{G2}$; that the two green pixels have the same dimensions, in other words. Not only would a POSITA have deduced this from Cok from the reasoning I have just outlined, but it would also have been consistent with ordinary practice in the art, where keeping pixels of the same color the same shape and size would have allowed for greater predictability during manufacturing and performance. (I also note that, based on the congruence between the green pixels, a POSITA would have understood that $W_R = H_R$, making the red pixel a square, and that the same is true of the blue pixel for parallel reasons.)

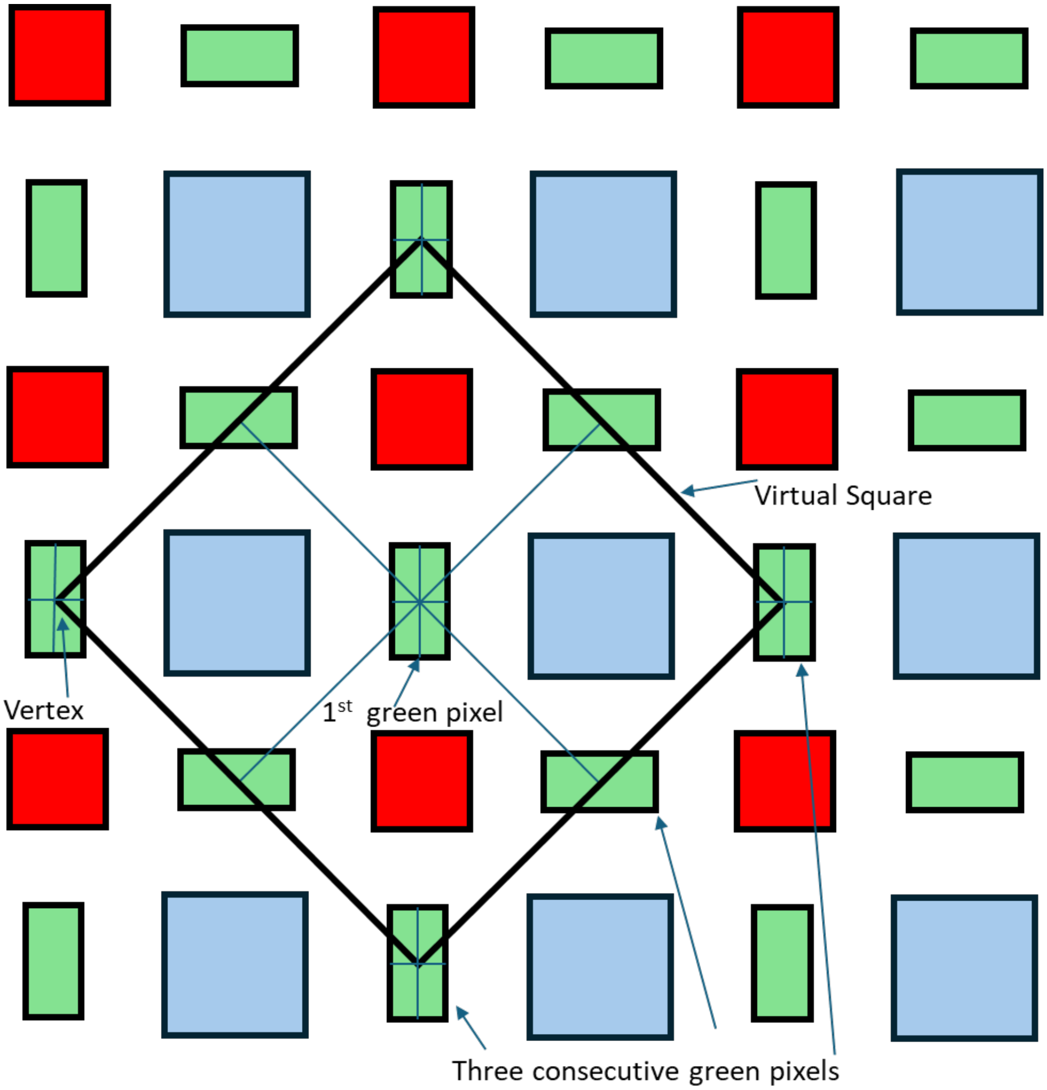
76. Cok teaches repeating such patterns to form an array. (EX1004, 6:1-4; 6:25-26.) The pattern shown in FIG. 1 of Cok can be repeated as shown below. The green pixels are positioned such that the centers of the green pixels are on an equal grid spacing, as shown by the orange grid below. A POSITA would

have understood that this object is a square based on the fact that the green pixels are identical to each other and the red and blue pixels are squares, providing the repeated RGBG pattern with a periodic symmetry in the positions of pixel centers.



77. 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. The area for each pixel is determined by using the Cok formula (2) as explained below. For example, the blue pixel may be larger to reduce current density since the blue OLED decays

with age more than green pixels. Therefore, 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.



78. Such a modification would also preserve aspects of Cok. For example, the modified display would still include plurality of individually addressable pixels for displaying an image, the individually addressable pixels being minimum addressable units of the OLED display and comprising: a plurality

of red pixels comprising an organic emission layer for emitting red light; a plurality of blue pixels comprising an organic emission layer for emitting blue light; and a plurality of green pixels comprising an organic emission layer for emitting green light because changing the sizes of the pixel would not change the basic operation or structure of the OLED display. The modified display would also still comprise a pixel defining layer defining areas of the plurality of red pixels, the plurality of blue pixels, and the plurality of green pixels, 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. Changing the sizes of the pixels would not change the basic structure or operation of the OLED display.

Calculation of pixel sizes using the teaching of Cok

79. To calculate pixel sizes, three display characteristics are needed: 1) aging characteristics of each color pixel, 2) color of each pixel to balance for white when fully illuminated, and 3) efficiency of each color pixel.

80. 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. Between the publication date of Cok in 2004 and the earliest claimed priority date of the ’066 patent in 2012, there was “rapid development” of OLED technology, including in the organic materials used for the emission layers of an OLED display. (EX1008 (“Nishimura”), 310; *see also* EX1023, EX1026.) A POSITA

would have known that such materials provided better longevity and performance for OLED displays.

81. 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 (shown in the blue table) and newer green and red phosphorescent materials (shown in the yellow table).

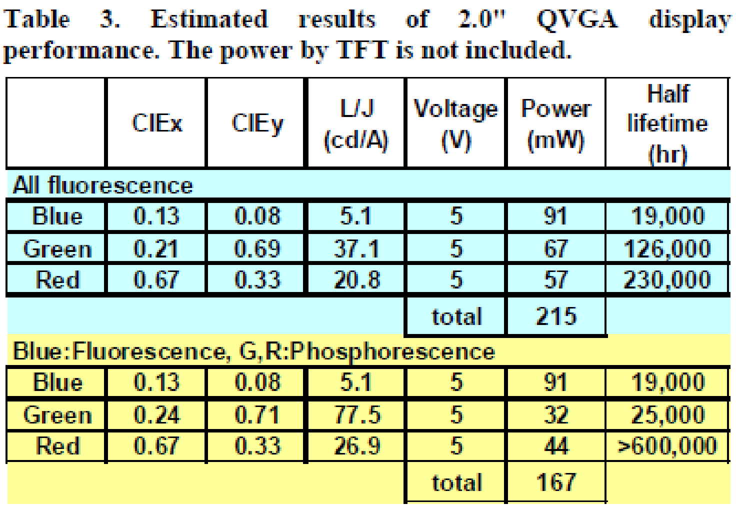


Table 3. Estimated results of 2.0" QVGA display performance. The power by TFT is not included.

	CIEx	CIEy	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	

82. Based on Table 3 above, a POSITA would have understood that, although the older fluorescent materials showed better lifetime for green emitters, 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). In addition to consuming less power, the newer red and green phosphorescent

materials enabled brighter displays so that OLEDs could be used in bright environments. The newer materials also enabled a wider color gamut due to the improved green color. A POSITA would have understood decreasing the power consumption of an OLED is important as decreased power consumption allows for OLEDs with higher efficiency and longer lifetimes. (EX1008, 310.) In view of this knowledge, as well as the ability to increase the brightness and color of OLEDs, 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.

83. 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 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.) Specifically, a POSITA would have looked to Cok's Equation (2) (*e.g.*, 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.

84. While I understand that Cok teaches three different equations, I have chosen Equation (2) over Equation (1) because it considers the desired white point

of a display. A POSITA would have understood that calibrating a display to a desired white point helps ensure that colors are rendered accurately and consistently. Further, I have chosen Equation (2) over Equation (3) because Equation (3) is specifically 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 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.

85. Turning back to Equation (2), for the relative area of a red pixel compared to a green pixel, for example, the equation would be S[r to g] = (A[r to g] x W[r]) /(E[r to g] x 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.

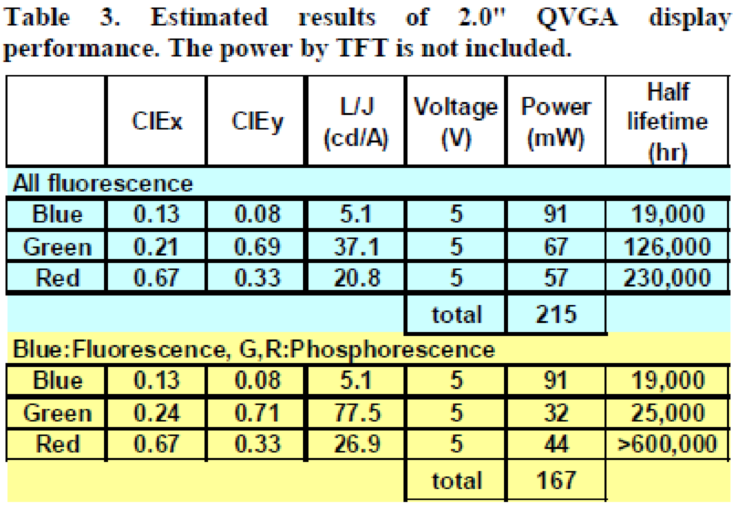


Table 3. Estimated results of 2.0" QVGA display performance. The power by TFT is not included.

	CIEx	CIEy	L/J (cd/A)	Voltage (V)	Power (mW)	Half lifetime (hr)
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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	

<u>"E" Value</u>

86. Nishimura shows the luminous flux for a given input energy L/J (also referred to as current efficiency) of the red, blue, and green materials in candelas/ampere (cd/A). To calculate the relative luminance efficiency of red to green (E[r to g]), a POSITA would have divided the current efficiency of a red pixel by the current efficiency of the green pixel. For example, using the values shown the yellow table above of Nishimura, a POSITA would have known that the relative luminance efficiency of red to green (E[r to g]) can be calculated as 26.9 cd/A / 77.5 cd/A= 0.3471. Similarly, a POSITA would have calculated the luminance efficiency of blue to green (E[b to g]) as 5.1 cd/A / 77.5 cd/A = 0.0658.

<u>"W" Value</u>

87. Nishimura also shows the chromaticity coordinates (CIEx and CIEy) of the red, blue, and green materials, which represent the quality of each color independent of brightness and can be used to calculate how much of each color contributes to a desired white point. For example, using the table, a POSITA would have understood $x_r = .67$, $y_r = .33$, $x_g = .24$, $y_g = .71$, $x_b = .13$, and $y_b = .08$. A POSITA would have known that a white point is defined by coordinates x_{white} and y_{white}, and that these values can be obtained by the equations $x_{white}=X_{white}$ /

$(X_{white}+Y_{white}+Z_{white})$ and $y_{white}=Y_{white}/(X_{white}+Y_{white}+Z_{white})$. (EX1010[2], 81-89; *see also* EX1025, EX1026.) A POSITA would also know that the white tristimulus (*e.g.*, X_{white}, Y_{white}, Z_{white}) values are obtained by adding the tristimulus values of the red, blue, and green pixels. (EX1010, 88-89.) For example, $X_{white}=X_r+X_{g+}X_b$, $Y_{white}=Y_r+Y_{g+}Y_b$, and $Z_{white}=Z_r+Z_{g+}Z_b$. (EX1010, 88-89.)

88. Additionally, a POSITA would have known the well-known relationship between CIEx and CIEy values (*e.g.*, x, y, and z) and tristimulus values (*e.g.*, X, Y, Z): $x=X / (X+Y+Z)$, $y=Y/(X+Y+Z)$, and $z= Z/(X+Y+Z)$. (EX1010, 81-82.) While usually only x and y values are given, a POSITA would have known this is because z values can be obtained by the equation $z=1-x-y$.

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[2] While I understand that EX1010 was published in April 2012, just weeks after the earliest priority date of the ’066 patent, I am relying on the well-known equations presented in EX1010 to demonstrate what a POSITA would have known at the relevant time. I am informed that this is appropriate in view of USPTO’s publications such as the “MPEP” (Manual of Patent Examining Procedure). *See* MPEP 2141.03 (“References which are not prior art may be relied upon to demonstrate the level of ordinary skill in the art at or around the relevant time”).

Based on these equations, a POSITA would have also known how to calculate tristimulus parameters as X=Y*x/y and Z=(Y/y) *(1-x-y).

89. By setting Y to 1 as was commonly done by those skilled in the art, a POSITA would have arrived at the following tristimulus values for the red, blue, and green pixels.

	X	Y	Z
Red	2.0303	1.0000	0
Green	0.3380	1.0000	0.0704
Blue	1.6250	1.0000	9.8750

90. A POSITA would have then determined the tristimulus values for the desired white point. A POSITA would have chosen D65, because it had been the SMPTE-170M standard in the United States and many other countries. (EX1010,

90; *see also* EX1025, EX1026.) D65 has coordinates of x_{white}=.3127 and y_{white}=.3290.

91. By setting Y to 1, a POSITA would have arrived at the following tristimulus values for the desired white point.

	X	Y	Z
White	.9505	1.000	1.089

92. To achieve the desired white point, a POSITA would have known it was necessary to adjust the intensities of the red, blue, and green pixels to ensure adequate white balance. (EX1010, 91.) To adjust the intensities, a POSITA would have known to multiply the Y values of each color pixel by an adjustment factor (which would also adjust the X and Z values by the same factor), such that $X_{adjusted}=A*X$, $Y_{adjusted}=A*Y$, and $Z_{adjusted}=A*Z$, where A is the adjustment factor. Knowing the relationship of the white tristimulus values to the tristimulus values of red, green, and blue pixels, a POSITA would have calculated the required adjustment factors of red, blue, and green intensities to obtain the desired white point by the following equations, where A_R, A_G, and A_B represent the adjustment factors for red, green, and blue respectively:

(1) $A_R*X_{red}+A_G*X_{green}+A_B*X_{blue}=X_{white}$,

(2) $A_R*Y_{red}+A_G*Y_{green}+A_B*Y_{blue}=Y_{white}$,

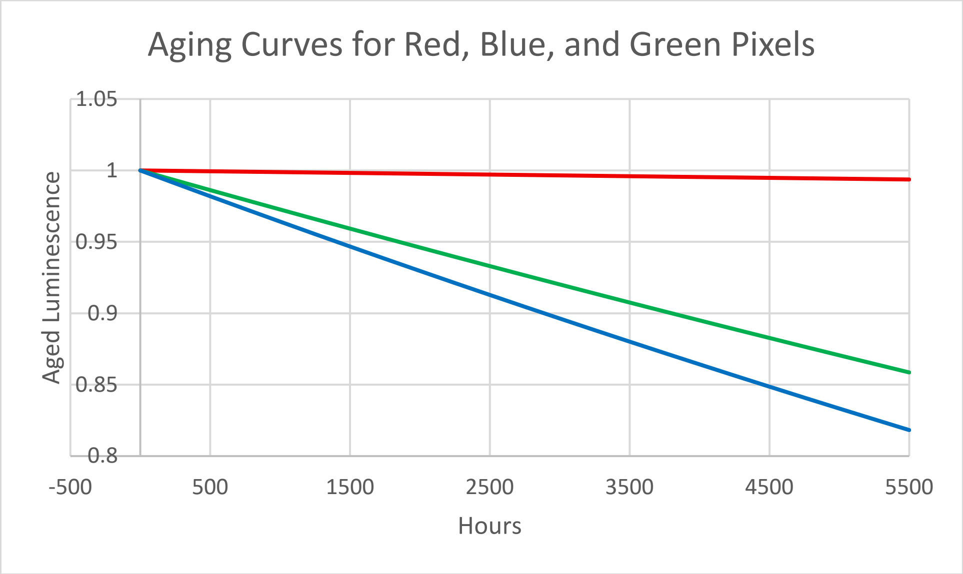
(3) $A_R*Z_{red}+A_G*Z_{green}+A_B*Z_{blue}=Z_{white}$.

93. Solving these equations, a POSITA would have obtained A_R=.281 $A_{G=}$.613, and A_B=.106. The relative contribution of a color to the white point W would then be the adjusted luminance of the color divided by the total luminance of the white point, or W[color]=A_{color} *Y_{color} / Y_{white}. Accordingly, a POSITA would have known that the contribution of red light to the white point (W[r]) is (A_{red})*(Y_{red})/Y_{white} = (.2813)*(1)/1=0.2813. Similarly, a POSITA would have also known that the contribution of blue light to the white point (W[b]) = (A_{blue})*(Y_{blue})/Y_{white} = (.1059)* (1)/(1)=0.1059.

<u>"A" Value</u>

94. 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 using the well-known equation $I=(0.5)^{pt/T}*I_0$, where I is the aged luminance value, I_o is the original luminance value, p is a relative sub-pixel value, t is time, and T is the half-lifetime. (EX1009, 1184; *see also* EX1024, EX1026.) Using the half-life data from Nishimura, assuming the relative sub-pixel values are equal, and setting

the original luminance value as 1 (*e.g.*, the luminance is not initially degraded), a POSITA would have obtained the following curves:



95. 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. For example, a POSITA would have known that a luminance drop between 9% - 15% caused significant distortion in an OLED display. (EX1009, FIG. 12 (showing that a user will view the distortion as "Slightly Annoying" between 10-15% luminance drop*)*, FIG. 13 (showing noticeable yellowing between 9% and 15% luminance drop).) Accordingly, a POSITA would have chosen the minimum threshold as when the blue pixel (the

pixel that ages the fastest according to the aging curve above) drops in luminance by 9%, which occurs at approximately 2,600 hours.

96. Based on the aging curves, a POSITA would have known that after aging approximately 2,600 hours, the luminescence of the red pixel would drop to .9970, the luminescence of a green pixel would drop to .9305, and the luminescence of a blue pixel would drop to .9095. A POSITA would have known to calculate the rate of aging at the minimum threshold as $R=I_0/I$, such that A[r to g] = R_{red}/R_{green} and A[b to g] = R_{blue}/R_{green}. Accordingly, a POSITA would have calculated the aging factor of the red light emitting element compared to the green light emitting element (A[r to g]) as (1/.9970)/(1/.9305) = 0.9333. Similarly, a POSITA would have calculated the aging factor of the blue light emitting element compared to the green light emitting element (A[b to g]) as (1/.9095)/(1/.9305) = 1.023.

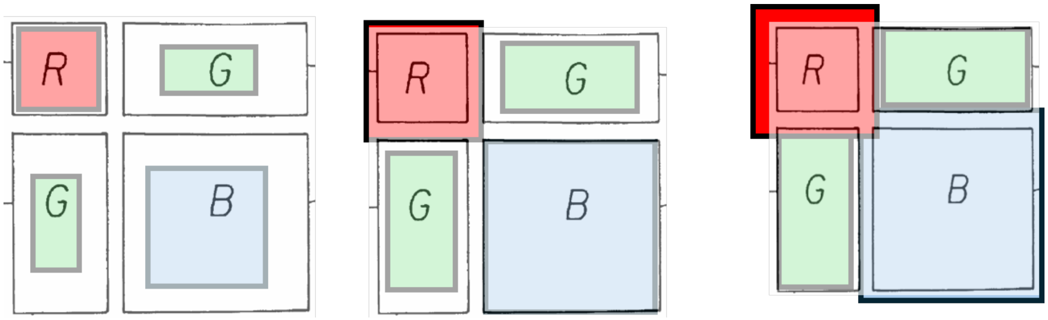
<u>Calculation of "S"</u>

97. 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 to g]) = (0.9333 x 0.2813)/(0.3471 x 0.5) = 1.513. Similarly, a POSITA would

obtain the relative size of the blue pixel to the green pixel (S[b to g]) = (1.023 x .1059)/(.0658 x 0.5) =3.293.

98. 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. 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. 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. Here, the POSITA would have found it especially obvious to try to maintain the area of the red pixel, since, as discussed in greater detail below, the POSITA would also have aimed to maintain the same pixel centers as shown in FIG. 1 of Cok. For example, keeping the red pixel unchanged relative to FIG. 1 would have helped to achieve this objective because maintaining the size of the red pixel, as opposed to either the

blue or green pixel, would be most likely to avoid overlapping pixels, as illustrated below.



99. Where the desired area ratios require smaller changes to pixel area than what is shown above, a POSITA would have recognized that maintaining the size of the green or blue pixels may have been viable without leading to overlap. But in any event, the simple adjustments proposed in paragraph 98—based on maintaining the size of the red pixel while applying Cok's equations and the resulting area ratios —would have been obvious to try as one of a finite set of predictable solutions. Thus, 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 µm x 60 µm or an area of 3600 µm^2. A red pixel size of approximately 60 µm x 60 µm is also reasonable considering OLED efficiencies, display luminance targets, and manufacturing tolerances and design rules in the 2000s. Using the relative areas calculated above, a POSITA would have obtained an area of 2380 µm^2 for the

green light emitting element and an area of 7835 μm^2 for the blue light emitting element.

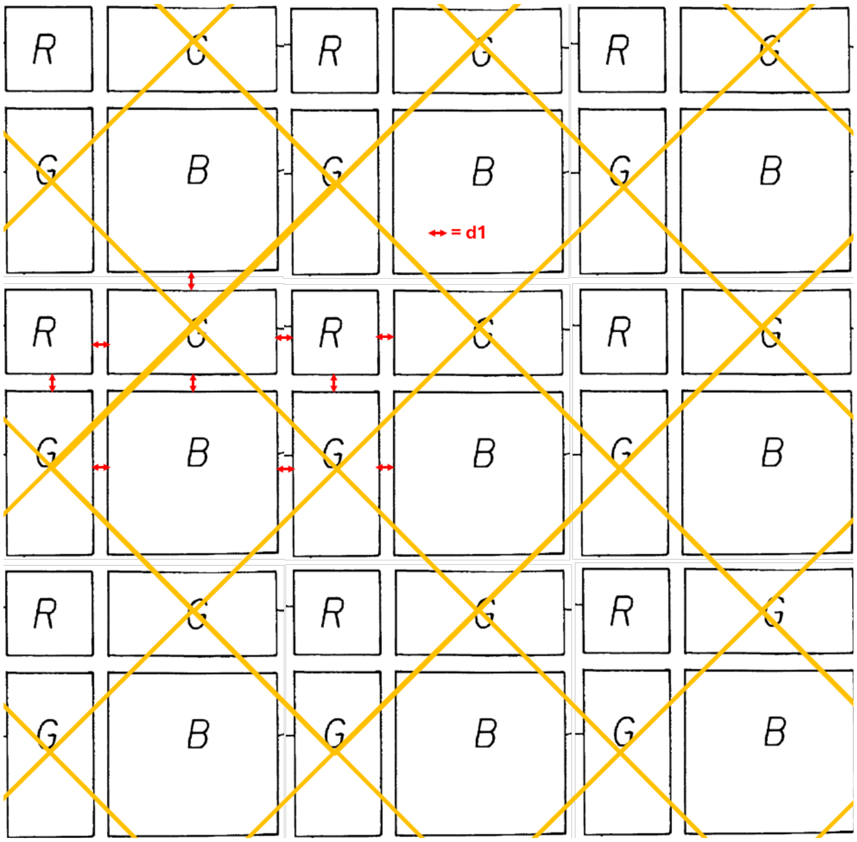
Arrangement of Pixels (Based on Calculated Sizes)

100. 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 (as shown below). (EX1004, 3:65-67.) 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. (EX1004, 3:65-67.) 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.

101. 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.) 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. 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. (EX1004, 3:65-67.) A POSITA would

have then repeated the resulting pattern to form the OLED display as shown above. (EX1004, 3:65-67.)

102. A POSITA would have maintained the relative centers of pixels (as shown below in relation to FIG. 1 of Cok) and 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. Under the Cok arrangement, the shortest distance between the green pixels and adjacent red and blue pixels is a same first length d1 due to the equal spacing between the four-pixel pattern, as shown below:



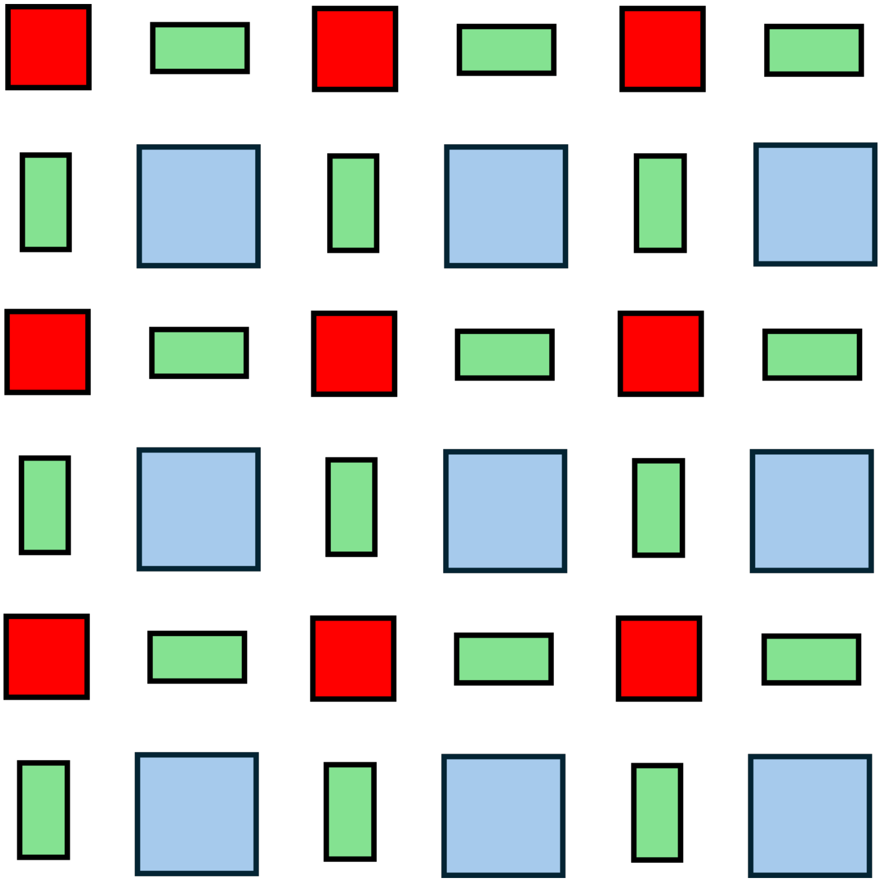
103. A POSITA would have known that since green pixels contain the majority of the white luminance (*e.g.*, ~ 60% for typical OLEDs), it would have been critical that the centers by equally spaced. If they are not, luminance errors, jagged edges (aliasing), color fringing or chromatic aberrations, or Moiré defects can occur. A POSITA would have known of one metric, known as "Just Noticeable Difference" (JND) which was developed by at least 2012. (EX1031, 820). A defect with one JND is detectable more than 50% of the time by a standard observer. A POSITA would have known that the size or spatial frequency of the defect and the viewing distance would affect the detectability. A deviation from a regular array of green sub-pixels can result in noticeable luminance or

chroma errors greater than one JND In addition, since the human visual system is extremely sensitive to deviations in parallel line spacing (“vernier acuity”) a POSITA would have known that even small deviations in pixel spacing could create noticeable errors. A POSITA would have also known that the equal spaced grid could have a pixel pitch with a unit length of 160 μm, such that the centers of the green pixels are 160 μm apart. (*See* EX1006, FIG. 12.)

104. It would also have been important to a POSITA to also maintain equal centers for red and blue pixels although the sensitivity is lower for several reasons. First, the sub-pixels are larger, second, the luminance is lower, and third, sub-pixel rendering is used to average the information to be displayed among pixels and can adjust for offsets. However, the positional accuracy (*e.g.*, the centers of red and blue pixels) must be uniform for the same reasons as for green.

105. A POSITA would have reasonably expected to succeed in modifying Cok in the manner discussed above. Cok itself 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.) 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.

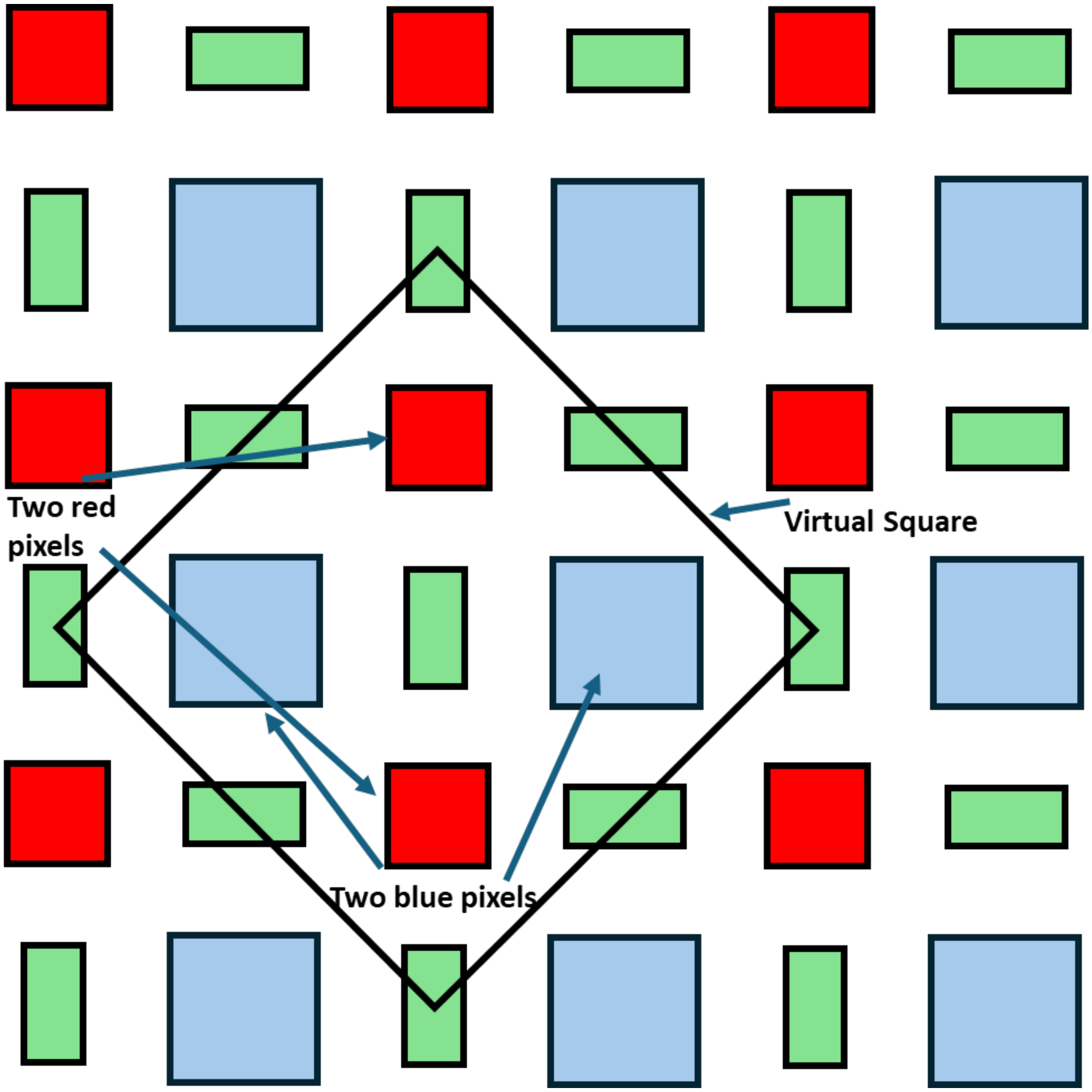
106. Combining the above calculated area ratios with FIG. 1 of Cok, a POSITA would arrive at the arrangement of pixels shown below (and annotated above).



