

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Yojiro Matsueda et al.

Attorney Docket No. 57874-0038PS1

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Title: DISPLAY DEVICE AND COMPUTER READABLE MEDIA

DECLARATION OF EXPERT

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

Date: 6 February 2026

By: Eric Bretschneider
Eric Bretschneider

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I. ASSIGNMENT

1. I have been retained on behalf of LG Display Co., Ltd. (“Petitioner” or “LG Display”) to offer technical opinions related to U.S. Patent No. 12,293,691 (“the ‘691 patent”) (EX1001). I understand that LG Display is requesting that the Patent Trial and Appeal Board (“PTAB” or “Board”) to institute an *Post Grant* review (“PGR”) proceeding of the ‘691 patent.

2. I have been asked to provide my independent analysis of the ‘691 patent based on the prior art publications cited in this declaration.

3. I am not and never have been, an employee of LG Display. I received no compensation for this declaration beyond my normal hourly compensation based on my time actually spent analyzing the ‘691 patent, the prior art publications cited below, and issues related thereto, and I will not receive any added compensation based on the outcome of any PGR or other proceeding involving the ‘691 patent.

II. QUALIFICATIONS AND BACKGROUND INFORMATION

4. I am over the age of 18 and am competent to write this declaration. I have personal knowledge, or have developed knowledge of these technologies based upon education, training, or experience, of the matters set forth herein.

5. My qualifications are summarized here and explained in more detail in my curriculum vitae, which is attached as Appendix A to this report. Appendix

A also includes a list of my publications and the cases in which I have testified at deposition, hearing, or trial within the past four years.

6. I have over 30 years of experience with LEDs, displays, lighting fixtures, and lighting including a comprehensive background in a full range of LED technologies, including solid state lighting (SSL) fixture/lamp design, integration, and reliability, LED chip and package testing and reliability, fabrication, optical design, thermal management, and color conversion.

7. Throughout the course of my career, I have designed and transferred into manufacturing over 150 different LED-based lighting products, including LED lighting products designed to be installed in fixtures and in different lighting environments and applications. I have also designed and transferred into manufacturing dozens of different LED chips and packages for a variety of different applications with a particular focus on display applications and general lighting.

8. I am recognized as a leading expert in matters related to reliability for all types of LED technology and have consulted with numerous companies to help develop internal testing methods and reliability standards for evaluating their products.

9. I also have extensive experience in the design of flat panel displays

including Thin Film Electroluminescent Devices (TFELDs), LED displays, Liquid Crystal Diode (LCD) displays, and Organic Light Emitting Diode (OLED) displays. Companies I have worked with in conjunction with design and manufacture of flat panel displays include: Planar Systems, Kopin, Kodak, Apple, Hewlett Packard, and Dell.

10. I am currently the Chief Technology Officer at EB Designs & Technology. In that capacity, I am, among other things, responsible for the design of solid-state lighting technologies for clients ranging from startups to Fortune 100 companies.

11. I also served as a member of the University of Florida's Department of Chemical Engineering Advisory Board for 25 years, from 1998 until 2022. During my tenure on this Advisory Board, I served as Chair for a total of 8 years. I also served on the Dean's Advisory board for the College of Engineering at the University of Florida from 2007-2009 and 2017-2022. I have been a Conference Chair for LED Measurement and Standards. I am also a member of numerous professional societies, including the International Society for Optics and Photonics (SPIE), Optica, the Society for Information Display (SID), the Materials Research Society (MRS), and the Illuminating Engineering Society (IES).

12. Inside the IES, I am a founding member of the Science Advisory

Panel, which has oversight over all testing and technical committees and work groups inside the IES. I am also a full member of the Test Procedures Committee which develops test, measurement and reliability standards for LEDs and lighting fixtures. Inside the Test Procedures Committee, I serve as chair of the projections and reliability subcommittee which develops reliability standards for LED based lighting products including utilizing all forms of lighting technologies. I recently led the work group that revised TM-21 which is the internationally accepted standard for predicting reliability of LED packages. I also developed a new mathematical model that, for the first time, allows prediction of the color shift of an LED package over its time. This model is the basis for a new IES standard known as TM-35, which predicts the rate of color shift for LED products over time.

13. I joined the IES in 2006 and have been a member of the Test Procedures Committee since that time. As a result, I have been an active participant in the development of testing standards related and have helped to formalize the terminology for solid state lighting since the beginnings of the industry. Additionally, I serve on the IES Color Committee and the IES Photobiology Committee.

14. Additionally, I have been a member of SID since 2005. Notably, I

gave the keynote address at the first three years of the SID Conference LEDs in Displays. My experience and reputation in the field of display technology led to my work with Apple in design of displays for the first generation iPad as well as displays for several laptop and desktop computers. I performed similar work with both Dell and Hewlett Packard in regards to design of displays for their products.

15. I previously served as Chief Technology Officer at QuarkStar, LLC., from 2016 until 2023. QuarkStar is primarily a technology development company that is focused on new approaches to improving performance and efficiency of products that rely on LED light sources. In this role, I helped negotiate the company's first technology license to a European manufacturer of lighting fixtures. This technology has since be incorporated into one of their premium product lines. I also lead the efforts to transition products into manufacturing to produce fixtures for the Museum of Fine Arts, Houston (MFAH). These fixtures provide over 60% of the artificial lighting in a \$500 million expansion.

16. Prior to my position at EB Designs & Technology, I served as the Director of Engineering at HeathCo, LLC. In that capacity, I was responsible for advanced technology/product development related to solid-state lighting, sensors, notifications, and control products.

17. Prior to my position as Director of Engineering at HeathCo, I was at

the Elec-Tech International Co., Ltd., where I held the positions of Chief Engineer, ETi Lighting Research Institute and VP of Research and Development, ETi Solid State Lighting. In my Elec-Tech capacities, my responsibilities included developing all technology and product roadmaps for markets in North America, China, Europe, and Japan. I designed and developed LEDs, LED packages and LED based lighting products for all of these markets.

18. Between 2008 and 2011, I was at Lighting Science Group Corporation (LSG), first as a product development manager, and my responsibilities included developing solid state lighting products, then as VP of Research, and my responsibilities included developing advanced LED models for product development and production control. In these roles, I was involved in the design and manufacture of numerous LED-based lighting fixtures and products. The products I helped launch included LSG's C2D (Curb to Door) products. These products were designed to be installed in outdoor locations including wall packs, parking lots, and streetlights. These fixtures, particularly the wall pack fixtures, were also suitable for installation in public transportation areas.

19. Between 2004 and 2008, I was at Toyoda Gosei North America, where I was a sales manager, and my responsibilities included managing and developing LED die and package sales accounts form the eastern region of North

America. I was also tasked with providing technical support for the entire western hemisphere. The support I provided included design of LED packages and design of lighting fixtures and products that incorporated LED packages. Notable successes at Toyoda Gosei included expanding market niches and applications for LED based backlights for LCD displays. I provided significant technical and design support to large customers, including 3M, Global Lighting Technologies, Apple, Dell, and Hewlett Packard.

20. Between 2003 and 2004, I was at Beeman Lighting, where I was Director of Solid State Lighting Engineering, and my responsibilities included leading development of solid state lighting systems and materials.

21. Between 1998 and 2003, I was at Uniroyal Optoelectronics. Uniroyal Optoelectronics was a joint venture between Uniroyal Technology Corporation and Emcore Corporation which was initially focused on development and production of GaN-based and AlInGap-based LED chips. Later, Uniroyal Optoelectronics expanded their scope to include LED packages. At Uniroyal Optoelectronics, I held a number of positions including Team Leader for the Epitaxial Growth and Materials Characterization areas, Sr. Epi Scientist, Director of Intellectual Property, University Relations and Government Contracts. My responsibilities included MOCVD hardware modification, epitaxial process development as well

as design, development and testing of new LED chip structures for both AlInGaP and GaN-based material systems. I was also responsible for providing technical support and assistance to customers on topics related to use of LED chips, design of LED packages and design of LED based lighting products and systems. This support included both optical and thermal design of LED packages and LED lighting products. My work at Uniroyal included providing technical support and package design for Kopin which resulted in the development of full color micro displays that were used as electronic viewfinders for Kodak digital cameras.

22. I have also authored and presented more than 30 publications, presentations, and seminars, and I am a named inventor on over 70 issued patents and more than 25 pending patents.

23. I earned a B.S.E. in Chemical Engineering from Tulane University in 1989.

24. I earned a Ph.D. in Chemical Engineering from the University of Florida in 1997, where my graduate work focused on development of optoelectronic devices, including novel silicon based visible LEDs and sulfide based TFELD structures and zinc selenide blue LEDs. As a graduate student, I was also an active participant in the Phosphor Technology Center of Excellence (PTCOE). The PTCOE was a large research consortium that was focused on

technology development of display technology for electroluminescent (both alternating current and direct current) displays, field emission displays, and plasma displays. This work included design and prototyping of flat panel emissive displays for medical and military equipment.

25. In 1989 I worked for Shell Oil Corporation in Norco, LA. I was tasked with modeling heat exchanger performance for the crude oil distillation column in order to identify cost saving opportunities. I developed an improved model for determining the operating efficiency of heat exchange units that incorporated determined the economic impact on different operating conditions. The model was designed to be compatible with all major operating units on site and resulted in costs savings of over \$20 million/year at the Norco Facility alone. My work was quickly adopted throughout the entire corporation and has resulted in sustained annual cost savings of approximately \$500 million/year.

26. My curriculum vitae, included as an appendix to this declaration, includes a list of publications on which I am a named author. It contains further details regarding my experience, education, publications, and other qualifications to render an expert opinion in connection with this proceeding.

27. In writing this Declaration, I have considered the following: my own knowledge and experience, including my work experience in the fields of emissive

display panels and light emitting device design; my experience in teaching those subjects; and my experience in working with others involved in those fields. In addition, I have analyzed the following publications and materials, in addition to other materials I cite in my declaration:

28. I have reviewed the '691 patent (EX1001), and relevant excerpts of the prosecution history (EX1002) of the '691 patent. Among various textbooks, documents, and publications, I have also reviewed the following prior art references:

29. U.S. Patent Application Publication No. 2015/0207094 to Hwang ("Hwang") (Exhibit EX1005)

30. U.S. Patent Application Publication No. 2014/0292622 to Lee ("Lee") (Exhibit EX1006)

31. U.S. Patent Application Publication No. 2012/0056531 to Park et al., ("Park'531") (Exhibit EX1007)

32. U.S. Patent Application Publication No. 2016/0225834 to Kim ("Kim'834") (Exhibit EX1008)

33. U.S. Patent Application Publication No. 2016/0260792 to Kim ("Kim'792") (Exhibit EX1009)

34. U.S. Patent Application Publication No. 2015/0129856 to Kim

(“Kim’856”) (Exhibit EX1010)

35. U.S. Patent Application Publication No. 2015/0364526 to Peng
(“Peng”) (Exhibit EX1011)

36. U.S. Patent Application Publication No. 2012/0307123 to Cok
(“Cok’123”) (Exhibit EX1012)

37. U.S. Patent Application Publication No. 2012/0098415 to Song
(“Song”) (Exhibit EX1013)

38. U.S. Patent Application Publication No. 2009/0121983 to Sung
(“Sung”) (Exhibit EX1014)

39. U.S. Patent Application Publication No. 2004/0217694 to Cok
(“Cok’694”) (Exhibit EX1015)

40. U.S. Patent Application Publication No. 2011/0291550 to Kim
(“Kim’550”) (Exhibit EX1016)

41. U.S. Patent No. 7,623,141 to Brown Elliott et al. (Exhibit EX1017)

42. U.S. Patent No. 4,853,592 to Strathman (“Strathman”) (Exhibit
EX1018)

43. U.S. Patent No. 7,948,170 to Striakhilev et al. (“Striakhilev”) (Exhibit
EX1019)

44. U.S. Patent No. 8,456,496 Credelle (“Credelle”) (Exhibit EX1020)

45. Sarma *et al.*, “Flat Panel Displays for Portable Systems,” 13 Journal of VLSI Signal Processing Systems 165-190, 1996 (Exhibit EX1021)

46. Counsel (Fish & Richardson) has informed me that I should consider these materials through the lens of one of ordinary skill in the art related to the ‘691 patent at the time of the earliest possible priority date of the ‘691 patent, and I have done so during my review of these materials. I have been informed by Counsel to use the date of **September 2, 2015** as the Priority Date.

47. I have no financial interest in the outcome of this proceeding. I am being compensated for my work as an expert on an hourly basis. My compensation is not dependent on the outcome of these proceedings or the content of my opinions.

48. My opinions, as explained below, are based on my education, experience, and expertise in the fields relating to the ‘691 patent. Unless otherwise stated, my testimony below refers to the knowledge of one of ordinary skill in the art as of the earliest possible priority date. Any figures that appear within this document have been prepared with the assistance of Counsel and reflect my understanding of the ‘691 patent and the prior art discussed below.

III. OVERVIEW OF CONCLUSIONS FORMED

49. This declaration explains the conclusions that I have formed based on my analysis of all of the considered materials and my personal experience. To

summarize those conclusions, based upon my knowledge and experience and my review of the prior art references listed above, I believe that:

- **Ground 1:** Claims 1-8 are invalid for being indefinite.
- **Ground 2:** Claims 1-8 are invalid for lack of written description.
- **Ground 3:** Claims 1-8 are invalid for lack of enablement.
- **Ground 4:** Claims 1-6 and 8 are obvious in view of Hwang and Lee.
- **Ground 5:** Claim 7 is obvious in view of Hwang, Lee, and Park'531.

50. In support of these conclusions, I provide an overview of the references in Section IX and more detailed comments regarding the obviousness of claims 1-8 (“the Challenged Claims”) of the ‘691 patent in Section X.

IV. LEVEL OF ORDINARY SKILL IN THE ART

51. In my opinion, one of ordinary skill in the art relating to, and at the time of, the Priority Date would have been someone with (1) a four-year undergraduate degree in electrical engineering or physics or a closely-related field , and (2) four years of experience in the design and implementation of flat panel display devices or components thereof. (“POSITA”). Additional graduate education could substitute for professional experience, and *vice versa*

52. Further, all positions in this declaration are from the vantage point of a POSITA as of **September 2, 2015**.

53. Based on my experiences, I have a good understanding of the capabilities of a POSITA. Indeed, I have taught, participated in organizations, and worked closely with many such persons over the course of my career. Based on my knowledge, skill, and experience, I have an understanding of the capabilities of a POSITA. For example, from my industry experience, I am familiar with what a POSITA would have known and found predictable in the art. From teaching and supervising my post-graduate students, I also have an understanding of the knowledge that a person with this academic experience possesses. Furthermore, I possess those capabilities myself.

V. LEGAL STANDARDS

A. Terminology

54. I have been informed by Counsel and understand that the best indicator of claim meaning is its usage in the context of the patent specification as understood by one of ordinary skill. I further understand that the words of the claims should be given their plain meaning unless that meaning is inconsistent with the patent specification or the patent's history of examination before the Patent Office. Counsel has also informed me, and I understand that, the words of the claims should be interpreted as they would have been interpreted by one of ordinary skill at the time of the invention was made (not today). The '691 patent was filed April 6, 2021, and claims priority to **September 2, 2015**, which I refer to

as the “Critical Date” in this proceeding. Because I do not know at what date the invention as claimed was made, if ever, I have used the Critical Date of the ‘691 patent as the point in time for claim interpretation purposes. My opinion does not change if the invention date is earlier.

B. Legal Standards

55. I have been informed by Counsel and understand that documents and materials that qualify as prior art can render a patent claim unpatentable as being anticipated or obvious.

56. I am informed by Counsel and understand that all prior art references are to be looked at from the viewpoint of a person of ordinary skill in the art at the time of the invention, and that this viewpoint prevents one from using his or her own insight or hindsight in deciding whether a claim is anticipated or rendered obvious.

C. Anticipation

57. I understand that patents or printed publications that qualify as prior art can be used to invalidate a patent claim as anticipated or as obvious.

58. I understand that, once the claims of a patent have been properly construed, the second step in determining anticipation of a patent claim requires a comparison of the properly construed claim language to the prior art on a limitation-by-limitation basis.

59. I understand that a prior art reference “anticipates” an asserted claim, and thus renders the claim invalid, if all limitations of the claim are disclosed in that prior art reference, either explicitly or inherently (i.e., necessarily present).

D. Obviousness

60. I understand that even if a patent is not anticipated, it is still invalid 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 invention was made to a POSITA.

61. I have been informed by Counsel and understand that a claim is unpatentable for obviousness and that obviousness may be based upon a combination of references. I am informed by Counsel and understand that the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. However, I am informed by Counsel and understand that a patent claim composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art.

62. I am informed by Counsel and understand that when a patented invention is a combination of known elements, a court determines whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue by considering the teachings of prior art references, the effects

of demands known to people working in the field or present in the marketplace, and the background knowledge possessed by a person having ordinary skill in the art.

63. I am informed by Counsel and understand that a patent claim composed of several limitations is not proved obvious merely by demonstrating that each of its limitations was independently known in the prior art. I am informed by Counsel and understand that identifying a reason those elements would be combined can be important because inventions in many instances rely upon building blocks long since uncovered, and claimed discoveries almost of necessity will be combinations of what, in some sense, is already known. I am informed by Counsel and understand that it is improper to use hindsight in an obviousness analysis, and that a patent's claims should not be used as a "roadmap."

64. I am informed by Counsel and understand that an obviousness inquiry requires consideration of the following factors: (1) the scope and content of the prior art, (2) the differences between the prior art and the claims, (3) the level of ordinary skill in the art, and (4) any so called "secondary considerations" of non-obviousness, which include: (i) "long felt need" for the claimed invention, (ii) commercial success attributable to the claimed invention, (iii) unexpected results of the claimed invention, and (iv) "copying" of the claimed invention by others.

65. I have been informed by Counsel and understand that an obviousness evaluation can be based on a single reference or a combination of multiple prior art references. I understand that the prior art references themselves may provide a suggestion, motivation, or reason to combine, but that the nexus linking two or more prior art references is sometimes simple common sense. I have been informed by Counsel and understand that obviousness analysis recognizes that market demand, rather than scientific literature, often drives innovation, and that a motivation to combine references may be supplied by the direction of the marketplace.

66. I have been informed by Counsel and understand that if a technique has been used to improve one device, and a person of ordinary skill at the time of invention would have recognized that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill.

67. I have been informed by Counsel and understand that practical and common sense considerations should guide a proper obviousness analysis, because familiar items may have obvious uses beyond their primary purposes. I have been informed by Counsel and understand that a person of ordinary skill looking to overcome a problem will often be able to fit together the teachings of multiple

prior art references. I have been informed by Counsel and understand that obviousness analysis therefore takes into account the inferences and creative steps that a person of ordinary skill would have employed at the time of invention.