107. Shown below is an overlay of the arrangement from FIG. 1C on the modified arrangement shown above.

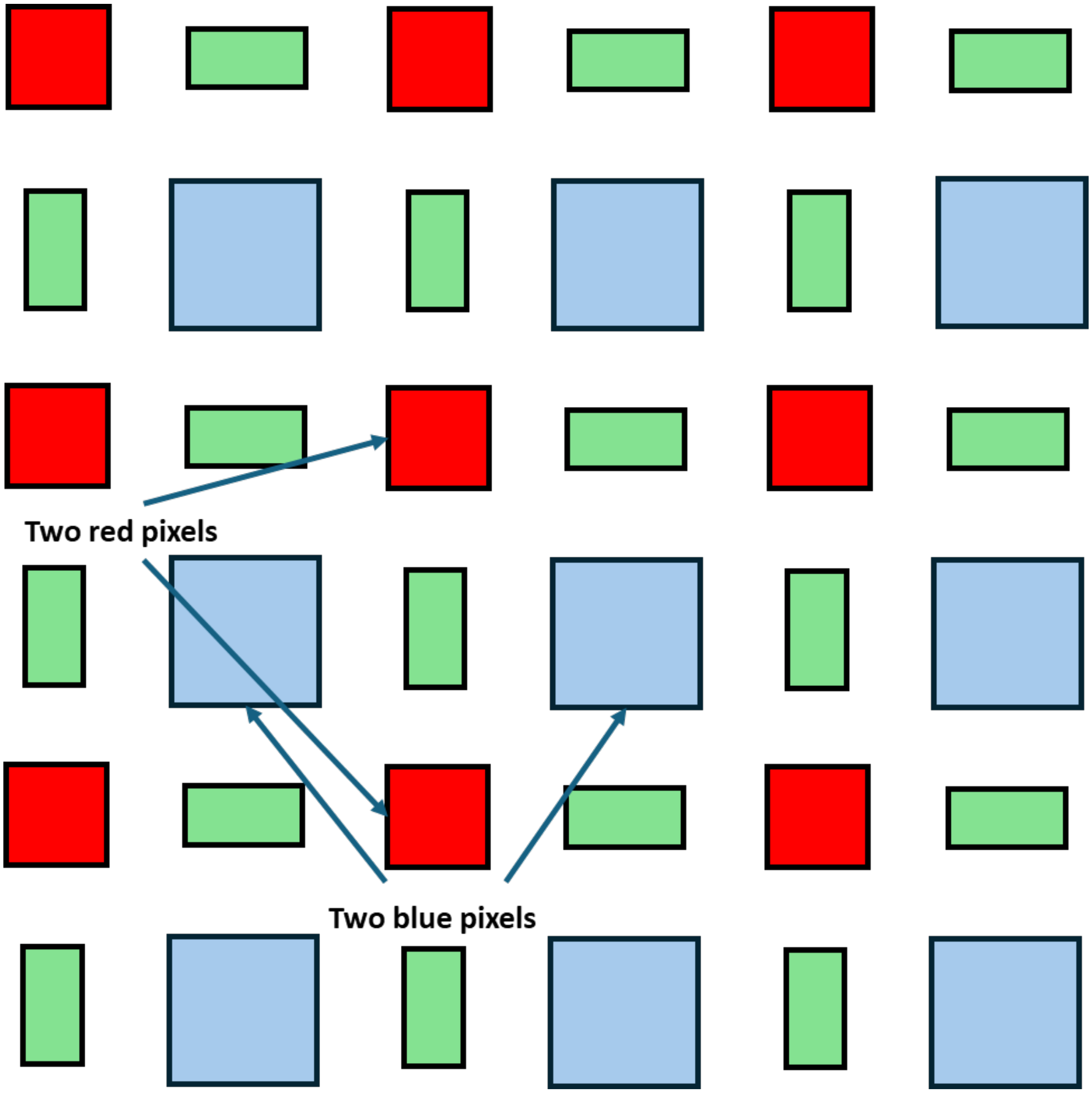
i. 1[H]: "wherein at least two blue pixels of the plurality of blue pixels and at least two red pixels of the plurality of red pixels are located entirely within boundaries of the virtual square,"

108. Cok teaches this element. As shown below, two blue pixels and two red pixels are located entirely within boundaries of the virtual square.



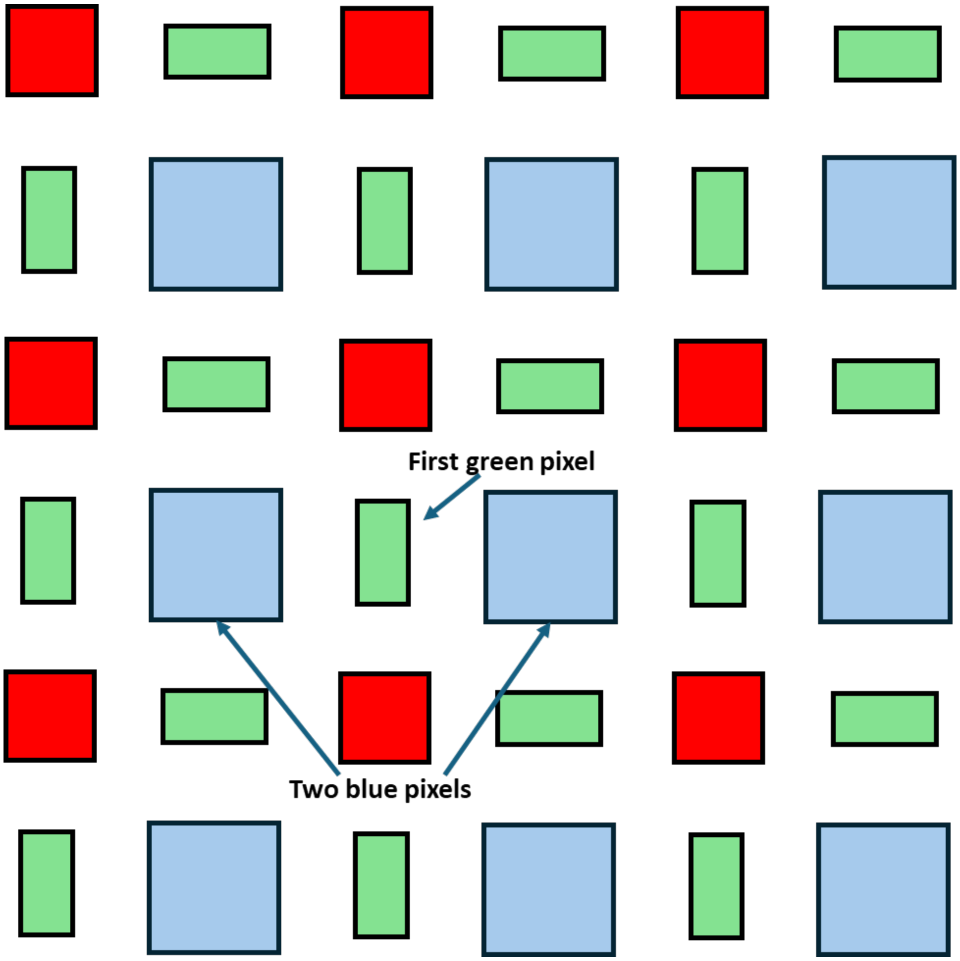
j. 1[I]: “wherein each of the at least two blue pixels has a larger area than each of the at least two red pixels,”

109. Cok teaches this element. As shown below, the two blue pixels each have an area of 7835 µm^2, which is larger than the area of each of two red pixels, which each have an area of 3600 µm^2.



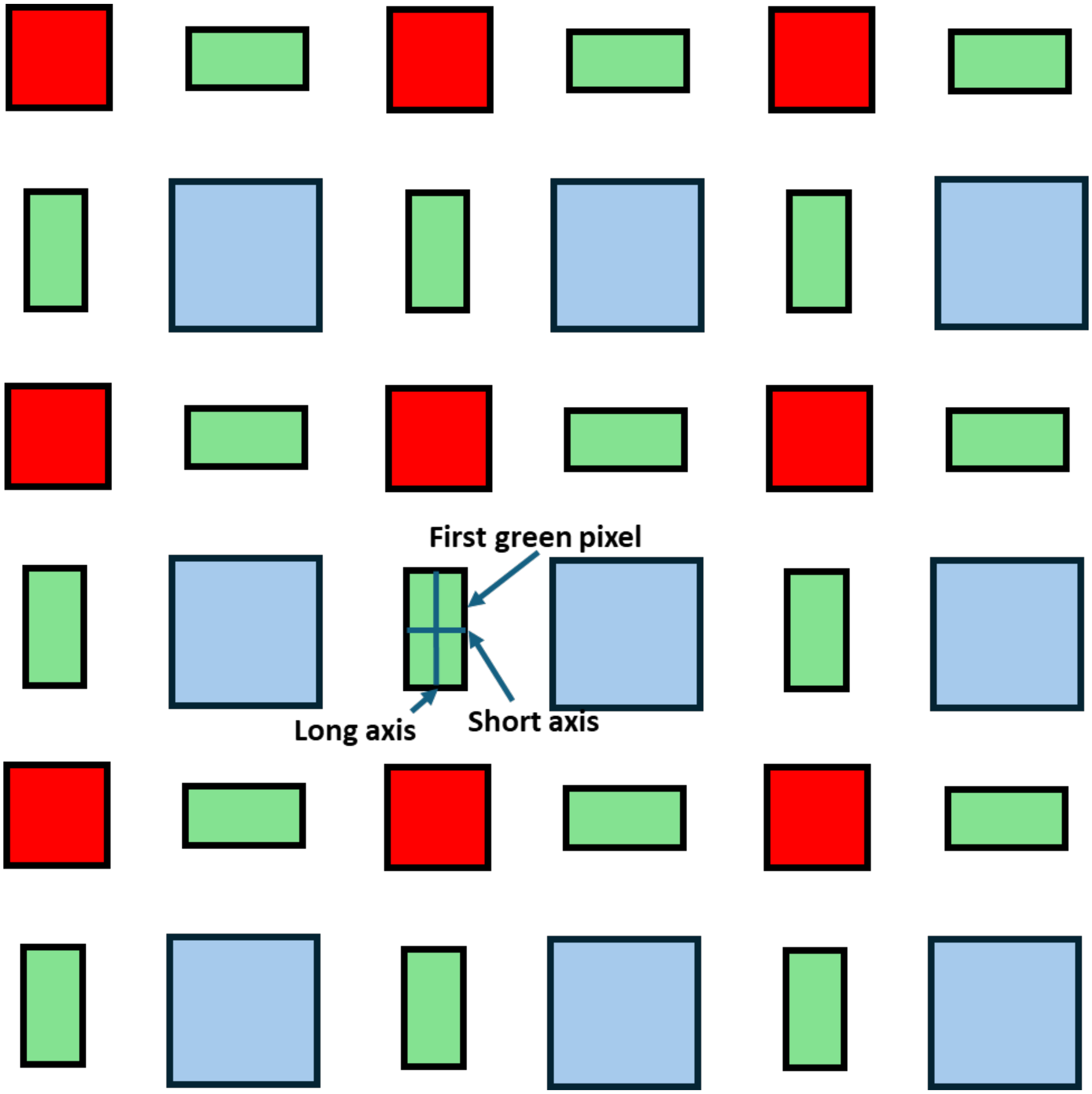
k. 1[J]: "wherein each of the at least two blue pixels has a larger area than that of the first green pixel,"

110. Cok teaches this element. The two blue pixels each have an area of 7835 μm^2, which is larger than the area of the green pixel which has an area of 2380 μm^2, as shown below.



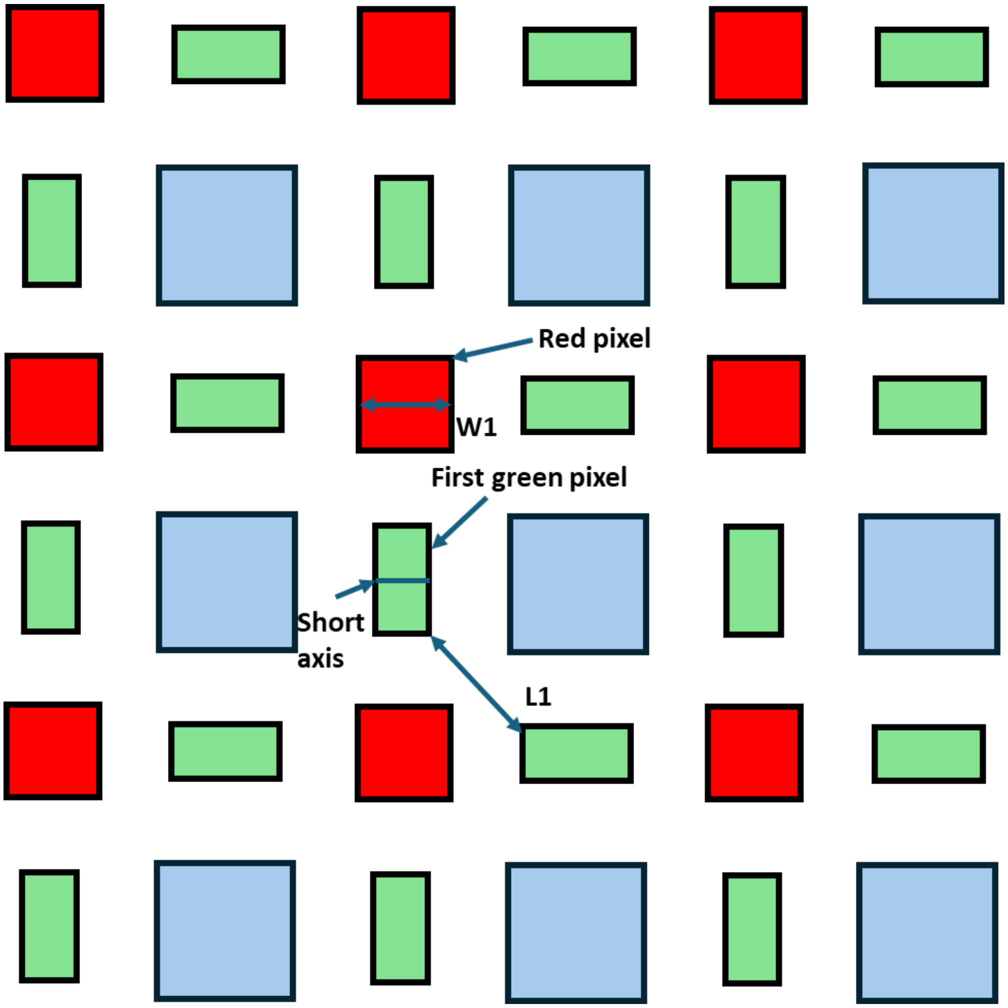
l. 1[K]: "wherein the first green pixel has a convex shape such that a line bisecting the first green pixel along a long axis thereof has a greater length than a line bisecting the first green pixel along a short axis thereof, and"

111. Cok teaches this element. As shown below, the green pixel has a convex shape such that a line along the long axis of the green pixel (68.986 µm) has a greater length than a line along a short axis of the green pixel (34.493 µm), keeping the same aspect ratio (2:1) as shown in FIG. 1 of Cok.

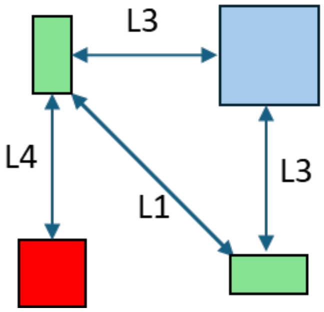


m. 1[L]: "wherein a shortest distance between two nearest ones of the plurality of green pixels is greater than a width of a first red pixel of the plurality of red pixels along a first direction parallel to the short axis of the first green pixel."

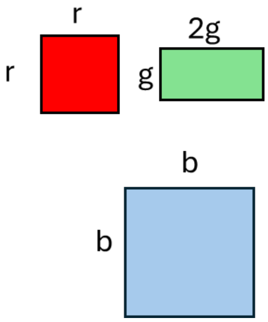
112. Cok teaches this element. A shortest distance L1 (88.844 µm) between two nearest green pixels is greater than a width W1 (60.000 µm) of a first red pixel along a direction parallel to the short axis of the first green pixel, as shown below.



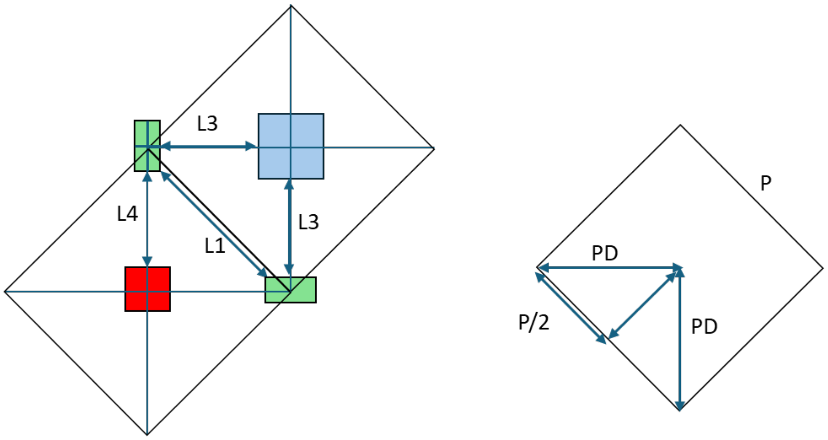
113. The POSITA would have calculated the length of L1 using basic geometry. For example, the various lengths described in the claims of the ’066 patent can be shown as L1, L3, and L4 below (with distances exaggerated for clarity):



114. The dimensions of the pixels can be as follows, where the red pixel has a length of “r,” the blue pixel has a length of “b” and the green pixel has a height of “g” and a width of 2*g, where r= 60.000 µm, g= 34.493 µm, and b= 88.515 µm.



115. As discussed above, the pixels are centered on an equal spaced grid, which has a pixel pitch with a unit length of 160 µm, such that the centers of the green pixels are 160 µm apart.

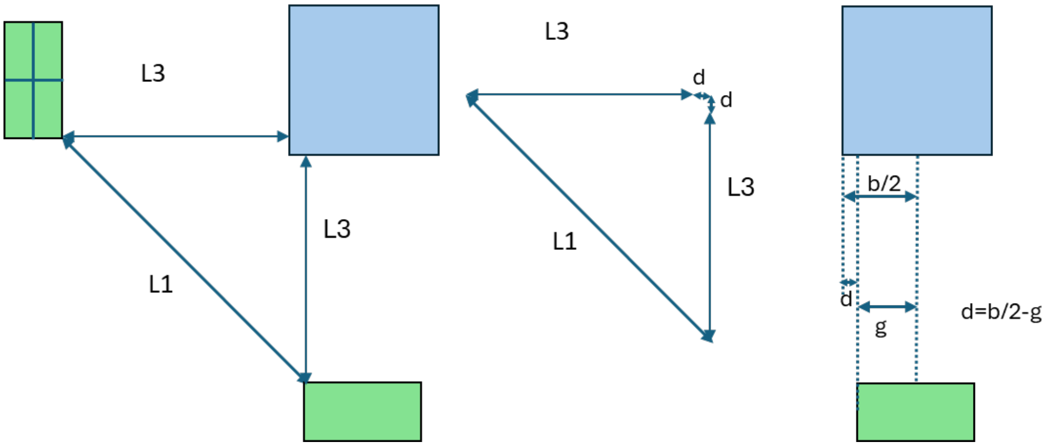


116. The POSITA would have known to calculate the length of L1 given the above, L3 or L4 should first be calculated, which can both be calculated relative to PD. As seen above, PD is half of the diagonal of one square of the equal spaced grid, or, in other words, the distance between the center of the blue pixel and the green pixels and the distance between the center of the red pixel and the green pixels. Therefore, the POSITA would have known that $PD=\sqrt{}((P/2)^2 + (P/2)^2) = \sqrt{}(80)^2 + (80^2) \approx 113.137$ µm.

117. Further, to calculate L3, the POSITA would have recognized that PD=g/2+L3+b/2 as shown above. Therefore, the POSITA would have known that L3= PD-b/2-g/2 = 113.137 µm - 88.515 µm/2-34.493 µm/2 =51.633 µm. Similarly, to calculate L4, the POSITA would have recognized that PD=g+L4+r/2

as shown above. Therefore, the POSITA would have known that L4=PD-r/2-g= 113.137 µm -60.000 µm /2-34.493 µm = 48.644 µm.

118. Subsequently, as shown below, the POSITA could have calculated L1 based on L3 (or L4).

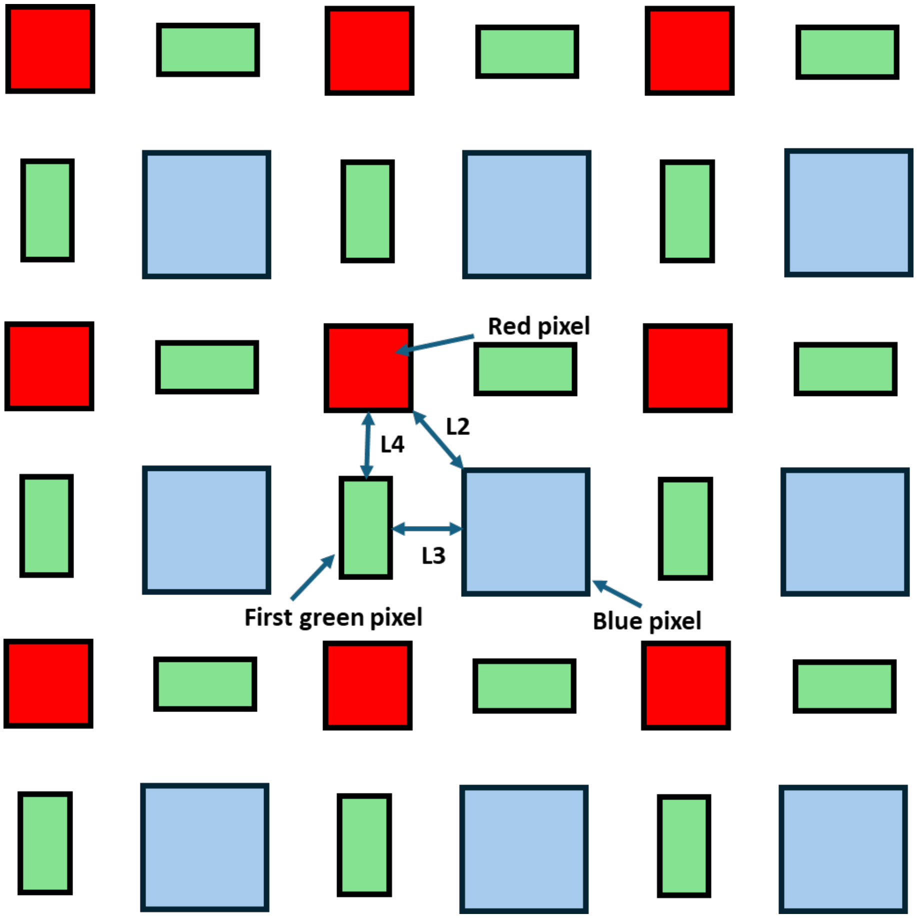


119. As shown above, $L1 = \sqrt{(L3+d)^2 + (L3+d)^2}$, where d=b/2-g. Therefore, $L1 = \sqrt{(L3+(b/2-g))^2 + (L3+(b/2-g))^2}=\sqrt{(51.633+(88.515/2-34.493))^2 + (51.633+(88.515/2-34.493))^2} \approx 86.829$ µm.

120. Accordingly, 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 above.

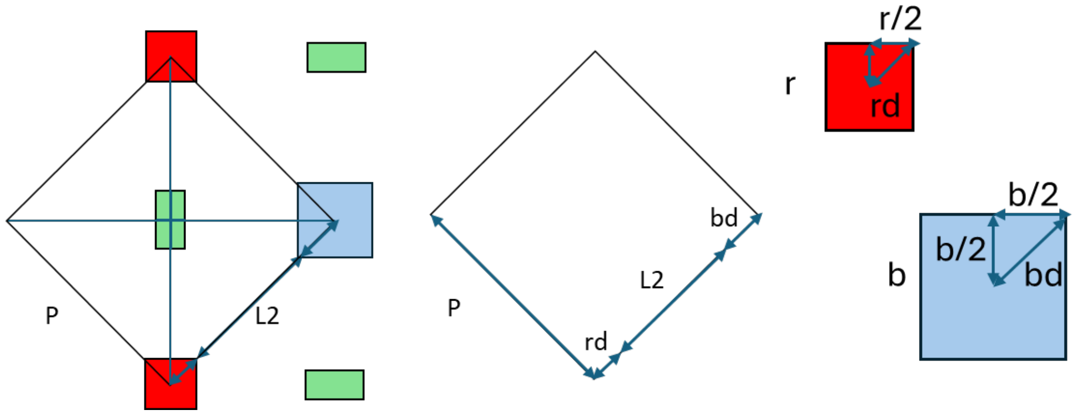
4. Claim 2: "The OLED display of claim 1, wherein a shortest distance between one of the at least two blue pixels and one of the at least two red pixels is greater than a shortest distance between the first green pixel and the one of the at least two blue pixels or a shortest distance between the first green pixel and the one of the at least two red pixels."

121. Cok in view of Suh teach claim 1, as shown in § X.A.3. Cok in view of Suh further teach this claim. 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.



122. The POSITA would have calculated L3 = 51.633 µm and L4 = 48.644 µm as described above in § X.A.3.m. The POSITA would have also known how to calculate L2 using basic geometry.

123. As discussed above, the pixels are centered on an equal spaced grid, which has a pixel pitch with a unit length (P) of 160 µm, such that the centers of the green pixels are 160 µm apart, and therefore, the centers of the red and blue pixels are also spaced 160 µm apart. The POSITA would accordingly solve for L2 as below:

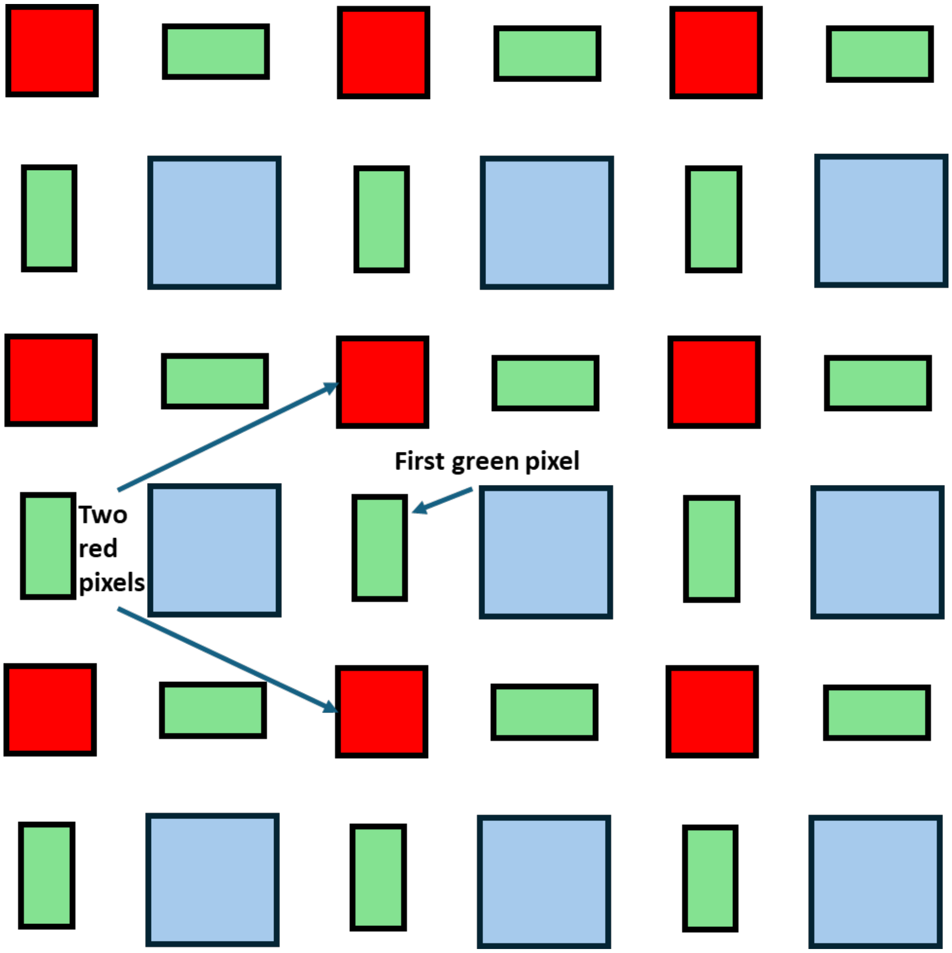


124. As seen above, P=rd+L2+bd, where bd=$\sqrt{((b/2)^2 + (b/2)^2)}$ and rd=$\sqrt{((r/2)^2 + (r/2)^2)}$. Accordingly, L2=P-rd-bd =P-$\sqrt{((r/2)^2 + (r/2)^2)}$-$\sqrt{((b/2)^2 + (b/2)^2)}$ =160-$\sqrt{((60/2)^2 + (60/2)^2)}$-$\sqrt{((88.515/2)^2 + (88.515/2)^2)}$ ≈ 54.984 µm. Thus, as shown above, 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.

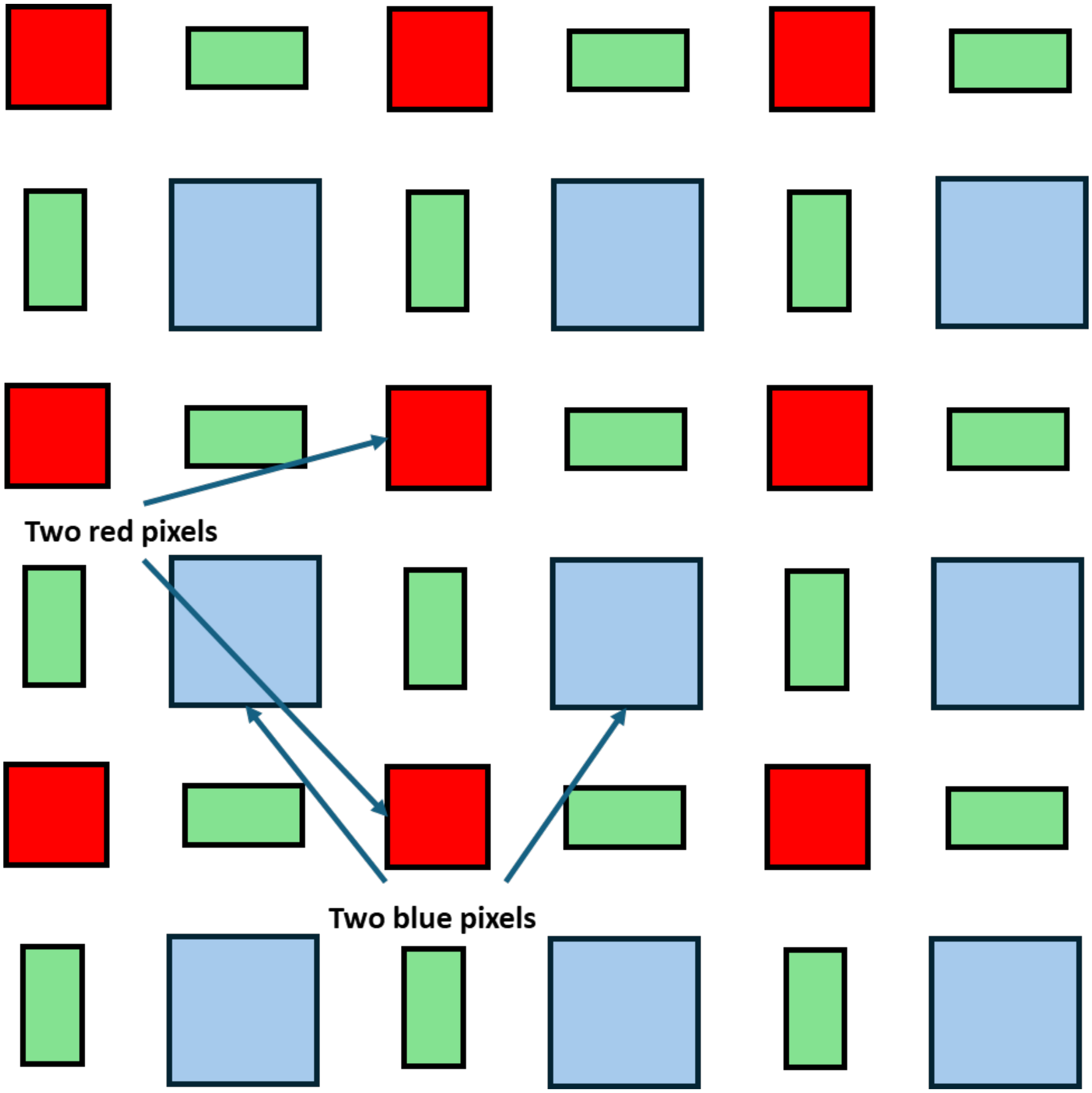
5. Claim 4: "The OLED display of claim 2, wherein the one of the at least two red pixels has an area that is larger than that of the first green pixel."

125. Cok in view of Suh teach claim 2, as shown as shown in § X.A.4. Cok in view of Suh further teach this claim. As discussed above, the areas of the pixels are determined using the equation of Cok as shown in § X.A.3.h. As shown below, the two red pixels each have an area of 3600 µm^2, which is larger than the area of the green pixel which has an area of 2380 µm^2.



6. 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."

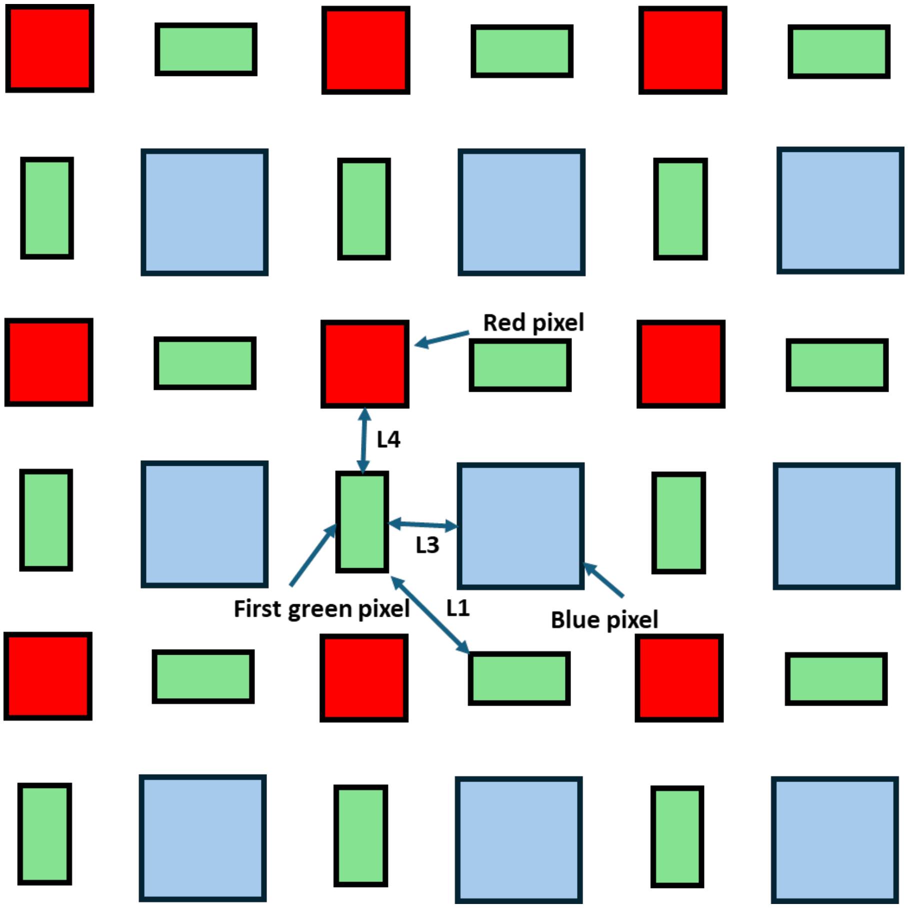
126. Cok in view of Suh teach claim 2, as shown in § X.A.4. Cok in view of Suh further teach this claim. The two blue pixels and the two red pixels have square shapes, and squares are quadrangles, as shown below. As described in the '066 patent, a polygonal shape can include "shapes such as an octagon, a hexagon, and a quadrangle." (EX1001, 12:29-30.)



7. 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."

127. Cok in view of Suh teach claim 1, as shown in § X.A.3. Cok in view of Suh further teach this claim. The lengths L1, L3, and L4 can be determined as shown in § X.A.3.m. As shown below, a shortest distance between the first green pixel and an adjacent green pixel L1 (86.829 µm) is greater than a shortest distance L3 (51.633 µm) between the first green pixel and one of the two blue

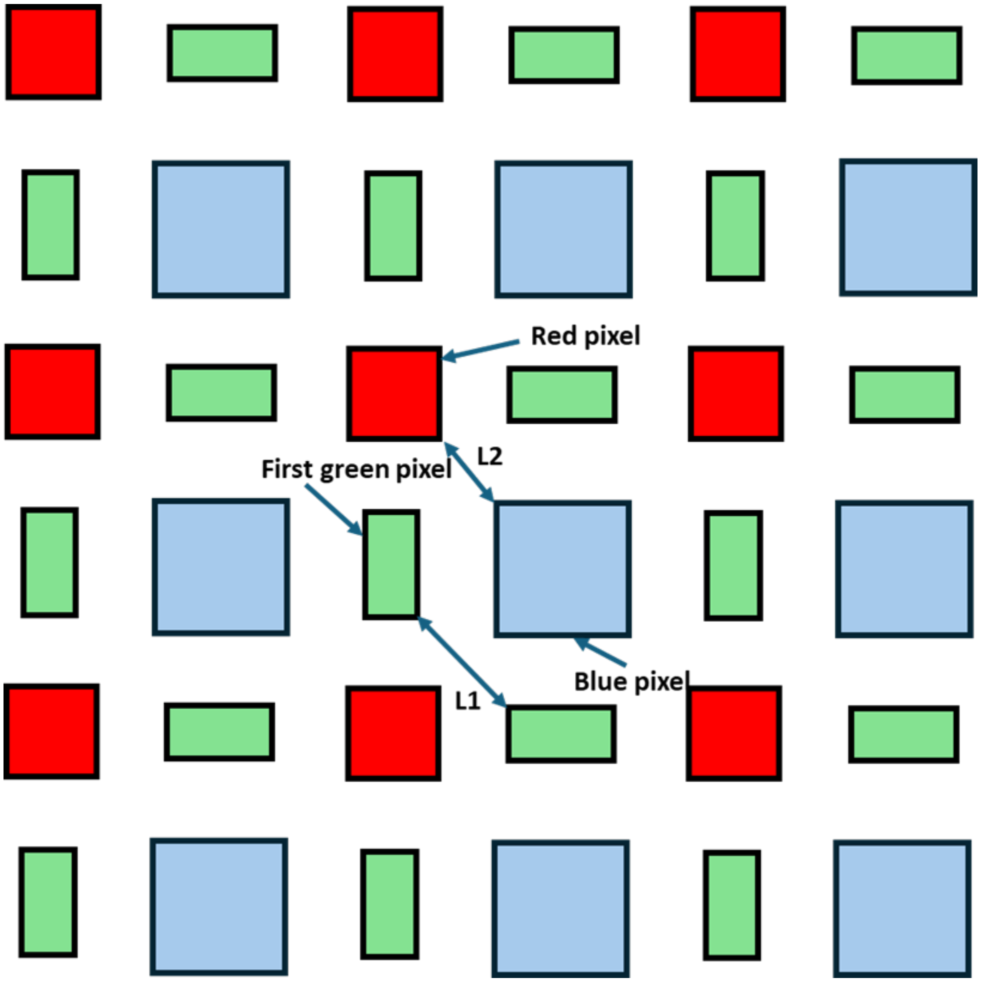
pixels or a shortest distance L4 (48.644 µm) between the first green pixel and one of the two red pixels.



8. 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."

128. Cok in view of Suh teach claim 1, as shown in § X.A.3. Cok in view of Suh further teach this claim. The lengths L1 and L2 can be determined as shown in §§ X.A.3.m and X.A.4. As shown below, a shortest distance L1 (86.829 µm) between two nearest green pixels is greater than (and not equal to) a shortest

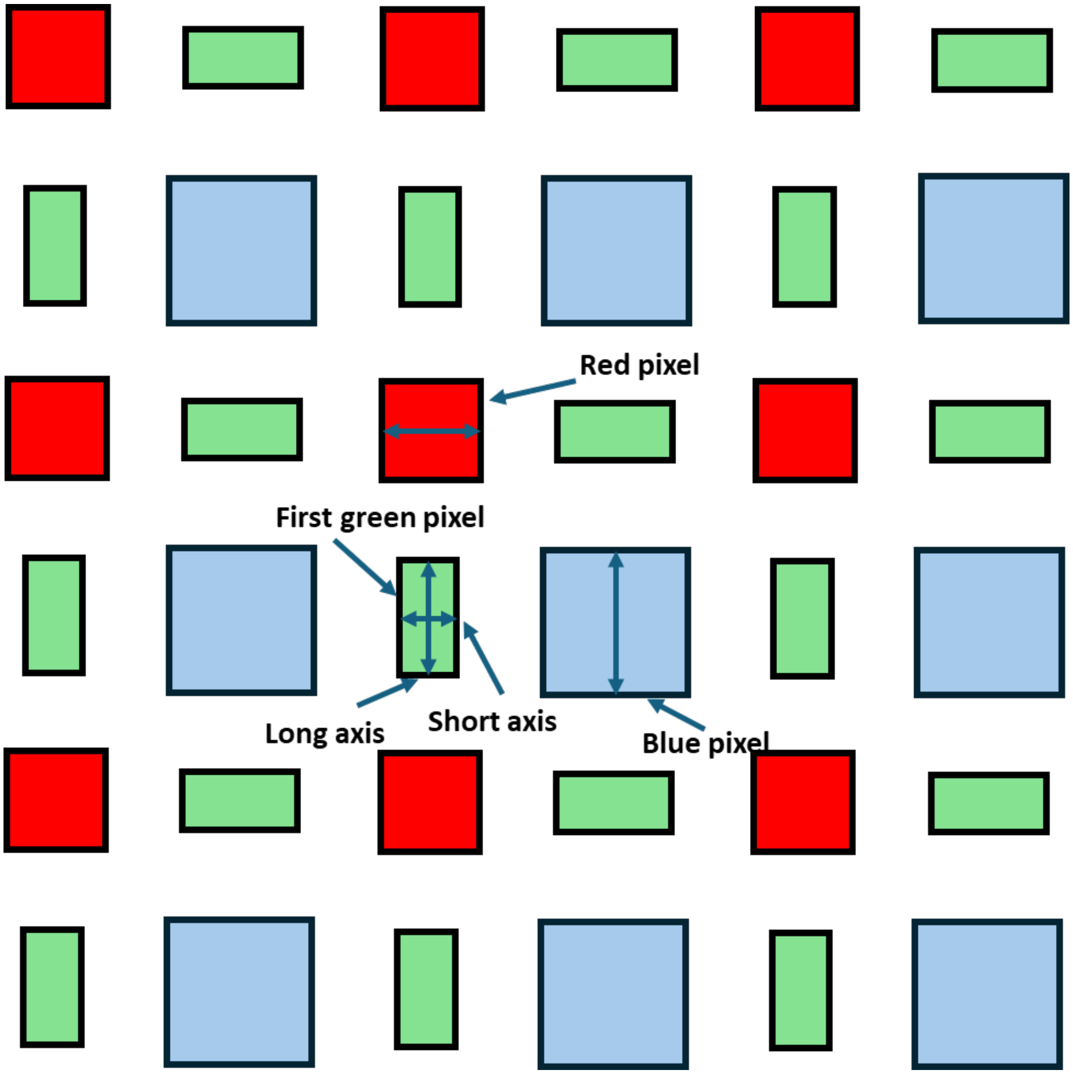
distance L2 (54.984 µm) between one of the two blue pixels and one of the two red pixels.



9. 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."

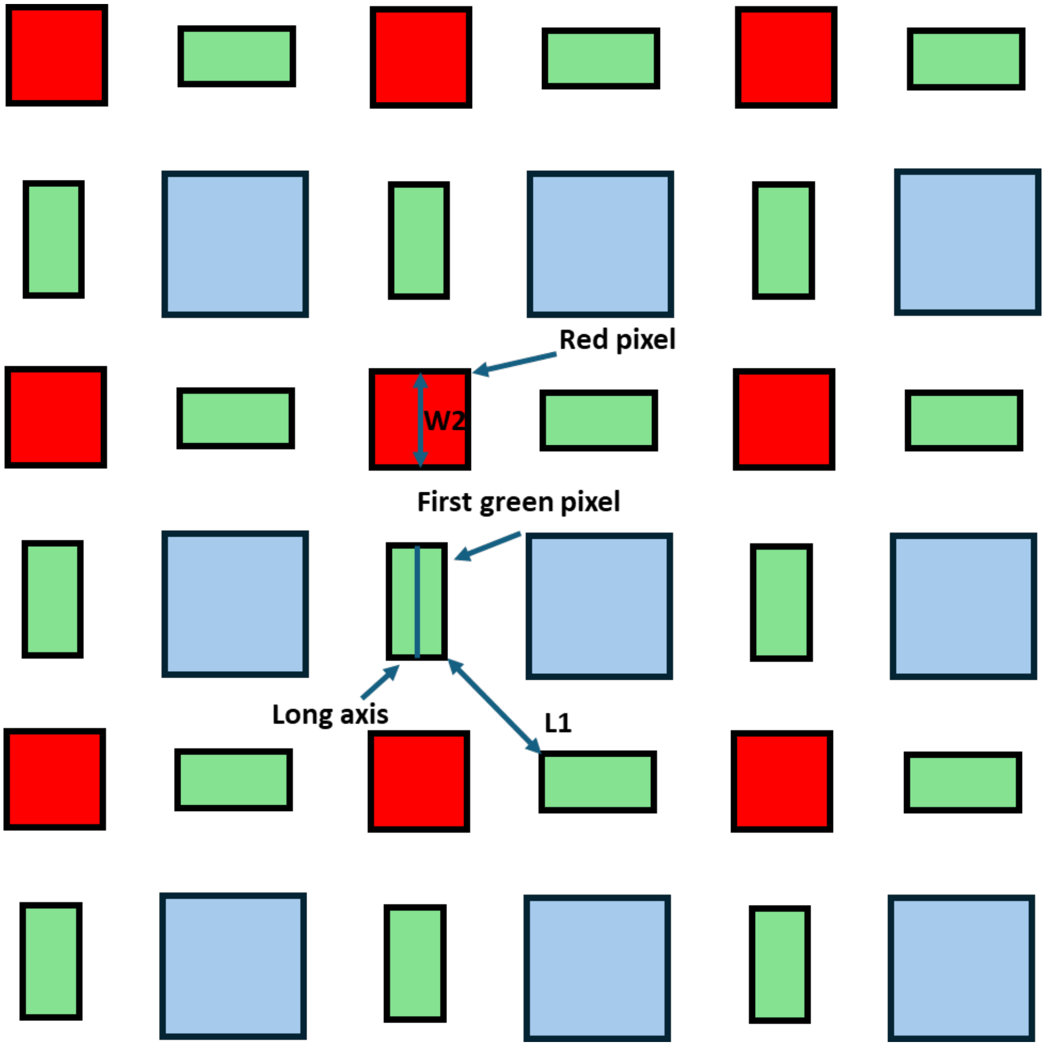
129. Cok in view of Suh teach claim 1, as shown in § X.A.3. Cok in view of Suh further teach this claim. A width of the first green pixel along the short axis

(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.



10. 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."

130. Cok in view of Suh teach claim 1, as shown in § X.A.3. Cok in view of Suh further teach this claim. The length L1 can be determined as shown in § X.A.3.m. 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.



11. Claim 15

a. Preamble: "A method for manufacturing an organic light emitting diode (OLED) display, comprising:"

131. Cok in view of Suh teaches the preamble. Cok discloses "OLED displays having repeated patterns of colored light emitting elements." (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].)

132. A POSITA would have found it obvious to use the manufacturing methods (including using a fine metal mask) taught by Suh with the pixel arrangement pattern of Cok. Both Cok and Suh are in the same field as the '066 patent. Like the '066 patent, Cok is directed to "OLED displays having repeated patterns of colored light emitting elements." (EX1004, 1:6-10.) Similarly, Suh is directed to "organic light emitting display[s]." (EX1005, ¶ [0005].)

133. 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. Indeed, a

POSITA would have viewed Suh as disclosing just one more way to manufacture the OLED display of Cok.

134. Moreover, a POSITA would have recognized that the combination would provide benefits. 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.

135. A POSITA would have reasonably expected the combination to succeed. Both references relate to OLED display technology. This combination would have been straightforward.

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

136. Cok in view of Suh teaches this element. 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] (emphasis added).)

137. The POSITA would have been motivated to use the method of manufacturing taught by Suh to manufacture the device of Cok as discussed above with respect to claim 1, Preamble. (*Supra* § X.A.3.a.)

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

138. Cok in view of Suh teaches this element. Suh teaches "The light emission layers 353 are formed in the regions corresponding to the pixels 301 (refer to FIG. 2). The 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] (emphasis added).)

139. 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 while the LITI method with FMM could have been used to deposit the various colors of

OLED, by itself it is not sufficient to create accurately designed areas for the various colors. The pixel define layers, on the other hand, do create clear boundaries such that the area of the pixel would be more defined than just using the LITI process. With clearly defined areas, the relative sizes of pixels in Cok can be accurately determined by the formulas. (EX1004, 3:57-67.)

140. The POSITA would have been motivated to use the method of manufacturing taught by Suh to manufacture the device of Cok as discussed above with respect to claim 1, Preamble. (*Supra* § X.A.3.a.)

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

141. Cok in view of Suh teaches this element as set forth in limitation 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] (emphasis added).)

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

142. Cok in view of Suh teaches this element as set forth in limitation 15[B]. Suh teaches "The light emission layers 353 are formed in the regions corresponding to the pixels 301 (refer to FIG. 2). The 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] (emphasis added).)

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

143. Cok in view of Suh teaches this element as set forth in limitation 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] (emphasis added).)

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

144. Cok in view of Suh teaches this element as set forth in limitation 15[B]. Suh teaches "The light emission layers 353 are formed in the regions

corresponding to the pixels 301 (refer to FIG. 2). The 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] (emphasis added).)

h. 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,

145. Element 15[G] is similar to element 1[A], which Cok in view of Suh renders obvious. (*Supra* § X.A.3.b.) The table below shows the similarities.

Element 1[A]	Element 15[G]
"a plurality of individually addressable pixels for displaying an image, the individually addressable pixels being minimum addressable units of the OLED display and comprising:"	"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"

i. 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,"

146. Element 15[H] is similar to element 1[E], which Cok in view of Suh renders obvious. (*Supra* § X.A.3.f.) The table below shows the similarities. The "first pixels," "second pixels," and "third pixels" of limitation 15[H] correspond to

the claimed "green pixels," "blue pixels," and "red pixels" of limitation 1[E], respectively.

Element 1[E]	Element 15[H]
"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,"	"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,"

j. 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,"

147. Element 15[I] is similar to element 1[F], which Cok in view of Suh renders obvious. (*Supra* § X.A.3.g.) The table below shows the similarities.

Element 1[F]	Element 15[I]
"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,"	"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"

k. 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,"

148. Element 15[J] is similar to element 1[G], which Cok in view of Suh renders obvious. (*Supra* § X.A.3.h.) The table below shows the similarities, where the "first pixels" of this element correspond to the claimed "green pixels" of claim 1, element 1[G].

Element 1[J]	Element 15[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,"	"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"

l. 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,"

149. Element 15[K] is similar to element 1[H], which Cok in view of Suh renders obvious. (*Supra* § X.A.3.i.) The table below shows the similarities, where the "second pixels" of this element correspond to the "blue pixels" of claim 1, element 1[H] and the "third pixels" of this element correspond to the "red pixels" of claim 1, element 1[H].

Element 1[H]	Element 15[K]
"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"	"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"

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

150. Element 15[L] is similar to element 1[I], which Cok in view of Suh renders obvious. (*Supra* § X.A.3.j.) The table below shows the similarities, where the "second pixels" of this element correspond to the "blue pixels" of claim 1,

element 1[I] and the "third pixels" of this element correspond to the "red pixels" of claim 1, element 1[I].

Element 1[I]	Element 15[L]
"wherein each of the at least two blue pixels has a larger area than each of the at least two red pixels,"	"wherein each of the at least two second pixels has a larger area than each of the at least two third pixels"

n. 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,"

151. Element 15[M] is similar to element 1[J], which Cok in view of Suh renders obvious. (*Supra* § X.A.3.k.) The table below shows the similarities, where the "second pixels" of this element correspond to the "blue pixels" of claim 1, element 1[J] and the "first pixels" of this element correspond to the "green pixels" of claim 1, element 1[J].

Element 1[J]	Element 15[M]
"wherein each of the at least two blue pixels has a larger area than that of the first green pixel"	"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,"

o. 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"

152. Element 15[N] is similar to element 1[K], which Cok in view of Suh renders obvious. (*Supra* § X.A.3.l.) The table below shows the similarities, where

the "first pixels" of this element correspond to the "green pixels" of claim 1, element 1[K].

Element 1[K]	Element 15[N]
"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"	"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"

p. 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."

153. Element 15[O] is similar to element 1[L], which Cok in view of Suh renders obvious. (*Supra* § X.A.3.m.) The table below shows the similarities, where the "first pixels" of this element correspond to the "green pixels" of claim 1, element 1[L] and the "third pixels" of this element correspond to the "red pixels" of claim 1, element 1[L].

Element 1[L]	Element 15[O]
"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."	"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."

12. 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.”

154. Cok in view of Suh teach claim 15, as shown in § X.A.12. Claim 17 is similar to claim 4, which Cok in view of Suh renders obvious. (*Supra* § X.A.5.) The table below shows the similarities.

Claim 4	Claim 17
“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”	“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.”

13. 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.”

155. Cok in view of Suh teach claim 15, as shown in § X.A.12. Claim 18 is similar to claim 5, which Cok in view of Suh renders obvious. (*Supra* § X.A.6.) The table below shows the similarities.

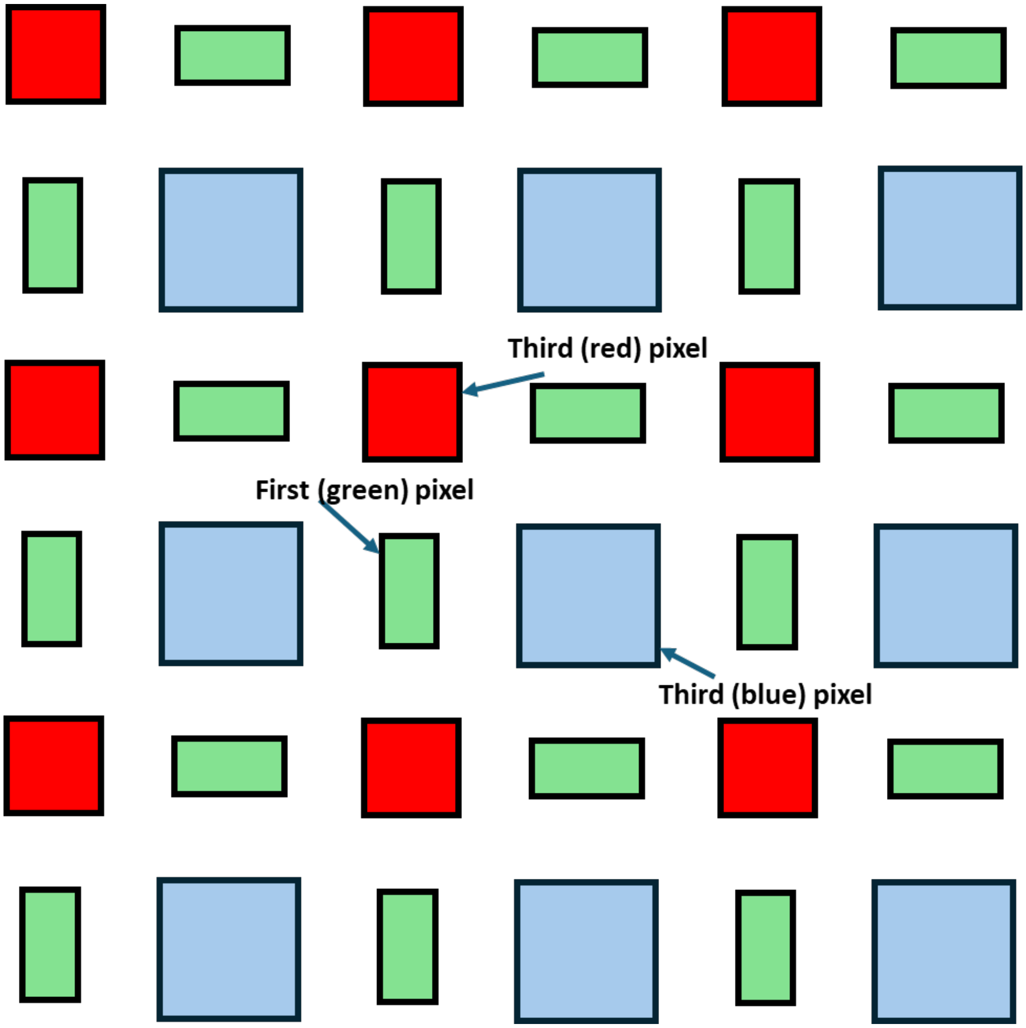
Claim 5	Claim 18
“The OLED display of claim 2, wherein the one of the at least two blue pixels and the one of the at least two red pixels have polygonal shapes with at least four sides.”	“The method of claim 15, wherein one of the at least two second pixels and one of the at least two third pixels have polygonal shapes with at least four sides.”

14. 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."

156. Cok in view of Suh teach claim 15, as shown in § X.A.12. Cok discloses "Organic light-emitting diode (OLED) display 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 "a pixel pattern 10 in an OLED display device according to one embodiment of the present invention includes two green light emitting elements 14 …, a red light emitting element 12 …, and a blue light emitting element 16," and that pixel patterns are repeated within the OLED display device, such that there are a plurality of green light emitting elements, red light emitted elements, and blue light emitting elements. (*Id.*, 2:14-19, 3:1-5, 4:7-13.)

157. 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 by a laser induced thermal imaging (LITI) method using the FMM 370." (EX1005, ¶ [0031].)

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



15. 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."

159. Cok in view of Suh teach claim 19, as shown in § X.A.15. Claim 29 is similar to claim 2, which Cok in view of Suh renders obvious. (*Supra* § X.A.4.) The table below shows the similarities.

Claim 2	Claim 20
"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."	"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."

16. 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."

160. Cok in view of Suh teach claim 20, as shown in § X.A.16. Claim 22 is similar to claim 4, which Cok in view of Suh renders obvious. (*Supra* § X.A.5.) The table below shows the similarities.

Claim 4	Claim 22

"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."	"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"

17. 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."

161. Cok in view of Suh teach claim 20, as shown in § X.A.16. Claim 23 is similar to claim 5, which Cok in view of Suh renders obvious. (*Supra* § X.A.6.) The table below shows the similarities.

Claim 5	Claim 23
"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."	"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."

18. 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."

162. Cok in view of Suh teach claim 15, as shown in § X.A.12. Claim 28 is similar to claim 12, which Cok in view of Suh renders obvious. (*Supra* § X.A.9.) The table below shows the similarities.

Claim 12	Claim 28
"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 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

the at least two blue pixels and one of the at least two red pixels."	between one of the at least two second pixels and one of the at least two third pixels"

19. 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."

163. Cok in view of Suh teach claim 15, as shown in § X.A.12. Claim 29 is similar to claim 13, which Cok in view of Suh renders obvious. (*Supra* § X.A.10.) The table below shows the similarities.

Claim 13	Claim 29
"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."	"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."

20. 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.”

164. Cok in view of Suh teach claim 15, as shown in § X.A.12. Claim 30 is similar to claim 14, which Cok in view of Suh renders obvious. (*Supra* § X.A.11.) The table below shows the similarities.

Claim 14	Claim 30
“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”	“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.”

B. Claim 11 is Obvious over Cok in view of Suh and Hong

1. Summary of Hong

165. 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." (*Id.*, ¶ [0048].) The distance d1 is sufficient to prevent the shadowing effect and the subsequent mixing of colors during deposition of the organic patterns. (*Id.*, ¶ [0044], ¶ [0048].)

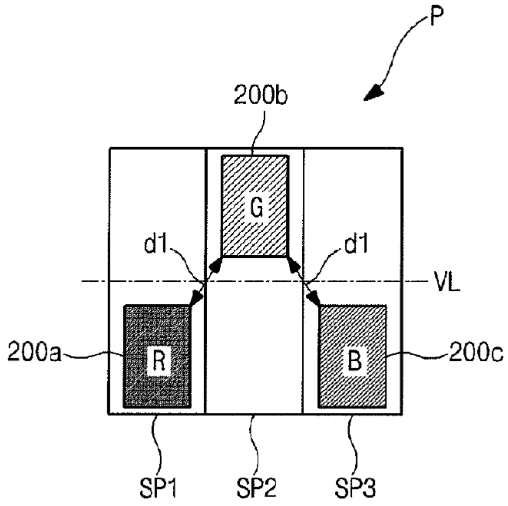


FIG. 5

166. Although FIG. 5 shows the red, blue, and green 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 of each organic pattern." (EX1039, ¶ [0074].) For example, "[w]hen the first, second and third organic patterns 250a, 250b and 250c emit red, green and blue colored lights, respectively, the emission efficiency of the first organic pattern 250a may be greater than the emission efficiency of the third organic pattern 250c and may be

smaller than the emission efficiency of the second organic pattern 250b." (*Id.*) To account for this difference in efficiency, "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.*) Such an arrangement would improve "uniformity in brightness and controllability of white balance." (*Id.*)[3]

167. Hong also describes how the organic electroluminescent display device is fabricated using a shadow mask. (EX1039, ¶ [0072].) The shadow mask

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[3] Hong incorrectly states "For example, the organic pattern having a higher emission efficiency may have an area ***greater*** than the organic pattern having a lower emission efficiency," instead of the correct "smaller" area. (EX1039, ¶ [0074] (emphasis added)). A POSITA would have known that this was a mere typo given the context of the rest of the paragraph, which applies the correct rule (that greater efficiency patterns should have a smaller area). For example, the same paragraph says "When the first, second and third organic patterns 250a, 250b and 250c emit red, green and blue colored lights, respectively, the emission efficiency of the first organic pattern 250a may be greater than the emission efficiency of the third organic pattern 250c and may be smaller than the emission

(or shadow masks if the subpixels have different areas) includes a plurality of open portions 350, through which organic material is deposited during a vacuum thermal evaporation process to form the 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 first, second and third organic patterns 250a, 250b and 250c are formed through a vacuum thermal evaporation method." (*Id.*) Such "deformation of the shadow mask 300 causes a shadowing effect." (*Id.*) The shadowing or color mixing can occur even if multiple masks are used because all masks will experience deformations such as warpage.

168. 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.

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efficiency of the second organic pattern 250b. Accordingly, the area of the first organic pattern 250a may be greater than the area of the second organic pattern 250b and may be smaller than the area of the third 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.*)

2. 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.”

169. 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.)

170. 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. As illustrated in FIG. 5 of Hong below, “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].)