68. I have been informed by Counsel and understand that a proper obviousness analysis focuses on what was known or obvious to a person of ordinary skill at the time of invention, not just the patentee. Accordingly, I understand that any need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed.

69. I have been informed by Counsel and understand that a claim can be obvious in light of a single reference, without the need to combine references, if the elements of the claim that are not found explicitly or inherently in the reference can be supplied by the common sense of one of skill in the art.

70. In sum, my understanding is that prior art teachings are properly combined where one of ordinary skill having the understanding and knowledge reflected in the prior art and motivated by the general problem facing the inventor, would have been led to make the combination of elements recited in the claims. Under this analysis, the prior art references themselves, or any need or problem known in the field of endeavor at the time of the invention, can provide a reason

for combining the elements of multiple prior art references in the claimed manner. .

E. Definiteness

71. I have been informed by Counsel and understand that a claim is indefinite when, viewed in light of the specification and prosecution history, the claim fails to inform those skilled in the art about the scope of the invention with reasonable certainty. .

F. Written Description

72. I have been informed by Counsel and understand that in order to satisfy the written description requirement, an application must reasonably convey to those skilled in the art that the inventor had possession of and actually invented the claimed subject matter. Moreover, I have been informed by Counsel and understand that this requirement is in place to ensure that the claims do not overreach the scope of the inventor's contribution to the field of art as described in the patent specification. I have been informed by Counsel and understand that the test for adequate written description support requires an objective inquiry into the four corners of the specification from the perspective of a person of ordinary skill in the art and that, based on such inquiry, the specification must describe an invention understandable to that skilled artisan and show that the inventor actually invented the invention claimed. .

G. Enablement

73. I have been informed by Counsel and understand that a patent must enable one of skill in the art to make and use the claimed invention, and that the scope of the claims must be less than or equal to that which is disclosed in the specification plus the scope of what would be known to one of ordinary skill in the art without undue experimentation. I have ben informed by Counsel and understand that a patentee who chooses broad claim language must make sure the broad claims are fully enabled.

74. I have been informed by Counsel and understand that in an *Post Grant* review, “the petitioner shall have the burden of proving a proposition of unpatentability,” including a proposition of obviousness, “by a preponderance of the evidence.” 35 U.S.C. §316(e).

VI. MATERIALS CONSIDERED

75. My analysis and conclusions set forth in this declaration are based on my educational background and experiences in the field (*see* Section II). Based on my knowledge and experience, I believe that I am considered to be an expert in the field. Also, based on my knowledge and experience, I understand and know of the capabilities of persons of ordinary skill in the field around the Critical Date, and I taught, participated in organizations, and worked closely with many such persons in the field during that time frame.

76. As part of my independent analysis for this declaration, I have

considered the following: the background knowledge/technologies that were commonly known to persons of ordinary skill in this art during the time before the Critical Date; my own knowledge and experiences gained from my work experience in the field of the '691 patent and related disciplines; and my experience in working with others involved in this field and related disciplines.

77. In addition, I have analyzed the publications and materials listed above.

78. My analysis and conclusions set forth in this declaration are based on the perspective of a POSITA.

VII. TECHNOLOGY OVERVIEW

79. In this section I provide an overview of the relevant technology and state of the technical community before the Critical Date. This description is not intended to be exhaustive, but to provide sufficient background to support and contextualize my analysis below.

A. DEVELOPMENT OF DISPLAYS

80. The general field of technology of the '691 patent is emissive display panels and more specifically color tunable emissive display panels. The first emissive displays were single color devices based on cathode ray tube (CRT) technology and were commercially introduced in the 1930s. CRTs used a phosphor disposed on the inner surface of a glass vacuum tube. A focused, high

energy electron beam was used to excite the phosphor and cause it to emit light.

81. The first versions of CRT displays used a single phosphor and were not capable of producing multi-color images. The intensity (current) of the electron beam was varied as it was scanned across the phosphor to produce images. Later iterations of this technology used discrete phosphor dots to improve resolution. At this time, mask sets were also used to define black (non-light emitting areas) between pixels.

82. By the 1950s CRT displays that multiple phosphors which emitted red, green, and blue light to allow color displays. These different phosphors were disposed as sub-pixels and arranged in groups of three. The use of discrete red, green, and blue (RGB) emitters inside a pixel allowed production of any color of light within the gamut defined by the individual color pixels.

83. By the 1990s new technologies for color displays were developed including field emission displays (FEDs), thin film electroluminescent displays (TFELDs), plasma displays. All of these technologies used some form of phosphor material to emit light. Field emission displays were based on the same concept as CRT, except that the size of the emitters was scaled down so each sub-pixel included its own electron beam assembly and phosphor.

84. As implied by their name, TFELDs were based on thin films of

materials deposited on a transparent substrate. In TFLEDs, the relevant device structures are created using the same techniques developed for semiconductor integrated circuit manufacturing.

85. By the early 1990s, Liquid Crystal Diodes (LCDs) technology was also in use for displays. Although LCDs do not emit light themselves, when used in conjunction with a light source, they can operate as tunable color filters and be used to create full color displays. Importantly, Thin Film Transistor (TFT) technology was developed for LCD displays which allowed control circuitry to be integrated into the panel of the display itself.

86. Different variations of LCD display technology included reflective (reflected ambient light), transflective (reflected light and allowed light to pass through) and transmissive. Transmissive LCD displays required a backlight to operate. Initial transmissive LCD displays used cold-cathode fluorescent (CCFL) light sources while later iterations (ca. 2010) used LED light sources for a backlight.

87. In 1993, efficient blue Light Emitting Diodes (LEDs) based on inorganic semiconductors became commercially available. As red and green LEDs had been commercially available since at least the 1980s, one of the first commercial uses of blue LEDs was in conjunction with existing green and red

LEDs to produce RGB (color tunable) LED displays. As both LCDs and LEDs are in fact diodes, numerous features of circuit topologies developed for LCD displays could also be used for LED displays with only minor modifications. The notable difference between the circuits was that the electrical current needed to operate LEDs was often much higher and the circuits were external to the display.

88. These types of color display technologies required significant consideration with respect to pixel size which directly impacted the achievable resolution. Additionally, these technologies often needed to consider sub-pixel layout to allow high contrast over short distances to minimize color artifacts at boundary regions between high and low light levels.

89. In particular, the degree to which TFT control circuitry for pixels and sub-pixels overlapped with the pixels and sub-pixels themselves in TFT LCD displays directly correlated with the resolution of the displays. In other words, minimizing the degree to which TFT control circuitry extended past the boundaries of the pixel or sub-pixel (in plan view) enabled production of higher resolution displays.

90. This understanding is evidenced by Fig. 2 of Striakhilev (EX1019) reproduced below which shows the control electrodes for a sub-pixel located substantially under the light emitting region of the sub-pixel.

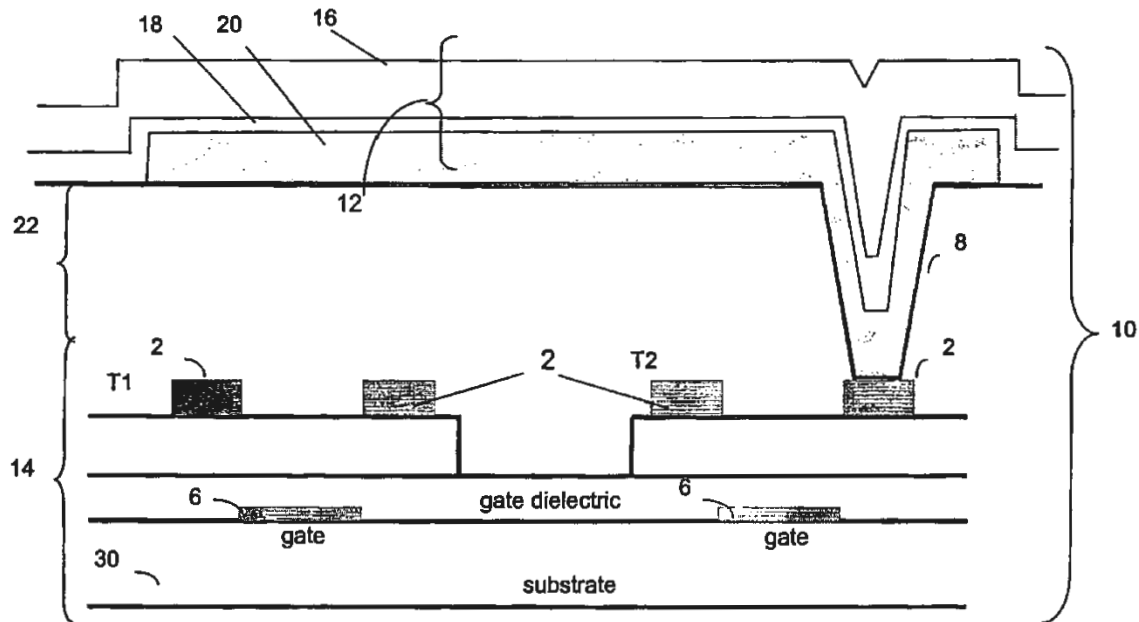


FIGURE 2

EX1019, FIG. 2

B. PIXEL ARCHITECTURE

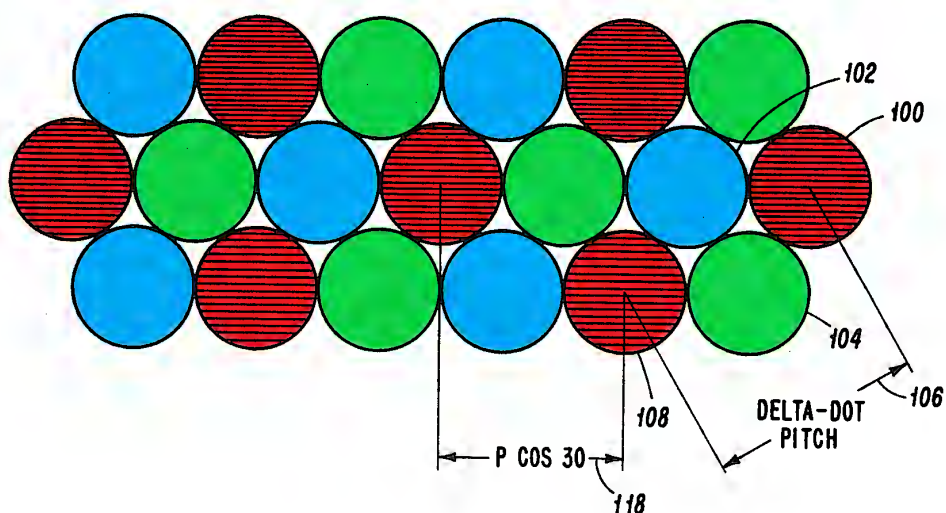
91. As discussed above, early displays were monochromatic (single color). These displays did not include sub-pixels.

92. Later displays with color tuning capability needed to incorporate sub-pixels in order to allow the perceived color of the pixel to be changed. Early versions of color displays used a standard sub-pixel configuration with pixels arranged in a rectangular grid. However, it was realized that higher resolutions could be achieved using multiple sub-pixel configurations and non-rectangular pixel matrices.

93. For example, well before the priority date of the '691 patent,

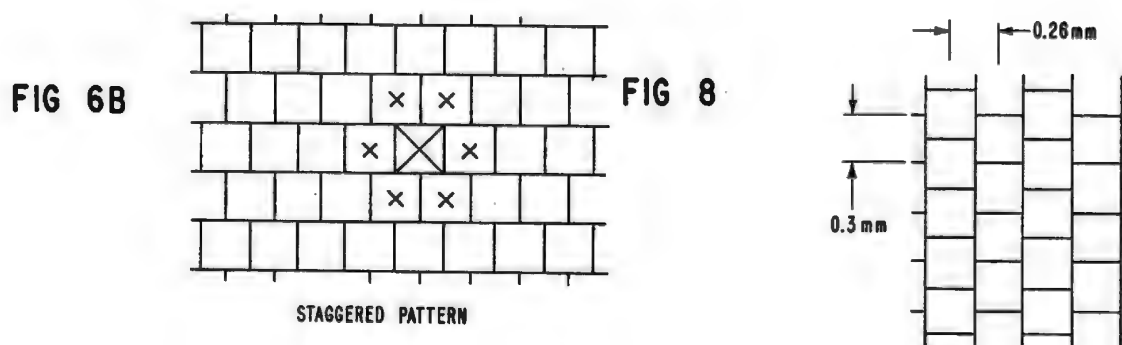
triangular sub-pixel configuration where known. This knowledge is exemplified in the annotated reproduction of Fig. 3A of Strathman (EX1018) below.

FIG 3A



EX1018, FIG. 3A

94. Vertically and horizontally staggered pixel configurations were similarly well known as evidenced by Figs. 6B and 8 of Stratham reproduced below.



EX1018, FIGS. 6B, 8

95. Although the described embodiments of Stratham are CRT displays, a POSITA would have understood that much of the teachings of Stratham are relevant to flat panel matrix displays in general. For example, Stratham describes that its “invention relates to flat panel matrix displays and, in particular, to a flat panel matrix display which emulates a raster scan cathode ray tube (CRT).” EX1018, 1:8-10. As Stratham explains, “[s]ince matrix pixel sizes and spacings are finitely discrete, as opposed to CRTs where analog control of the electron beam(s) allows continuous luminance gradations and analog deflection allows continuous beam(s) positioning, care must be exercised in the design of the matrix so as to preclude unwanted visible matrix structure patterns. It is an object of the present invention to provide improved flat panel matrix displays (i.e., active matrix LCDs), which have resolution acceptable for avionic applications.” EX1018, 1:42-52.

96. Other, similar pixel arrangements were also well known. The annotated version of Fig. 42B of Elliott (EX1017) shows a pixel matrix in which the two pixel configurations are arranged in a checkerboard type pattern.

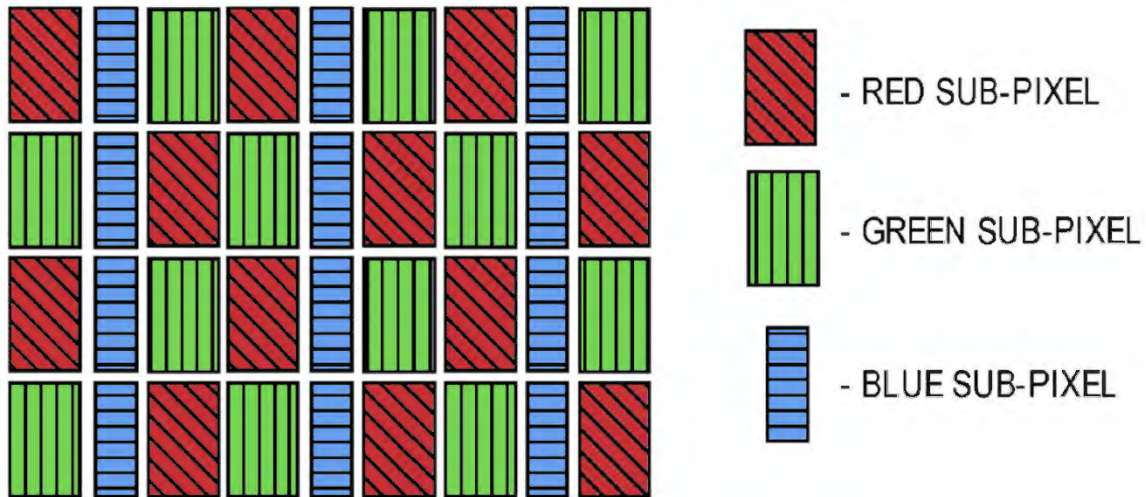


FIG. 42B

EX1017, FIG. 42B

97. Further, a POSITA would have been aware that other alternating sub-pixel configurations were possible and desirable as evidenced by the annotated versions of Figs. 18A-18B of Credelle (EX1020) shown below.

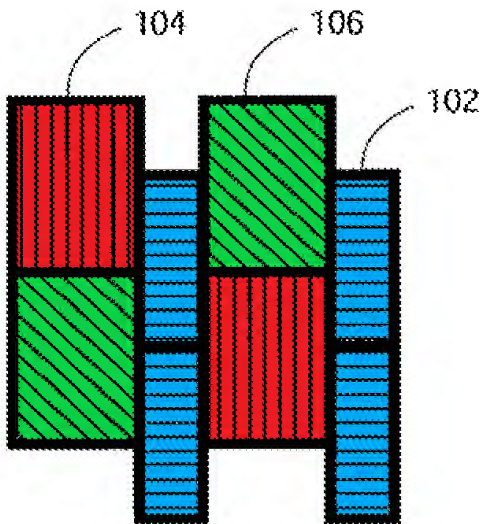


FIG. 18A

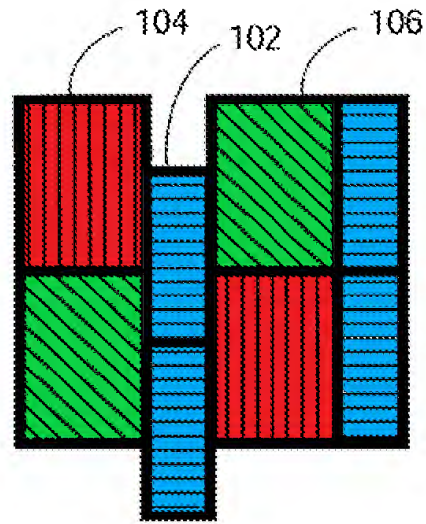


FIG. 18B

EX1020, FIGS. 18A, 18B

98. Indeed, Credelle teaches “As subpixel shapes may vary under the scope of the present invention, so too may the exact positions of the subpixels be varied under the scope of the present invention. For example, FIGS. 18A and 18B depict a similar octal subpixel grouping wherein one or both of the majority stripes 102 are offset (relatively or otherwise) from the other subpixels 104 and 106. Other vertical offsets are also possible.” EX1020, 4:21-27.

99. The concept of using sub-pixel rendering was exceptionally well known to a POSITA well before the priority date of the ‘691 patent. At least as early as 2012, overview papers were being published discussing the benefits of

sub-pixel rendering. Such papers included specific references to sub-pixel technology being used in the Apple II computer ca. 1992. “About 20 years ago, the Apple II personal computer Introduced a proprietary high-resolution LCD graphics display, in which each pixel has two vertical stripe subpixels with green and magenta colors, respectively. Without subpixel technology, a diagonal white line on Apple II display could only be drawn using “whole” white pixels composed of a paired green and purple subpixels, as shown in Fig. 1(a) [3]. Thanks to Apple’s built-in subpixel technology, white pixels are often composed of adjacent subpixels to yield a much smoother result, as shown in Fig. 1(d).” EX1022, [Fang2012 p1].