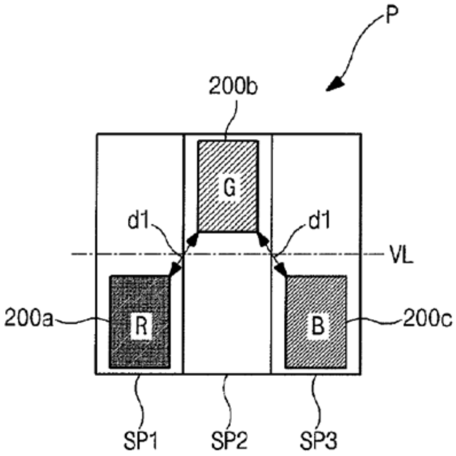
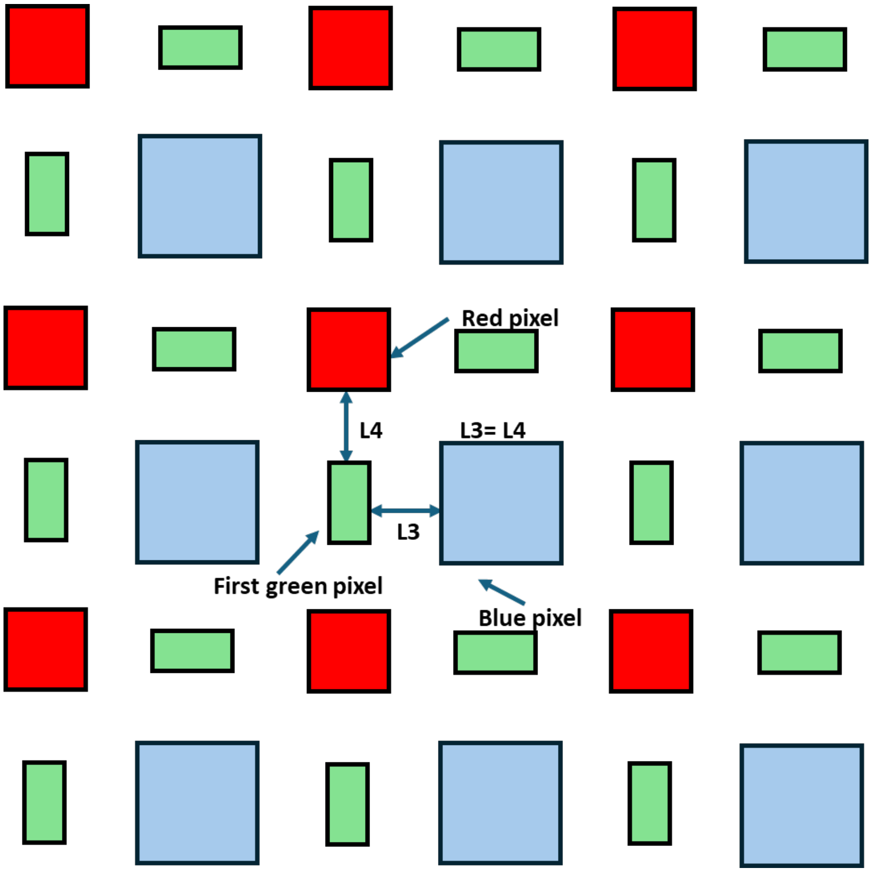


FIG. 5

171. That is, 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].) 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.



172. A POSITA would have found it obvious to implement the pixel arrangement pattern of Cok in view of Hong's teachings. Both Cok and Hong in the same field as the '066 patent. Like the '066 patent, Cok is directed to "OLED displays having repeated patterns of colored light emitting elements." (EX1004, 1:6-10.) Similarly, Hong is directed to an "organic electroluminescent display (ELD) device." (EX1039, ¶ [0005].) A POSITA would have been motivated to make this combination in order to improve the manufacturability and performance of an OLED display. 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. Indeed, a POSITA would have viewed Hong as disclosing just one more way to space the pixels in the OLED display of Cok.

173. Furthermore, modifying the device of Cok to have the spacings of Hong would be advantageous to prevent or reduce shadowing. 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 d1" can prevent a shadowing effect along the direction of the space between the pixels. (EX1039, ¶ [0048].) 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. To do so would have been particularly beneficial given Cok's RGBG pattern, wherein green-red and green-blue adjacent pairs share parallel horizontal sides that, as Hong teaches, would amplify the shadowing effect (as opposed to, for example, red-blue adjacent pairs that are closest to each other at their corners, which have a reduced risk of shadowing due to the limited area of overlap compared to pairs sharing full sides). (EX1008, ¶¶ [0010], [0036].) When choosing a pixel arrangement, the POSITA would have sought to weigh several considerations, including Hong's teachings about the benefits of reducing the effect of shadowing, together with the benefits of

efficiency and white balance motivating the area ratios discussed under claim 1 above.

174. 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. 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. 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, ¶¶ [0070]-[0072]; EX1005, ¶ [0006].) 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].) 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. The POSITA would have also recognized that the equal spacing taught by Hong can minimize the effects of such warpage and thermal deformation. 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.

175. Since 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. This consistency in spacing and positioning allows for a more consistent application of each color, reducing the likelihood of color mixing or unintended patterns that can arise from uneven deposition. Additionally, since the direction and extent of mask deformations are unpredictable, maintaining equal spacings between the green-blue pixel pairs and the green-red pixel pairs acts as a safeguard, ensuring that any deformation will have a consistent effect rather than creating localized areas of excessive shadowing or color mixing.

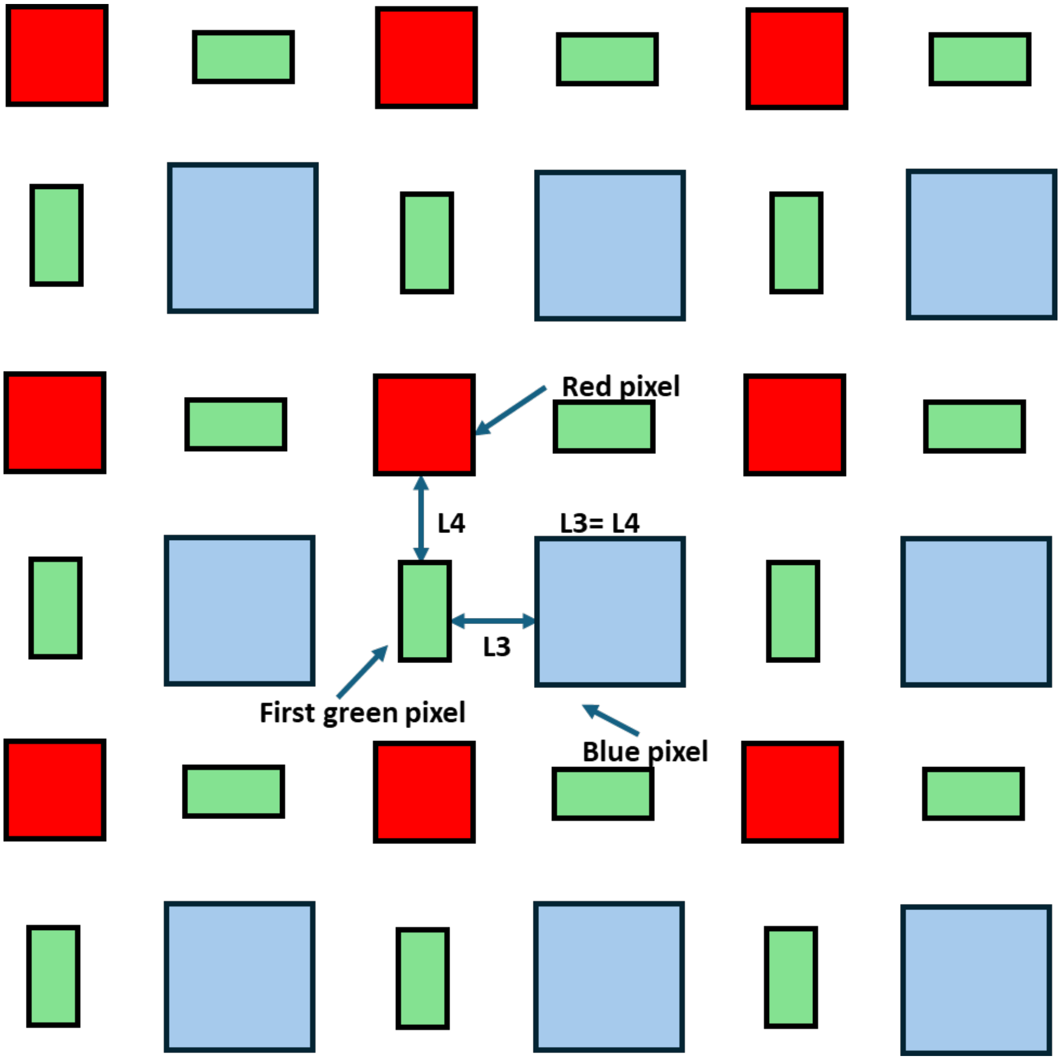
176. Thus, the POSITA would have been motivated to maintain an equal minimum distance between the green-blue pixel pairs and the green-red pixel pairs, such that the shadowing effect will be reduced equally in these directions. Similarly, a POSITA would have recognized that shadow masks for forming a display with unequal subpixel sizes would benefit in the same manner as with equal size subpixels; that is, a minimum equal distance between the green-blue pixel pairs and the green-red pixel pairs will mitigate the shadowing effect. Accordingly, the POSITA would have recognized that adopting Hong's teaching of

equal distances between adjacent pixels would mitigate the adverse effects of thermal expansion. 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.

177. A POSITA would have reasonably expected the combination to succeed. 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. The combination of Cok and Hong, with its resulting pixel arrangement above, would have been straightforward.

178. For example, to achieve the equal spacing disclosed in Hong, a POSITA could 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), where L3 and L4 are calculated using the same method as above.



179. Such a modification would still achieve the limitations of claim 1. For example, the two blue pixels still have a larger area (8100 μm^2) than the red pixels (3600 μm^2) and the green pixels (1800 μm^2), and the shortest distance L1 between two nearest ones of the plurality of green pixels (96.360 μm) is still greater than a width of a first red pixel of the plurality of red pixels along a first

direction (60.000 μm), where L1 is calculated according to the same method as above.

C. Claims 1, 2, 4, 5, 10-13, 15, 17-23, 28, And 29 Are Obvious Over Credelle-379 In View Of Cok and Suh

1. Summary of Credelle-379

180. Credelle-379 discloses "improved color pixel arrangements" which can be used in Active Matrix OLED displays. (EX1006, 1:45-46, 10:51-54.) 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," forming an RGBG pixel pattern. (*Id.,* 4:23-25.)

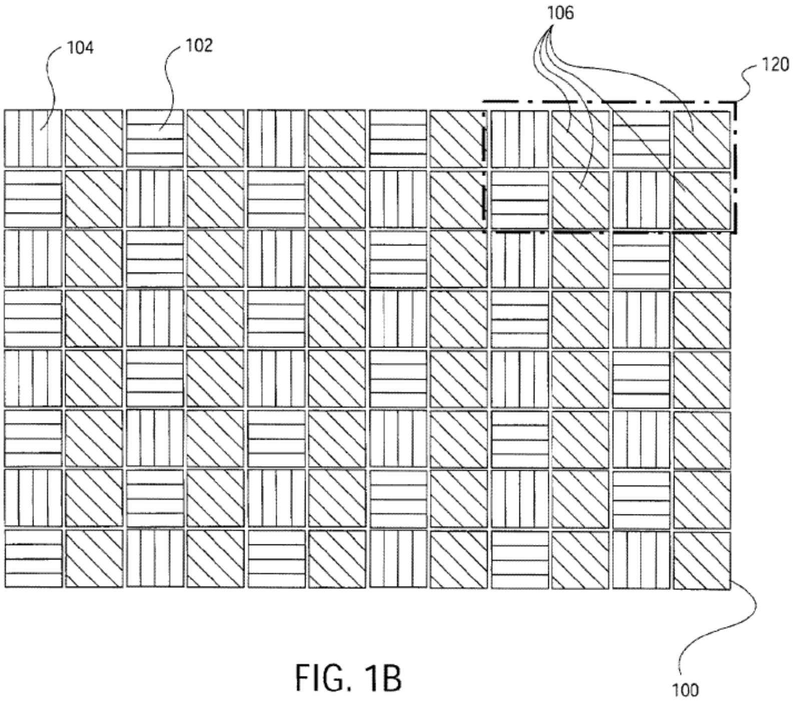


FIG. 1B

181. Credelle-379 also 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.)

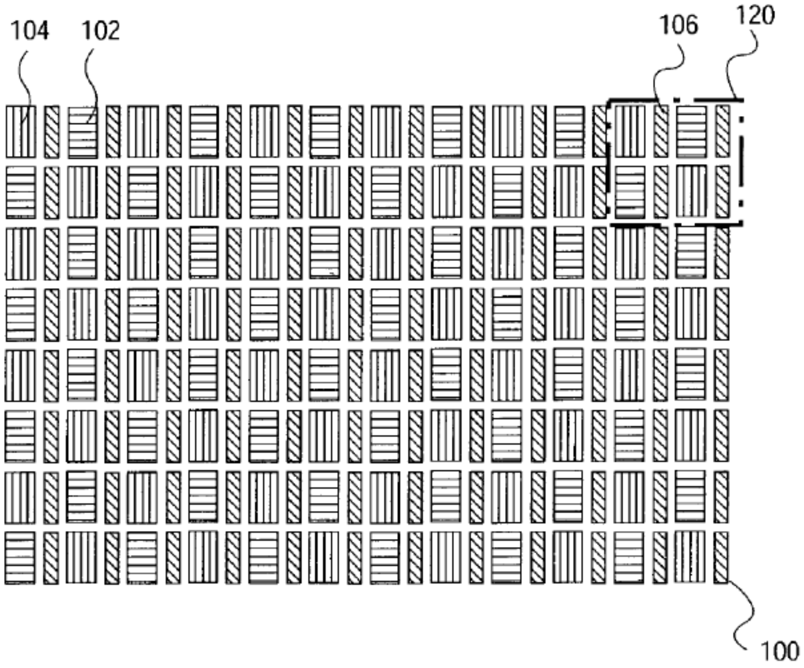
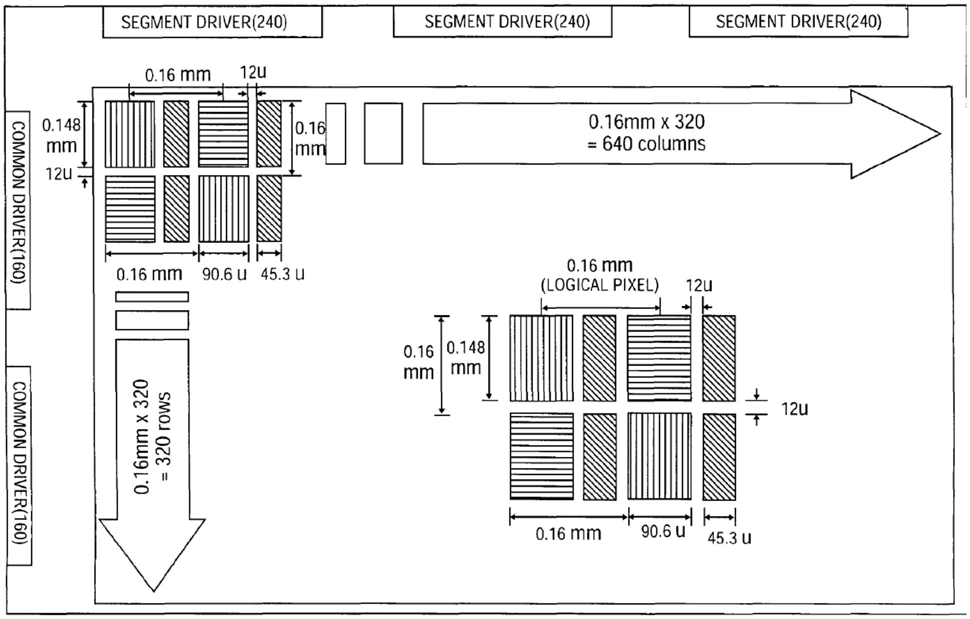


FIG. 1C

182. Credelle-379 also discloses that the sub-pixels are spaced apart from one another, as seen in FIGS. 1B and 1C, as well as 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 also

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



183. 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 for a single embodiment." (*Id.*, 10:39-44.)

184. 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. It will also put the minority color sub-pixel emitters 102 and 104 on, or nearly on, an idealized 'checkerboard.'" (*Id.*, 4:27-32.)

185. Beyond changing the sizes, aspect ratios, and spacings of the sub-pixels, 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.)

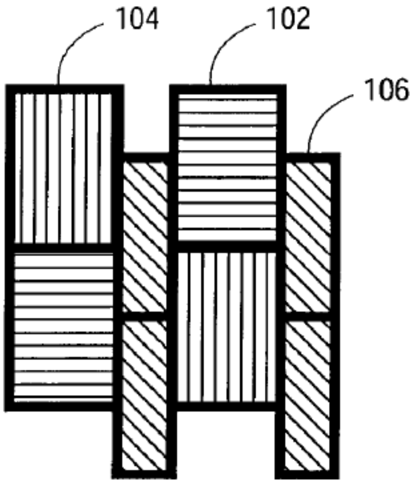


FIG. 8A

186. 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 contemplated within the scope of the present invention. For example, a multitude of other regular or irregular shapes for the subpixels are possible and are desirable if manufacturable." (*Id.*, 4:51-56.)

187. 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.

2. Claim 1

a. Preamble: "An organic light emitting diode (OLED) display, comprising:

188. Credelle-379 describes "A pixel arrangement structure of an organic light emitting diode (OLED)". For example, Credelle-379 describes "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, claim 23.)

b. 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:"

189. Credelle-379 teaches "a plurality of individually addressable pixels for displaying an image, the individually addressable pixels being minimum addressable units of the OLED display." For example, 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, claim 23.) Although Credelle-379 describes the individual light emitting elements as "sub-pixel emitters" or "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.) A POSITA would have known that a characteristic of AMOLEDs is that each sub-pixel of Credelle-379 (corresponding to the claimed "pixels") has its own dedicated circuitry, such that the sub-pixels are individually addressable.

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

190. Credelle-379 in view of Suh discloses this element. Credelle-379 discloses "color pixel arrangements" for "display technologies such as Organic Light Emitting Diode (OLED)." (EX1006, 1:45-46, 10:51-54.) 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] (emphasis added).)

191. 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, 10:51-54.) The POSITA would have thus turned to Suh to fill in the details regarding the structure and manufacturing process of OLED displays.

192. 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.

193. Credelle-379 and Suh in the same field as the '066 patent. Like the '066 patent, Credelle-379 is directed to "improved color pixel arrangements" that can be used in OLED (including AMOLED) displays. (EX1006, 1:44-46.) Similarly, Suh is directed to "organic light emitting display[s]." (EX1005, ¶ [0005].)

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

194. Credelle-379 in view of Suh discloses this element. Credelle-379 discloses "color pixel arrangements" for "display technologies such as Organic Light Emitting Diode (OLED)." (EX1006, 1:45-46, 10:51-54.) 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] (emphasis added).)

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

195. Credelle-379 in view of Suh discloses this element. Credelle-379 discloses "color pixel arrangements" for "display technologies such as Organic Light Emitting Diode (OLED)." (EX1006, 1:45-46, 10:51-54.) 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] (emphasis added).)

f. 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,"

196. Credelle-379 in view of Suh discloses this element. 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 Credelle-379 because the pixel define layer of Suh allows for clear definition and separation of pixel areas.

197. A POSITA also would have found it obvious to use OLED structure taught by Suh with the pixel arrangement pattern of Credelle-379. Credelle-379 and Suh are in the same field as the '066 patent. Like the '066 patent, Credelle-379 is directed to "improved color pixel arrangements" that can be used in OLED

(including AMOLED) displays. (EX1006, 1:44-46.) Similarly, Suh is directed to "organic light emitting display[s]." (EX1005, ¶ [0005].)

198. A POSITA also 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. Indeed, a POSITA would have viewed Suh as disclosing just one more way to manufacture the OLED displays of Credelle-379 and Cok.

199. Furthermore, 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, claim 23.) A POSITA would have known that using a pixel defining layer to define the pixels was beneficial in OLED displays, and particularly in active matrix OLED devices. 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].) Indeed, as

discussed in the ’066 patent, configurations such as insulation layers and pixel defining layers were technologies known in the art. (EX1001, 4:58-65.)

200. 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].) 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.

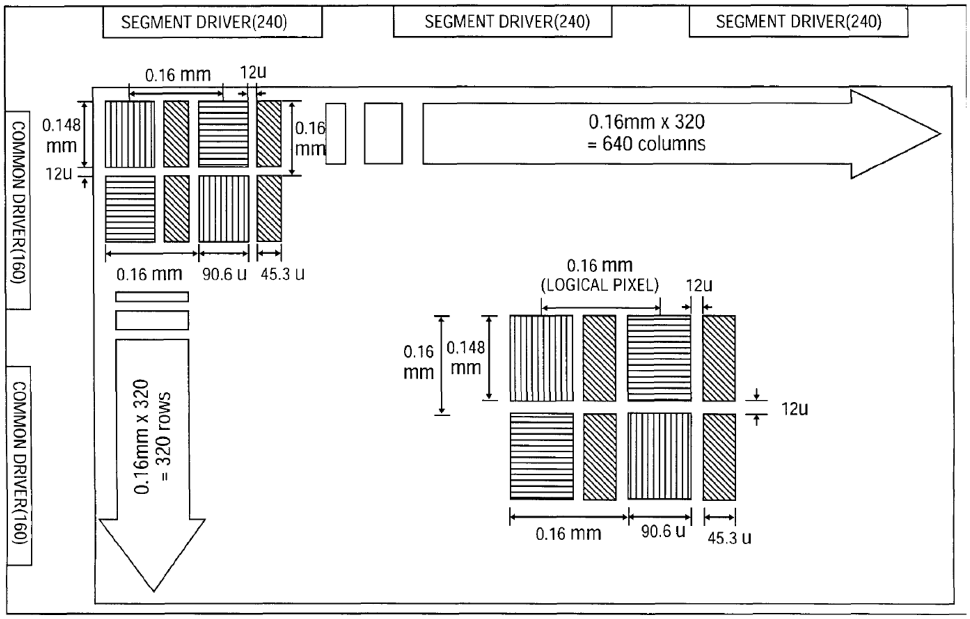
201. A POSITA would have reasonably expected the combination to succeed. Both references relate to OLED display technology. Given these disclosures and the knowledge of a POSITA, the combination would have been straightforward.

g. 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,”

202. Credelle-379 discloses this element. 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, which shows explicit spacing between the pixels for an exemplary display. (EX1006, FIG. 12.) FIG. 12 of Credelle-379 also teaches that the spacing between the centers of the blue and red pixels, and correspondingly, the spacing between the centers of the green pixels, is 160 µm for an exemplary display.

FIG. 12



h. 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,"

203. 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.

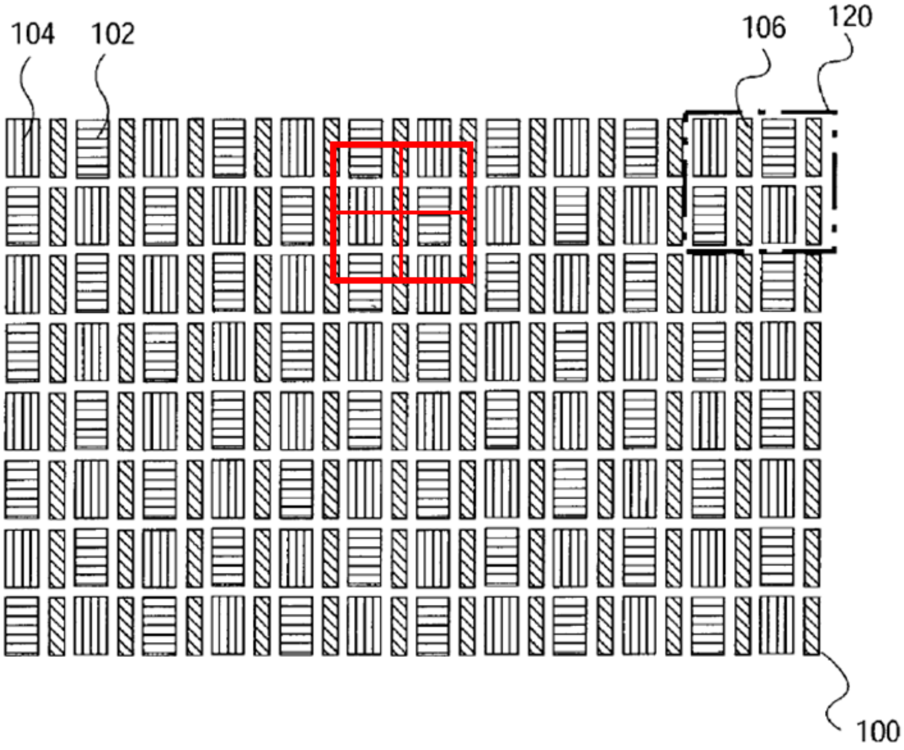
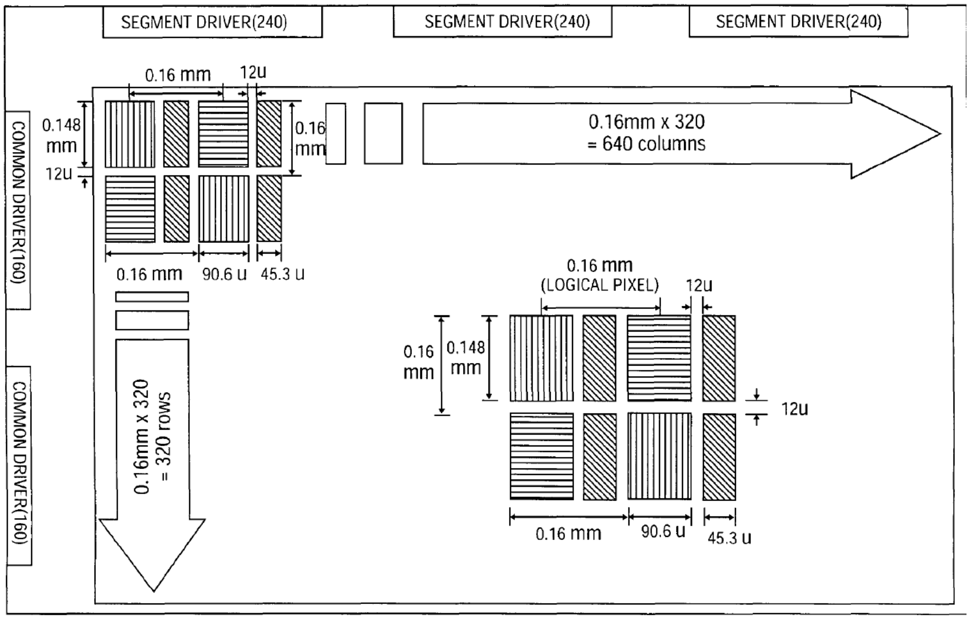


FIG. 1C

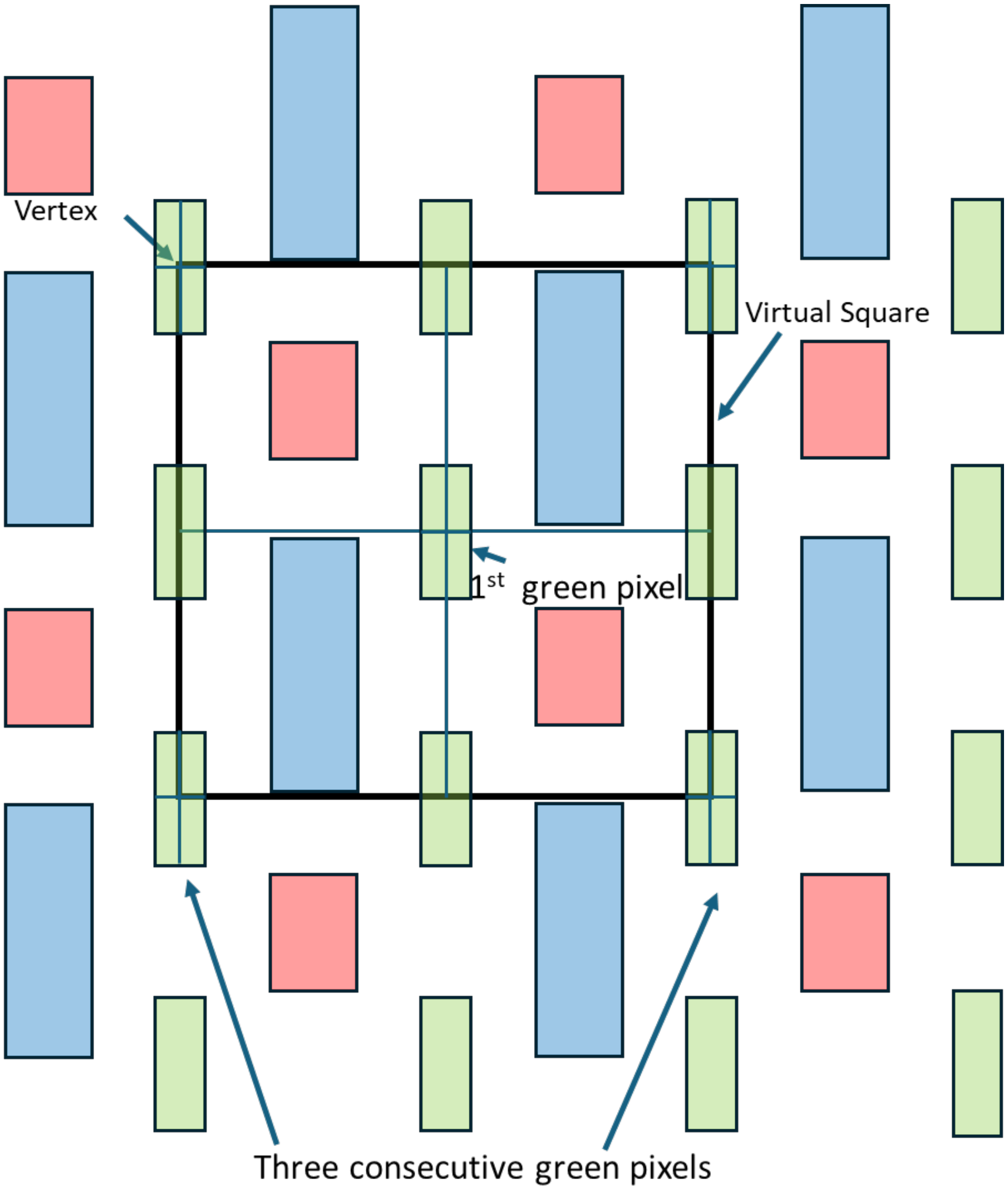
204. FIG. 12 of Credelle-379 also teaches that the spacing between the centers of the blue and red pixels, and correspondingly, the spacing between the centers of the green pixels, is 160 μm for an exemplary display.

FIG. 12



205. As discussed above, Credelle-379 teaches that the relative sizes, aspect ratios, spacings (*e.g.*, as shown by the modification of the pixel arrangement structure of FIG. 1B to the one shown in FIG. 1C), and positions (*e.g.*, particularly vertical offsets as shown in FIG. 8A and 8B) 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 (corresponding to the claimed "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.



206. 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. Between the publication date of Credelle-379 in 2003 and the publication of Cok in 2004, and certainly by the priority date of the challenged patent here,

there was "rapid development" of OLED technology, including in the organic materials used for the emission layers of an OLED display. (EX1008, 310.) A POSITA would have known such materials provided better longevity and performance for OLED displays. For example, a POSITA would have known of the improved phosphorescent red and green host materials as described in Nishimura. He or she would have been motivated to use such improved materials to improve the lifetime, as well as reduce power-consumption, of an OLED display. (*Supra,* § X.A.3.h.)

207. 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 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). (EX1004, 4:31-45.) As explained in detail above, based on Cok's formula and the table of Nishimura, 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, and would have applied those area ratios to the arrangement taught by Credelle-379.

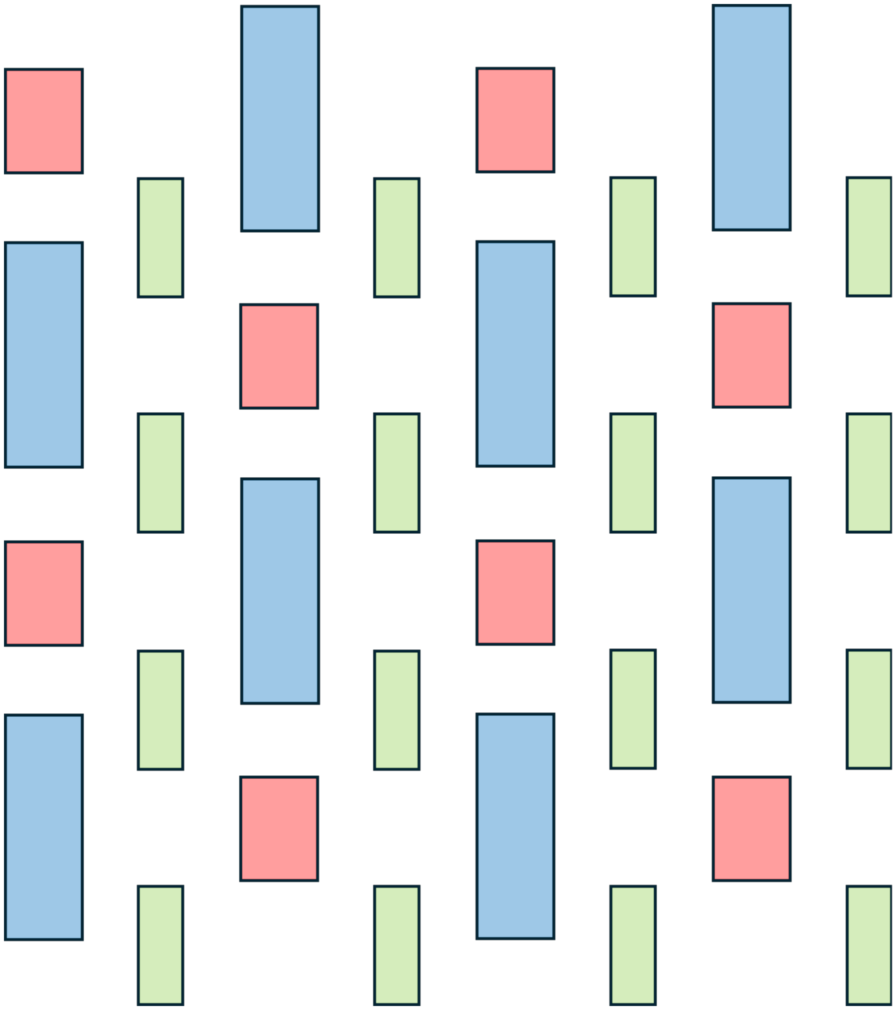
208. For example, considering an OLED display with a 0.16 mm pixel pitch (typical for displays in the 2000s), a POSITA would have reasonably chosen dimensions of 30 µm x 80 µm or an area of 2400 µm^2 for a rectangular green pixel. A green pixel size of 30 µm x 80 µm is also reasonable considering OLED efficiencies, display luminance targets, and manufacturing tolerances and design rules in the 2000s. Using the relative areas calculated above, a POSITA would have then obtained an area of 3631 µm^2 for the red light emitting element and an area of 7902 µm^2 for the blue light emitting element.

209. 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. For example, the pixel arrangement in Fig. 8A creates a pattern with a green pixel at the center and surrounded by shared red and blue pixels. Additionally, a POSITA would have known that shifting the green sub-pixels vertically by one half of the pixel spacing would have allowed the array of pixels to be rotated. This would have allowed for manufacturing flexibility in the position of thin film transistors and interconnections. A POSITA would have also known that offsetting the green pixel is compatible with sub-pixel rendering. Red and blue information is

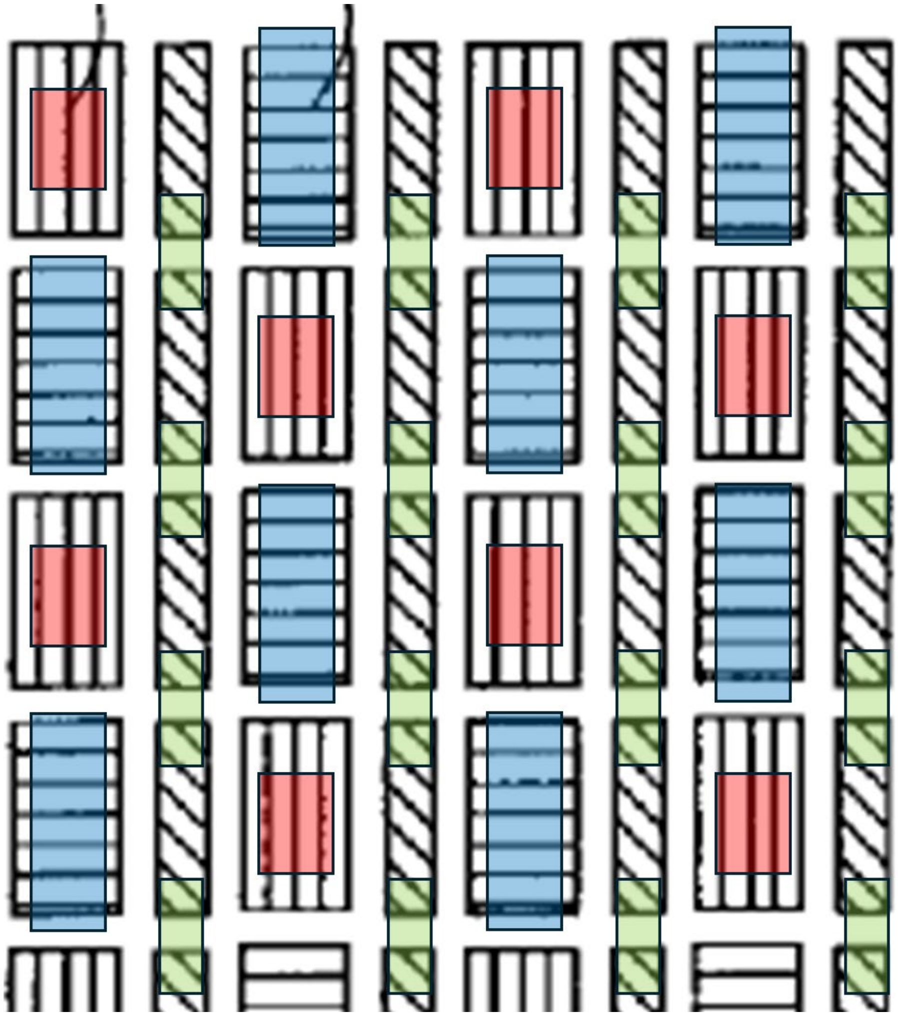
displayed on the red and blue sub-pixels by weighting the red and blue digital data from a 3x3 sampling of incoming data. The weighting factors can be adjusted to create a virtual center of luminance for red or blue information and thus can be shifted vertically or horizontally. Because of this feature, the green pixels (which do not require sub-pixel rendering) can be shifted vertically.

210. 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. 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 rectangular pixels shown below (and annotated above).



211. Shown below is an overlay of the arrangement from FIG. 1C on the modified arrangement shown above.



212. A POSITA would have maintained the grid-like spacing of the green pixels 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. A POSITA would have known that since green pixels contain the majority of the white luminance (*e.g.*, ~ 60% for typical OLEDs), it would have been critical that the centers by equally spaced. If they are not, luminance errors, jagged edges

(aliasing), color fringing or chromatic aberrations, or Moiré defects could occur. A POSITA would have known of one metric, known as "Just Noticeable Difference" (JND) which was developed by at least 2012. (EX1031, 820). A defect with one JND is detectable more than 50% of the time by a standard observer. A POSITA would have known that the size or spatial frequency of the defect and the viewing distance would affect the detectability. A deviation from a regular array of green sub-pixels can result in noticeable luminance or chroma errors greater than one JND. In addition, since the human visual system is extremely sensitive to deviations in parallel line spacing ("vernier acuity") a POSITA would have known that small deviations in pixel spacing can create noticeable errors. It would have been important to a POSITA to also maintain equal centers for red and blue pixels although the sensitivity is lower for several reasons. First, the sub-pixels are larger, second, the luminance is lower, and third, sub-pixel rendering is used to average the information to be displayed among pixels and can adjust for offsets. However, the positional accuracy (*e.g.*, the centers of red and blue pixels) must be uniform for the same reasons as for green.

213. 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 in the same field as the '066 patent. Like the '066 patent, Credelle-379 is directed to "improvements to display layouts, and, more particularly, to improved color

pixel arrangements" that can be used in OLED (including AMOLED) displays. (EX1006, 1:44-46, 5:55-57.) Similarly, Cok is directed to "OLED displays having repeated patterns of colored light emitting elements." (EX1004, 1:6-10.)

214. 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. 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.

215. 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, because "the relative sizes of the light emitting elements are proportional to the rate at which their materials age and to their relative efficiencies, [thus,] the light emitting elements will age at approximately the same rate, thus improving the lifetime of the device." (EX1004, 4:31-36.) 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.) Utilizing

Cok's formula would also have compensated for different efficiency of the different color pixels.

216. Additionally, as found by the Board during the original examination of the '616 patent (a parent application to the '066 patent), "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, 4:52-57, 4:59-65, 10:39-45, FIGS. 1B, 1C, 8A, and 8B; *see also* EX1028 for a comparison of Credelle-179 and Credelle-379.)

217. A POSITA would have reasonably expected the combination to succeed. Both references relate to OLED display technology. Both already teach using RGBG pixel arrangements. (EX1006, FIGS. 1B, 1C, 8A, 8B; EX1004, FIGS. 1, 3.) And Credelle-379 itself discloses that the relative sizes, aspect ratios, spacings (*e.g.*, as shown by the modification of the pixel arrangement structure of FIG. 1B to the one shown in FIG. 1C), and positions (*e.g.*, particularly vertical offsets as shown in FIG. 8A and 8B) of the pixels can be altered. (EX1006, 4:27-

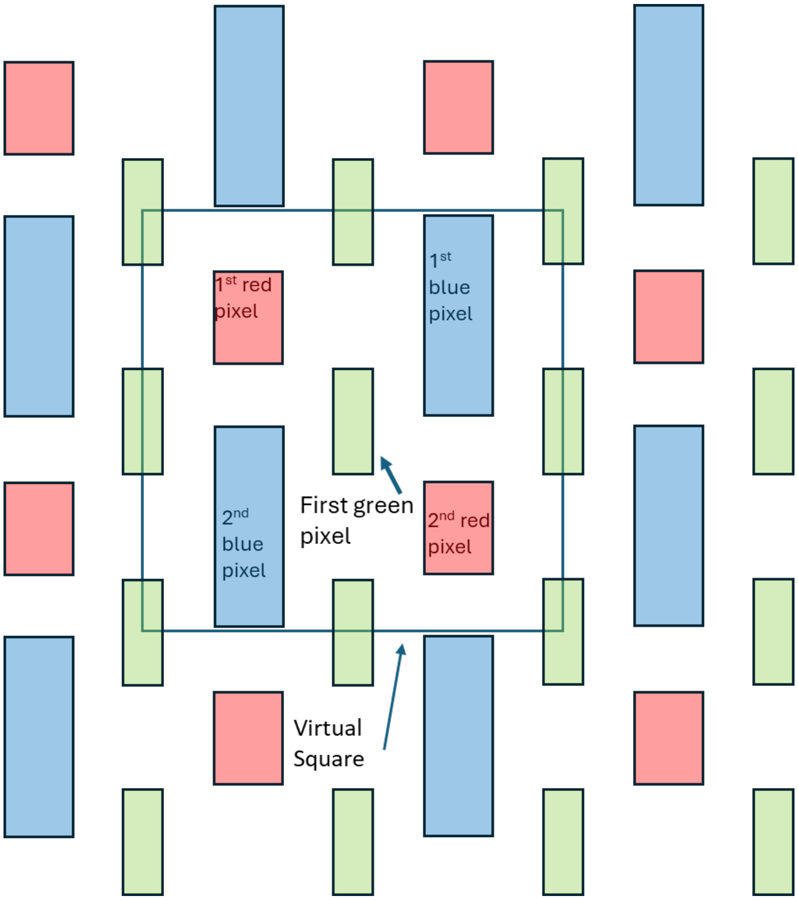
32, 4:52-57, 4:59-65, 10:39-45, FIGS. 1B, 1C, 8A, and 8B.) The combination of Credelle-379 and Cok, with its resulting pixel arrangement above, would have been straightforward.

218. As taught by Credelle-379, the modification has adjusted aspect ratios. Upon determining the areas of the red and blue pixels based on the size of the green as discussed above in paragraph 208, a POSITA would have next determined what dimensions to use for the red and blue pixels to achieve their respective desired areas. 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. 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.

219. Such a modification would also preserve the aspects of Credelle-379 in view of Suh that teach limitations 1[A]-1[F] because changing the sizes of the pixels would not change the basic structure or operation of the OLED display.

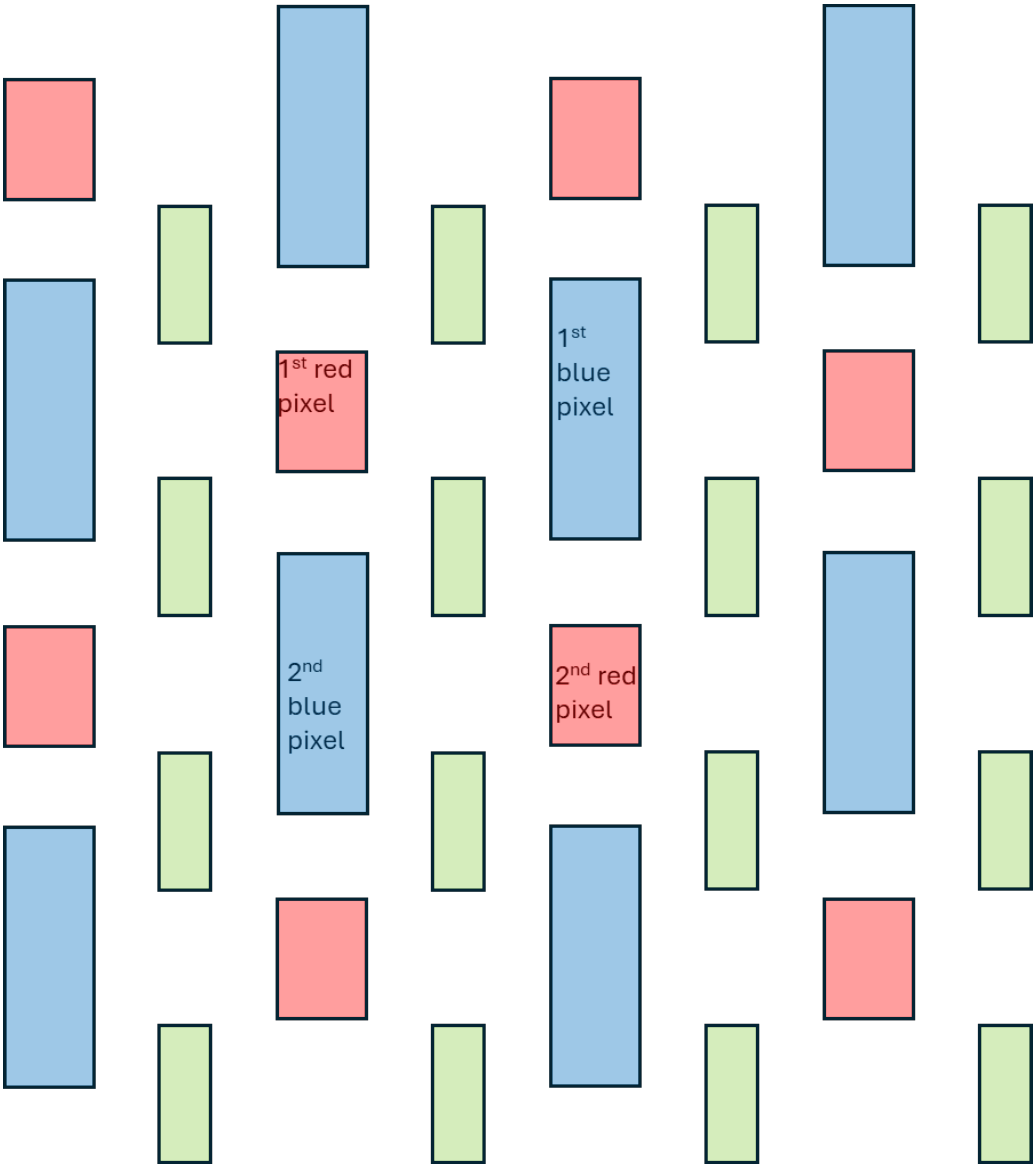
i. 1[H]: "wherein at least two blue pixels of the plurality of blue pixels and at least two red pixels of the plurality of red pixels are located entirely within boundaries of the virtual square,"

220. Credelle-379 in view of Cok and Suh teach this element. As shown below, two blue pixels and two red pixels are located entirely within boundaries of the virtual square.



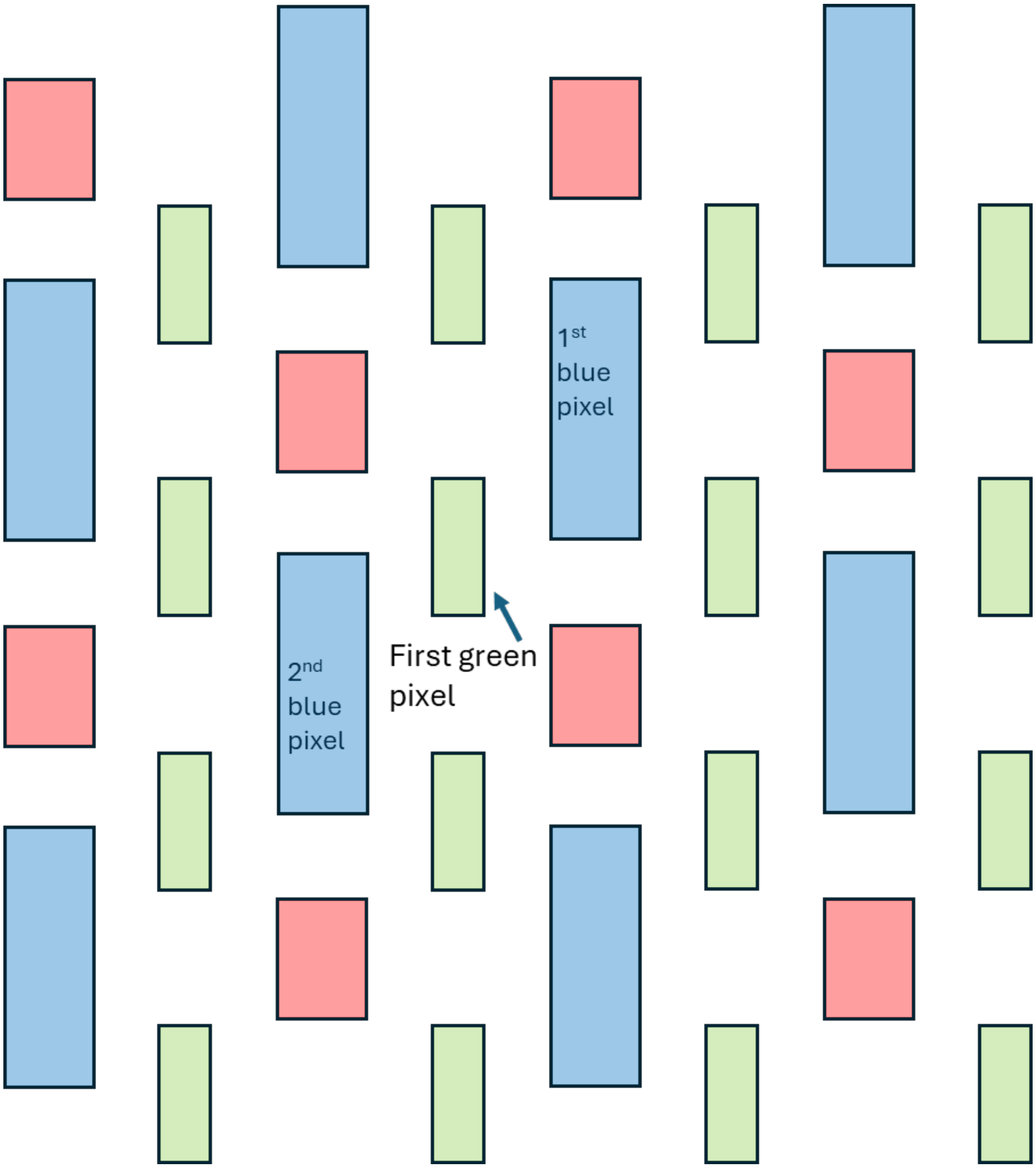
j. 1[I]: "wherein each of the at least two blue pixels has a larger area than each of the at least two red pixels,"

221. Credelle-379 in view of Cok and Suh teach this element. As shown below, the two blue pixels each have an area of 7902 µm², which is larger than the area of each of two red pixels, which each have an area of 3631 µm².



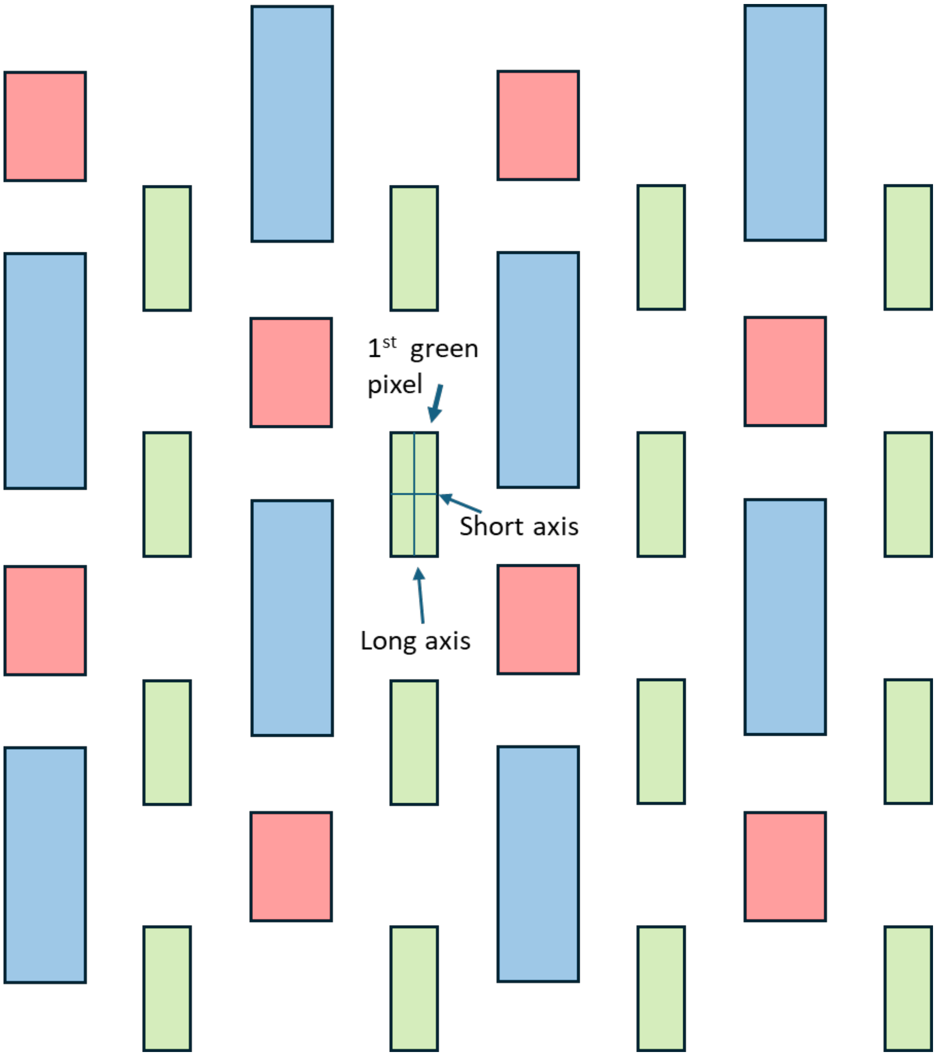
k. 1[J]: "wherein each of the at least two blue pixels has a larger area than that of the first green pixel,"

222. Credelle-379 in view of Cok and Suh teach this element. The two blue pixels each have an area of 7902 μm^2, which is larger than the area of the green pixel which has an area of 2400 μm^2, as shown below.



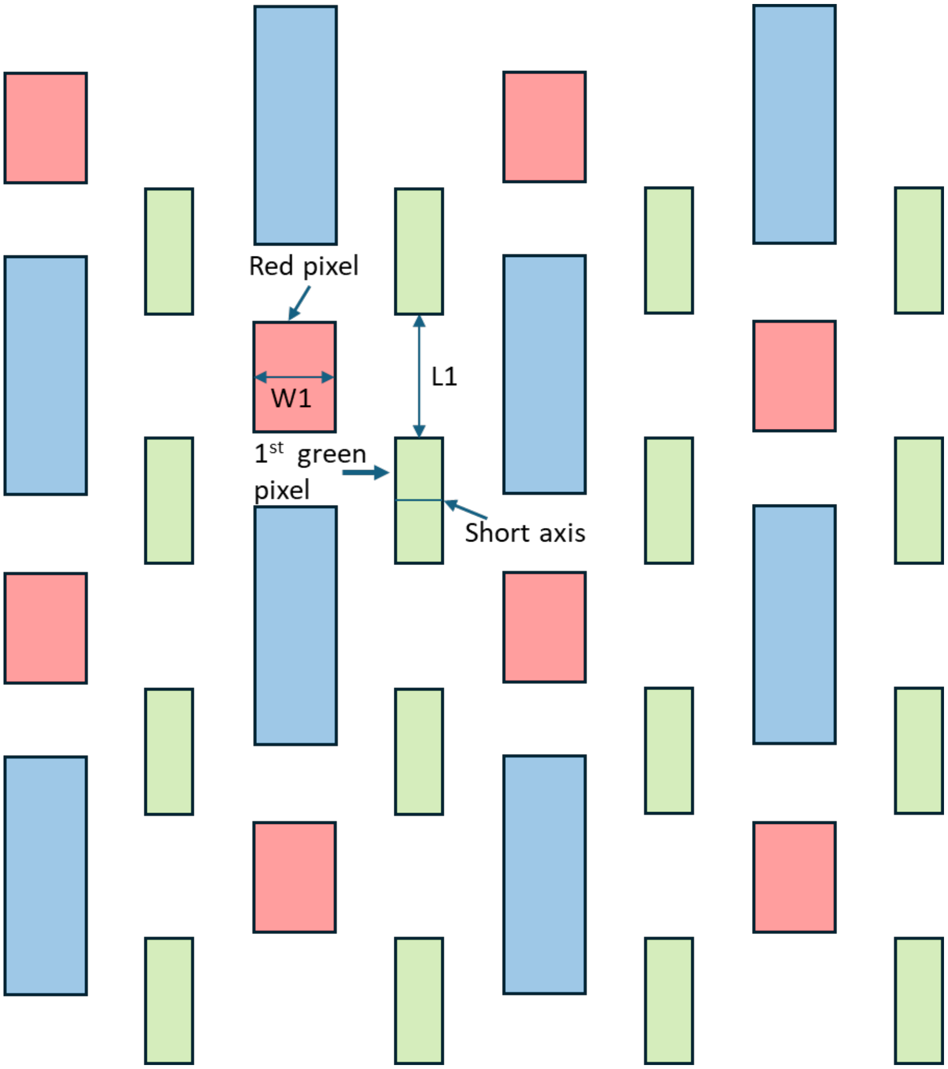
l. 1[K]: “wherein the first green pixel has a convex shape such that a line bisecting the first green pixel along a long axis thereof has a greater length than a line bisecting the first green pixel along a short axis thereof, and”

223. Credelle-379 in view of Cok and Suh teach this element. As shown below, the green pixel has a convex shape such that a line along the long axis of the green pixel (80.00 µm) has a greater length than a line along a short axis of the green pixel (30.00 µm).

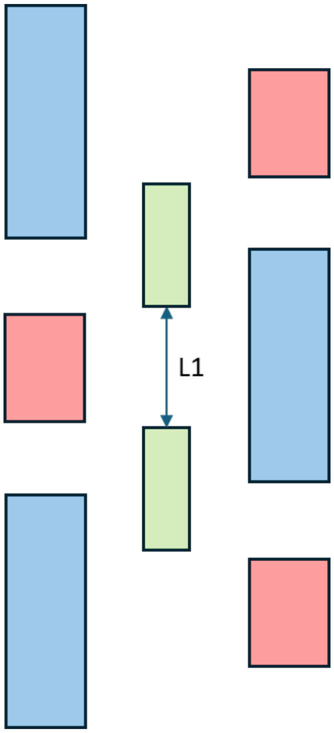


m. 1[L]: "wherein a shortest distance between two nearest ones of the plurality of green pixels is greater than a width of a first red pixel of the plurality of red pixels along a first direction parallel to the short axis of the first green pixel."

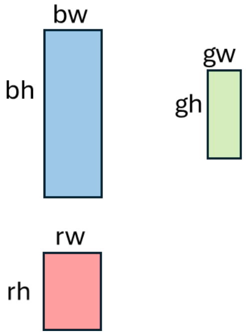
224. Credelle-379 in view of Cok and Suh teach this element. A shortest distance L1 (80.00 µm) between two nearest green pixels is greater than a width W (60.00 µm) of a first red pixel along a direction parallel to the short axis of the first green pixel, as shown below.



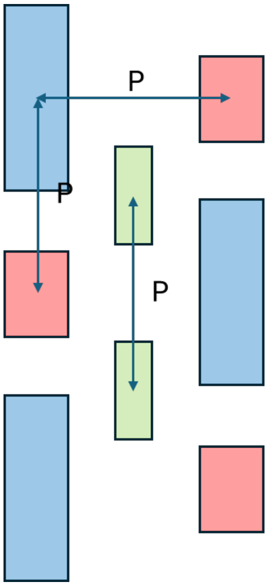
225. The POSITA would have calculated the length of L1 using basic geometry. For example, the length L1 is shown below:



226. The dimensions of the pixels can be as follows, where the red pixel has a height of “rh” and a width of “rw,” the blue pixel has a height of “bh” and a width of “bw”, and the green pixel has a height of “gh” and a width of “gw”, where rh= 60.5 µm, rw= 60.0 µm, bh= 131.7 µm, bw= 60.0 µm, gh= 80.0 µm, and gw= 30.0 µm, as described above.



227. As discussed above, the pixels are centered on an equal spaced grid, which has a pixel pitch with a unit length (P) of 160 µm, such that the centers of the green pixels are 160 µm apart and the centers of the red and blue pixels are 160 µm apart:

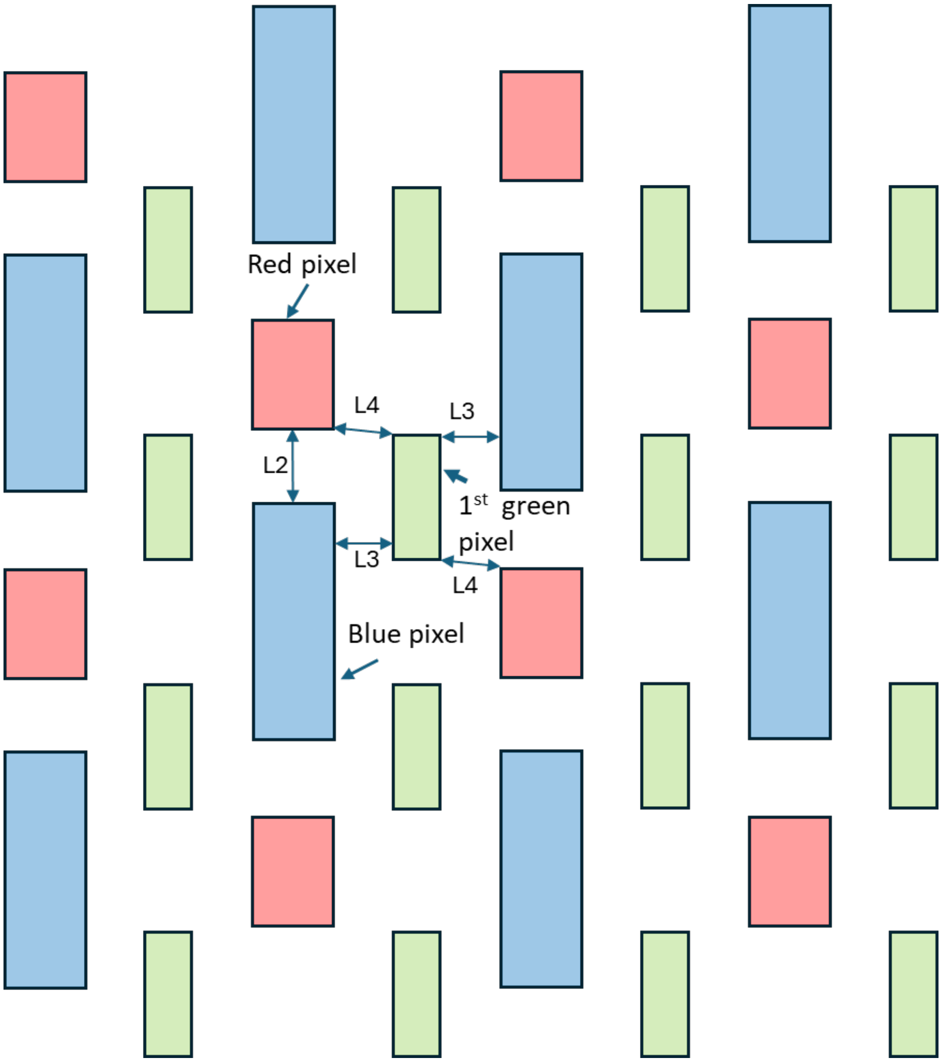


228. As shown above, P=gh/2+L1+gh/2. Accordingly, L1=P-gh=160-80=80 µm. Accordingly, a shortest distance L1 (80.0 µm) between two nearest green pixels is greater than a width W1 (60.0 µm) of a first red pixel along a direction parallel to the short axis of the first green pixel, as shown above.