VIII. THE ‘691 PATENT

A. Overview of the ‘691 patent

100. Based on my review, the ’691 patent is directed to a display device that includes pixels having “different arrangements of subpixels and reducing a color edge.” EX1001, Abstract.

101. In the Background section, the ’691 patent states as a goal to “secure an opening ratio (aperture ratio) at a high resolution in an OLED display device.” EX1001, 1:21-36. The ’691 patent describes prior attempts to achieve this goal by using “a pixel array where columns including alternately-arranged subpixels of red and green and columns including subpixels of blue are alternately arranged” in

particular citing a previously published Japanese Patent Application Laid-Open No 2011-249334 (which the '691 patent refers to as "Patent Document 1"). EX1001, 1:21-36. The Background of the '691 patent explains that "the pixel array of Patent Document 1 is a pixel array including two types of pixels having different arrangements of subpixels of blue in the pixels. In a display device having such a pixel array, for example, in a case a black letter is displayed on white background, the edge of the letter may seem to be slightly colored" (a problem referred to as "color edge" in the '691 patent). EX1001, 2:21-26.

102. According to the '691 patent, it proposes to resolve this problem of color edge by using a "luminance allocation unit" that allocates "luminance" to different subpixels according to a "predetermined ratio." EX1001, Abstract.

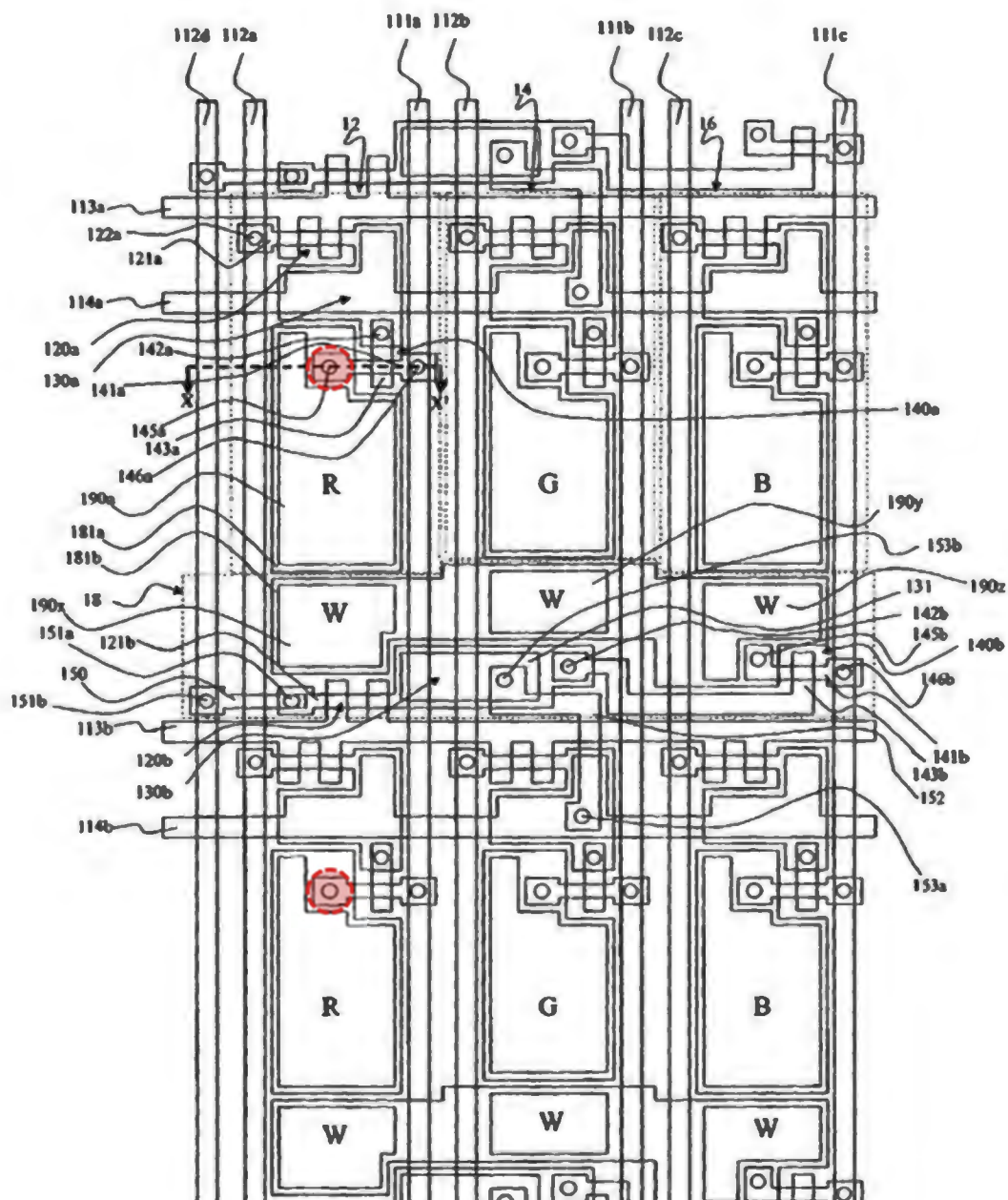
103. However, based on my review, the claims of the '691 patent say nothing of this allegedly novel feature of controlling "luminance." Rather, the claims merely describe the decades-old well-known structure of "alternately arranged" subpixels as described above. In fact, the '691 patent itself acknowledges this type of structure as being prior art (e.g., in the Background discussed above). As such, the claims of the '691 patent are not directed to the alleged novelty of the patent, but instead merely describe well-known features of pixel and subpixel arrangements and underlying subpixel circuitry, all of which

were notoriously well-known in the art prior to the Critical Date. More specifically, the ability to control luminance is both *necessary* and *required* for any display.

B. Prosecution History of the ‘691 patent

104. During prosecution, I note that the claims were amended extensively to overcome rejections in seven different Office Actions. The Examiner issued a notice of allowance on January 7, 2025, indicating as the only allowable subject matter the limitation “*a biased position where the connection part of the subpixel of the first color in the first pixel is disposed with respect to the middle of the long axis of the subpixel of the first color in the first pixel when viewed from the row direction is relatively different from a biased position where the connection part of the subpixel of the first color in the second pixel is disposed with respect to the middle of the long axis of the subpixel of the first color in the second pixel when viewed from the row direction*” (labeled [1.12] in Section X.C). EX1002, Notice of Allowance, p. 7. The Examiner explained that Cok’694 (EX1015) does not disclose the claimed “*relatively different*” positioning of connection parts in first and second pixels in [1.12], and that Cok’694 instead discloses “the connection part 145a for the blue subpixel is placed at relatively the same position with respect to the middle of the long axis of the subpixel.” EX1002, Notice of Allowance, p. 7; EX1015 (Cok’694), FIG. 12. I have reproduced FIG. 12 of Cok’694 below, for

reference (with color added to highlight the connection part 145a of the red subpixel).



EX1015 (Cok'694), FIG. 12 (annotated and color added)

105. However, as I explain below, limitation [1.12] and its claimed

“*relatively different*” positioning of connection parts in different pixels was well-known in the art, as demonstrated in Hwang (EX1005) as well as other references such as Kim’792 (EX1009).

106. Based on my review of the prosecution history, I did not see anywhere the Examiner considering Hwang (EX1005) during examination. I note that the Examiner cited Lee (EX1006) in an Office Action dated March 25, 2022 as being “relevant” (explaining that it “illustrates the overlapping connecting structure” in regard to the then-claimed limitation “*a position where the at least one connection part is disposed overlaps with one of the subpixels in a plan view*”). However, it appears the Examiner never used Lee in any formal rejection of the claims.

Park’531 (EX1007) was cited by the Examiner in an Office Action dated Oct. 26, 2021 for “its disclosure of the arrangement of subpixels in different pixels” (citing FIG. 3 of Park’531), and was relied upon by the Examiner as a fourth reference in an obviousness rejection in an Office Action dated March 10, 2023 as disclosing the feature now recited in claim 7, which Applicant cancelled from the independent claims without overcoming the rejection over Park’531. EX1002, Office Action dated Oct. 26, 2021 and Office Action dated March 10, 2023.

107. Moreover, as discussed above, a POSITA would be aware of the desirability for connection parts to overlap portions of subpixels as this allows the

spacing between adjacent subpixels and pixels to be minimized which allows an increase in the resolution of a display.

108. More specifically, as I discuss below, Hwang and Lee render obvious claims 1-6 and 8, and, further in view of Park'531, render obvious claim 7.

IX. OVERVIEW AND COMBINATIONS OF PRIOR ART REFERENCES

A. Overview of Hwang

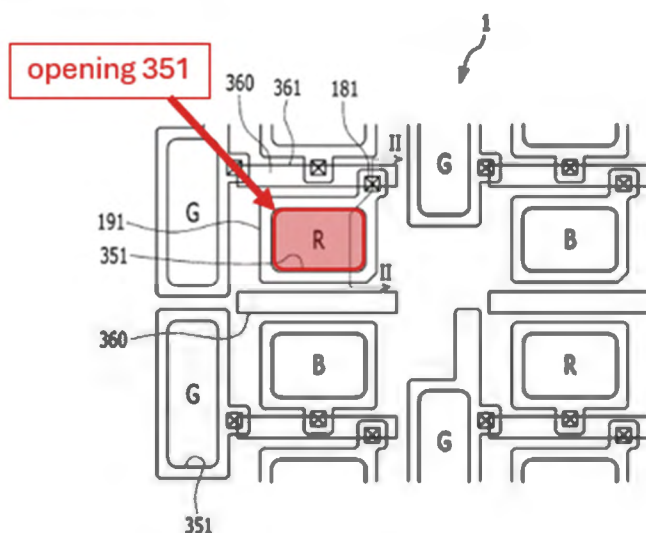
109. Hwang is analogous art to the '691 patent because, like the '691 patent, Hwang is directed to a display device, such as an organic light emitting diode (OLED) display device, that displays images by combining at least three colors emitted from an arrangement of pixels. EX1005, Abstract, [0005], [0007]; EX1001, Abstract, 1:21-36.

110. Hwang describes a “display device” (e.g., an “OLED display device”) implementing a “display panel 1.” EX1005, [0005], FIG. 7. Hwang's display panel includes an arrangement of “organic light emitting elements 70” each connected to respective circuitry to emit different colors, such as red, green, and blue. EX1005, [0007], [0008], [0040], [0041].

111. Each of Hwang's light emitting elements emits light through an “opening 351” in an upper layer of the display panel, defining a “pixel area” which is a light-emitting region of each pixel. EX1005, [0046], FIGS. 1, 2.

Hwang

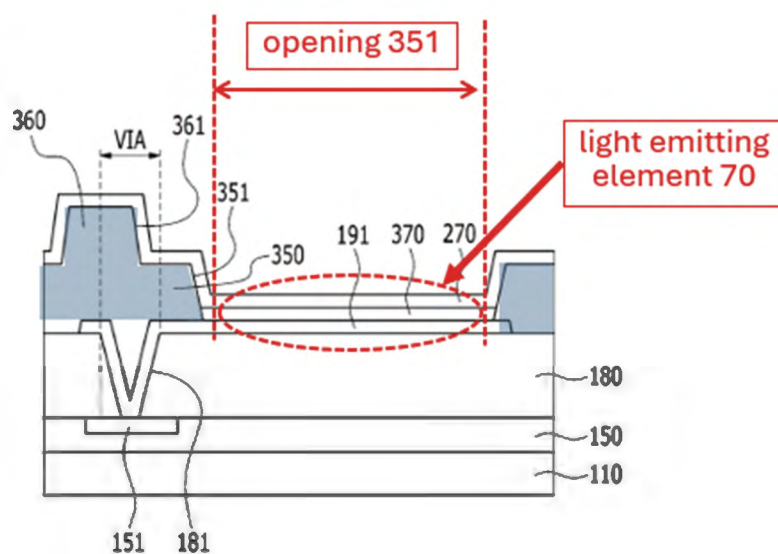
FIG. 1



EX1005, FIG. 1 (annotated and color added)

Hwang

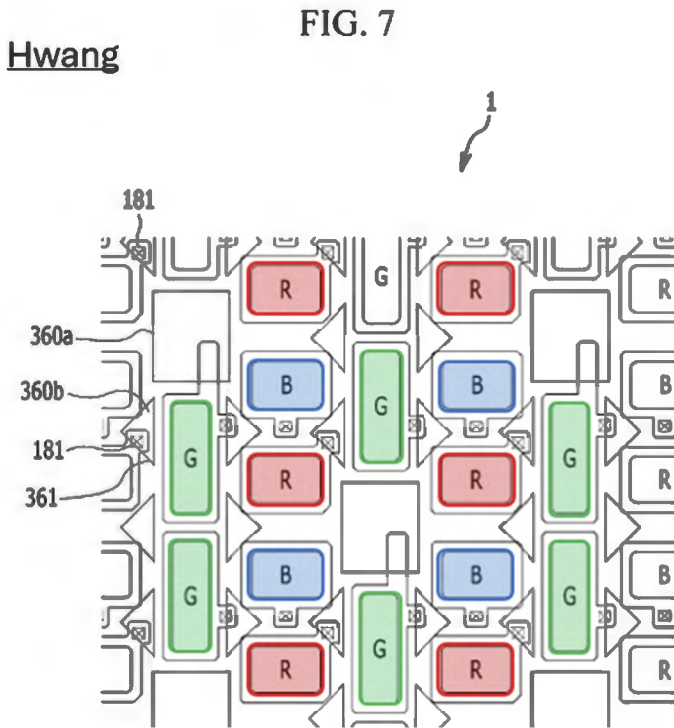
FIG. 2



EX1005, FIG. 2 (annotated and color added)

112. Three pixels of different colors (red pixel R, green pixel G, blue pixel B) are “regularly arranged” in an alternating manner in vertical and horizontal

directions. EX1005, [0057]-[0059], FIG. 7.

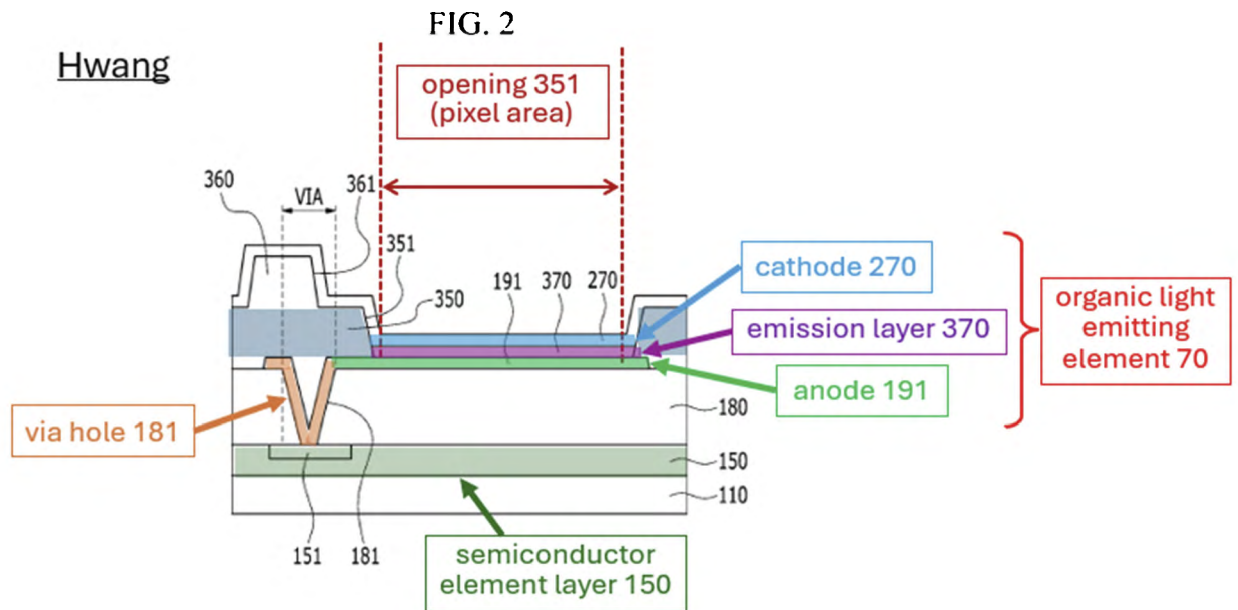


EX1005, FIG. 7 (annotated and color added)

113. Specifically, the red and blue pixels (R, B) are “alternately arranged in a vertical direction” and the green pixel (G) is “arranged at one side” of the red and blue pixels R, G. EX1005, [0058], [0059], [0074], FIG. 7. The green pixel G is “continuously arranged in the vertical direction” and “a column of the green pixel G and a column where the red pixel R and the blue pixel B are arranged may be alternately arranged.” *Id.* The green pixel G is “longer” in the vertical direction than the red and blue pixels R, B. *Id.*

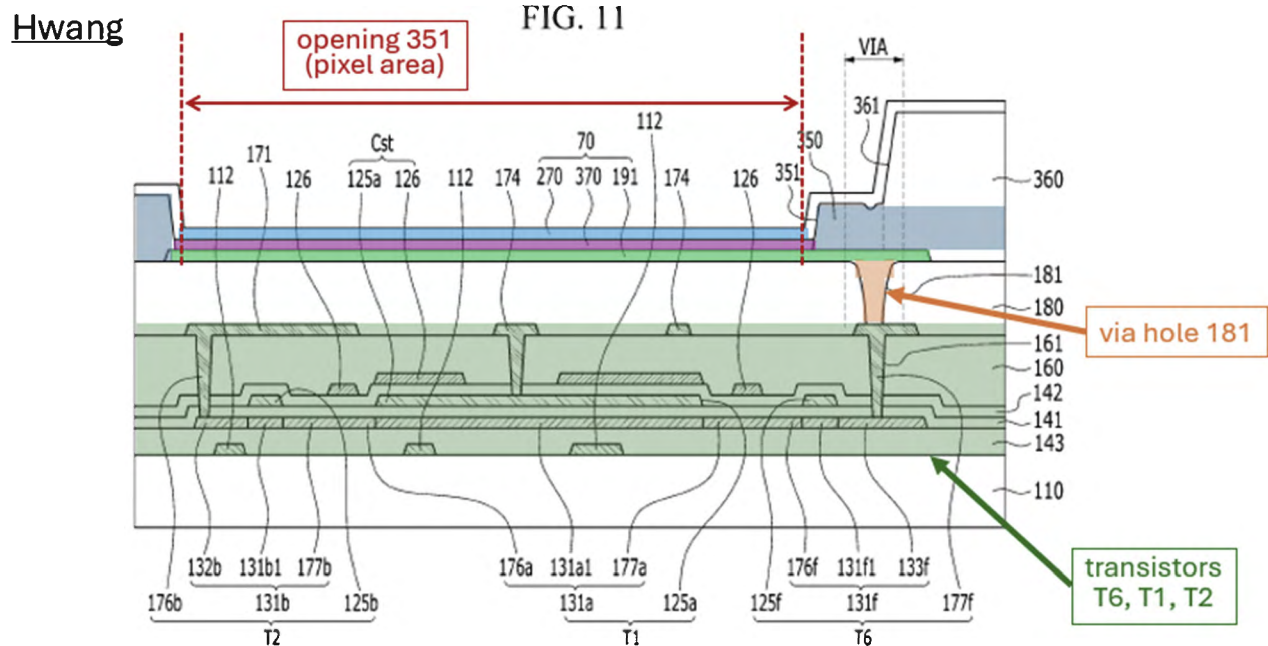
114. Each of Hwang’s light emitting elements is driven by a

“semiconductor element layer 150” disposed under and connected to an anode 191 of the light emitting element through a “via hole 181.” EX1005, [0040], [0043], FIG. 2.