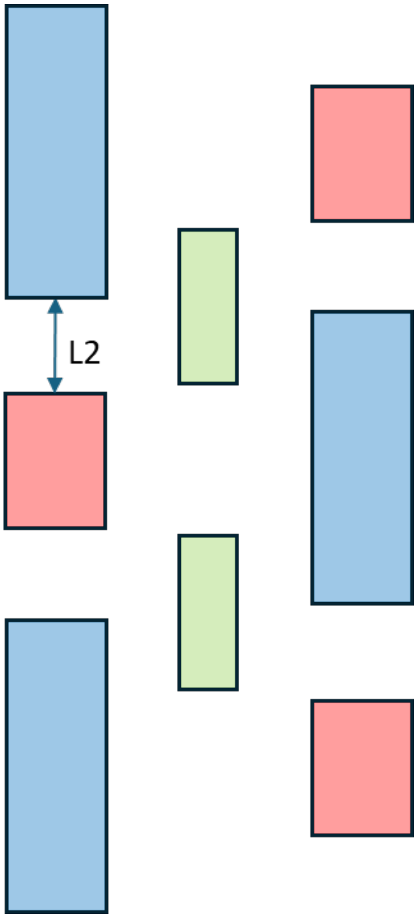
3. Claim 2: "The OLED display of claim 1, wherein a shortest distance between one of the at least two blue pixels and one of the at least two red pixels is greater than a shortest distance between the first green pixel and the one of the at least two blue pixels or a shortest distance between the first green pixel and the one of the at least two red pixels."

229. Credelle-379 in view of Cok and Suh teach claim 1, as shown in § X.B.2. Credelle-379 in view of Cok and Suh further teach this claim. As shown

below, a shortest distance L2 (63.9 µm) between one two blue pixels and one red pixels is greater than a shortest distance L3 (35.0 µm) between the first green pixel and the one of the at least two blue pixels or a shortest distance L4 (36.3 µm) between the first green pixel and the one of the at least two red pixels.

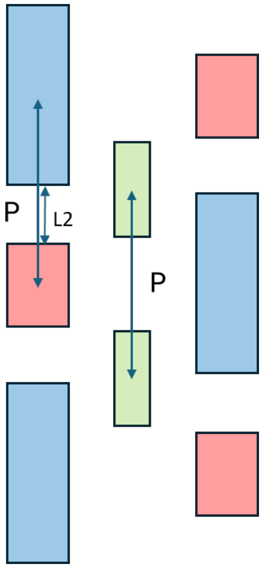


230. The POSITA would have calculated the lengths of L2, L3, and L4 using basic geometry. For example, the length L2 is shown below:



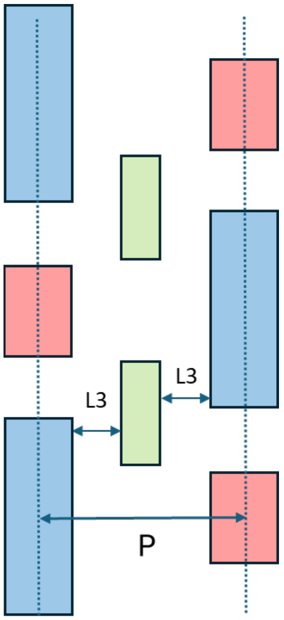
231. As discussed above, the pixels are centered on an equal spaced grid, which has a pixel pitch with a unit length (P) of 160 µm, such that the centers of

the green pixels are 160 µm apart and the centers of the red and blue pixels are 160 µm apart:



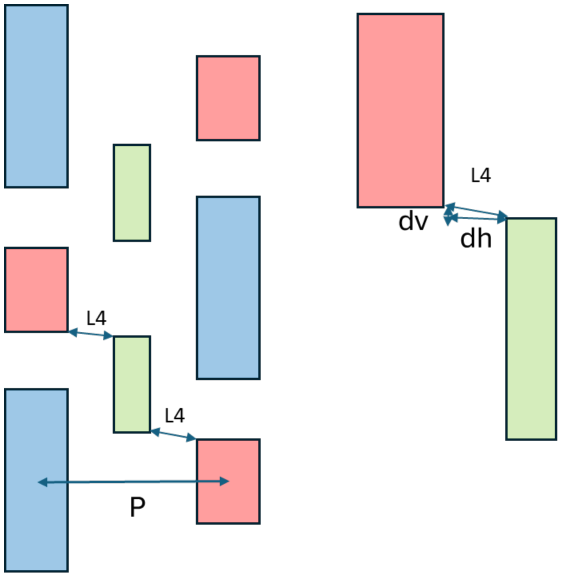
232. As shown above, P=bh/2+L2+rh/2. Accordingly, L2=P- bh/2- rh/2 =160-131.7/2-60.5/2 =63.9 µm.

233. Further, the length L3 is shown below, along with P:

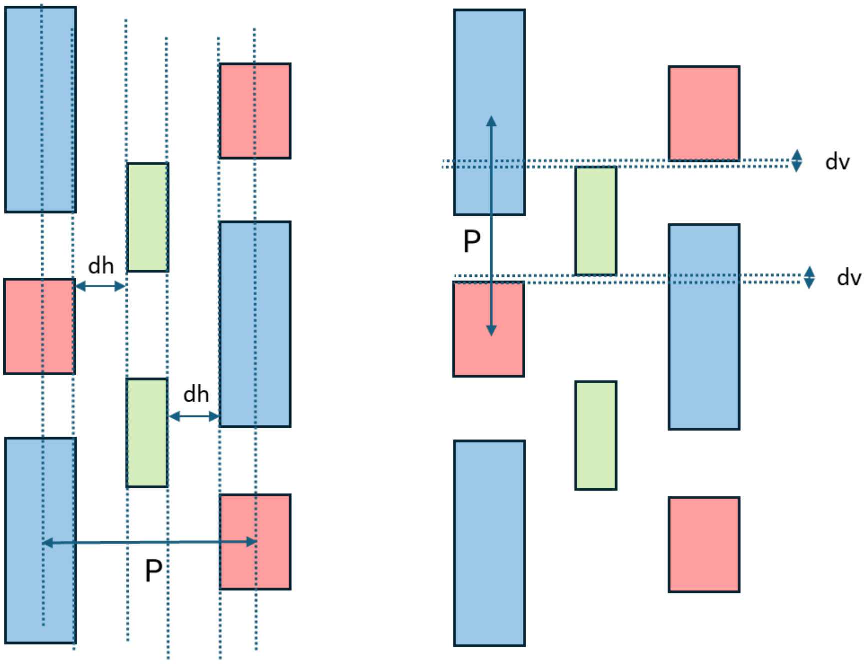


234. As shown above, P=bw/2+L3+gw+L3+bw/2. Accordingly, L3=(P-bw-gw)/2 =(160- 60.0-30.0)/2 = 35.0 µm.

235. Further, L4 can be calculated as below:



236. As shown above, L4=√ ($dv^2 + dh^2$). Further, dv and dh can be calculated as below:

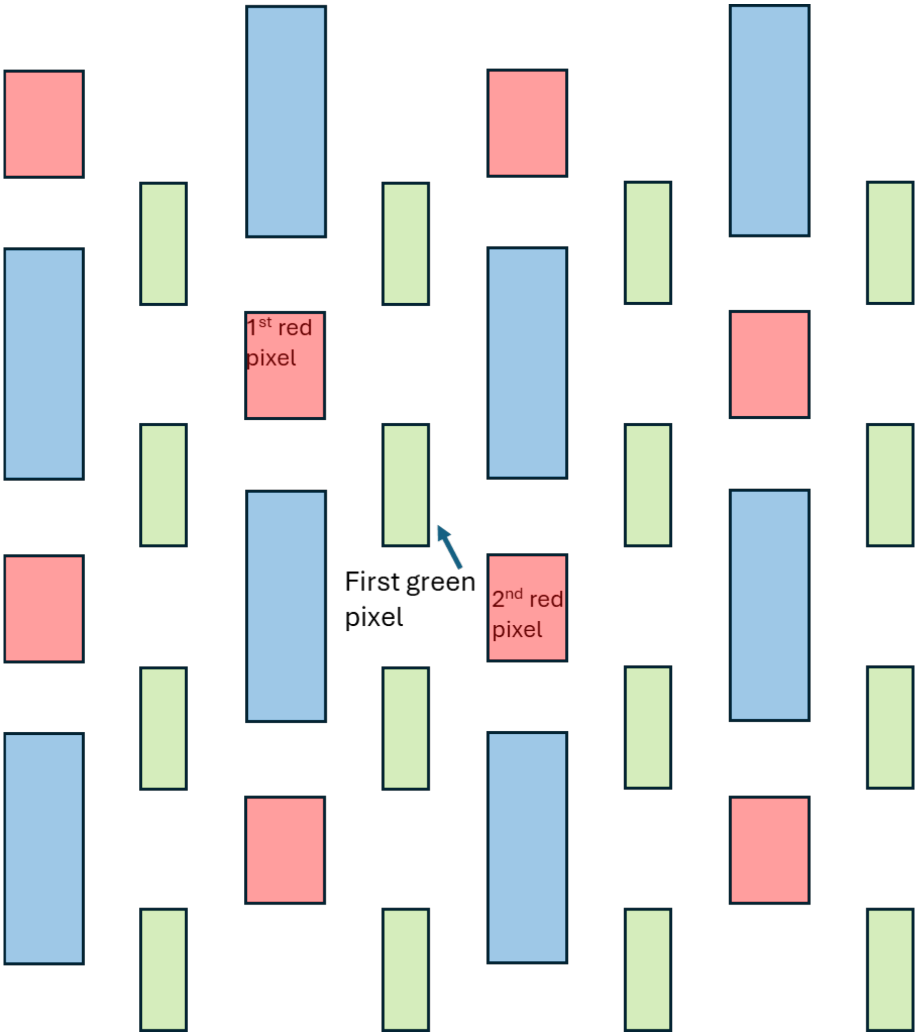


237. As shown above, P=rw/2+dh+gw+dh+rw/2. Accordingly, dh=(P- rw-gw)/2=(160- 60-30)/2 = 35 µm. Similarly, P=rh/2+dv+gh+dv+rh/2. Accordingly, dv=(P- rh-gh)/2 =(160- 60.5 -80)/2 = 7.8 µm. Thus, L4=$\sqrt{}$ (dv^2 + dh^2) = $\sqrt{}$(9.8^2 + 35^2)≈ 36.3 µm. That is, a shortest distance L2 (63.9 µm) between one two blue pixels and one red pixels is greater than a shortest distance L3 (35.0 µm) between the first green pixel and the one of the at least two blue pixels or a shortest distance L4 (36.3 µm) between the first green pixel and the one of the at least two red pixels.

4. 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."

238. Credelle-379 in view of Cok and Suh teach claim 2, as shown in § X.B.3. Credelle-379 in view of Cok and Suh further teach this claim. The areas of the pixels can be determined as shown in § X.C.2.h. As shown below, the two red

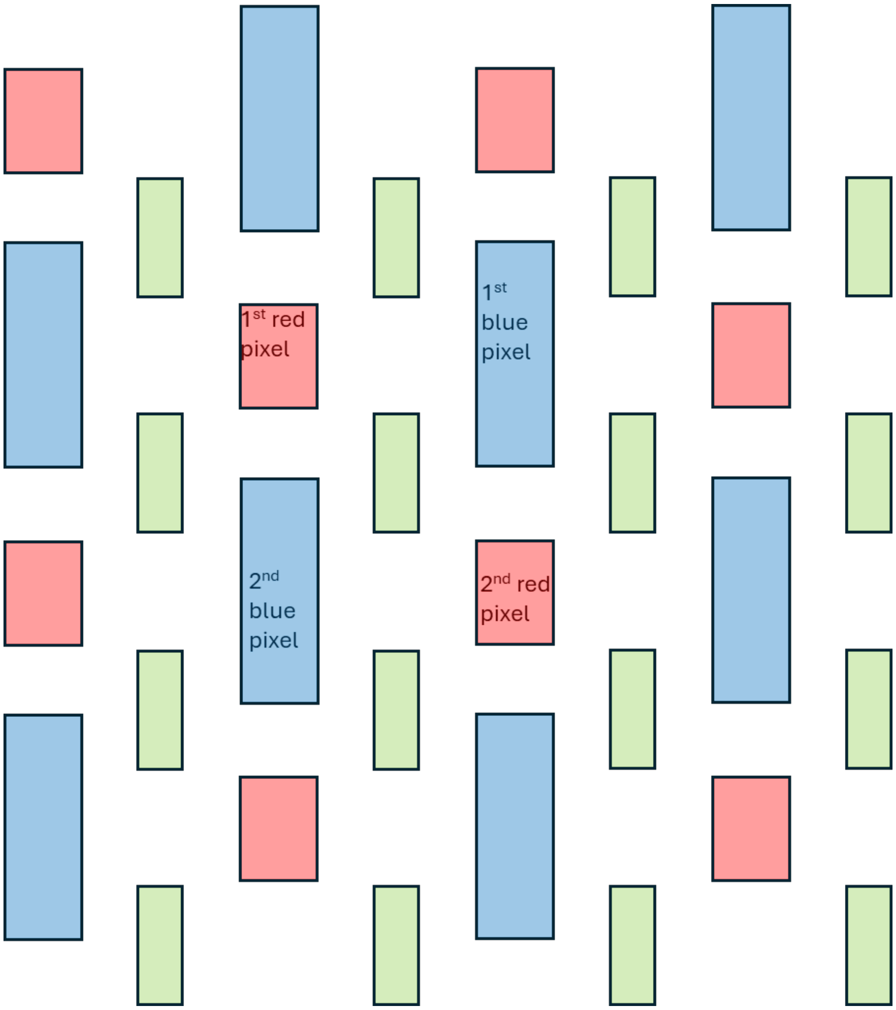
pixels each have an area of 3631 μm², which is larger than the area of the green pixel which has an area of 2400 μm².



5. 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."

239. Credelle-379 in view of Cok and Suh teach claim 2, as shown in § X.B.3. Credelle-379 in view of Cok and Suh further teach this claim. As shown below, the two blue pixels and the two red pixels have square shapes, and squares

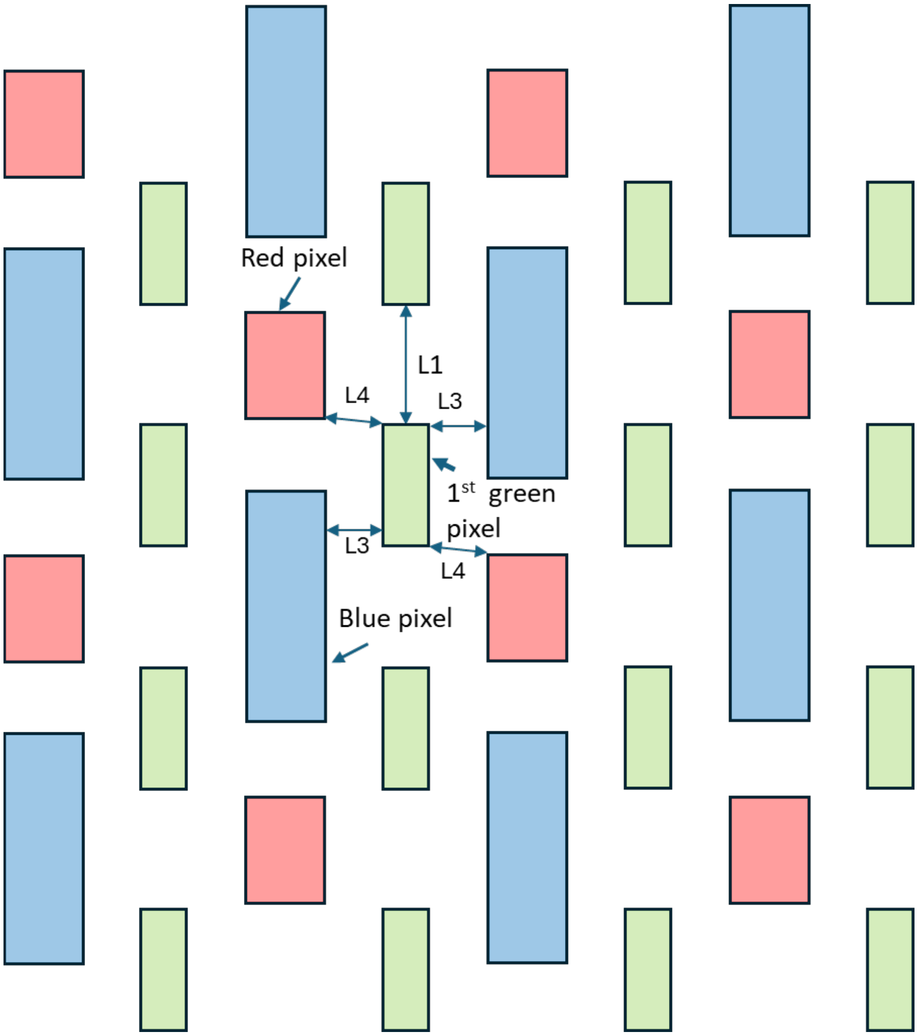
are quadrangles. As described in the ’066 patent, a polygonal shape can include “shapes such as an octagon, a hexagon, and a quadrangle.” (EX1001, 12:29-30.)



6. 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.”

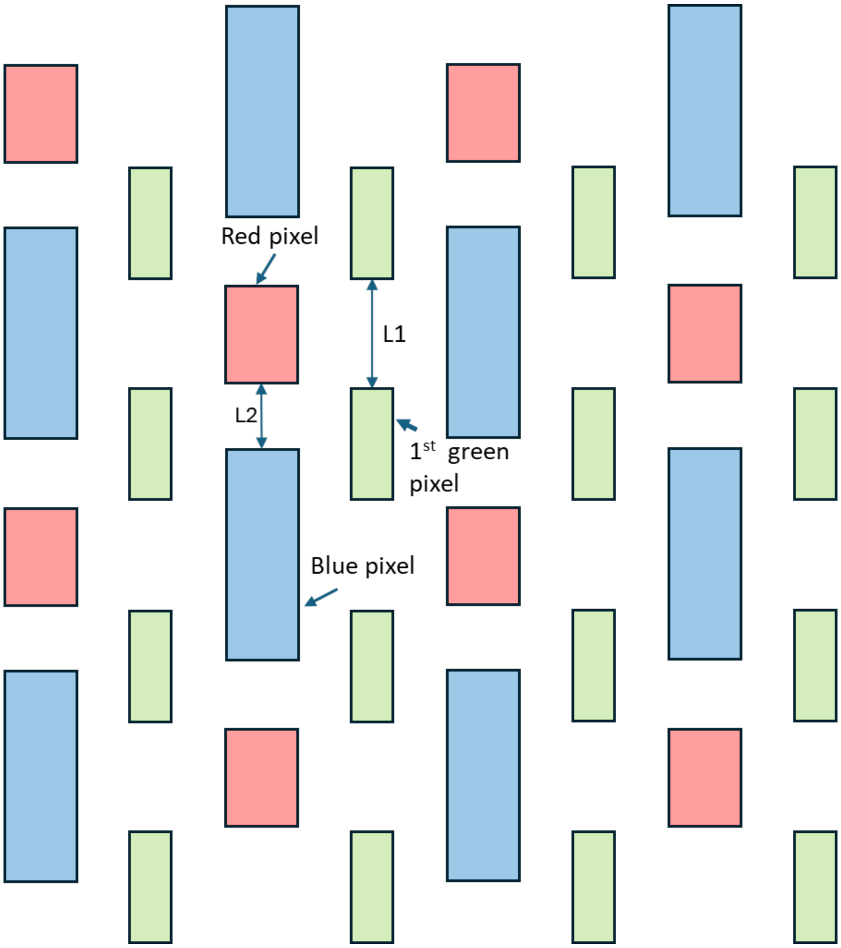
240. Credelle-379 in view of Cok and Suh teach claim 1, as shown in § X.B.2. Credelle-379 in view of Cok and Suh further teach this claim. The lengths L1, L3, and L4 can be determined as shown in §§ X.A.3.m and X.A.4. As shown

below, a shortest distance L1 (80.00 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.



7. 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."

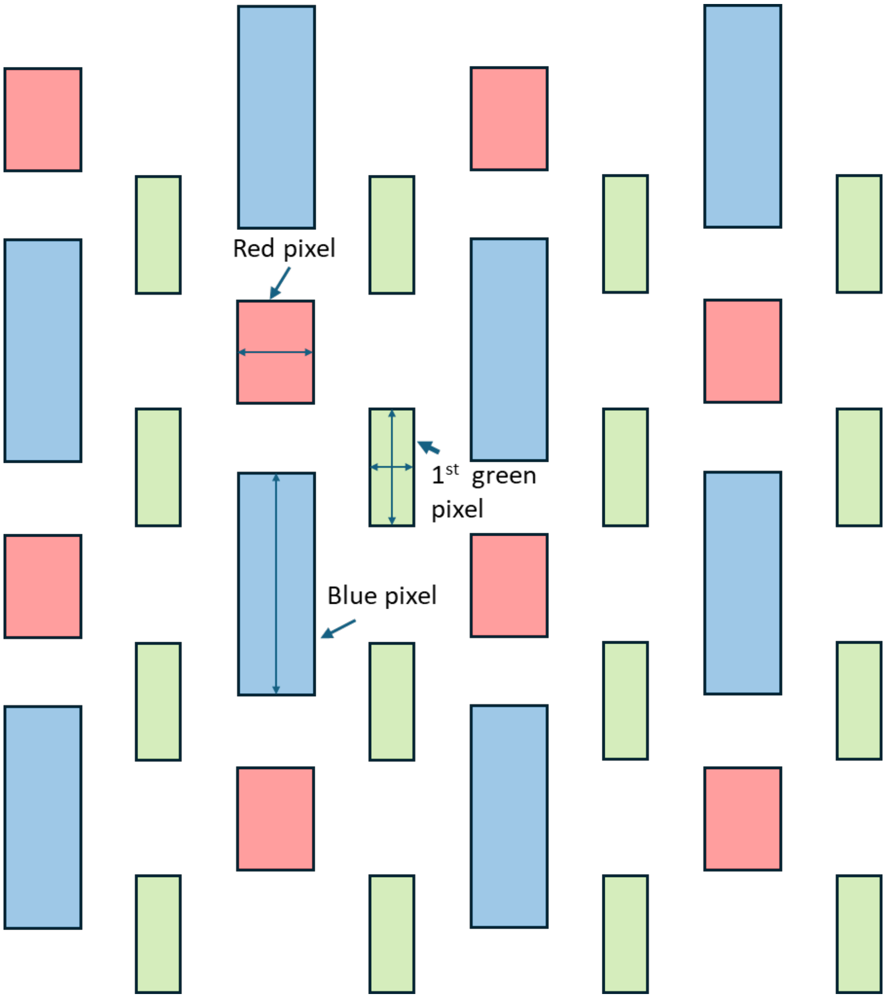
241. Credelle-379 in view of Cok and Suh teach claim 1, as shown in § X.B.2. Credelle-379 in view of Cok and Suh further teach this claim. The lengths L1 and L2 can be determined as shown in §§ X.A.3.m and X.A.4. As shown below, a shortest distance L1 (80.00 µm) between the first green pixel and an adjacent green pixel is greater than (and not equal to) a shortest distance L2 (63.9 µm) between one of the two blue pixels and one of the two red pixels.



8. 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."

242. Credelle-379 in view of Cok and Suh teach claim 1, as shown in § X.B.2. Credelle-379 in view of Cok and Suh further teach this claim. 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 (80.00 µm) is different from a width of

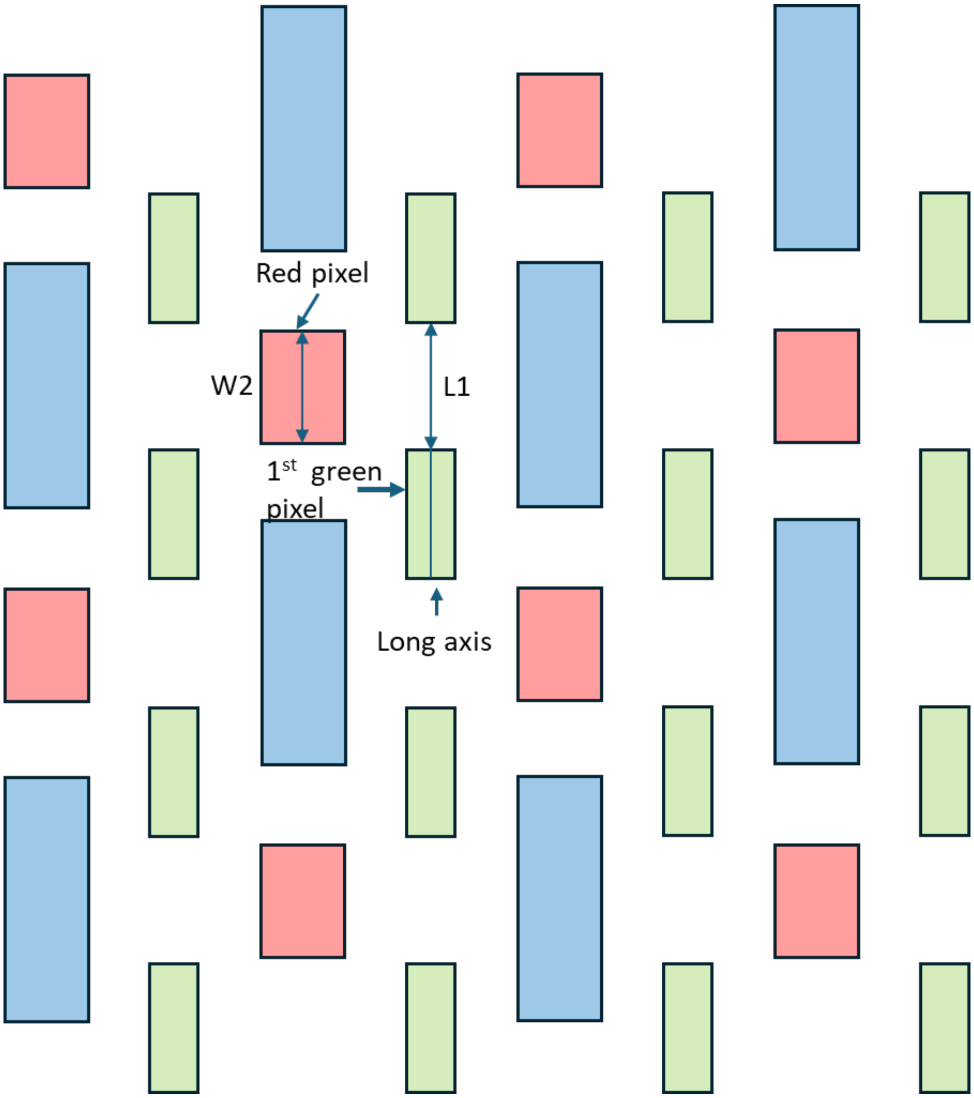
one of the two blue pixels (131.7 µm) along a second direction parallel to the long axis.



9. 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."

243. Credelle-379 in view of Cok and Suh teach claim 1, as shown in § X.B.2. Credelle-379 in view of Cok and Suh further teach this claim. A shortest distance L1 (80.00 µm) between the two nearest green pixels 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.



10. Claim 15

a. Preamble: "A method for manufacturing an organic light emitting diode (OLED) display, comprising:"

244. Credelle-379 in view of Suh teach "a method for manufacturing an organic light emitting diode (OLED) display." Credelle-379 discloses "improved color pixel arrangements" which can be "implemented in other display

technologies such as Organic Light Emitting Diode (OLED)." (EX1006, 1:45-46, 10:51-54.) 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].) As discussed below, 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."

245. A POSITA would have found it obvious to use the manufacturing methods (including using a fine metal mask) taught by Suh with the pixel arrangement pattern of Credelle-379. Both Credelle-379 and Suh in the same field as the '066 patent. Like the '066 patent, Credelle-379 is directed to "improved color pixel arrangements" that can be used in OLED (including AMOLED) displays. (EX1006, 1:44-46, 5:51-58.) Similarly, Suh is directed to "organic light emitting display[s]." (EX1005, ¶ [0005].)

246. 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 Credelle-379 with predictable results because the two references describe the same, underlying OLED technology. Indeed, a POSITA would have viewed Suh as disclosing just one more way to manufacture the OLED display of Credelle-379.

247. Moreover, a POSITA would have recognized that the combination would provide benefits. 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].) 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.

248. A POSITA would have reasonably expected the combination to succeed. Both references relate to OLED display technology. This combination would have been straightforward.

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

249. Credelle-379 in view of Suh teaches this element. 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] (emphasis added).)

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

250. Credelle-379 in view of Suh teaches this element. Suh teaches "[t]he light emission layers 353 are formed in the regions corresponding to the pixels 301 (refer to FIG. 2). The 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] (emphasis added).)

251. A POSITA would have been motivated to combine the teachings of Credelle-379 and Suh as described above with respect to limitation 15[A]. (*Supra* § X.B.11.b.)

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

252. Credelle-379 in view of Suh teaches this element as set forth for limitation 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] (emphasis added).)

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

253. Credelle-379 in view of Suh teaches this element as set forth for limitation 15[B]. Suh teaches "[t]he light emission layers 353 are formed in the regions corresponding to the pixels 301 (refer to FIG. 2). The 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] (emphasis added).)

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

254. Credelle-379 in view of Suh teaches this element as set forth for limitation 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] (emphasis added).)

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

255. Credelle-379 in view of Suh teaches this element as set forth for limitation 15[B]. Suh teaches "[t]he light emission layers 353 are formed in the regions corresponding to the pixels 301 (refer to FIG. 2). The 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] (emphasis added).)

h. 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,"

256. Element 15[G] is similar to element 1[A], which Credelle-379 in view of Cok and Suh renders obvious. (*Supra* § X.B.2.b.) The table below shows the similarities.

Element 1[A]	Element 15[G]
"a plurality of individually addressable pixels for displaying an image, the individually addressable pixels being minimum addressable units of the OLED display and comprising:"	"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"

i. 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,"

257. Element 15[H] is similar to element 1[E], which Credelle-379 in view of Cok and Suh renders obvious. (*Supra* § X.B.2.f.) The table below shows the similarities. The "first pixels," "second pixels," and "third pixels" of limitation

15[H] correspond to the claimed "green pixels," "blue pixels," and "red pixels" of limitation 1[E], respectively.

Element 1[E]	Element 15[H]
"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,"	"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,"

j. 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,"

258. Element 15[I] is similar to element 1[F], which Credelle-379 in view of Cok and Suh renders obvious. (*Supra* § X.B.2.g.) The table below shows the similarities.

Element 1[F]	Element 13[I]
"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,"	"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"

k. 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,"

259. Element 15[J] is similar to element 1[G], Credelle-379 in view of Cok and Suh renders obvious. (*Supra* § X.B.2.h.) The table below shows the

similarities, where the "first pixels" of this element correspond to the claimed "green pixels" of claim 1, element 1[G].

Element 1[J]	Element 13[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,"	"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"

l. 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,"

260. Element 15[K] is similar to element 1[H], which Credelle-379 in view of Cok and Suh renders obvious. (*Supra* § X.B.2.i.) The table below shows the similarities, where the "second pixels" of this element correspond to the "blue pixels" of claim 1, element 1[H] and the "third pixels" of this element correspond to the "red pixels" of claim 1, element 1[H].

Element 1[H]	Element 13[K]
"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"	"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"

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

261. Element 15[L] is similar to element 1[I], which Credelle-379 in view of Cok and Suh renders obvious. (*Supra* § X.B.2.j.) The table below shows the similarities, where the "second pixels" of this element correspond to the "blue pixels" of claim 1, element 1[I] and the "third pixels" of this element correspond to the "red pixels" of claim 1, element 1[I].

Element 1[I]	Element 13[L]
"wherein each of the at least two blue pixels has a larger area than each of the at least two red pixels,"	"wherein each of the at least two second pixels has a larger area than each of the at least two third pixels"

n. 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,"

262. Element 15[M] is similar to element 1[J], which Credelle-379 in view of Cok and Suh renders obvious. (*Supra* § X.B.2.k.) The table below shows the similarities, where the "second pixels" of this element correspond to the "blue pixels" of claim 1, element 1[J] and the "first pixels" of this element correspond to the "green pixels" of claim 1, element 1[J].

Element 1[J]	Element 15[M]
"wherein each of the at least two blue pixels has a larger area than that of the first green pixel"	"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,"

o. 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”

263. Element 15[N] is similar to element 1[K], which Credelle-379 in view of Cok and Suh renders obvious. (*Supra* § X.B.2.l.) The table below shows the similarities, where the “first pixels” of this element correspond to the “green pixels” of claim 1, element 1[K].

Element 1[K]	Element 15[N]
“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”	“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”

p. 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.”

264. Element 15[O] is similar to element 1[L], which Credelle-379 in view of Cok and Suh renders obvious. (*Supra* § X.B.2.m.) The table below shows the similarities, where the “first pixels” of this element correspond to the “green

pixels" of claim 1, element 1[L] and the "third pixels" of this element correspond to the "red pixels" of claim 1, element 1[L].

Element 1[L]	Element 15[O]
"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."	"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."

11. 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."

265. Credelle-379 in view of Cok and Suh teach claim 15, as shown in § X.B.11. Claim 17 is similar to claim 4, which Credelle-379 in view of Cok and Suh renders obvious. (*Supra* § X.B.4.) The table below shows the similarities.

Claim 4	Claim 17
"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"	"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."

12. 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."

266. Credelle-379 in view of Cok and Suh teach claim 15, as shown in § X.B.11. Claim 18 is similar to claim 5, which Credelle-379 in view of Cok and Suh renders obvious. (*Supra* § X.B.5.) The table below shows the similarities.

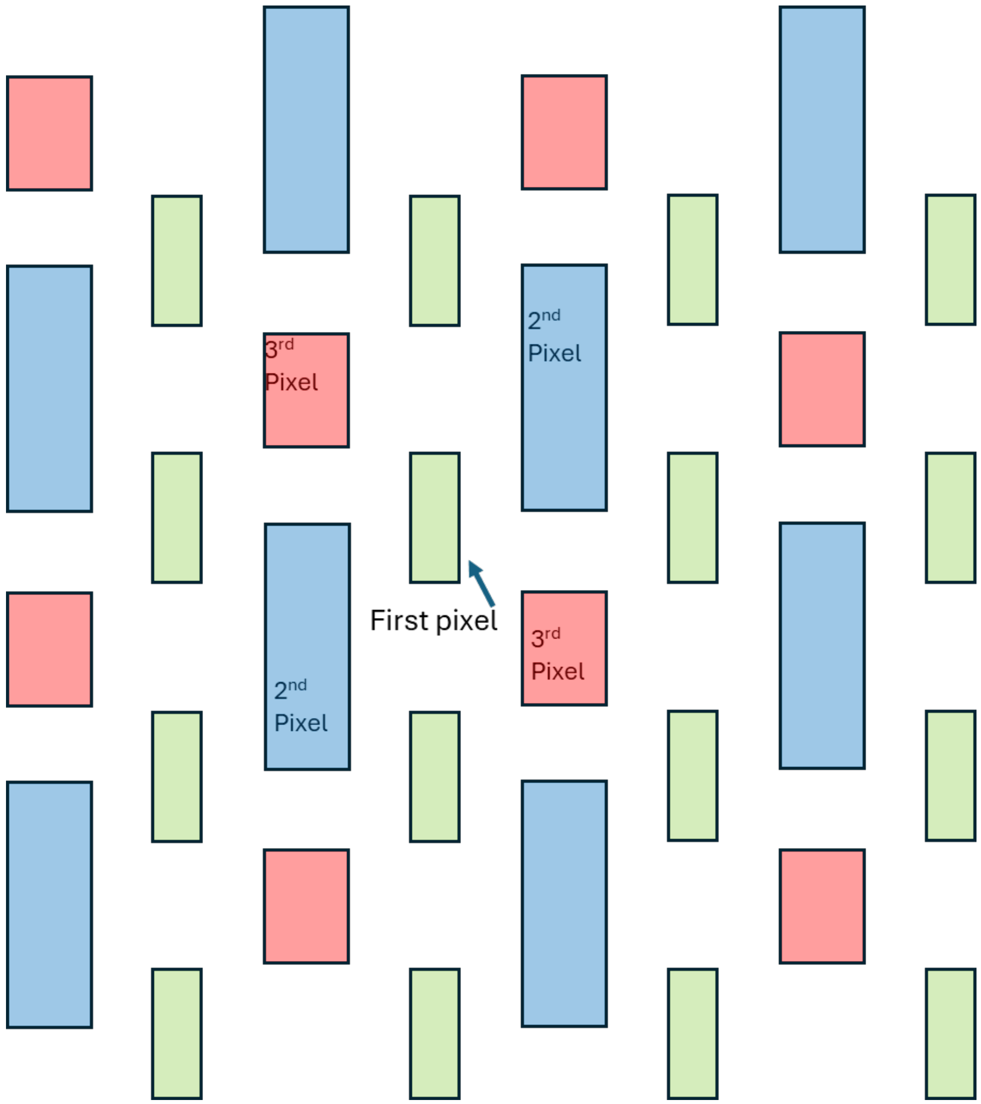
Claim 5	Claim 18
"The OLED display of claim 2,	"The method of claim 15, wherein one

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."	of the at least two second pixels and one of the at least two third pixels have polygonal shapes with at least four sides."

13. 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."

267. Credelle-379 in view of Cok and Suh teach claim 15, as explained in § X.B.11. Credelle-379 in view of Cok and Suh further teach this element. FIGS. 1B, 1C, and 8A, of Credelle-379 show the pixel 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." (EX1005, ¶¶ [0005], [0006],

[0031].) As shown below, the first pixels emit green light, the second pixels emit blue light, and the third pixels emit red light.



14. 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."

268. Credelle-379 in view of Cok and Suh teach claim 19, as shown in § X.B.14. Claim 29 is similar to claim 2, which Credelle-379 in view of Cok and Suh renders obvious. (*Supra* § X.B.3.) The table below shows the similarities.

Claim 2	Claim 20
"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."	"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."

15. 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."

269. Credelle-379 in view of Cok and Suh teach claim 20, as shown in § X.B.15. Claim 22 is similar to claim 4, which Credelle-379 in view of Cok and Suh renders obvious. (*Supra* § X.B.4.) The table below shows the similarities.

Claim 4	Claim 22
"The OLED display of claim 2, wherein the one of the at least two red	"The method of claim 20, wherein the one of the at least two third pixels has

pixels has an area that is larger than that of the first green pixel."	an area that is larger than that of the first one of the plurality of first pixels"

16. 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."

270. Credelle-379 in view of Cok and Suh teach claim 20, as shown in § X.B.15. Claim 23 is similar to claim 5, which Credelle-379 in view of Cok and Suh renders obvious. (*Supra* § X.B.5.) The table below shows the similarities.

Claim 5	Claim 23
"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."	"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."

17. 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."

271. Credelle-379 in view of Cok and Suh teach claim 15, as shown in § X.B.11. Claim 28 is similar to claim 12, which Credelle-379 in view of Cok and Suh renders obvious. (*Supra* § X.B.8.) The table below shows the similarities.

Claim 12	Claim 28
"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."	"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"

18. 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."

272. Credelle-379 in view of Cok and Suh teach claim 15, as shown in § X.B.11. Claim 29 is similar to claim 13, which Credelle-379 in view of Cok and Suh renders obvious. (*Supra* § X.B.9.) The table below shows the similarities.

Claim 13	Claim 29
"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."	"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."

19. 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."

273. Credelle-379 in view of Cok and Suh teach claim 15, as shown in § X.B.11. Claim 30 is similar to claim 14, which Credelle-379 in view of Cok and Suh renders obvious. (*Supra* § X.B.10.) The table below shows the similarities.

Claim 14	Claim 30
"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"	"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."

D. Claims 3, 16, and 21 Are Obvious over Credelle-379, Cok, And Elliott-724

1. Summary of Elliott-724

274. Elliott-724 discloses "Subpixel arrangements" and that OLED displays will be "improved using this teaching." (EX1007, ¶¶ [0041], [0075],

[0116].) In one embodiment, as shown in FIG. 19, some sub-pixels are made hexagonal. (*Id.*, FIG. 19.)

275. Elliott-724 is directed to the same problem (pixel arrangements) in the same field of endeavor (OLED displays) as the ’066 patent. (EX1007, ¶¶ [0041], [0075].)

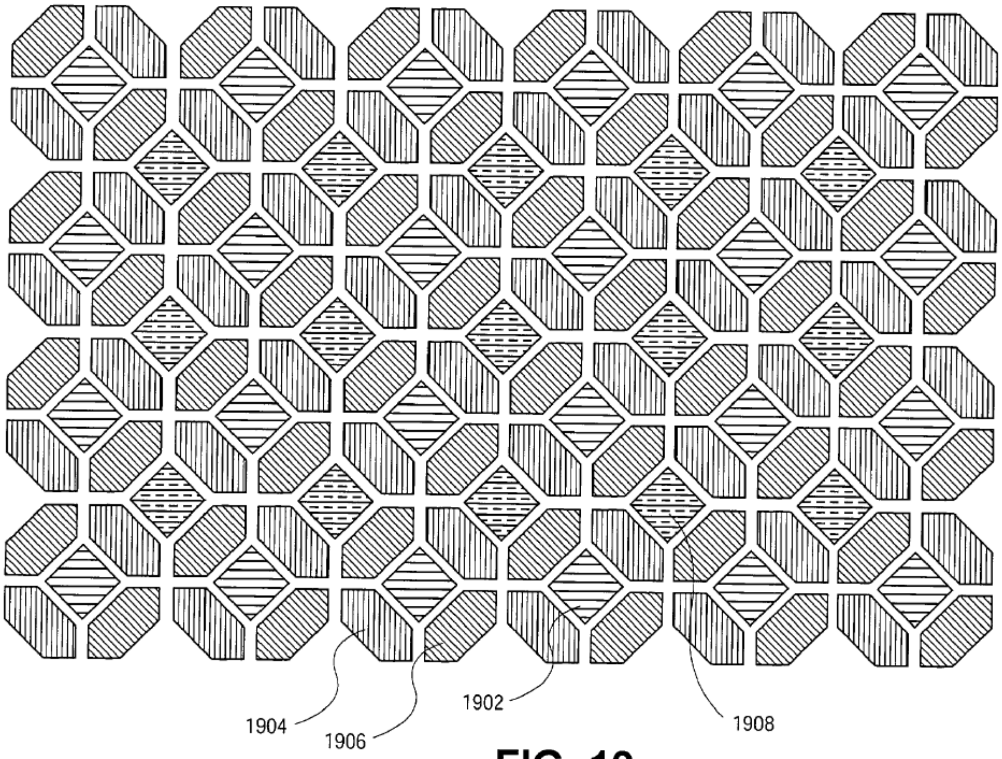


FIG. 19

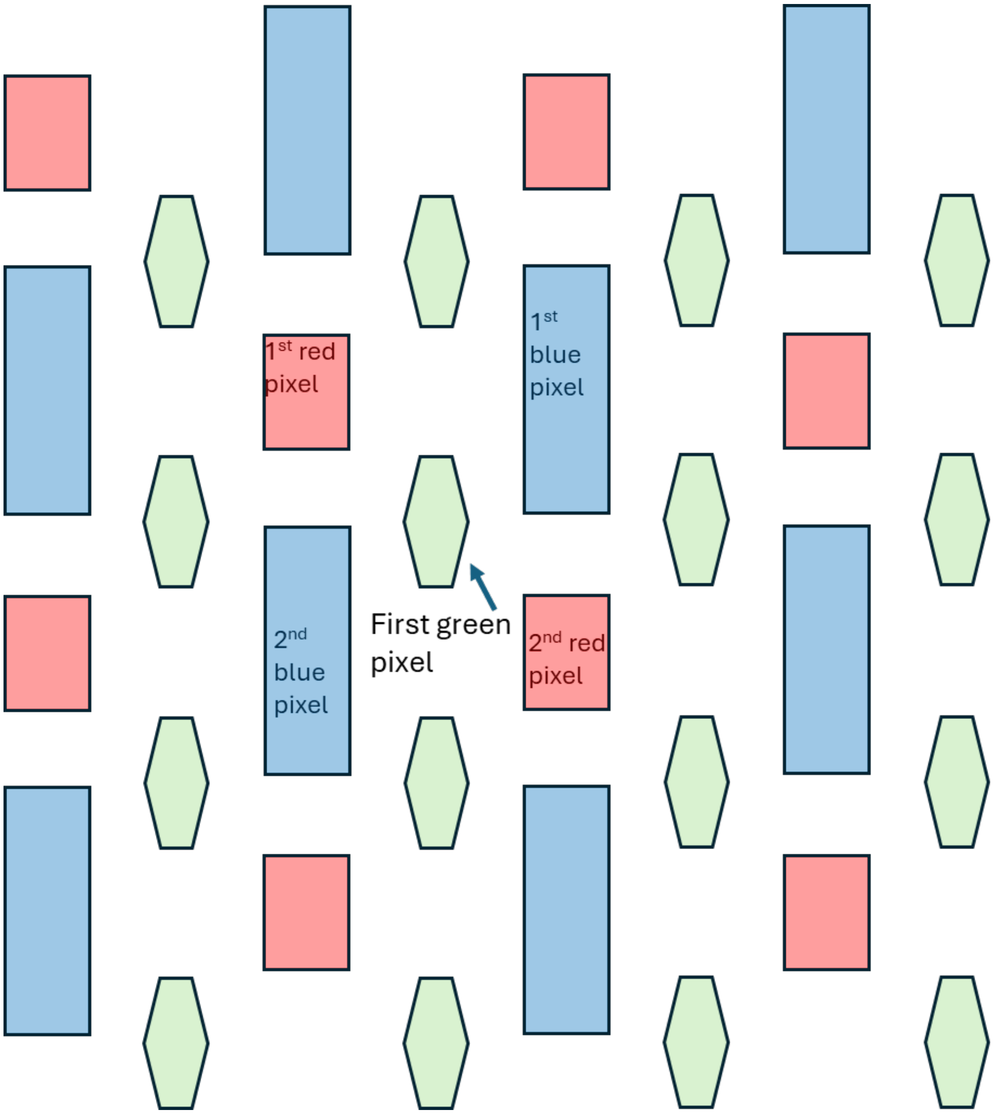
2. Claim 3: “The OLED display of claim 2, wherein the first green pixel has a different shape than the one of the at least two blue pixels and the one of the at least two red pixels.”

276. Credelle-379 in view of Cok and Suh teach claim 2, as shown in § X.B.3. Credelle-379 in view of Cok and Suh in further view of Elliott-724 further teach this claim. Credelle-379 discloses “[i]t should be appreciated that other

shapes to the subpixels are also possible and are contemplated …a multitude of other regular or irregular shapes for the subpixels are possible and are desirable if manufacturable." (EX1006, 4:51-56.) Further, Elliott-724, which is the parent application of Credelle-379 and incorporated by reference, teaches in FIG. 19 that sub-pixels can be made hexagonal. (EX1007, FIG. 19.)

277. 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. 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.



278. As discussed above, a POSITA would have found it obvious to use Cok's formula to adjust the pixel arrangement of Credelle-379, as well as to use the pixel define layer and fine metal mask of Suh in manufacturing the OLED display of Credelle-379. Further, 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. Like Credelle-379, Cok, and Suh, Elliott-724 in the same field as the ’066 patent. Like the ’066 patent, Elliott-724 is directed to “[s]ub-pixel arrangements” that can be used in OLED displays. (EX1007, ¶¶ [0041], [0075].)

279. Credelle-379 itself discloses “[i]t should be appreciated that other shapes to the subpixels are also possible and are contemplated … a multitude of other regular or irregular shapes for the subpixels are 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.) Further, it would have been obvious to try making the green pixels hexagonal, while maintaining the shapes of the red and blue pixels. When choosing to modify pixels to take on a certain shape, a POSITA would have recognized a finite number of identified, predictable solutions. For example, there would have been 8 possible solutions when considering whether to use hexagonal pixels with Credelle-379’s default pattern: 1) making only green pixels hexagonal, 2) making only red pixels hexagonal, 3) making only blue pixels hexagonal, 4) making green and red pixels hexagonal, 5) making green and blue pixels hexagonal, 6) making red and blue pixels hexagonal, 7) making all pixels hexagonal, and 8) making no pixels hexagonal.

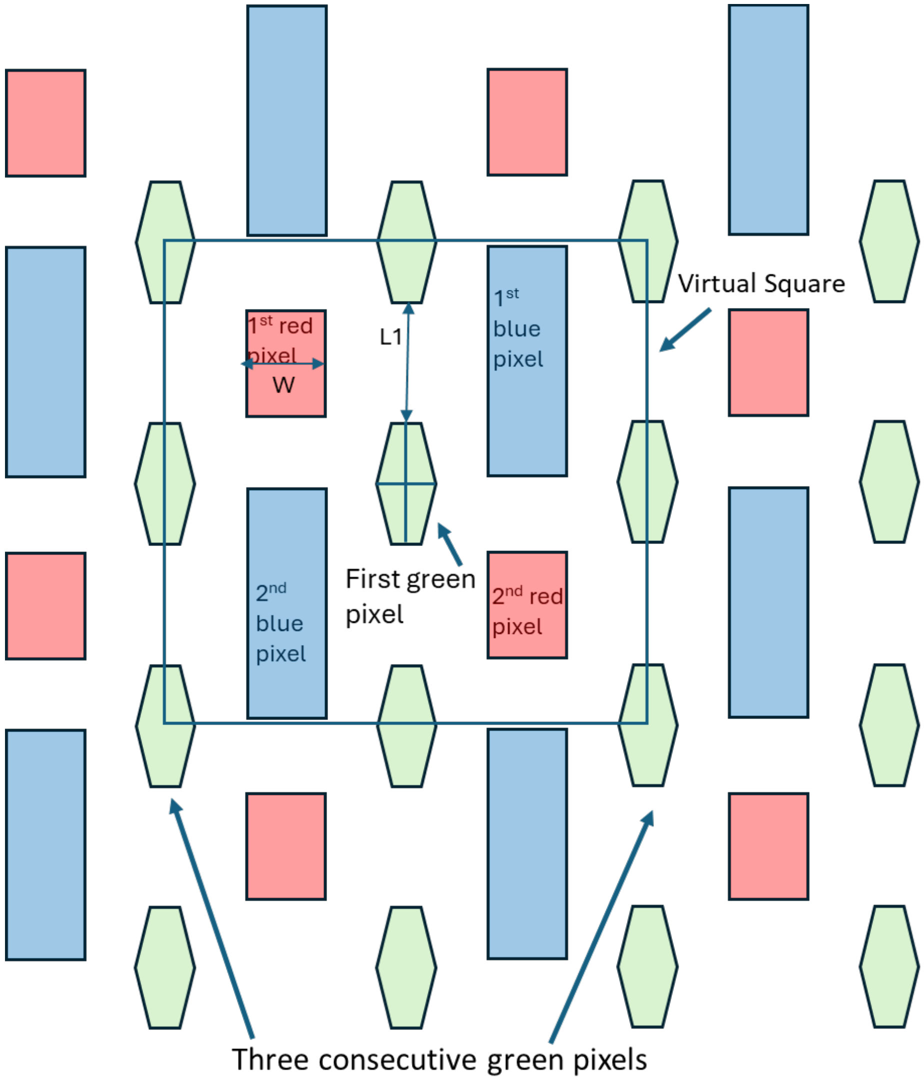
Accordingly, it would have been obvious for a POSITA to try option 1, making the green pixels hexagonal while maintaining the shape of the red and blue pixels.

280. 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. Indeed, a POSITA would have viewed Elliott-724 as disclosing just one more way to shape Credelle-379's sub-pixels.

281. Moreover, a POSITA would have reasonably expected the combination to succeed. 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 contemplated … a multitude of other regular or irregular shapes for the subpixels are 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.

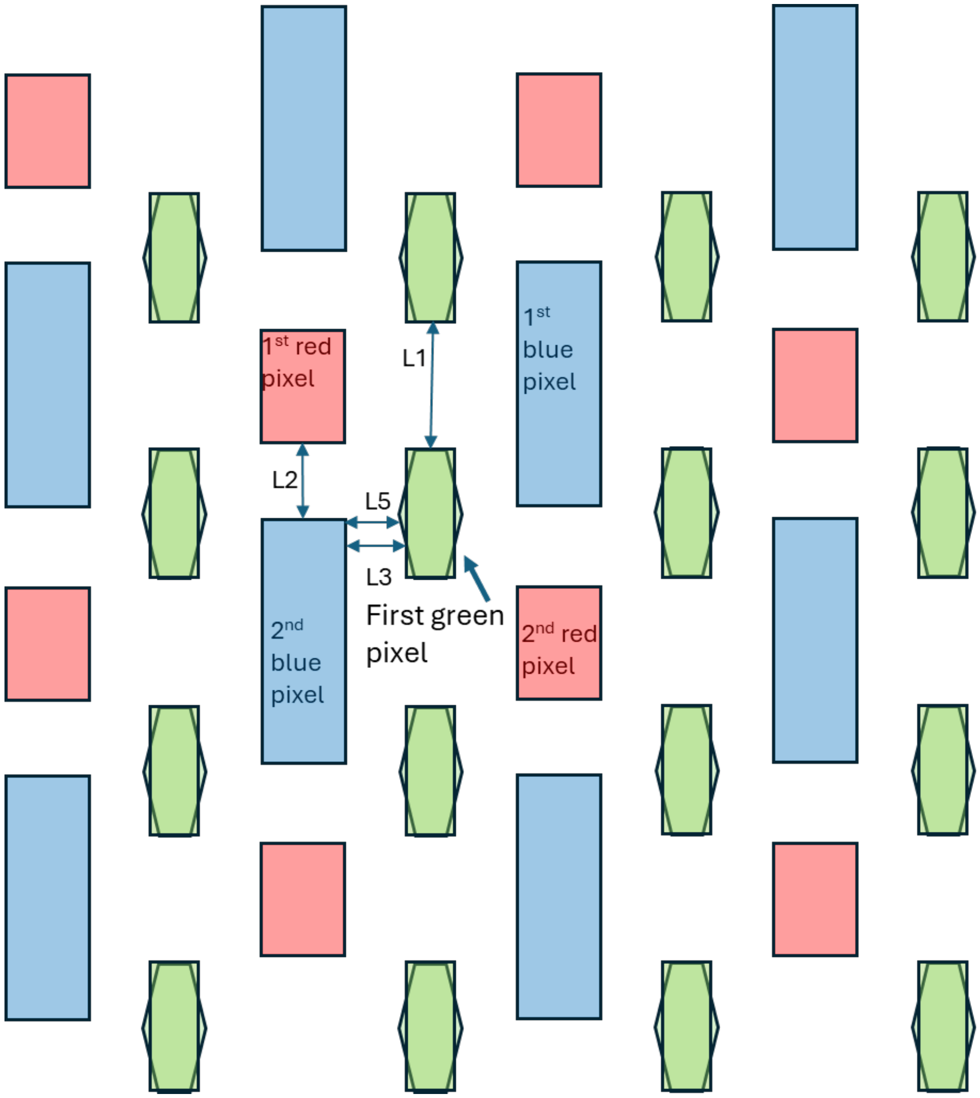
282. Such a modification would still satisfy the limitations of claims 1 and 2, from which claim 3 depends. For example, as shown below, a first green pixel of the plurality of green pixels has a center coinciding with a center of a virtual square, each vertex of the virtual square coinciding with a center of a different one

of the plurality of green pixels and each edge of the virtual square overlapping three consecutive green pixels, 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, each of the at least two blue pixels has a larger area than each of the at least two red pixels, each of the at least two blue pixels has a larger area than that of the first green pixel, and 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.



283. Further, as shown below where the modified hexagonal green pixels are overlaid with the original rectangular green pixels, the distance L2 has not changed. As discussed above, L2 is greater than L3. L5 represents the shortest distance between the blue pixel and the hexagonal green pixel. As shown below, given the convexity of the side of the green pixel, L5 is less than L3. Accordingly, a shortest distance L2 between one of the at least two blue pixels and one of the at

least two red pixels is greater than a shortest distance L5 between the first green pixel and the one of the at least two blue pixels.



3. 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."

284. Credelle-379 in view of Cok and Suh teach claim 15, as shown in § X.B.11. Claim 16 is similar to claim 3, which Credelle-379 in view of Cok and

Suh and in further view of Elliott-724 render obvious. (*Supra* § X.C.2.) The table below shows the similarities.

Claim 3	**Claim 16**
"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."	"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."

4. 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."

285. Credelle-379 in view of Cok and Suh teach claim 20, as shown in § X.B.15. Claim 21 is similar to claim 3, which Credelle-379 in view of Cok and Suh and in further view of Elliott-724 render obvious. (*Supra* § X.C.2.) The table below shows the similarities.

Claim 3	**Claim 21**
"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."	"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."

E. Claim 11 is Obvious over Credelle-379, Cok, And Hong

1. 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."

286. Credelle-379 in view of Cok and Suh teach claim 1, as shown in § X.B.2. Credelle-379 in view of Cok, Suh, and Hong further teach this claim. For example, as illustrated by FIG. 5 of Hong, "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 200 b and 200 c are spaced apart from each other by the first distance d1 along the diagonal direction." (EX1039, ¶ [0048].)

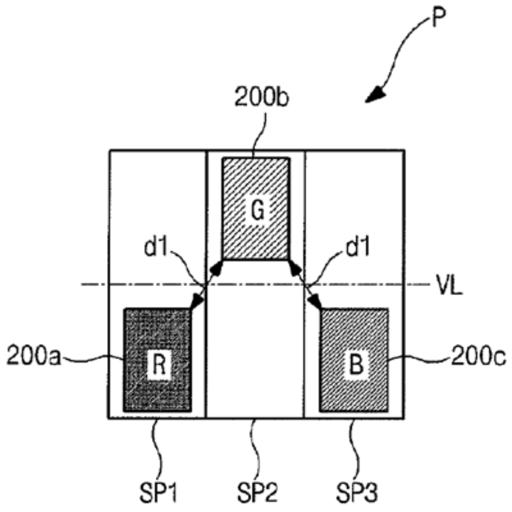
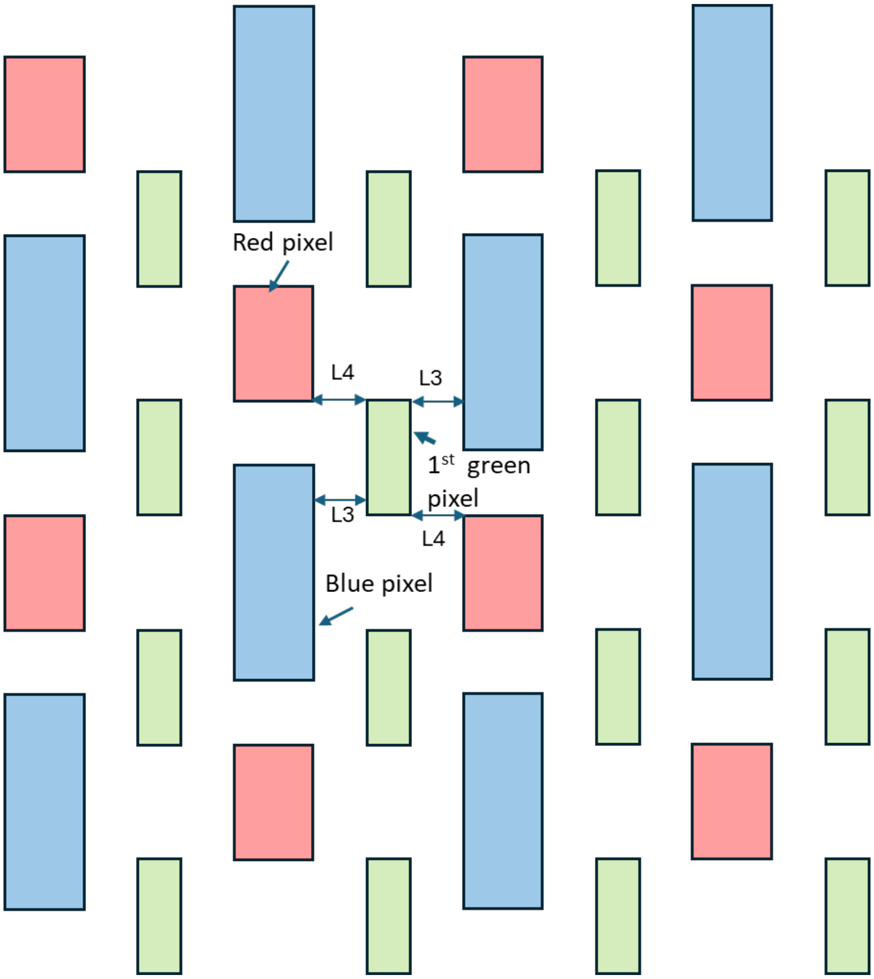


FIG. 5

287. That is, 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].) In accordance with this teaching, 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.



288. A POSITA would have found it obvious to use the spacing of Hong with the pixel arrangement pattern of Credelle-379. Both Credelle-379 and Hong in the same field as the ’066 patent. Like the ’066 patent, Credelle-379 is directed to “improved color pixel arrangements” which can be used in Active Matrix OLED displays. (EX1006, 1:45-46, 10:51-54.) Similarly, Hong is directed to an “organic electroluminescent display (ELD) device.” (EX1039, ¶ [0005].)

289. A POSITA would have been motivated to make this combination in order to improve the manufacturability and performance of an OLED display. 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. Indeed, a POSITA would have viewed Hong as disclosing just one more way to space the pixels in the OLED display of Credelle-379.

290. Furthermore, modifying the device of Credelle-379 to have the spacings of Hong would be advantageous to prevent or reduce shadowing. 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 d1” can prevent a shadowing effect along the direction of the space between the pixels. (EX1039, ¶ [0048].) 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. Credelle-379 is silent with respect to manufacturing an OLED display, and thus a POSITA would have looked to Hong to supply those details. 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, ¶¶ [0070]-[0072]; EX1005, ¶ [0006].) 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].) 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. The POSITA would have also recognized that the equal spacing taught by Hong can minimize the effects of such warpage and thermal deformation. 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.

291. Since 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. This consistency of spacing and positioning allows for a more

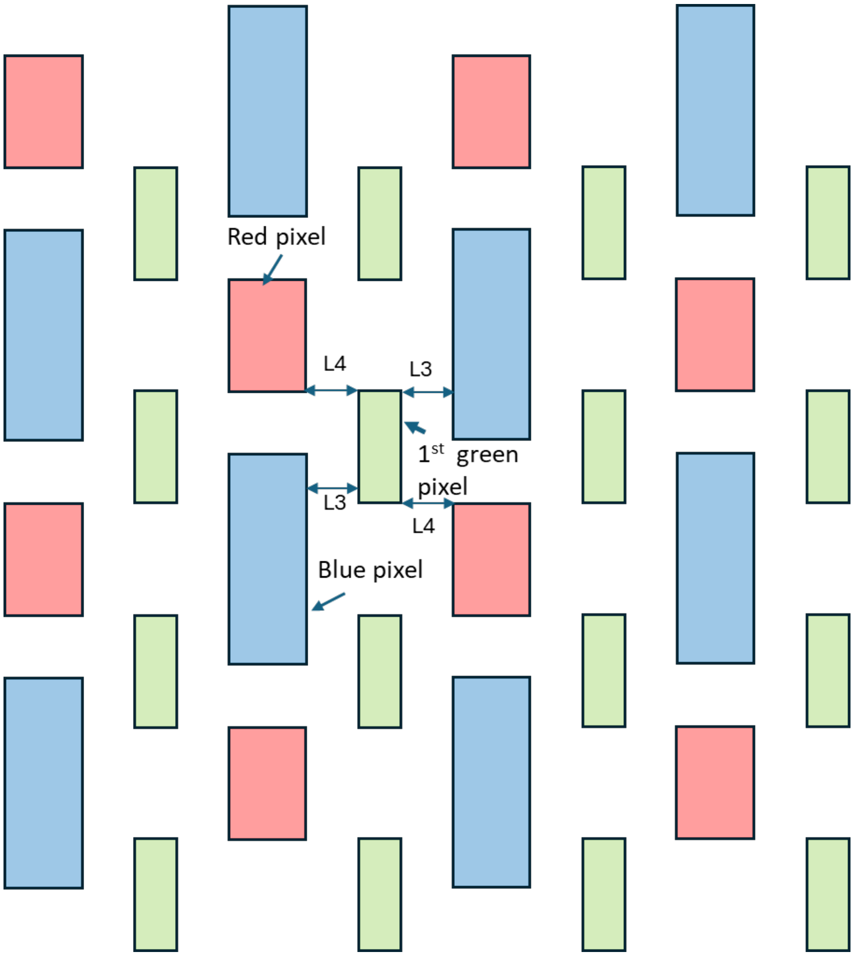
consistent application of each color, reducing the likelihood of color mixing or unintended patterns that can arise from uneven deposition. Additionally, since the direction and extent of mask deformations are unpredictable, maintaining equal spacings between the green-blue pixel pairs and the green-red pixel pairs acts as a safeguard, ensuring that any deformation will have a consistent effect rather than creating localized areas of excessive shadowing or color mixing.