EX1005, FIG. 2 (annotated and color added)

115. Hwang’s semiconductor element layer 150 includes interconnected transistors, such as a driving transistor T1 and switching transistor T2, that provide various signals to the pixel. EX1005, [0121], [0081], [0083], FIG. 11.



EX1005, FIG. 11 (annotated and color added)

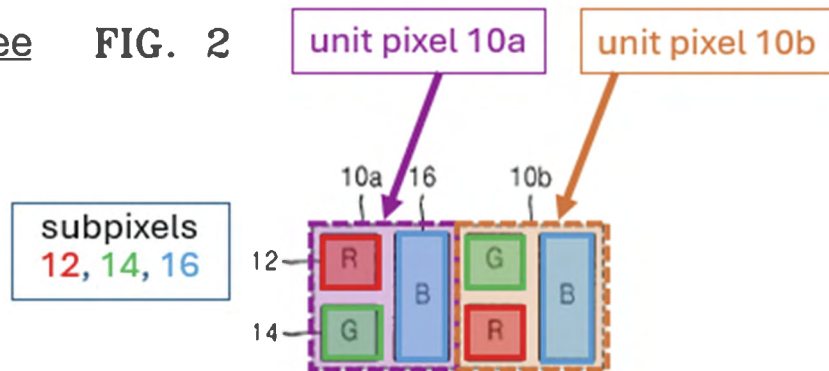
B. Overview of Lee

116. Lee is analogous art to the '691 patent because, like the '691 patent, Lee is directed to a display device, such as an organic light emitting diode (OLED) display device, that displays images by combining at least three colors emitted from an arrangement of pixels. EX1006, Abstract, [0006],[0007], [0048]; EX1001, Abstract, 1:21-36.

117. Lee's display device includes a "pixel arrangement" with two types of unit pixels, "unit pixels 10a and 10b." EX1006, [0049], FIGS. 1, 2. Each unit pixel is formed of three sub-pixels 12, 14, and 16 that emit different colors (e.g., red, blue, green) and are "alternately and repeatedly arranged in a row direction."

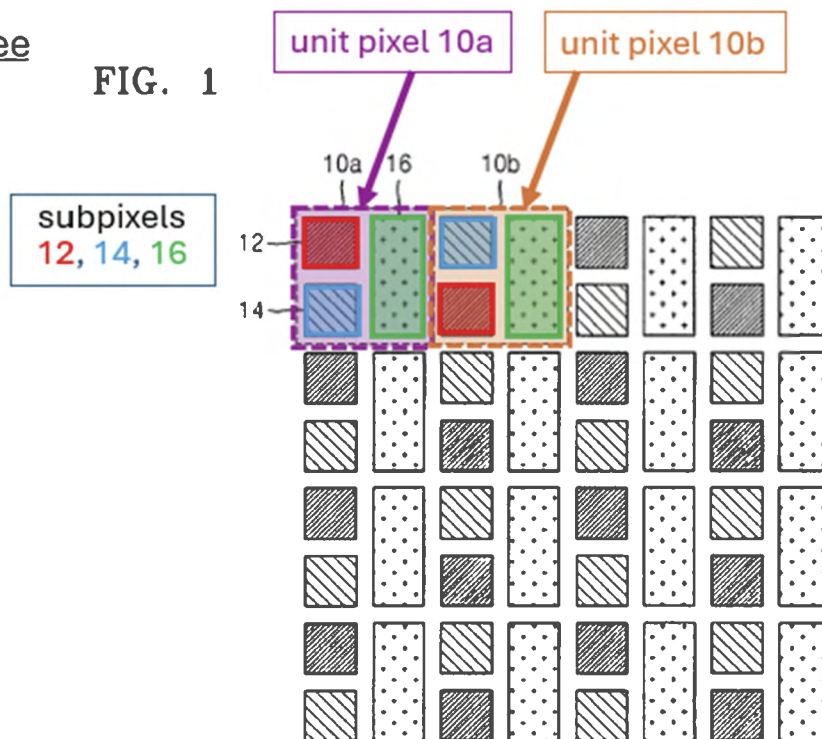
EX1006, [0049]-[0053], FIGS. 1-4.

Lee **FIG. 2**



EX1006, FIG. 2 (annotated and color added)

Lee FIG. 1

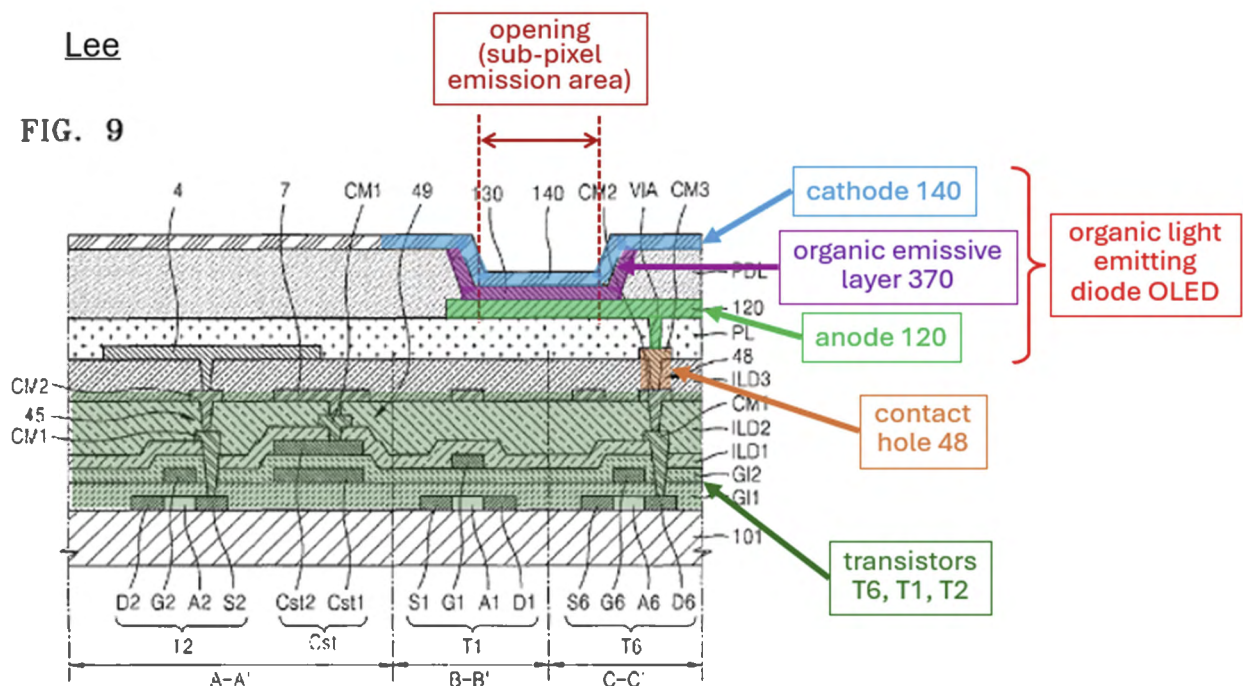


EX1006, FIG. 1 (annotated and color added)

118. Lee's unit pixels 10a and 10b are distinguished by the specific arrangement of the three sub-pixels (12, 14, 16) in each unit pixel. EX1006,

[0050]-[0051], FIG. 1. In particular, “positions of the first and second sub-pixels 12 and 14 of the first unit pixel 10a are opposite to those of the first and second sub-pixels 12 and 14 of the second unit pixel 10b.” *Id.* The first and second sub-pixels 12 and 14 “have the same size” and can be arranged in either “a left column or a right column” of each of unit pixel 10a, 10b. *Id.* The third sub-pixel 16 “has a height that is more than two times” that of the first or second sub-pixel 12, 14 in the column direction, and can be arranged in the other of the “right column or a left column” of each unit pixel 10a, 10b. *Id.*

119. Each of Lee’s sub-pixels (12, 14, 16) emits light through an “opening” in an upper layer of the display device, defining an “emission portion” of each sub-pixel. EX1006, [0112], FIG. 9.



EX1006, FIG. 9 (annotated and color added)

120. Each of Lee's sub-pixels (12, 14, 16) includes an organic light emitting diode (OLED) driven by a "pixel circuit" including various transistors (T6, T1, T2) disposed under and connected to an anode 120 of the OLED through a "contact hole 48." EX1006, [0110]-[0111], FIG. 9.

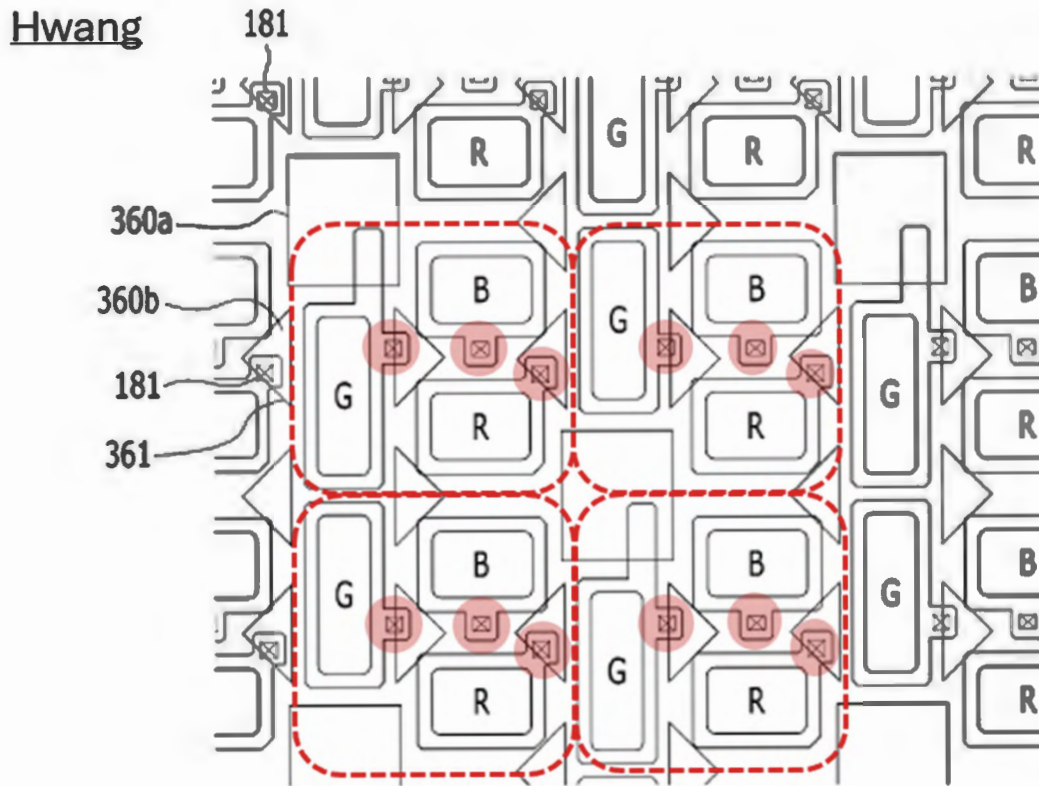
C. Combination of Hwang and Lee

121. Lee provides further details of features already disclosed in Hwang, such as details of grouping of sub-pixels into pixels and details of certain aspects of pixel circuitry.

122. As discussed above, Hwang provides a foundational teaching of the well-known concept that display devices, including OLED devices, display images by combining pixels of three "primary colors" (red, blue, green) to display full-color images. EX1005, [0007] (Hwang's OLED display can "express full colors by combining the pixels" of the three primary colors), [0040] (Hwang's red, blue, and green pixels are "regularly arranged" and "display a desired image by a spatial sum of the colors."). As discussed above, Hwang's three-colored pixels are alternately arranged in a regular repeating pattern. EX1005, [0058], [0059], [0074], FIG. 7.

123. Moreover, in Hwang's pixel arrangement, groups of three adjacent pixels (R, G, B) each have a respective "pixel electrode 191" that is "protruded toward a space between" the three pixels, "thereby being connected to electrode

151 of semiconductor element through the via hole 181.” EX1005, [0038], [0039], [0043], [0044], FIG 7 (reproduced below).



EX1005, FIG. 7 (annotated and color added)

124. Based on these teachings of Hwang, a POSITA would have understood or found obvious that every three adjacent Hwang pixels are grouped according to their pixel electrodes 191 protruding into a space between the three pixels for connecting to electrode 151. Based on my knowledge and experience, I understand it was common to group R, G, and B color emission components into a pixel in display technology at the time of the '691 patent. The background of the '691 patent itself recognizes that “[d]isplay devices displaying a color image by

using pixels configured by combining subpixels of three colors that are red, green, and blue have been used.” EX1001, 1:21-23; 1:33-36 (“In an OLED display device, a color image is displayed by combining subpixels of, for example, three colors that are red, green, and blue. Herein, each subpixel emits light of any one of red, green, and blue.”). With this background and a POSITA’s knowledge of the well-known technique of grouping R, G, and B light emitting elements into pixels in a display at the time of the ’691 patent, a POSITA reviewing Hwang would have understood or found obvious that Hwang’s display includes pixels of R, G, B groupings as shown above in the annotated version of FIG. 7. Electronic displays generally work by providing a matrix of “pixels,” each of which emit light. EX1021, 6. By controlling the light emitted by each pixel, these displays can generate images. *See id.* For color displays, each pixel typically comprises “sub-pixels” each of which is responsible for emitting light of a particular color on command. *See, e.g., id.* at 20-21.

125. Lee provides further details for implementing such a grouping. A POSITA would have turned to Lee and its teaching of combining subpixels into “unit pixels” for further details of grouping Hwang’s pixels into groups of three R, G, B elements. As discussed above, Lee teaches a “pixel arrangement” that groups subpixels of the three primary colors (red, blue, green) into “unit pixels” 10a and

10b. The two types of unit pixels 10a, 10b are distinguished by the specific arrangement of the three primary-colored sub-pixels in each unit pixel. EX1006, [0050]-[0051], FIG. 1.

126. As explained below in more detail, I believe that combining Hwang and Lee would have been obvious at least because such a combination would have merely involved (1) combining prior art elements according to known methods to yield predictable results; and the (2) use of known techniques to improve similar devices in the same way.

127. Given the extensive similarities between Hwang and Lee, a POSITA would have understood that Hwang and Lee are compatible. Sections IX.A and IX.B, *supra*. Lee merely provides explicit teachings and further details for what Hwang would have already conveyed to a POSITA, namely that Hwang's pixels of three primary colors (R, G, B) should be grouped.

128. The resulting Hwang-Lee combination is shown below.

Hwang-Lee

FIG. 7

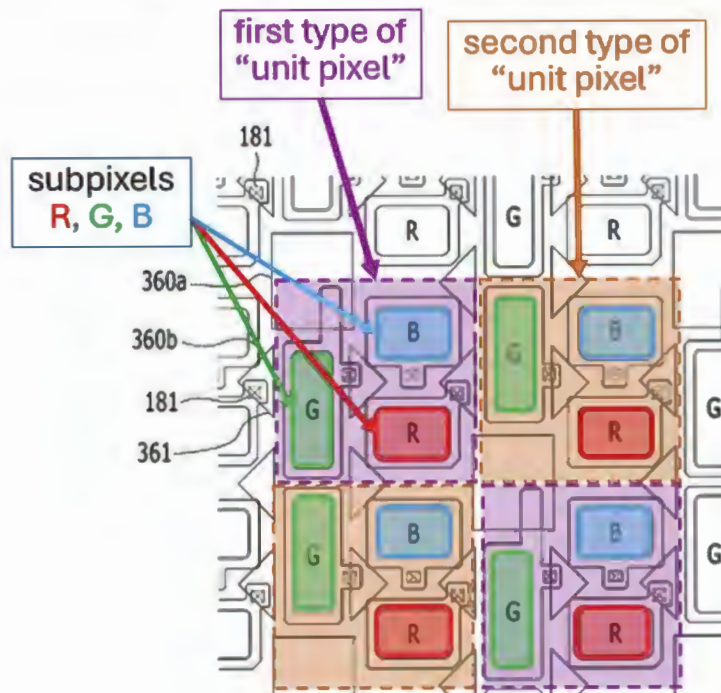


Diagram A (the Hwang-Lee combination)

129. Lee explains a benefit of this two-dimensional pixel grouping arrangement (compared to a linear “stripe arrangement”) is to reduce the size of a “black matrix” and achieve higher “aperture ratio” for improved display resolution. EX1006, [0052], [0082], [0134], [0135], [0006]-[0008]. This is aligned with, and would ensure, Hwang’s stated goal of achieving “a high resolution organic light emitting device” and “improving display quality.” EX1005, [0103], [0109].

130. The resulting Hwang-Lee combination would not require any structural or functional modifications to Hwang’s display device. Instead, the Hwang-Lee combination merely makes explicit to a POSITA what would have

already been understood to be at least implicitly disclosed or rendered obvious by Hwang, namely that Hwang's pixels of three colors (R, G, B) would have been grouped together based on their electrode connectivity and arrangement.

131. Furthermore, although Hwang and Lee use different terminology when referring to the same light-emitting structure, namely Hwang's terminology "pixel" and Lee's terminology "subpixel," based on my knowledge and experience, I understand that a POSITA would have known it was common in the art to interchangeably use the terms "pixel" and "subpixel" when referring to the structure above as a smallest light-emitting unit of a display device. *See, e.g.*, Cok'123, EX1012, [0003] as explaining that pixels and sub-pixels "are **not distinguished herein**" and that "**all light-emitting elements are called pixels,**" Kim'792, EX1009, [0036] as using the term "**pixel**" in the same manner as Hwang and explaining that a pixel refers to "**a minimum unit**" for displaying an image," Song, EX1013, [0040]-[0041], [0045], describing pixels that can each emit one of three different colors. Also, I note that during prosecution of the '691 patent, the Examiner and Applicant both acknowledged prior art disclosures of "pixels" as disclosing the same structural element as the claimed "subpixels". For example, in an Office Action dated August 4, 2022, the Examiner relied on Kim'834 (EX1008) and its disclosure of "pixels" to map to the claimed "subpixels". Similar to

Hwang, Kim'834 does not use the term "sub-pixels" but instead uses the term "pixels" to refer to an equivalent concept. Nonetheless, the Examiner asserted that Kim'834's "pixels" disclosed the claimed "subpixels of the three colors."