292. 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 these directions. Similarly, a POSITA would have recognized that shadow masks for forming a display with unequal subpixel sizes would benefit in the same manner as with equal size subpixels; that is, a minimum equal distance between the green-blue pixel pairs and the green-red pixel pairs will mitigate the shadowing effect. 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. 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.

293. A POSITA would have reasonably expected the combination to succeed. All four references relate to OLED display technology. A POSITA would have viewed Hong as disclosing just one more way to space Credelle-379's pixels. The combination of Credelle-379, Cok, Suh, and Hong, with its resulting pixel arrangement above, would have been straightforward. For example, to achieve the equal spacing disclosed in Hong, a POSITA could have slightly

modified the dimensions of the red pixels to be 60.0 µm x 80.0 µm, to arrive at the arrangement shown below, such that L3=L4.



294. Such a modification would still achieve the limitations of claim 1. For example, the two blue pixels still have a larger area (7902 µm^2) than the red pixels (4800 µm^2) and the green pixels (2400 µm^2), and the shortest distance L1 between two nearest ones of the plurality of green pixels (80 µm) 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 µm).

* * *

I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and that these statements were made with knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code.

Dated: Sept 23, 2025

Thomas Credelle

Thomas L. Credelle
Curriculum Vitae

Professional Summary

Mr. Credelle is a recognized expert in the flat panel/touch industry with over 40 years of expertise in all aspects of flat panel displays, LEDs, LED displays, and optics. He has made significant contributions in the areas of R&D, engineering, marketing, and senior management. He has served at an executive level at start-up businesses within major corporations and start-up companies in Silicon Valley and has had extensive interaction with flat panel producers and customers in Japan, Taiwan, Korea and China. Mr. Credelle holds 84 issued US patents in various flat-panel related technologies including display design, display electronics, materials, algorithms, systems, RFID, and optics, with additional pending.

Mr. Credelle is a Fellow of the Society for Information Display and currently consults regarding technology, business, and patent issues involving Flat Panel Display and LED Technology for various clients. He has written expert-analysis reports for private clients on patent portfolios of over 500 patents and has written numerous IPR ITC, and District Court Case reports and has given depositions on many. He has testified at four District Court cases and three ITC Hearings.

Expertise

- Flat Panel Display Technology
- LEDs and LED lighting
- Display electronics
- Electro-optics
- Patent analysis
- Expert witness (reports, testimony)
- TFT and Liquid Crystal Display R&D

Education

Year	College or University	Degree
1970	Massachusetts Institute of Technology	M.S., Electrical Engineering Emphasis: Electro-optics and Solid State Physics Thesis: “Optical Properties of High Purity Stannic Oxide”
1969	Drexel University	B.S., Electrical Engineering (Honors Program)

Thomas L. Credelle
Curriculum Vitae

Professional Experience

From: 2008
To: Present
Organization: **TLC Display Consulting**
Title: President
Summary:

- Technical consulting in the field of flat panel displays, LEDs, and display electronics
- Business/patent consulting in the fields of displays, LEDs, optics, new technology

From: 2016
To: 2018
Organization: **RealD**
Title: Acting CEO, RealD Me (2016-2017), Strategic Advisor, RealD 2017-2019)
Summary:

- Business and technical advisor to RealD Intelligent Backlight Business Unit

From: 2012
To: 2016
Organization: **Innova Dynamics, Inc.,** San Francisco, CA
Title: VP, Application Engineering and Device Performance
Summary:

- Primary interface between customer and product engineering
- Testing and qualification of all products
- Business development/technical contact for new opportunities

From: 2008
To: 2018
Organization: **Display Engineering, Inc.** San Jose, CA
Title: Contractor
Summary:

- Design and testing of high-brightness LED backlights for outdoor signage
- Circuit design and thermal analysis of LED light bars
- Developed new methods for passive cooling of LED light sources

Thomas L. Credelle
Curriculum Vitae

From: 2007
To: 2008
Organization: **Puredepth, Inc**., Redwood City, CA and Auckland, NZ
Title: Senior VP Engineering
Summary:

- Recruited to establish first senior management leadership position for hardware and software engineering related to Puredepth's Multi Layer Display (MLD) technology.
- Rapidly learned details of technology, established new development plans, and supported customer engagements in US, Korea, and Japan.
- Divided time between US and NZ offices, supporting sales/marketing and leading engineering effort.

From: 2001
To: 2007
Organization: **Clairvoyante, Inc**, Cupertino, CA
Title: VP Engineering
Summary:

- Responsible for engineering, product development, product roadmap, marketing of technology that improves resolution and reduces power of color flat panel displays.
- Responsible for applied R&D, IC development, customer training and support for all technology integration programs.
- Creation of new intellectual property to advance adoption of Clairvoyante technology.
- Monthly interaction with leading LCD producers in Taiwan, Korea, Japan; management of all vendors relating to product development (8-10 on-site visits per year).

From: 1999
To: 2001
Organization: **Alien Technology Corporation**, Morgan Hill, CA
Title: VP of Operations
Summary:

- Key member of management team to develop novel technology for nanoblock-IC assembly using fluidic process. Responsible for facilities, manufacturing operations, IT, and HR; managed $20M construction project for mfg.
- Key contributor to display-related use of Alien manufacturing processes.
- Contributed to patent portfolio for Alien with key inventions in Nanoblock™ IC manufacturing techniques for displays and RFID tags.

Thomas L. Credelle
Curriculum Vitae

From: 1996
To: 1999
Organization: **Motorola**, Flat Panel Display Division, Tempe, AZ
Title: Director, Product Marketing
Summary:

- Responsible for establishing market direction and initial sales approach for new Field Emission Displays (FED) under development within the Division.
- Won potential business for initial small FEDs in industrial and automotive applications.
- Established and managed marketing communications department, creating new brand image for product as well as managing all trade show activities.
- Contributed to product development and spec generation. Generated patent disclosures aimed at solving customer-related issues.

From: 1994
To: 1996
Organization: **Allied Signal**, Los Gatos, CA
Title: Director, Advanced Product Marketing
Summary:

- Responsible for establishing product marketing direction and establishing customer contacts for newly-developed optical films for viewing angle enhancement for LCDs.
- Participated in product development, product improvement based on customer input.

From: 1991
To: 1994
Organization: **Apple Computer**, Cupertino, CA.
Title: Manager, Display Engineering
Summary:

- Responsible for all LCD engineering and qualification for first PowerBook notebook computers introduced to market.
- Extensive interaction with Asian suppliers.
- Generated patent disclosures related to LCD integration in notebook PCs

Thomas L. Credelle
Curriculum Vitae

From:	1986
To:	1991
Organization:	**GE** R&D Center, Schenectady, NY
Title:	Manager, TFT LCD Research and Development
Summary:	▪ Managed R&D in TFT and LCD technology for avionics applications. Led the team that built the first 1 million pixel color LCD. Led development of various optical devices based on liquid crystal materials. ▪ Established photonics effort based on liquid crystal technology.

From:	1970
To:	1986
Organization:	**RCA** Sarnoff Labs, Princeton, NJ
Title:	Individual Contributor, then Group Manager
Summary:	▪ Increasing levels of responsibility in the R&D of optical materials and flat panel displays. ▪ Key contributor to novel methods for large screen flat panel TFT. ▪ Established TFT LCD Program at Sarnoff Labs in 1983. ▪ Led development of first polySi TFT LCDs at Sarnoff Labs.

Legal Consulting

Expert Engagement:

Type of Matter:	Deposition on patent dispute
Client:	Alien Technology
Case Name:	Alien v. Avery, Case No. 08-cv-00795
Services Provided:	Deposed as expert and inventor on behalf of Alien
Date:	October 29, 2008

Expert Engagement:

Type of Matter:	Patent Infringement, LCD Projection
Client:	McKenna Long & Aldridge LLP
Case Name:	Undisclosed
Services Provided:	Non-testifying expert on ITC case
Date:	November 2011

Expert Engagement:
Type of Matter: LCD backlight
Client: Steptoe and Johnson LLP on behalf of LG
Case Name: In the Matter of Certain Devices for Improving Uniformity Used in a Backlight Module and Products Containing the Same Inv. No. 337-TA-805
Services Provided: Non-testifying expert on ITC case (settled)
Date: November 2011

Expert Engagement:
Type of Matter: Display driving method for eBooks
Client: Klarquist Sparkman LLP on behalf of Amazon (v. Positive Technologies)
Case Name: 2:11-cv-2226, N.D. Calif.
Services Provided: Expert Reports, Testifying Expert (settled)
Date: October 2012 – April 2013

Expert Engagement:
Type of Matter: Display driving method for eBooks
Client: Alston and Bird LLP on behalf of Barnes and Noble (v. Positive Technologies)
Case Name: 3:11-cv-02226-SI
Services Provided: Testifying expert on District Court Case (settled) Non infringement and non-enablement reports written.
Date: March 2013 – July 2013

Expert Engagement:
Type of Matter: LCD driving method
Client: Kenyon and Kenyon LLP on behalf of Sony (v. Surpass)
Case Name: IPR2015-0863
Services Provided: IPR Reports and Deposition
Date: Jan 2015-Mar 2016

Expert Engagement:
Type of Matter: LCD Optics and TFT design
Client: Marc Labgold on behalf of Funai (v. Gold Charm Ltd.)
Case Name: IPR2015-01448
Services Provided: IPR Report
Date: Apr, 2015 – Jul, 2015

Expert Engagement:
Type of Matter: LCD Backlights using LEDs
Client: Shearman & Sterling LLP/Fried Frank LLP on behalf of Mercedes Benz (v. Innovative Display Technologies)
Case Name: IPR2015-01995, IPR2015-01115, IPR2015-01113 and 2: 14-cv-00535 TXEDC
Services Provided: IPR Expert Reports
Date: Mar 2015 – May 2015

Expert Engagement:

Type of Matter:	TFT array and LCD panel interconnect
Client:	Covington & Burling on behalf of Samsung Display Co. (v. MiiC & Partners)
Case Name:	IPR205-01469, IPR2015-01499
Services provided:	IPR Expert Reports
Date:	May 2015- Mar 2016

Expert Engagement:

Type of Matter:	LCD Backlights using LEDs
Client:	Mayer Brown on behalf of KJ Pretech (v. Innovative Display Technologies)
Case Name:	IPR2015-01866, IPR2015-01867, IPR2015-01868
Services Provided:	IPR reports and depositions (3)
Date:	Aug 2015-Jun 2016

Expert Engagement:

Type of Matter:	LCD backlights using LEDs
Client:	Gibson, Dunn, and Crutcher LLP on behalf of Vizio (v. Delaware Display Group LLC)
Case Name:	Case No. 13-cv-2112
Services Provided:	Non-infringement Report, Deposition, Testifying Expert (settled)
Date:	Sep 2015-Mar 2017

Expert Engagement:

Type of Matter:	LCD manufacturing, TFT array design
Client:	Sughrue Mion PLLC on behalf of TCL
Case Name:	Arbitration (Hong Kong) between AUO and TCL
Services Provided:	Non-infringement analysis of TFT array design (settled)
Date:	Jun 2017 – Sep 2017

Expert Engagement:

Type of Matter:	LED display panels
Client:	Adduci Mastriani & Schaumberg on behalf of Ultravision Technologies LLC (v. >20 Chinese companies)
Case Name:	ITC Case 337-TA-1114
Services Provided:	Expert Reports (Invalidity and Non-infringement) and Deposition (3 days)
Date:	Jan 2018 – Feb, 2019

Expert Engagement:

Type of Matter:	LCD gamma circuit
Client:	K&L Gates on behalf of Wistron (v. plaintiff Phenix Longhorn)
Case Name:	IPR2018-01255, 2:17 cv-00711 TXEDC
Services Provided:	Expert report and Expert Testimony as needed (settled)
Date:	May 2018 – Jun 2019

Expert Engagement:

Type of Matter:	LED packaging
Client:	Davidson, Berquist, Jackson & Gowdey, LLP on behalf of Document Security Systems (v. defendants Seoul Semiconductor, Nichia Corp, Cree, Inc., Everlight Electronics)
Case Name:	IPR2018-00966, 2018-01165
Services Provided:	Expert Reports, Depositions (2) and Expert Testimony at trial as needed
Date:	June 2018 – May 2019

Expert Engagement:

Type of Matter:	TFT-LCD technology
Client:	Vinson and Elkins on behalf of AUO (v. plaintiff Vista Park Ventures)
Case Name:	2:18 cv-00276, 00278, 00279 TXEDC
Services Provided:	Expert reports and Expert Testimony as needed (settled)
Date:	Dec 2018 – Sep 2019

Expert Engagement:

Type of Matter:	LED Display Panels
Client:	Fabricant LLP on behalf of Plaintiff Ultravision (v. >10 companies)
Case Name:	2:18 cv-00112, 00118, 00150 TXEDC
Services Provided:	Expert report and Expert Testimony as needed; two days deposition in 2020, two depositions in 2021. **Testified at trial May 2021**
Date:	Jan 2019 – Present

Expert Engagement:

Type of Matter:	TFT-LCD technology
Client:	McDermott, Will and Emery on behalf of TCL (v. plaintiff Vista Park Ventures)
Case Name:	2:19 cv-00188, 00189, 00190, 00191 TXEDC
Services Provided:	Expert reports and Expert Testimony as needed (settled)
Date:	Aug 2019 – Oct 2019

Expert Engagement:

Type of Matter:	TFT-LCD technology
Client:	McDermott, Will and Emery on behalf of GiantPlus (v. plaintiff Vista Park Ventures)
Case Name:	2:19 cv-00183, 00184, 00185, 00187 TXEDC
Services Provided:	Expert reports and Expert Testimony as needed (settled)
Date:	Oct 2019 – Jan, 2020

Expert Engagement:

Type of Matter: TFT-LCD technology
Client: Vincent and Elkins on behalf of JDI (v. plaintiff Vista Park Ventures)
Case Name: 2:19 cv-00323, 00324, 00325 TXEDC
Services Provided: Expert reports and Expert Testimony as needed (settled)
Date: Nov 2019 – Jun 2020

Expert Engagement:
Type of Matter: TFT-LCD technology
Client: Sidley on behalf of LG Electronics (v. defendant Hisense)
Case Name: 2:19 cv-09474 CACDC
Services Provided: Expert reports and Expert Testimony as needed (settled)
Date: Feb. 2020 – Jan. 2021

Expert Engagement:
Type of Matter: Quantum dot technology
Client: Murtha Law on behalf of RPI (v. defendant Samsung)
Case Name: 2:19 cv-20097 KM-ESK
Services Provided: Expert reports and Expert Testimony as needed
Date: Jan. 2020 – Jun 2021

Expert Engagement:
Type of Matter: OLED, touch panels
Client: RAK Law on behalf of Solas (v. defendant Samsung)
Case Name: 2:19-cv-00152-JRG (E.D. Tex)
Services Provided: Expert reports and Expert Testimony; two depositions in 2020. **Testified at trial Mar. 2021**.
Date: Apr. 2020 – Mar. 2021

Expert Engagement:
Type of Matter: LCD technology
Client: Morgan Lewis on behalf of Fuji Film (v. plaintiff Vista Park Ventures)
Case Name: 2:20 cv-00064, 65, 66 E.D. Tex.
Services Provided: Expert reports and Expert Testimony as needed (settled)
Date: Jul. 2020 – Oct 2020

Expert Engagement:
Type of Matter: Touch panels
Client: DLA Piper, Alston and Bird, on behalf of Microsoft, Dell (v. plaintiff Neodron)
Case Name: 2:19-cv-00318-ADA (W.D. Tex)
Services Provided: Expert Reports and Expert Testimony as needed (settled)
Date: Aug. 2020 – Nov. 2020

Expert Engagement:
Type of Matter: LCD
Client: Vincent and Elkins on behalf of Japan Display Inc (v. defendant Tianma)
Case Name: 2:20-CV-00283, 284, 285-JRG (E.D. Tex)
Services Provided: Expert Reports, depositions, and Expert Testimony as needed (settled)
Date: Jan 2021 – Jan 2022

Expert Engagement:
Type of Matter: LCD
Client: Perkins Coie on behalf of Truly Semiconductor, Hannstar (v. plaintiff Vista Park Ventures)
Case Name: 2:20-CV-250, 251, 252 (E.D. Tex)
Services Provided: Expert Reports and Expert Testimony as needed (settled)
Date: Jan 2021 – June 2021

Expert Engagement:
Type of Matter: Quantum dots
Client: Mintz on behalf of Nanoco (v. defendant Samsung)
Case Name: 2:20-CV-00038-JRG (E.D. Tex)
Services Provided: Expert Reports, depositions, case settled day before trial opening arguments
Date: Jan 2021 – Jan 2023

Expert Engagement:
Type of Matter: OLED circuits
Client: Morrison Forster on behalf of JOLED (v. defendant Samsung)
Case Name: Case No. 6:20cv559 (W.D. Tex.)
Services Provided: Expert Reports and Expert Testimony (settled)
Date: July 2020 – April 2021

Expert Engagement:
Type of Matter: OLED circuits
Client: Perkins Coie on behalf of AUO (v. defendant Samsung)
Case Name: TBD
Services Provided: Expert Reports and Testimony (settled)
Date: Feb. 2021 – May 2021

Expert Engagement:
Type of Matter: LED circuits
Client: Kim IP on behalf of CAST Lighting (v. Plaintiff WAC Lighting)
Case Name: ITC Inv. No. 337-TA-1261
Services Provided: Expert Reports and Testimony (settled)
Date: May 2021 – Oct 2021

Expert Engagement:

Type of Matter:	OLED circuits
Client:	RAKLaw on behalf of Solas, Ltd. (v. Defendant Samsung)
Case Name:	ITC Inv. No. 337-TA-1243
Services Provided:	Expert Reports and **Testified at Hearing Nov. 15-19, 2021**
Date:	May 2021 – Dec 2021

Expert Engagement:

Type of Matter:	OLED circuits
Client:	PV Law on behalf of TCL (vs. Plaintiff SEL Co.)
Case Name:	8:21-cv-00554-JAK-ADS (CDCA)
Services Provided:	Expert Reports and Depositions; case settled
Date:	July 2021 – July 2023

Expert Engagement:

Type of Matter:	LED circuits
Client:	Carmichael IP on behalf of Lynk Labs (vs. defendant Samsung)
Case Name:	IPR Proceedings
Services Provided:	Expert Reports and Depositions, case settled.
Date:	Jan 2022 – Jan 2023

Expert Engagement:

Type of Matter:	OLED circuits
Client:	Baker Botts on behalf of FujiFilm (vs. defendant ButterflyQ)
Case Name:	C.A. No. 22-309-JPM
Services Provided:	Expert Reports and Depositions, testify at trial if needed (settled Nov, 2023)
Date:	Jul 2022 – Nov. 2023

Expert Engagement:

Type of Matter:	Outdoor LCD signage
Client:	Kilpatrick Townsend on behalf of MRI, Inc. (vs. defendants Samsung et al)
Case Name:	ITC 337-TA-1331
Services Provided:	Expert Reports, Depositions, **Testified at Hearing June 26-30, 2023**
Date:	Oct 2022 – Aug 2023

Expert Engagement:

Type of Matter:	OLED circuits and pixel arrangements
Client:	Orrick Herrington & Sutcliffe LLP on behalf of BOE (vs. plaintiff Samsung et al)
Case Name:	ITC 337-TA-1351
Services Provided:	Expert Reports, Depositions. **Testified at Hearing July 16, 2024**
Date:	Sep 2023 – Sept 2024

Expert Engagement:
Type of Matter: Light concentrators, LCD backlights
Client: Katz PLLC on behalf of SVV (vs. defendants Asus and Acer)
Case Name: WD Tex 6:22-cv-0311, 312, 313, 511, 512, 513, 639, 640, 641-ADA
Services Provided: Expert Reports, Depositions, **testified at trial (v. Acer), June, 2024; testified at trial (v. ASUS), Sept, 2024**
Date: Jan 2023- Oct 2024 (Plaintiff won in both trials)

Expert Engagement:
Type of Matter: LCD AMOLED circuits,
Client: Kramer Alberti on behalf of Polaris PowerLED Technologies, LLC (vs. defendant Samsung et al)
Case Name: EDTEX 2:22-cv-oo469-JRG
Services Provided: Expert Reports (IPR and DC), Depositions, testifying expert (trial scheduled for Jan 2025)
Date: Mar 2023- Dec 2024 (settled)

Expert Engagement:
Type of Matter: LCD AMOLED circuits,
Client: Morrison & Forester LLP on behalf of Crystal Leap (vs. defendant HKC)
Case Name: No. 2:22-cv-00382 (EDTEX)
Services Provided: Expert Reports (IPR and DC), Depositions, testifying expert, settled Mar, 2024
Date: Jul 2023- Mar 2024 (settled)

Expert Engagement:
Type of Matter: LCD AMOLED circuits,
Client: Kramer Alberti on behalf of Polaris PowerLED Technologies, LLC (vs. various defendants)
Case Name: 2:23-cv-03478-GW-PD (CD CAL)
Services Provided: Expert Reports (IPR and DC), Depositions, testifying expert
Date: Dec 2023- present

Expert Engagement:
Type of Matter: Image sensor circuits,
Client: PVLaw on behalf of Keyence (vs. plaintiff Al Core Technologies, LLC)
Case Name: 2:24-cv-00438-RWS-RSP,
Services Provided: Expert Reports (IPR and DC), Depositions, testifying expert
Date: Dec 2023- Nov 2024 (settled)

Expert Engagement:
Type of Matter: AMOLED design, circuits
Client: Morrison & Forester LLP on behalf of BOE (vs. Plaintiff SDC)
Case Name: No. 2:25-cv-00430 (E.D. Tex.), *Samsung Display Co., Ltd. v. BOE Technology Group Co., Ltd. et al.*, No. 2:23-cv-00426 (E.D. Tex.)
Services Provided: Expert Reports (IPR and DC), Depositions, testifying expert
Date: Jun 2025 - present

Expert Engagement:
Type of Matter: AMOLED design, circuits
Client: Orrick on behalf of BOE
Case Name: Not yet assigned
Services Provided: Expert Reports (IPR and DC), Depositions, testifying expert
Date: May 2025 - present

Expert Engagement:
Type of Matter: AMOLED design
Client: PVLaw on behalf of defendant CSOT (v. SDC)
Case Name: No. 3:25-cv-01430-S (NDTEX)
Services Provided: Technical Expert
Date: Aug 2025 - present

Consulting Projects

Consulting Engagement:
Client: Tessera
Services Provided: Business case analysis for M&A department
Date: Mar 2008 to 2011

Consulting Engagement:
Client: Sipix Imaging
Services Provided: Technical consulting on display algorithms
Date: Mar 2008 to 2009

Consulting Engagement:
Client: Holox Technologies, Inc. (self-funded start up in holographic optics)
Services Provided: CEO; business leadership, fund raising, market analysis, optical design of advanced diffusers for LCD backlights, solar collectors, window films.
Date: Sept 2008 to June 2012

Consulting Engagement:
Client: Innova Dynamics, Inc.

Services Provided: Technical and business development consulting in touch screen technology
Date: October 2011 to November 2012

Technical and Patent Consulting:

Client: LG Display
Services Provided: Technical consulting on pixel processing algorithms, OLED displays; patent generation for advanced pixel concepts for OLED.
Date: Aug 2009 to Dec 2011

Consulting Engagement:

Client: Scivax
Services Provided: Technical and business development consulting in nanoimprinting technology
Date: Feb 2018 to Jul 2018

Thomas L. Credelle
Curriculum Vitae

Professional Affiliations, Achievements & Awards

- Fellow of the Society for Information Display (SID)
- Past Director, SID Symposium Committee (10 years)
- Conference and Program Chair, SID Symposium and IDRC
- Past Member, SID Program Committee (15 years)

US Patents & Publications

Patent	Date	Description
10,163,985	12/25/2018	Subpixel arrangement structure for a display device
9,583,034	02/28/2017	Subpixel arrangement structure for a display device
9,041,625	05/26/2015	Subpixel arrangement structure for a display device and display device
9,001,167	04/07/2015	Display panel having crossover connections effecting dot inversion
8,933,959	01/13/2015	Subpixel layouts and subpixel rendering methods for directional displays and systems
8,876,937	11/04/2014	Production of nanostructures
8,797,344	08/05/2015	Memory structures for image processing
8,754,913	06/17/2014	Subpixel arrangement structure of display device
8,704,744	04/22/2014	Systems and methods for temporal subpixel rendering of image data
8,633,886	01/21/2014	Display panel having crossover connections effecting dot inversion
8,519,910	08/27/2013	Image processing method and display device using the same
8,516,683	08/27/2013	Methods of making a radio frequency identification (RFID) tags
8,456,496	06/04/2013	Color flat panel display sub-pixel arrangements and layouts for sub-pixel rendering with split blue sub-pixels
8,456,414	06/04/2013	Gamma adjustment with error diffusion for electrophoretic displays
8,436,799	05/07/2013	Image degradation correction in novel liquid crystal displays with split blue subpixels
8,421,820	04/16/2013	Methods and systems for sub-pixel rendering with adaptive filtering
8,411,022	04/02/2013	Multiprimary color display with dynamic gamut mapping
8,405,692	03/26/2013	Color flat panel display arrangements and layouts with reduced blue luminance well visibility
8,378,947	02/19/2013	Systems and methods for temporal subpixel rendering of image data
8,294,741	10/23/2012	Four color arrangements of emitters for subpixel rendering
8,259,127	09/04/2012	Systems and methods for reducing desaturation of images rendered on high brightness displays
8,144,094	03/27/2012	Liquid crystal display backplane layouts and addressing for non-standard subpixel arrangements

8,134,583	03/13/2012	Two color flat panel display sub-pixel arrangements and layouts for sub-pixel rendering with split blue sub-pixels
8,035,599	10/11/2011	Display panel having crossover connections effecting dot inversion
8,018,476	09/13/2011	Subpixel layouts for high brightness displays and systems
8,013,867	09/06/2011	Systems and methods for implementing improved gamut mapping algorithms
7,969,456	06/28/2011	Methods and systems for sub-pixel rendering with adaptive filtering
7,876,341	06/25/2011	Subpixel layouts for high brightness displays and systems
7,864,194	01/04/2011	Systems and methods for motion adaptive filtering
7,791,679	09/07/2010	Alternative thin film transistors for liquid crystal displays
7,755,652	07/13/2010	Color flat panel display sub-pixel rendering and driver configuration for sub-pixel arrangements with split sub-pixels
7,701,476	04/20/2010	Four color arrangements of emitters for subpixel rendering
7,646,430	01/12/2010	Display system having improved multiple modes for displaying image data from multiple input source formats
7,592,996	09/22/2009	Multiprimary color display with dynamic gamut mapping
7,583,279	09/01/2009	Subpixel layouts and arrangements for high brightness displays
7,573,493	08/11/2009	Four color arrangements of emitters for subpixel rendering
7,573,448	08/11/2009	Dot inversion on novel display panel layouts with extra drivers
7,559,131	07/14/2009	Method of making a radio frequency identification (RFID) tag
7,505,053	03/17/2009	Subpixel layouts and arrangements for high brightness displays
7,492,379	02/17/2009	Color flat panel display sub-pixel arrangements and layouts for sub-pixel rendering with increased modulation transfer function response
7,417,648	08/26/2008	Color flat panel display sub-pixel arrangements and layouts for sub-pixel rendering with split blue sub-pixels
7,397,455	07/08/2008	Liquid crystal display backplane layouts and addressing for non-standard subpixel arrangements
7,283,142	10/16/2007	Color display having horizontal sub-pixel arrangements and layouts
7,260,882	08/28/2007	Methods for making electronic devices with small functional elements supported on a carriers
7,248,271	07/24/2007	Sub-pixel rendering system and method for improved display viewing angles
7,218,301	05/15/2007	System and method of performing dot inversion with standard drivers and backplane on novel display panel layouts
7,187,353	03/06/2007	Dot inversion on novel display panel layouts with extra drivers
7,184,066	02/27/2007	Methods and systems for sub-pixel rendering with adaptive filtering
7,167,186	01/23/2007	Systems and methods for motion adaptive filtering
7,084,923	08/01/2006	Display system having improved multiple modes for displaying image data from multiple input source formats
7,068,287	06/27/2006	Systems and methods of subpixel rendering implemented on display panels
7,046,256	05/16/2006	System and methods of subpixel rendering implemented on display panels
6,985,361	01/10/2006	Electronic devices with small functional elements supported on a carrier
6,917,368	07/12/2005	Sub-pixel rendering system and method for improved display viewing angles

6,816,380	11/09/2004	Electronic devices with small functional elements supported on a carrier
6,731,353	05/04/2004	Method and apparatus for transferring blocks
6,693,384	02/17/2004	Interconnect structure for electronic devices
6,606,247	08/12/2003	Multi-feature-size electronic structures
5,961,362	10/05/1999	Method for in situ cleaning of electron emitters in a field emission device
5,883,467	03/16/1999	Field emission device having means for in situ feeding of hydrogen
5,477,350	12/19/1995	Interferometric spatial switch for polarized or unpolarized light using liquid crystal
5,373,393	12/13/1994	Optical interferometric device with spatial light modulators for switching substantially coherent light
5,363,228	11/08/1994	Optical device with spatial light modulators for switching arbitrarily polarized light
5,345,321	09/06/1994	Compact polarization dependent optical switching units
5,319,477	06/07/1994	Compact polarization independent optical switching units
5,317,445	05/31/1994	Optical device with spatial light modulators for switching polarized light
4,630,893	12/23/1986	LCD pixel incorporating segmented back-to-back diode
4,598,227	07/01/1986	Electron beam convergence and scanning structures for flat panel display device
4,517,489	05/14/1985	Modulator structure and method for flat panel display devices
4,484,103	11/20/1984	Color selection electron beam guide assembly for flat panel display devices
4,362,966	12/07/1982	Electron leakage reduction in flat panel display devices
4,335,332	06/15/1982	Focus mesh structure and biasing technique for flat panel display devices
4,316,118	02/16/1982	Guided beam display device
4,298,819	11/03/1981	Beam Clean up structure for flat panel display devices
4,234,815	11/18/1980	Flat display tube having shielding member between beam guide and screen
4,174,881	11/20/1979	Recording a synthetic focused-image hologram on a thermally deformable plastic
4,153,856	05/08/1979	Proximity focused element scale image display device
4,148,636	04/10/1979	Broadening the spatial frequency pass band of a thermoplastic layer
4,137,478	01/30/1979	Color flat panel television
4,137,077	01/30/1979	Broadening the spatial frequency pass band of a thermoplastic layer
4,131,823	12/26/1978	Modular flat display device with beam convergence
4,121,137	10/17/1978	System for achieving image uniformity in display devices
4,103,205	07/25/1978	Flat display device with beam guide
4,103,204	07/25/1978	Flat display device with beam guide
4,088,920	05/09/1978	Flat display device with beam guide

Publications

1. “Thermoplastic Media for Holographic Recording,” RCA Review: A Technical Journal (1972)
2. “Guided Beam Displays for Large Screen Flat-Panel Color TV,” Information Display (1983)
3. “Recent trends in color avionic LCDs,” Information Display (1987)
4. “Thin-film transistors for video applications,” Inter. Display Research Conference Record (1988)
5. “TFT-LCD for video applications,” Information Display (1989)
6. “LCDs,” JTEC Panel Report on Display Technologies in Japan (1992)
7. “Viewing-Angle-Enhancement System for LCDs” SID Digest of Technical Papers (1995)
8. “SpectraVue™: A new system to enhance the viewing angle of LCDs,” SID Journal (1997)
9. “The Business Case for Motorola's Flat-Panel-Display Division,” Information Display (1997)
10. “MTF of high-resolution PenTile Matrix™ displays,” Proc Eurodisplay (2002)
11. “Adding a White Subpixel,” Information Display (2005)
12. “Low Power, High-Pixel-Density Mobile Displays Using PenTile RGBW™ Architectures**,”** SID Mobile Displays Digest of Technical Papers (2006)
13. *“Invited Paper:* High-Pixel-Density Mobile Displays: Challenges and Solutions,” SID Digest of Technical Papers (2006)