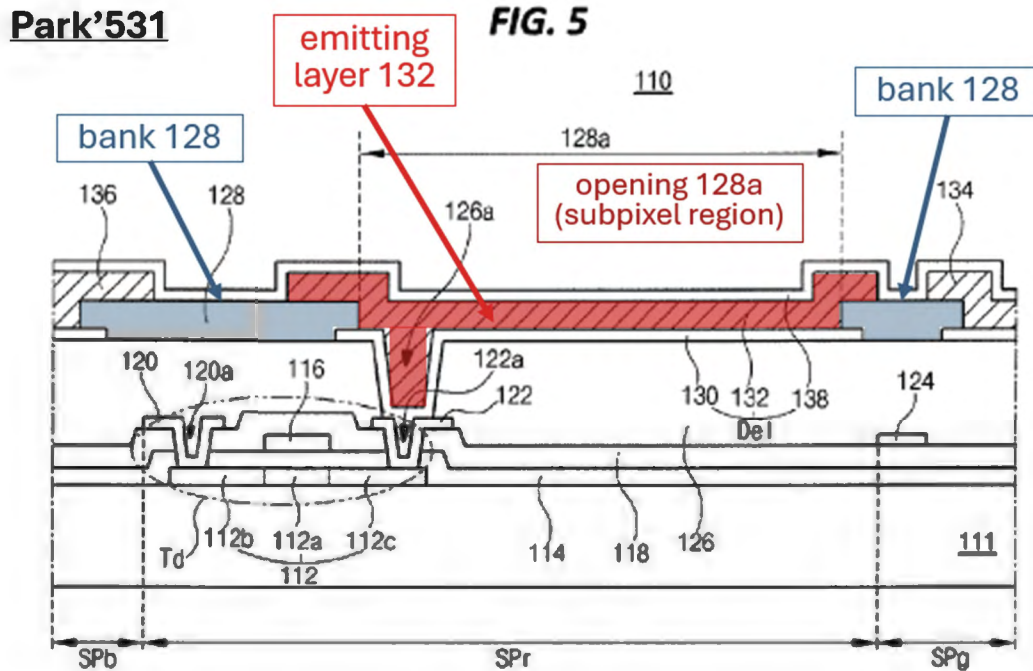
EX1002, Office Action dated Aug 4, 2022, page 3. The Applicant did not dispute the Examiner's mapping of the Kim'834 pixels to the claimed "subpixels." As another example, in a subsequent Office Action dated March 10, 2023, the Examiner cited Sung (EX1014) and its colored "pixels" as disclosing the claimed "subpixels." As with Hwang and Kim'834, Sung does not use the term "subpixels" but instead uses the term "pixels" to refer to an equivalent concept. Nonetheless, the Examiner cited paragraph [0084] of Sung and its disclosure of "blue pixels" to reject the claimed "subpixel of a first color." EX1002, Office Action dated Mar 10, 2023, page 6. Again, the Applicant did not dispute the Examiner's mapping of Sung's pixels to the claimed "subpixels."

132. Both Hwang and Lee are directed to OLED devices that implement an arrangement of pixels with alternating and repeating patterns of differently-colored light emitting elements. The combination would have simply involved incorporating the teachings of Lee into the compatible teachings of Hwang, thus, for at least this reason, making the Hwang-Lee combination predictable and foreseeable with a reasonable expectation of success.

D. Overview of Park’531

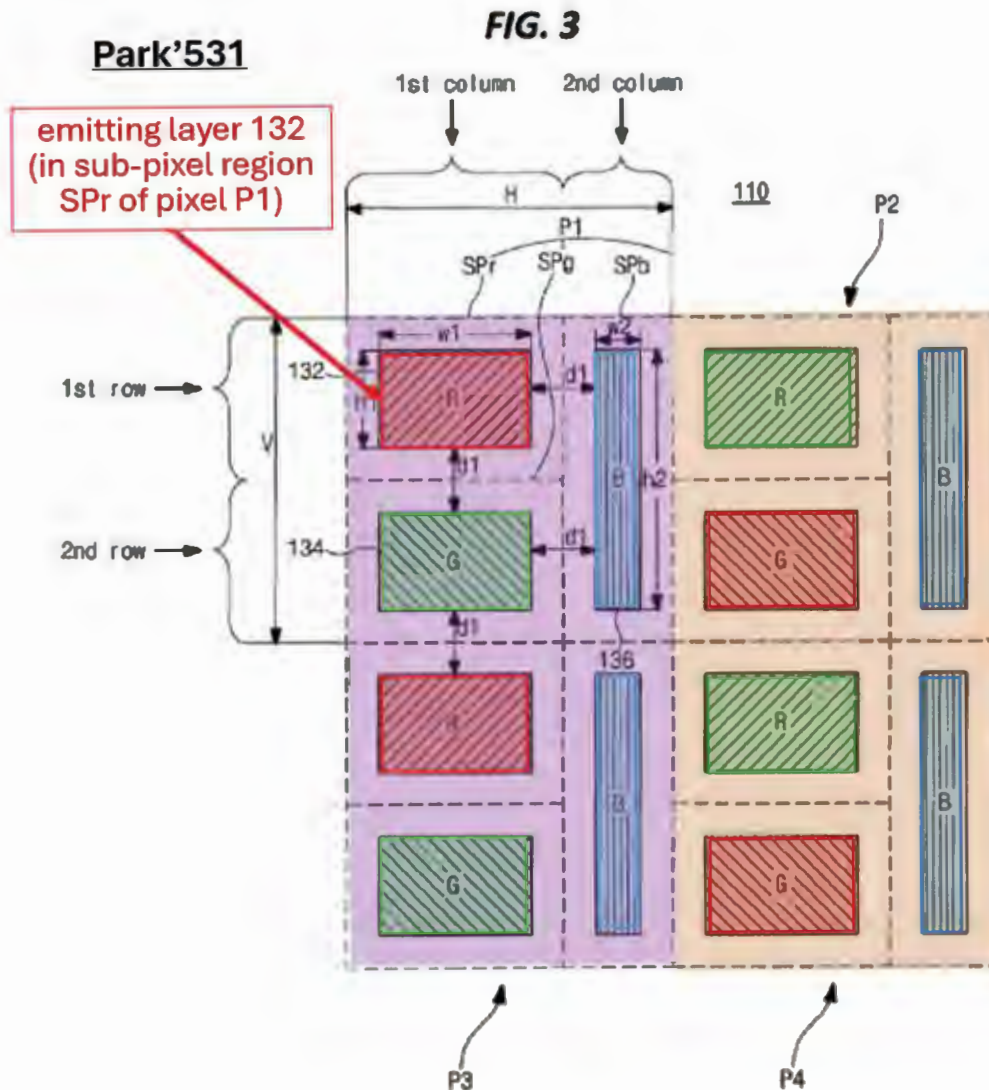
133. Park’531 is analogous art to the ’691 patent because, like the ’691 patent, Park’531 is directed to an organic electroluminescent display (OLED) device that displays images by combining three primary colors emitted from an arrangement of pixels. EX1007, Abstract, [0003],[0005], [0009]; EX1001, Abstract, 1:21-36.

134. Park’531 discloses details of fabricating an “emitting layer” of an individual “sub-pixel” in an OLED display device. EX1007, [0005], [0012], [0015], [0048], [0070], [0074]-[0079], [0080]-[0082]. In particular, Park’531 explains a well-known technique of “thermal deposition using a shadow mask” (e.g., the shadow mask can be a “metal plate”). EX1007, [0012]. The metal shadow mask has numerous “opening portions” through which an “emitting material” is deposited onto a sub-pixel region. EX1007, [0012], [0047], [0080]-[0082], [0094]. In particular, the emitting material is deposited into an “opening” of a “bank,” where the sub-pixel is to be formed. EX1007, [0047]-[0049]. As a result, by using a metal shadow mask and thermal deposition, an emitting layer can be formed for a sub-pixel. *Id.* Park’531 provides an example of the resulting emitting layer of a sub-pixel, in FIG. 5 (a cross section view of a single sub-pixel region), which illustrates a result of emitting layer 132 deposited onto an opening 128a of a bank 128. EX1007, FIG. 5.



EX1007, FIG. 5 (annotated and color added, showing a single subpixel region)

135. By repeating this thermal deposition process for different sub-pixel regions, Park'531 discloses a resulting matrix of “pixel regions” (e.g., P1, P2, P3, P4 in FIGS. 3 and 8) where each pixel region includes “red, green and blue sub-pixel regions” (SPr, SPg, SPb). EX1007, [0041]-[0043], [0057], [0086]-[0091], FIGS. 3, 8. Each pixel region has a “rectangular shape” in which red and green sub-pixels (SPr, SPg) are “alternately arranged with each other in a first column” and the blue sub-pixel (SPb) is “arranged in a second column.” EX1007, [0043], [0087], FIGS. 3, 8.



EX1007, FIG. 3 (annotated and color added)

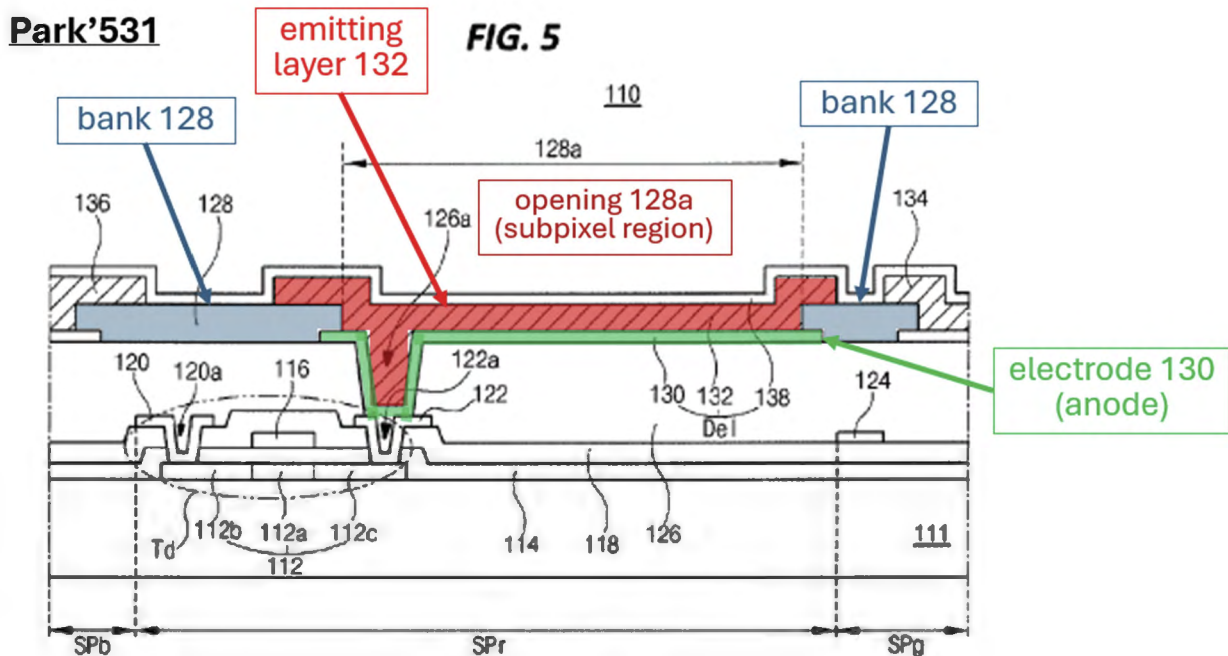
136. Notably, Park'531 provides insight into a distinction between the actual area of emitting layer 132 as compared to the area of the emitting layer 132 shown in the plan view of FIG. 3. EX1007, [0012]-[0013], [0048], [0070], FIGS. 3, 8. In particular, Park'531 explains that "[a]n area of the red, green and blue emitting layers 132, 134 and 136 **may be larger** than that in FIG. 3." EX1007,

[0013], [0048], FIGS. 2, 3, 5. The reason for this distinction, Park’531 explains, is that FIG. 3 only shows “an area of the red, green and blue emitting layers 132, 134 and 136 corresponding to the **overlapped portions** of the first and second **electrodes 130 and 138.**” *Id.* Park’531 refers to this area of the emitting layers that overlaps the electrodes as the “**effective emitting portion**” and Park’531 clarifies that the “emitting layers 132, 134 and 136” that “**are shown**” in FIG. 3 are actually the “effective emitting portions.” EX1007, [0048], FIGS. 3, 5; *see also* [0013], FIG. 2.

137. Further, a POSITA would understand that it is necessary for the organic layers of an OLED to extend beyond at least one electrode to prevent the possibility of the electrodes making contact which would result in an electrical short circuit and prevent the OLED from functioning.

138. In more detail, Park’531 explains that there is only “a **portion** of each of the **emitting layers** 132, 134 and 136, which **contacts** the first **electrode** 130, such that **the portion** of the each of the **emitting layers** 132, 134 and 136 **emits light.**” EX1007, [0070]. Therefore, Park’531 explains the “important fact” that when determining measurements such as “an aperture ratio” of the emitting layers (132, 134, 136), only the “**exposed area** of the first **electrode** 130 **through the opening 128a** of the bank 128” should be considered, and “[a]ccordingly, the red,

green and blue **emitting layers** 132, 134 and 136 **corresponding to the opening**
128a of the bank 128 **are shown in FIG. 3.”** *Id.*



EX1007, FIG. 5 (annotated and color added)

139. In view of these disclosures, a POSITA would have understood that the plan view illustrations of sub-pixel arrangements in Park'531 (e.g., FIGS. 3, 8) only illustrate a portion of the emitting layer 132 which contacts the electrode 130 which is exposed through the opening 128a, and that the actual emitting layer 132 may be larger than this exposed portion.

E. Combination of Hwang-Lee and Park's

140. A POSITA would have understood that the teachings of Park’531, discussed above, are highly relevant to Hwang-Lee’s display device. As discussed

in Sections IX.A -D, above, both Hwang-Lee and Park'531 are directed to OLED display devices that implement an arrangement of alternating pixels, each of which includes different arrangements of sub-pixels of three colors.

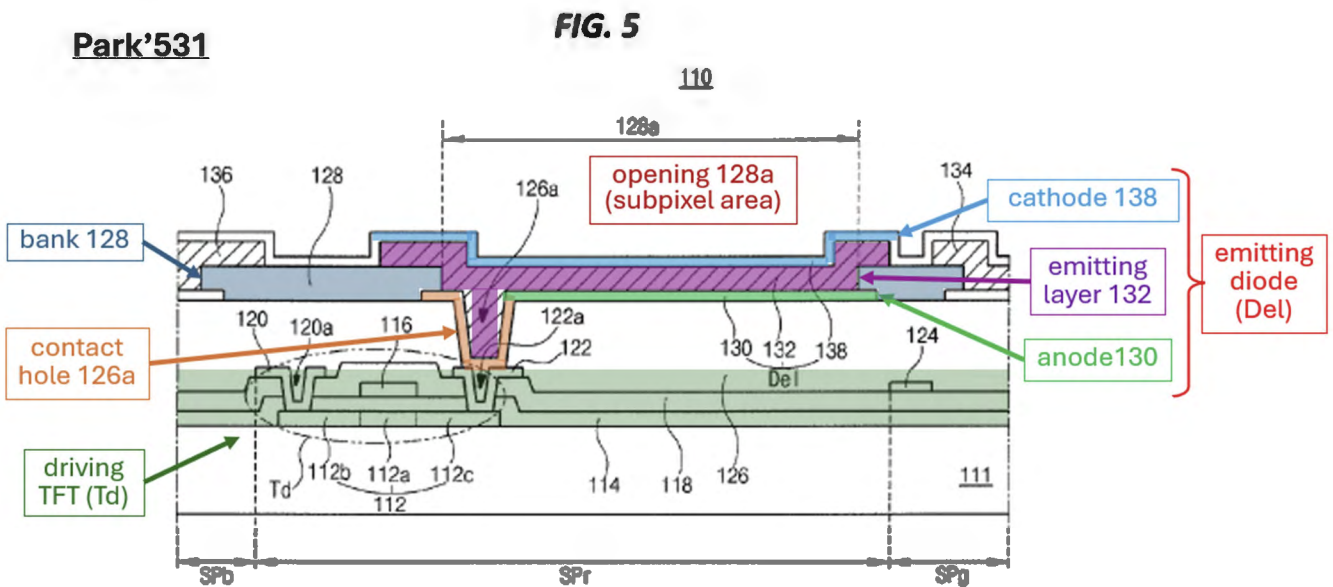
141. As discussed in Section IX.A-C, above, Hwang-Lee describes how to design and implement the overall arrangement of pixels and sub-pixels in an OLED display device, as well as the underlying pixel circuitry.

142. Park'531 supplements Hwang-Lee by providing further details and design considerations for specifically fabricating the “emitting layer” (Hwang’s “emission layer 370”) of each individual sub-pixel, as discussed in Section IX.D, above.

143. As I explain below in more detail, combining Hwang-Lee and Park'531 would have been obvious at least because such a combination would have merely involved (1) combining prior art elements according to known methods to yield predictable results; and the (2) use of known techniques to improve similar devices in the same way.

144. Similar to Hwang-Lee, Park'531 discloses an alternating arrangement of pixels, where each pixel includes red and green sub-pixels (SP_r, SP_g) that are “alternately arranged with each other in a first column” and the blue sub-pixel (SP_b) is “arranged in a second column.” EX1007, [0043], [0087], FIGS. 3, 8.

145. Furthermore, Park'531 provides details of the cross-sectional structure of each sub-pixel, in FIG. 5, which are similar to Hwang-Lee, such as a “substrate 111,” a “driving TFT Td” over the substrate 111, and an “emitting diode Del” (including the emitting layer 132) that is “connected to the driving TFT.” EX1007, [0058], FIG. 5.



EX1007, FIG. 5 (annotated and color added)

146. Similar to Hwang-Lee, Park'531 discloses a “bank 128” formed with an “opening 128a” that exposes a portion of an “emitting diode (Del)” which includes a “first electrode 130” (functioning as an anode), a “second electrode 138” (functioning as a cathode), and an “emitting layer 132” therebetween. EX1007, [0066]-[0071], FIG. 5. The first electrode 130 (anode) of the emitting diode Del is connected to a “drain electrode 122” of a “driving TFT” (Td), which is disposed

below the emitting diode Del, through a “drain electrode contact hole 126a.” *Id.*

147. Based on the teachings of Park’531, a POSITA would have understood that, in Hwang-Lee, the plan view illustrations of sub-pixels (e.g., in Hwang’s FIGS. 1-3, 5, 7) illustrate only a **portion** of Hwang’s emission layer 370 (namely, the “effective emitting portion” as taught in Park’531) which contacts the electrode 191 exposed through the opening 351. A POSITA would have understood that the actual emission layer 370 of Hwang (e.g., as formed through thermal deposition, taught in Park’531) may be “**larger**” than the exposed portion shown in the plan view figures of Hwang. Alternatively, a POSITA would have found obvious to extend Hwang’s emission layer 370 by implementing the emissive material geometry of Park’531 based on the teachings of Park’531.

148. As discussed above, a POSITA would also have been motivated to extend Hwang’s emission layer beyond the boundaries of the opening in the pixel definition layer to eliminate the possibility of an electrical short circuit between the anode and cathode. More specifically, a POSITA would understand that attempting to design an OLED structure in which the emission layer exactly matched the opening in the pixel definition layer would result in a process with a low manufacturing yield. No manufacturing process is perfectly reproducible and the relative positions and dimensions of the emission layer and the pixel definition

layer would vary to some extent between each manufacturing iteration. Any deviations in alignment would result in a failed device. Any deviations which resulted in a slight reduction in the size of the emission layer or a slight increase in the size of the opening in the pixel definition layer would similarly result in a failed device.

149. As a result, based on the combined teachings of Hwang-Lee and Park'531 ("Hwang-Lee-Park'531"), a POSITA would have understood that the emission layer 370 of Hwang (i.e., the layer formed through thermal deposition of emissive material, as taught in Park'351) would be larger than Hwang's opening 351 through which light is emitted. For example, a POSITA would have understood that Hwang's emission layer 370 would have extended to cover Hwang's pixel definition layer 350, in accordance with the teachings of Park'531 (e.g., FIG. 5). An example of the resulting Hwang-Lee-Park'531 combination, in comparison with unmodified Hwang-Lee, is shown in Diagram E, below (which is based on FIG. 11 of Hwang).

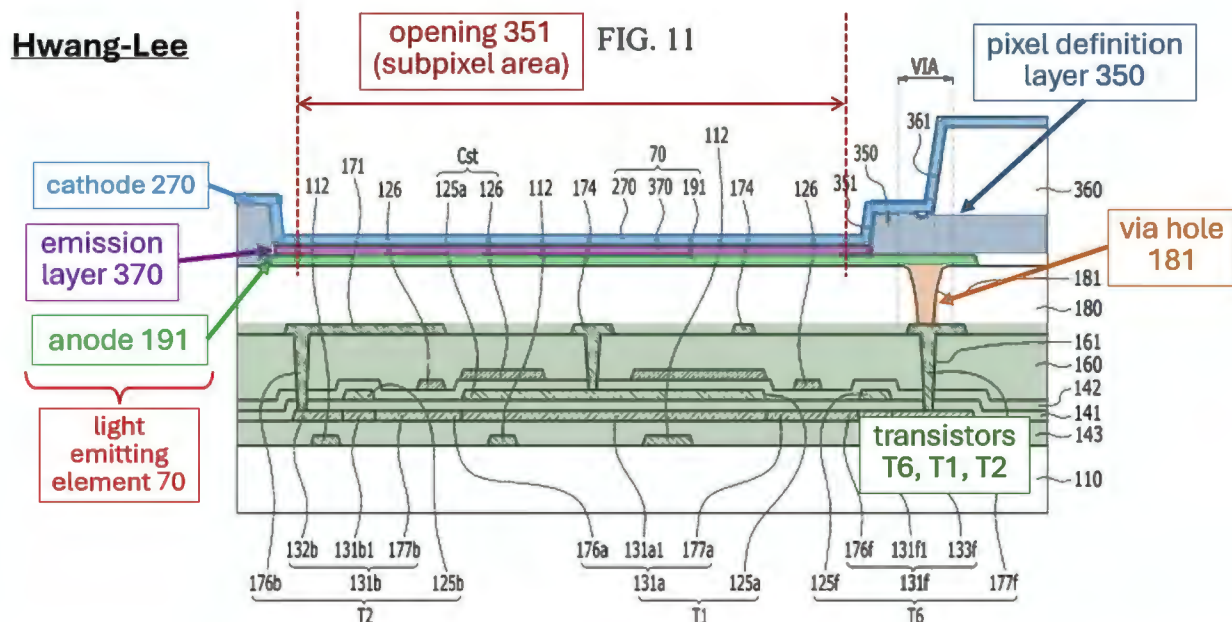
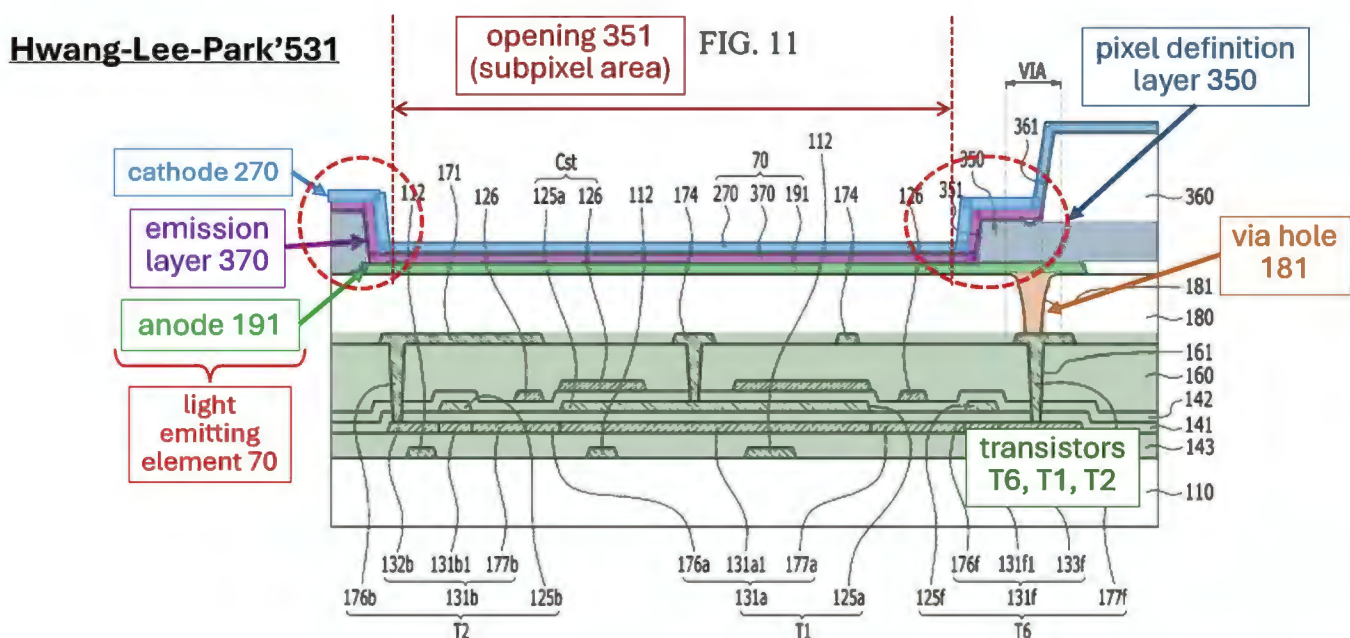


Diagram E (comparing Hwang-Lee with Hwang-Lee-Park'531)

150. Based on my knowledge and experience, I understand that a POSITA would have known, at the time of the '691 patent, that it was common in the art to

fabricate a subpixel by depositing a layer of emissive material (e.g., through thermal deposition) to have a larger area than the opening of the subpixel. One reason for this was to reduce the risk of direct contact between the anode and cathode of the sub-pixel, which would result in a short circuit that renders the subpixel non-functional. To mitigate this risk, it was well-known in the art to deposit the emissive material (e.g., the material deposited to form Hwang's emission layer 370) to be larger than the opening (e.g., Hwang's opening 351), thereby ensuring that the emissive material completely covers the bottom of the opening to avoid direct contact between the anode and electrode.

151. Both Hwang-Lee and Park'531 are directed to OLED devices that implement an arrangement of pixels with alternating and repeating patterns of differently colored light emitting elements. The combination would have simply involved incorporating the teachings of Park'531 into the compatible teachings of Hwang-Lee, thus, for at least this reason, making the Hwang-Lee-Park'531 combination predictable and foreseeable with a reasonable expectation of success.

X. MANNER IN WHICH THE PRIOR ART REFERENCES RENDER THE '691 PATENT CLAIMS UNPATENTABLE

A. Ground 1: Claims 1-8 are Indefinite

152. Claim 1 of the '691 patent includes several limitations that are unclear and fail to inform those skilled in the art about the scope of the invention with

reasonable certainty.

1. Inconsistent and Unclear Use of “relatively different” and “relatively same”

153. Limitation [1.12] recites that: “a biased position where the connection part of the subpixel of the first color in the first pixel is disposed with respect to the middle of the long axis of the subpixel of the first color in the first pixel when viewed from the row direction is relatively different from a biased position where the connection part of the subpixel of the first color in the second pixel is disposed with respect to the middle of the long axis of the subpixel of the first color in the second pixel when viewed from the row direction.” EX1001, 32:46-55.

154. Limitation [1.13] recites that: “a position where the connection part is disposed with respect to the subpixel of the second color, a position where the connection part is disposed with respect to the subpixel of the third color and a position where the connection part is disposed with respect to the subpixel of the first color in the first pixel are relatively same as a position where the connection part with respect to the subpixel of the second color, a position where the connection part is disposed with respect to the subpixel of the third color and a position where the connection part is disposed with respect to the subpixel of the first color in the second pixel.” EX1001, 32:46-55.

155. As an initial matter, the '691 patent lacks clarity on the scope of what is required when modifying “different” and “same” with “relatively.” The

specification of the '691 patent does not use the term “relative” or “relatively” and it fails to otherwise provide guidance on a degree of difference (or sameness) required for positions to be considered relatively different (or relatively the same).

156. Moreover, no manufacturing process is perfectly repeatable and the photolithography masks, deposition processes and etching processes used to define each layer/component in a display structure inherently result in some variation between subpixel or pixel elements across a single display. Some degree of difference is necessarily expected and without clear guidance or even discussion, a POSITA has no ability to understand “relatively different” or “relatively same”.

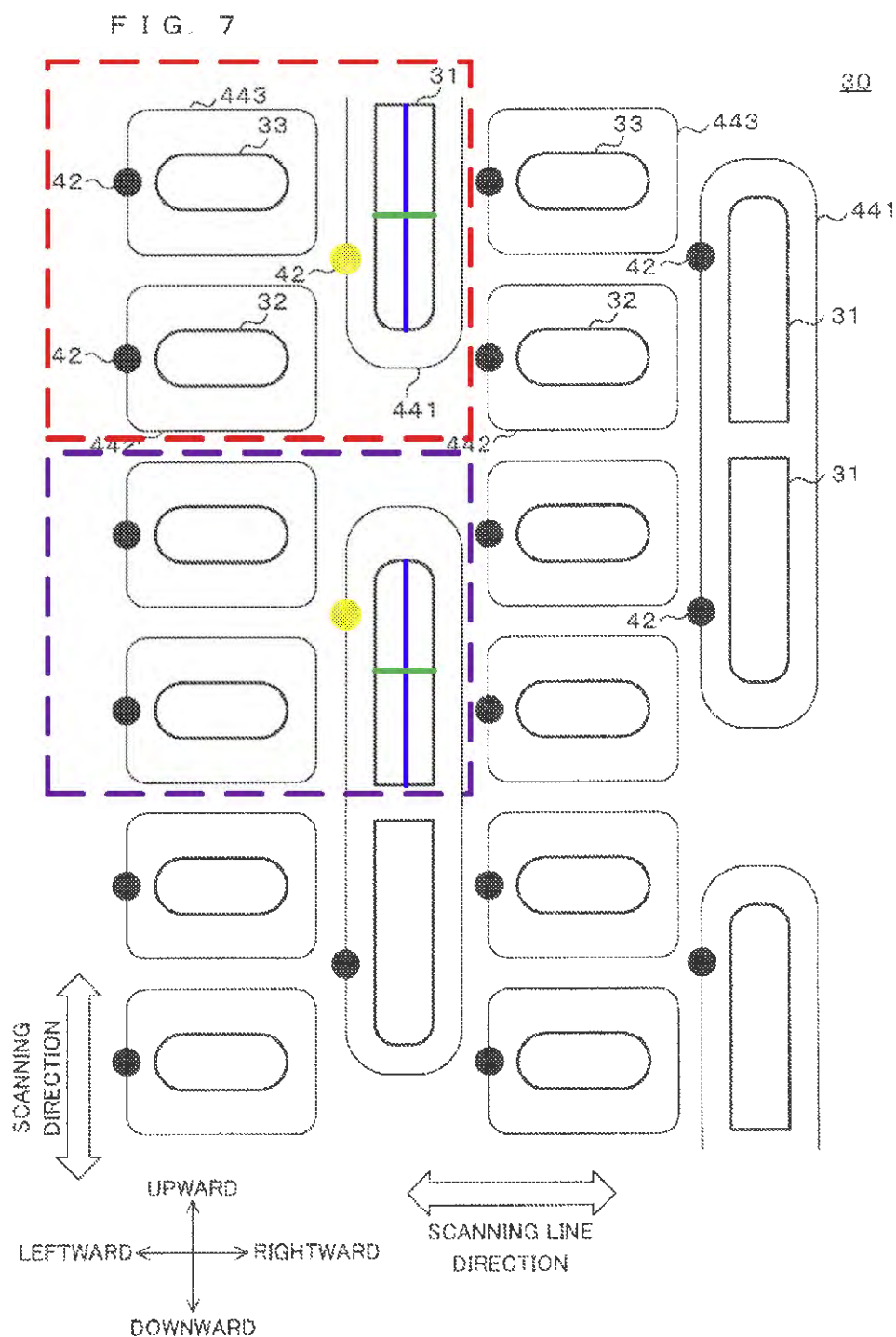
157. The specification of the '691 patent also does not describe what it means by “a biased position” or offer additional description of the positional relationship of connection portions relative to subpixels. Instead, limitations [1.12] and [1.13] appear to draw support solely from FIG. 7. But FIG. 7 is merely an example arrangement and does not give clear guidance on the scope of “relatively different” and “relatively same.” Indeed, the '691 patent confirms that it is not limited to its description/figures. EX1001, 2:52-55 (“both the foregoing general description and the following detailed description are exemplary and explanatory and are not restrictive of this disclosure”); EX1001, 16:8-10; EX1001, 31:51-57 (“the disclosed embodiment is illustrative and not restrictive in all aspects. The

scope of the present invention is defined by the appended claims *rather than* by the description preceding them”). Without sufficient guidance, the ’691 patent fails to provide reasonable clarity on the outer bounds of what it means for the positions of connection parts and subpixels to be “relatively different” or “relatively same.”

158. Further, claim 1 and the specification is unclear as to how “the biased position” in limitation [1.12] is relatively different while “the position” in limitation [1.13] is relatively the same. Specifically, limitation [1.12] recites “a biased position where the connection part of the subpixel of the first color in the first pixel is disposed with respect to the middle of the long axis of the subpixel of the first color in the first pixel when viewed from the row direction.” Initially, it is unclear what “when viewed from the row direction” adds and how the biased position with respect to the middle of the long axis of the subpixel of the first color in the first pixel might be differently when viewed from a different direction.

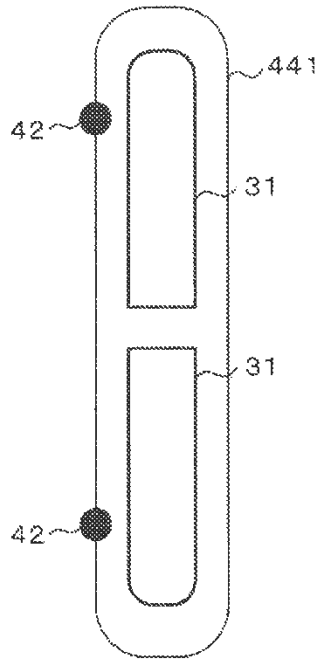
159. In addition, as shown in the annotated version of FIG. 7 below, the middle of the long axis of the subpixel of the first color lacks clarity in terms of whether it refers to the middle in the upward/downward direction (i.e., green line added to first subpixels below), the leftward/rightward (i.e., blue line added to first subpixels below), or even the depth direction (i.e., into/out of the page). This breadth adds to the confusion because it creates uncertainty as to which aspect of

“the subpixel of the first color” is the reference point for evaluating the positional requirements in limitation [1.12].



160. As shown above, the connection part of the subpixel of the first color (highlighted in yellow) of the first pixel (dashed red rectangle) and the second pixel (dashed purple rectangle) appears to be positioned the same relative to the middle of the long axis in the leftward/rightward direction (i.e., blue line added to first subpixels). The highlighted connection parts also appear to be positioned the same distance from the middle of the long axis in the upward/downward direction (i.e., green line added to first subpixels). The highlighted connection parts further appear to be positioned the same relative to the rounded end of the first subpixel. A difference appears to be that the connection part of the subpixel of the first color in the first pixel (dashed red rectangle) is downward from the middle of the long axis in the upward/downward direction (i.e., green line added to first subpixels), but upward in the second pixel (dashed purple rectangle). But it is far from clear that is the relative difference specified in limitation [1.12] and the claim is unclear as to what differences might fall within its scope.

161. More specifically, examination of the rightmost elongated pixel shows it to be vertically symmetric as can be seen in the portion reproduction of Fig. 7 of the '691 patent shown below.



162. As such, connection portion 42 is in the same relative position with respect to first subpixel 31. Fig. 7 of the '691 patent is the only figure which shows the relationship between the connection portion and the subpixel, but all positions are equivalent (i.e., the same). Because the '691 patent does not describe or illustrate a difference, a POSITA is unable to understand the meets and bounds of the claim.

163. Also, if the position upward or downward from the middle of the long axis in the upward/downward direction (i.e., green line added to first subpixels) is the difference in limitation [1.12], that difference would be the same in limitation [1.13] and it is unclear how the position in limitation [1.13] could be relatively the same. Specifically, limitation [1.13] recites that “a position where the connection

part is disposed with respect to the subpixel of the first color in the first pixel [is] relatively same as ... a position where the connection part is disposed with respect to the subpixel of the first color in the second pixel.” Notably, limitation [1.13] recites its positional requirement (“with respect to the subpixel of the first color”) more broadly than limitation [1.12] (“the middle of the long axis of the subpixel of the first color”). But this breadth makes limitation [1.13] even less clear because it does not provide guidance as to which part of the subpixel of the first color should be judged in assessing whether the position of the connection part is the same or different in the first and second pixels. Indeed, if judged from the middle of the subpixel of the first color (i.e., the middle of the long axis of the subpixel of the first color), which seems like a reasonable choice, the position would have the same relative difference as discussed above for limitation [1.12]. How can a position of a connection part be relatively different with respect to the middle of the long axis of the subpixel of the first color, but also relatively the same with respect to the subpixel of the first color? How can it be both different and the same at the same time? Clearly, it cannot.

164. In addition to “the subpixel of the first color,” limitation [1.13] also specifies a “relatively same” position for “the subpixel of the second color” and “the subpixel of the third color.” If you overlaid the first pixel (dashed red

rectangle in annotated version of FIG. 7 above) on top of the second pixel (dashed purple rectangle in annotated version of FIG. 7 above), the subpixels of the second color and the subpixels of the third color would overlap identically, but the subpixels of the first color would not. The specification does not clarify how identical overlap/positioning satisfies the “relatively same” limitation while non-identical overlap/positioning also satisfies the “relatively same” limitation. In fact, the specification fails to provide guidance on how much non-identical overlap/positioning is allowed (“relatively same”) or required (“relatively different”), thereby leaving a POSITA uncertain as to the scope of the claims.

165. For these reasons, the '691 patent does not provide reasonable clarity as to the scope of “relatively different” and “relatively same” in limitations [1.12] and [1.13], much less explain how these inconsistent/impossible limitations could both be met. Thus, a POSITA would not be reasonably certain of the scope of limitations [1.12] and [1.13] in claim 1 of the '691 patent and it is indefinite.

2. Inconsistent and Unclear Use of “a plurality of first pixels,” “one of the first pixels,” “the first pixel,” and corresponding “subpixel” limitations

166. Claim 1 of the '691 patent introduces confusion and ambiguity by its use of the terms “a plurality of first pixels,” “one of the first pixels,” and “the first pixel.” As shown below with highlights in yellow, claim 1 starts off in limitation [1.1] by reciting “a plurality of first pixels” and “one of the first pixels.” EX1001,

31:60-67.

1. A display device comprising:
 - [1.1] a display unit where a plurality of first pixels each including subpixels of three colors and a plurality of second pixels each including subpixels of three colors arranged differently from the subpixels in one of the first pixels are alternately arrayed in a row direction and a column direction, the subpixels of the three colors including a subpixel of a first color, a subpixel of a second color and a subpixel of a third color;

167. After introducing these concepts and as shown below with highlights in yellow, claim 1 then refers to “the first pixel” in limitations [1.4] and [1.5].

EX1001, 32:6-15.

- [1.4] in the first pixel and the second pixel adjacent to each other in the column direction, the subpixel of the second color and the subpixel of the third color are arrayed alternately in the column direction.
- [1.5] a column where the subpixel of the first color in the first pixel and the subpixel of the first color in the second pixel are arrayed in parallel with a column where the subpixel of the second color and the subpixel of the third color are alternately arrayed, the columns being arrayed alternately in the row direction.

168. Although claim 1 does not have explicit antecedent basis for “the first pixel” in limitations [1.4] and [1.5] because it does not previously recite “a first pixel,” the references to “the first pixel” in limitations [1.4] and [1.5] presumably refer back to the “one of the first pixels” recited in limitation [1.1]. Specifically, “the first pixel” is singular and the previous recitation of “one of the first pixels” specifies “one” (singular) of “the first pixels.” Indeed, when claim 1 of the ’691

patent intends to refer to multiple pixels, it does. *See, e.g.*, EX1001, 31:60 (“plurality of first pixels_s”), 31:63-64 (“the first pixels_s”), 32:16 (“the first pixels_s”). And when claim 1 of the ’691 patent intends to modify “each” of a group of pixels or subpixels in the claim, it also does. *See, e.g.*, EX1001, 31:60-61 (“plurality of first pixels each including subpixels”), 31:61-62 (“plurality of second pixels each including subpixels”), 32:1-2 (“disposed below each of the subpixels”). Accordingly, when limitations [1.4] and [1.5] recite “the first pixel,” these limitations refer to a single pixel within “the plurality of first pixels” and presumably the “one” first pixel introduced in limitation [1.1] because the “one” first pixel introduced in limitation [1.1] is the only singular pixel introduced at this point of the claim.

169. And there are more such instances in claim 1. As shown below in blue, green, and orange highlighting, limitations [1.6], [1.8], and [1.10] each introduce an additional instance of “one of the first pixels.” EX1001, 32:16-40.

[1.6] the subpixel of the first color in one of the first pixels has a biased arrangement and is positioned toward a side of the subpixel of the second color in an array direction of the subpixel of the second color and the subpixel of the third color that are arrayed alternately,

⋮

[1.8] the subpixel of the first color in one of the first pixels has a rectangle or rounded rectangle shape whose long axis is parallel with the direction in which the subpixel of the second color and the subpixel of the third color are arrayed alternately,

⋮

[1.10] the at least one connection part of the subpixel of the first color in one of the first pixels is one connection part and is biased from a middle of a long axis of the subpixel of the first color toward an end of the long axis when viewed from the row direction,

170. Each of these limitations has the same wording as limitation [1.1] and, in the same way as limitation [1.1], reference any pixel in the plurality of first pixels. It must be “one” pixel, but like limitation [1.1], these limitations do not specify any particular pixel in the plurality. Notably, these limitations also do not refer back to “the first pixel” used in limitations [1.4] and [1.5]. With this structure, limitations [1.6], [1.8], and [1.10] could cover different pixels from the plurality of first pixels than “the first pixel” referenced in limitations [1.1], [1.4], and [1.5].

171. At this point, claim 1 has now introduced four, potentially different first pixels:

172. First Pixel One with the limitations of [1.1], [1.4], and [1.5] (yellow above);

173. First Pixel Two with the limitations of [1.6] (blue above);

174. First Pixel Three with the limitations of [1.8] (green above); and

175. First Pixel Four with the limitations of [1.10] (orange above).

176. After introducing these four, potentially different first pixels, claim 1 then again refers to “the first pixel.” As shown below in red highlighting, limitation [1.14] in claim 1 refers to “the first pixel.” EX1001, 33:1-9.

in a pixel array including the first pixel and the second pixel arrayed in the column direction, the connection part of the subpixel of the first color is disposed between a column where the subpixel of the second color and the subpixel of the third color are alternately arrayed and a column where the subpixel of the first color arranged in parallel with the column where the subpixel of the second color and the subpixel of the third color are alternately arrayed.

177. At this point, it is unclear as to which “one” of the first pixels “the first pixel” refers to in limitation [1.14].¹ Is it First Pixel One (yellow), First Pixel Two (blue), First Pixel Three (green), and/or First Pixel Four (orange)? With this claim structure, a POSITA cannot be reasonably certain what “the first pixel” in limitation [1.14] requires. Does it require the limitations of [1.1], [1.4], [1.5], [1.6], [1.8], and [1.10]? Or can it exclude any of them? Can the claim be satisfied if the

¹ Limitations [1.12] and [1.13] also recite “the first pixel,” which adds additional confusion as to the requirements of claim 1.

limitations of [1.14] are met in First Pixel Four with the limitations of [1.10], but without the limitations of [1.1], [1.4], [1.5], [1.6], and [1.8]? The claim does not specify and a POSITA cannot reasonably discern the scope of the claim and what “the first pixel” in limitation [1.14] requires.²

178. Limitation [1.12] adds to the confusion. Specifically, limitation [1.12] recites “the connection part of the subpixel of the first color in the first pixel.” The only prior limitation in the claim that refers to a connection part and a first pixel is limitation [1.10]—“the at least one connection part of the subpixel of the first color in one of the first pixels.” EX1001, 32:46-47. So, “the first pixel” in limitation [1.12] must refer to First Pixel Four (orange) in limitation [1.10]. But limitation [1.10] clearly refers to “one of the first pixels;” not First Pixel One (yellow) set forth in limitations [1.1], [1.4], and [1.5]. Thus, the phrase “the first pixel” is used inconsistently throughout claim 1 and a POSITA cannot reasonably discern its scope, particularly in limitation [1.14] after “one of the first pixels” has been recited four separate times in limitations [1.1], [1.6], [1.8], and [1.10] and

² Claim 1 also recites “the second pixel” in limitation [1.14]. Because claim 1 includes similar limitations for second pixels as it does for the first pixel limitations discussed here, the same indefiniteness issues exist for “the second pixel” in limitation [1.14] as for “the first pixel” in limitation [1.14].

“the first pixel” has been recited in limitations [1.3], [1.4], [1.12], and [1.13].

179. The specification does not help. Although the specification provides an example pixel arrangement in Figs. 4 and 7, the specification makes clear that “[t]he arrangement and shapes of the first subpixel 31, the second subpixel 32, and the third subpixel 33 are not limited to FIG. 4.” EX1001, 16:8-10. The specification also confirms that “both the foregoing general description and the following detailed description are exemplary and explanatory and are not restrictive of this disclosure.” EX1001, 2:52-55. And it confirms that: “the disclosed embodiment is illustrative and not restrictive in all aspects. The scope of the present invention is defined by the appended claims rather than by the description preceding them, and all changes that fall within metes and bounds of the claims, or equivalence of such metes and bounds thereof are therefore intended to be embraced by the claims.” EX1001, 31:51-57.

180. With this disclosure, the ’691 patent specification does not provide clarity and, instead, embraces the confusion of its claims.

181. For these reasons, claim 1 of the ’691 patent aligns precisely with the textbook example of indefiniteness set forth in the MPEP. As explained in the MPEP, “if two different levers are recited earlier in the claim, the recitation of ‘said lever’ in the same or subsequent claim would be unclear where it is uncertain

which of the two levers was intended.” MPEP § 2173.05(e). Claim 1 is even worse; it recites four different first pixels before limitation [1.14]’s reference to “the first pixel.”

182. Because claim 1 of the ’691 patent recites with four different first pixels to choose from, a POSITA faced with “the first pixel” in limitation [1.14] is left to wonder which of the different first pixels is “the first pixel.” Moreover, the different singular and plural uses and mismatches in claim 1 of the ’691 patent further confuses an already confused claim.

183. In addition, claim 1 of the ’691 patent introduces even more confusion by reciting “subpixels,” “a subpixel of a first color,” “a subpixel of a second color,” and “a subpixel of a third color” for each of the first and second pixels. EX1001, 31:60-33:9. For example, when limitation [1.14] recites “the subpixel of the first color” it is unclear to which “subpixel” the limitation refers. EX1001, 33:1-9. Indeed, limitation [1.14] does not specify whether “the subpixel of the first color” is a subpixel of a first pixel or a second pixel, much less specify to which of the various subpixels of the first color recited earlier in claim 1 it refers. Thus, the various recitations “subpixels,” “the subpixel of the first color,” “the subpixel of the second color,” and “the subpixel of the third color” further confuse an already confusing claim.

184. For these reasons, a POSITA would not be reasonably certain of the scope of claim 1 of the '691 patent and it is indefinite.

3. Inconsistent and Unclear Use of “at least one connection part” and “the connection part”

185. Limitation [1.3] of claim 1 recites “**at least one connection part** that connects the TFT circuit and **one of** the subpixels.” EX1001, 32:3-4. Notably, the “at least one connection part” connects the TFT circuit and “one of” the subpixels. *Id.* Similar to the use of “one of” discussed above for the first pixel limitations, limitation [1.3] refers to “one” subpixel in the singular form. Again, similar the analysis of the first pixel limitations discussed above, the “one of” language contrasts with the language in the TFT circuit limitation in [1.2], which states that the TFT circuit is “disposed below **each of the subpixels** to control **the subpixels**.” EX1001, 32:1-2. Accordingly, limitation [1.3] confirms that the “at least one connection part” connects to “one” subpixel.

186. Limitations [1.10] and [1.11] refer back to the “at least one connection part” in limitation [1.3]. Limitation [1.10] recites that: “**the at least one connection part** of the subpixel of the first color in one of the first pixels **is one connection part** and is biased from a middle of a long axis of the subpixel of the first color toward an end of the long axis when viewed from the row direction.” EX1001, 32:36-40.

187. Limitation [1.11] similarly recites that: “the at least one connection part of the subpixel of the first color in one of the second pixels is one connection part and is biased from a middle of a long axis of the subpixel of the first color toward an end of the long axis when viewed from the row direction.” EX1001, 32:41-45.

188. These limitations are unclear. How can “the at least one connection part” be “one connection part” for each of the different subpixel arrangements claimed? If it is only “one” connection part, which the ’691 patent consistently uses to refer to a singular component, how can “the at least one connection part” be multiple, “one” (singular) connection parts? Is it one connection part for both subpixels? Claim 1 is unclear on these points and fails to provide reasonable certainty as to the requirements of “the at least one connection part.”

189. Also, claim 1 is unclear how the subpixel arrangements specified in limitations [1.10] and [1.11] relate to the “one” subpixel specified in limitation [1.3]. Is the subpixel in limitation [1.3] the same as “the subpixel of the first color in one of the first pixels” in limitation [1.10], the same as “the subpixel of the first color in one of the second pixels” in limitation [1.11], or another subpixel entirely? Claim 1 does not say.

190. It also does not say how the “one connection part” in limitation [1.10]

and the “one connection part” in limitation [1.11] connect to the “one” subpixel in limitation [1.3]. The “one connection part” in limitation [1.10] and the “one connection part” in limitation [1.11] are both referenced as “the at least one connection part” and limitation [1.3] clearly states that the “at least one connection part” connects to “one” of the subpixels. But the claim is unclear how both the “one connection part” in limitation [1.10] and the “one connection part” in limitation [1.11] connect to “one” subpixel, particularly when limitations [1.10] and [1.11] refer to specific subpixels that are different.

191. The confusion over the “at least one connection part” multiplies at limitation [1.13], which uses the term “the connection part” six times. EX1001, 32:56-67. Prior to limitation [1.13], claim 1 makes five references to connection part:

192. “at least one connection part” in limitation [1.3];

193. “one connection part” in limitation [1.10];

194. “one connection part” in limitation [1.11];

195. “the connection part of the subpixel of the first color in the first pixel” in limitation [1.12]; and

196. “the connection part of the subpixel of the first color in the second pixel” in limitation [1.12].

197. When limitation [1.13] makes six references to “the connection part,” it is unclear to which connection part the claim refers. For example, limitation [1.13] refers to “a position where the connection part is disposed with respect to the subpixel of the second color.” EX1001, 32:56-57. But to which connection part does this refer? Is it “the connection part of the subpixel of the first color in the first pixel,” “the connection part of the subpixel of the first color in the second pixel,” or some other connection part associated with the subpixel of the second color? Claim 1 does not specify or provide a POSITA reasonable certainty as to which connection part(s) must meet the positional requirements set forth in limitation [1.13].

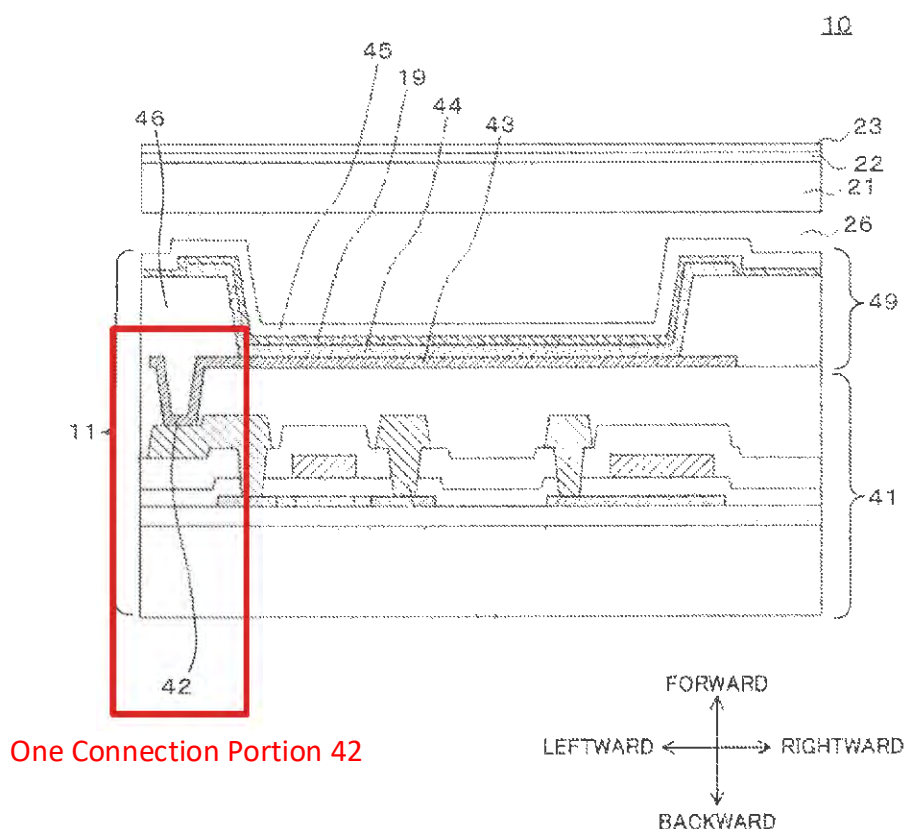
198. Limitation [1.14] continues the confusion by reciting “the connection part of the subpixel of the first color.” EX1001, 33:2-3. Limitation [1.14] does not specify if the connection part is for a subpixel of a first pixel or a second pixel, much less provide clarity as to which of the six uses of “the connection part” in limitation [1.13] it refers.

199. Finally, claim 1 is unclear how the seven uses of “the connection part” in limitations [1.13] and [1.14] relate to the “one” subpixel in limitation [1.3]. As discussed above, limitation [1.3] clearly states that the “at least one connection part” connects to “one” of the subpixels. But the claim is unclear how the seven

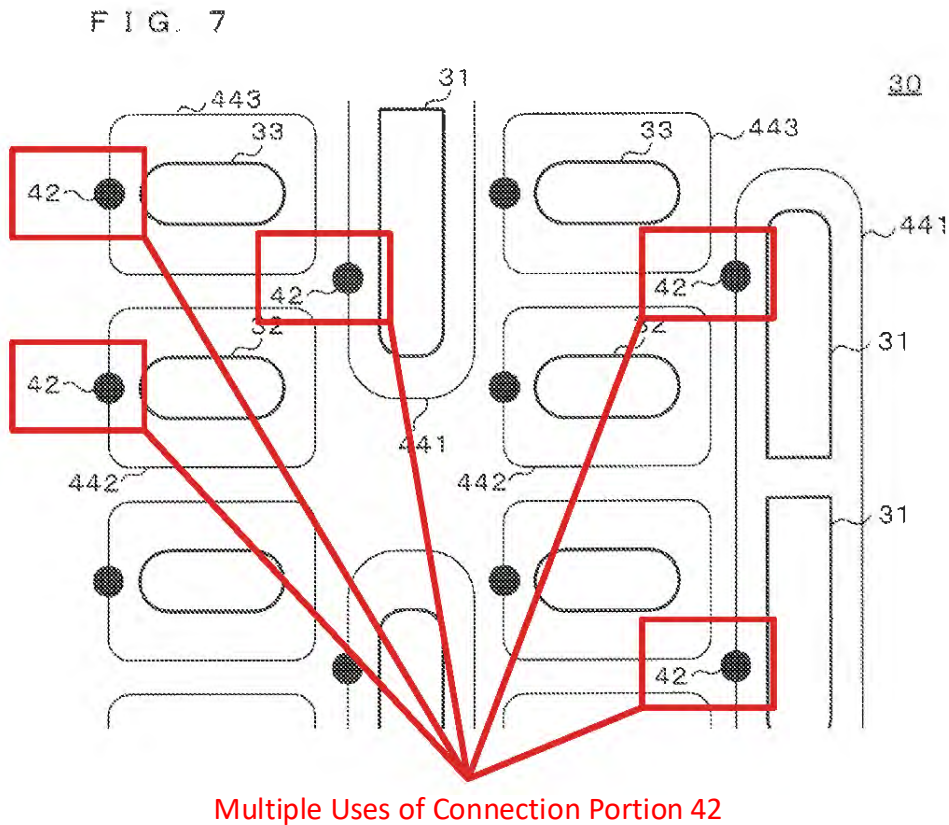
uses of “the connection part” in limitations [1.13] and [1.14] connect to the “one” subpixel in limitation [1.3], particularly when limitations [1.13] and [1.14] refer to various subpixels of three, different colors.

200. Similar to the first pixel limitations discussed above, the specification does not help. Specifically, the specification does not use the term “connection part” and, instead, refers to a “connection portion.” EX1001, 9:6-7. It is unclear the difference between the described “connection portion,” and the claimed “connection part.” Also, FIG. 6 (below) shows the “TFT circuit output connection portion 42” as a single connection and the corresponding portion of the specification describes “[a] TFT circuit output connection portion 42 and electronic circuits which connect the demultiplexer 15 and the scan driver 16 with the subpixels.” *Id.*, 9:6-10.

FIG. 6



201. FIG. 7 (excerpt, below) then shows multiple instances of the “TFT circuit output connection portion 42” and the specification describes that “[o]ne TFT circuit output connection portion 42 is arranged in the vicinity of each subpixel.” EX1001, 10:23-24.



202. It is unclear how a TFT circuit output connection portion 42 connects with multiple subpixels per the description of FIG. 6 and how one TFT circuit output connection portion 42 is arranged in the vicinity of each subpixel per the description of FIG. 7. Accordingly, the specification does not resolve the confusion over the connection part limitations discussed above. This is particularly true because the specification embraces the confusion of its claims as discussed above for the first pixel limitations. EX1001, 2:52-55; 16:8-10; 31:51-57.

203. For these reasons and reasons similar to those discussed above for the first pixel limitations, a POSITA would not be reasonably certain of the scope of

the “at least one connection part” and “the connection part” limitations in claim 1 of the ’691 patent and it is indefinite.

204. Further, claim 7 includes additional features that are indefinite. Claim 7 recites that “the OLED layer is disposed above the at least one connection part, and a position where the at least one connection part is disposed overlaps with the OLED layer in a plan view.” EX1001, 34:16-20. As an initial matter, “the OLED layer” in claim 7 lacks antecedent basis in claim 1 and the ’691 patent does not clarify the layer in claim 1 that claim 7 is modifying.

205. Beyond this confusion, claim 7 refers to “the at least one connection part” and its overlap with “the OLED layer.” But as discussed above, limitations [1.10] and [1.11] each separately require the at least one connection part to be “one connection part.” And limitations [1.13] and [1.14] thereafter refer to “the connection part” seven more times. Accordingly, when claim 7 refers to “the at least one connection part,” the ’691 patent does not provide reasonably clarity as to which connection part the claim refers and whether the overlap with the OLED layer needs to be met for all previously-recited connection parts or not. For these reasons, claim 7 is indefinite.

206. Claim 3, which recites “a position where the at least one connection part is disposed overlaps with the anode electrode in a plan view,” suffers from

similar deficiencies as claim 7.

4. The “TFT” and “subpixel” Limitations are Misaligned with the Specification and the General Understanding of Display Technology at the time of the ’691 Patent

207. The claimed relationship between a “subpixel” and a “TFT circuit” is inconsistent with the specification and a POSITA’s general understanding of display technology at the time of the ’691 patent, which renders claims 1-8 indefinite. Specifically, limitation [1.2] requires a TFT circuit to be “**disposed below** each of the subpixels to control the subpixels.” EX1001, 32:1-2. The specification does not use the term “below” or otherwise describe a TFT circuit disposed below each of the subpixels to control the subpixels.

208. FIG. 6 is a “**cross sectional**” diagram illustrating arrangement of **components of a subpixel** in a display device.” EX1001, 3:3-5; 8:60-66 (“FIG. 6 schematically illustrates a **cross-sectional** diagram obtained by cutting **one subpixel** in the display device 10 along a plane perpendicular to the plane displaying an image.”). Thus, per the ’691 patent, FIG. 6 shows components included in a subpixel. One component shown in FIG. 6 as part of a subpixel is the **TFT** substrate 11. *Id.*, 8:64-9:6. And although the TFT substrate 11 includes a wiring portion 41 disposed below a pixel array portion 49, the ’691 patent does not describe the pixel array portion 49 as including a subpixel. *Id.*, 9:5-17; FIG. 6. Rather, as the description of FIG. 6 clearly states, each of the pixel array portion 49

and the wiring portion 41 are “components of a subpixel.” *Id.*, 3:3-5; 8:60-66.

209. Indeed, the description of FIG. 6 states that “[e]ach of the subpixels includes a pixel circuit, an organic light emitting element which includes the anode electrode 43, the cathode electrode 19 and an organic light emitting layer (OLED layer) disposed between the anode electrode 43 and the cathode electrode 19.” EX1001, 9:20-25. The ’691 patent subsequently (and repeatedly) confirms that the pixel circuit of the subpixel includes the TFT components. *Id.*, 13:46-47 (“The pixel circuit includes a switching TFT, a driving TFT, and a storage capacitor C1 in addition to the OLED”); 29:21-23; FIGS. 12, 30, 33. FIG. 12 “illustrat[es] a pixel circuit” and clearly shows the TFT components as part of the pixel circuit. *Id.*, 13:38-64.

210. Because each subpixel includes a pixel circuit and the pixel circuit includes the TFT circuit, the TFT circuit is part of a subpixel. EX1001, 9:20-25; 13:38-64; 29:21-23; FIGS. 12, 30, 33. The ’691 patent is consistent on this point, which aligns with FIG. 6’s depiction of the TFT circuit as a component of a subpixel. *Id.*, 3:3-5; 8:60-9:17. Thus, in the ’691 patent, the TFT circuit is part of a subpixel. Based on my knowledge and experience, I understand that the description in the ’691 patent aligns with a POSITA’s general knowledge that TFTs are part of subpixels, not below them.

211. However, claim 1 of the '691 patent introduces confusion by, for the first time, reciting that the TFT circuit is “disposed below” each of the subpixels to control the subpixels.” EX1001, 32:1-2. But how can the TFT circuit be disposed below the subpixels when the TFT circuit is part of each subpixel? It can't. Claim 1, thus, suffers from uncertainty and ambiguity in the metes and bounds of the claimed “TFT circuit” and “subpixel,” specifically whether a “subpixel” includes a “TFT circuit” or not and whether it requires the impossible condition of a component being below itself. For these reasons, a POSITA would not be reasonably certain of the scope of limitation [1.2] in claim 1 of the '691 patent and it is indefinite.

5. Unclear Use of “array direction”

212. Limitation [1.6] of claim 1 introduces the concept of “an array direction.” EX1001, 32:16-20. This follows the introduction of “a row direction” and “a column direction” in limitation [1.1]. *Id.*, 31:64-65.

213. The specification of the '691 patent does not use the term “array direction,” but references at least eleven other directions. Specifically, the '691 patent describes “row and column directions” (EX1001, Abstract), “various directions of forward, backward, leftward, rightward, upward, and downward” (*id.*, 4:5-8), “the longitudinal directions of each subpixel” (*id.*, 7:17-18), “the diagonal direction of the pixel” (*id.*, 17:35), and “the scan line direction” (*id.*, 21:6-7). A

POSITA would presume that the “array direction” in limitation [1.6] has a different meaning from these eleven other directions described in the ’691 patent. But the ’691 patent does not explain which of these directions is being referred to by the “array direction” or whether it is some other direction not described in the specification.

214. The ’691 patent also describes that “FIG. 7 is a diagram illustrating an array of subpixels.” EX1001, 10:5-6. But the lower portion of FIG. 7 lists six other directions and fails to provide clarity as to which direction is the “array direction” or the “array” shown in FIG. 7.

215. In addition, after introducing the array direction in limitation [1.6], limitation [1.8] refers to “the direction in which the subpixel of the second color and the subpixel of the third color are arrayed alternately.” EX1001, 32:26-30. Although unclear, presumably, “the direction” in limitation [1.8] refers to the column direction because limitation [1.4] recites that “the subpixel of the second color and the subpixel of the third color are arrayed alternately in the column direction,” which aligns with the language in limitation [1.8].

216. Notably, limitation [1.6] uses different language when referring to the array direction—“an array direction of the subpixel of the second color and the subpixel of the third color that are arrayed alternately.” EX1001, 32:18-20. Yet,

the '691 patent provides no explanation for how a direction “in which the subpixel of the second color and the subpixel of the third color are arrayed alternately” is different from a direction “of the subpixel of the second color and the subpixel of the third color.” *Id.*, 32:18-30.

217. By introducing a new direction that is different from all of the directions described in the specification and by using different language to describe that direction, the '691 patent fails to provide clarity as to which direction is required to meet the “array direction” recited in limitation [1.6]. Thus, a POSITA would not be reasonably certain of the scope of claim 1 of the '691 patent and it is indefinite.

B. Grounds 2 and 3: Claims 1-8 Lack Written Description Support And Are Not Enabled

1. The '691 Patent Does Not Describe or Enable the “relatively different” and “relatively same” Limitations

218. As discussed above at Section X.A.1 (incorporated here), the specification of the '691 patent does not use the term “relative” or “relatively” and does not provide text-based descriptions of the “relatively different” and “relatively same” limitations. The specification of the '691 patent also does not describe what it means by “a biased position” or offer additional description of the positional relationship of connection portions relative to subpixels.

219. Instead, the '691 patent appears to attempt to find support for the

“relatively different” and “relatively same” limitations based solely on FIG. 7. Yet, as discussed above at Section X.A.1 (incorporated here), FIG. 7 does not reasonably convey the positioning requirements of the “relatively different” and “relatively same” limitations. In fact, as discussed above at Section X.A.1 (incorporated here), the positioning requirements of the “relatively different” and “relatively same” limitations are impossible—the position of the connection part relative to the subpixel of the first color cannot be both different and the same.

220. Because FIG. 7 does not reasonably convey the “relatively different” and “relatively same” limitations, which have impossible requirements, FIG. 7 does not provide a written description, much less enable a POSITA to make and use the “relatively different” and “relatively same” limitations. Thus, claims 1-8 lack written description support and are not enabled.

2. The '691 Patent Does Not Describe or Enable the “connection part” Limitations

221. As discussed above at Section X.A.3 (incorporated here), limitation [1.3] recites “**at least one connection part** that connects the TFT circuit and **one of** the subpixels.” EX1001, 32:3-4. Claim 1 then, in limitations [1.10] through [1.14], references multiple connection parts as being part of the at least one connection part. The specification of the '691 patent, however, does not describe multiple connection parts connecting to “one” pixel as required.

222. Specifically, the specification describes “[a] TFT circuit output connection portion 42 and electronic circuits which connect the demultiplexer 15 and the scan driver 16 with the subpixels.” EX1001, 9:6-10. And it describes that “[one TFT circuit output connection portion 42 is arranged in the vicinity of each subpixel.” *Id.*, 10:23-24. But it never describes multiple connection parts connected to “one” subpixel and does not reasonably convey to a POSITA that the inventors possessed an invention where multiple connection parts connect to “one” subpixel. Thus, claims 1-8 of the ’691 patent lack written description support.

223. Further, if multiple connection parts connect to “one” subpixel, the display device of claim 1 would not work. This is because the multiple connection parts would send different and incorrect/inconsistent signals to the “one” subpixel and the “one” subpixel would not be able to be separately controlled by “one” TFT circuit as is customary in display technology. In addition, if multiple connection parts connect different subpixels together, the subpixels would not be individually controllable and, instead, respond to signals from various connection parts. Without the ability to separately and individually control subpixels, the display device would not properly display images and would not function properly – it would quite literally not be a display. For these reasons, claims 1-8 of the ’691 patent are not enabled.

224. Further, as discussed in Section III.A.3 (incorporated here), claim 7 requires that a position where the at least one connection part is disposed overlaps with the OLED layer in a plan view. Yet, the specification does not describe all of the connection parts that potentially fall within the scope of the at least one connection part as overlapping with an OLED layer, much less a layer recited in claim 1. Thus, claim 7 fails to meet the written description and enablement requirements.

225. Claim 3, which recites “a position where the at least one connection part is disposed overlaps with the anode electrode in a plan view,” suffers from similar deficiencies to those discussed for claim 7. In addition, the specification describes that “[o]ne anode electrode 43 is connected to one TFT circuit output connection portion 42.” EX1001, 9:28-29. FIG. 6 shows the connection portion 42 and the anode electrode 43 where the opening of the connection portion 42 does not overlap with the anode electrode (unless the connection portion 42 extends beyond the illustrated opening to overlap with the anode electrode 43). For these reasons, unless the connection portion 42 extends beyond its opening to a point where it connects to the anode electrode 43, claim 3 lacks written description support.

3. The '691 Patent Does Not Describe or Enable a TFT circuit “disposed below each of the subpixels to control the subpixels”

226. As discussed above at Section X.A.4 (incorporated here), the specification of the '691 patent does not use the term “below” and does not describe a TFT circuit disposed below each of the subpixels to control the subpixels. The only possible support for this limitation is FIG. 6. But, as discussed above at Section X.A.4 (incorporated here), FIG. 6 shows components of a subpixel, including the TFT circuit. EX1001, 3:3-5; 8:60-9:17. Thus, FIG. 6 shows a TFT circuit as part of a subpixel; not a TFT circuit below a subpixel. The '691 patent also repeatedly confirms that “[e]ach subpixel includes a pixel circuit” and the pixel circuit of the subpixel includes the TFT components. *Id.*, 9:20-25; 13:38-64; 29:21-23; FIGS. 12, 30, 33. For these reasons, the '691 patent does not provide a written description of a TFT circuit “disposed below each of the subpixels to control the subpixels,” as required by limitation [1.2].

227. In addition, the '691 patent fails to enable a POSITA to make and use a TFT circuit “disposed below each of the subpixels to control the subpixels.” Because the '691 patent repeatedly and consistently describes the TFT circuit as part of a subpixel, it fails to provide guidance as to how to construct a TFT circuit that is “disposed below each of the subpixels to control the subpixels.” EX1001, 3:3-5; 8:60-9:17; 9:20-25; 13:38-64; 29:21-23; FIGS. 12, 30, 33. Indeed, based on

my knowledge and experience, I understand that the description in the '691 patent aligns with a POSITA's general knowledge that TFTs are constructed as parts of subpixels, not below them. For these reasons, the '691 patent fails to teach a POSITA how to make and use a TFT circuit "disposed below each of the subpixels to control the subpixels."

228. For these reasons, claims 1-8 lack written description support and are not enabled.

4. The '691 Patent Does Not Describe the "array direction" Limitations

229. As discussed above at Section X.A.5 (incorporated here), the specification of the '691 patent does not use the term "array direction." It, instead, references at least eleven other directions, including "row and column directions" (EX1001, Abstract), "various directions of forward, backward, leftward, rightward, upward, and downward" (*id.*, 4:5-8), "the longitudinal directions of each subpixel" (*id.*, 7:17-18), "the diagonal direction of the pixel" (*id.*, 17:35), and "the scan line direction" (*id.*, 21:6-7). But the '691 patent does not explain which of these directions is an "array direction" or otherwise describe an "array direction."

230. The '691 patent also describes that "FIG. 7 is a diagram illustrating an array of subpixels." EX1001, 10:5-6. But the lower portion of FIG. 7 lists six other directions and fails to describe which direction is the "array direction."

231. Limitation [1.6] also refers to "an array direction of the subpixel of

the second color and the subpixel of the third color that are arrayed alternately.”

EX1001, 32:18-20. Yet, the '691 patent provides no description of a direction “*of* *the* subpixel of the second color and the subpixel of the third color.” *Id.*, 32:18-30.

232. Because the specification does not reasonably convey the “array direction” limitations, the '691 patent does not provide a sufficient written description. Thus, claims 1-8 lack written description support.

C. Ground 4: Combination of Hwang and Lee Renders Obvious Claims 1-6 and 8

233. Below, I rely on the disclosure of Hwang and Lee and explain why this disclosure, when interpreted in view of the general knowledge of a POSITA, renders obvious claims 1-6 and 8. As discussed above in Grounds 1-3, the outer bounds of various limitations of the claims lack clarity and the specification fails to provide an enabling disclosure of several features. To the extent the '691 patent provides an enabling disclosure of claims with sufficient definiteness, the diagrams shown in FIGS. 4, 6, and 7 of the '691 patent (which were cited repeatedly by Applicant during prosecution as providing support for the claims) must fall within the scope of such claims. Accordingly, in the analysis below, I provide a mapping of the prior art to the claims in a manner consistent with FIGS. 4, 6, and 7. Because Hwang and Lee provide prior art disclosure that is commensurate with the disclosure that the '691 patent relies on for support of claims 1-6 and 8 (i.e., the

disclosure of FIGS. 4, 6, and 7), claims 1-6 and 8 of the '691 patent are obvious over Hwang and Lee.

234. Specifically, Hwang discloses a pixel arrangement and pixel emission structure that are nearly identical to those disclosed in the '691 patent specification. Lee provides further details of features already disclosed in Hwang, such as details of grouping of sub-pixels into pixels and details of certain aspects of pixel circuitry.

235. Before a claim-by-claim analysis, first, a detailed comparison is presented, in Diagram B below, showing cross-section views of Hwang's TFT and subpixel structure with that of the '691 patent and their extensive similarities. EX1005, FIG. 2; EX1001, FIG. 6 (the only such cross-section view in the '691 patent). This discussion is incorporated by reference into each of the claim limitation analyses below.

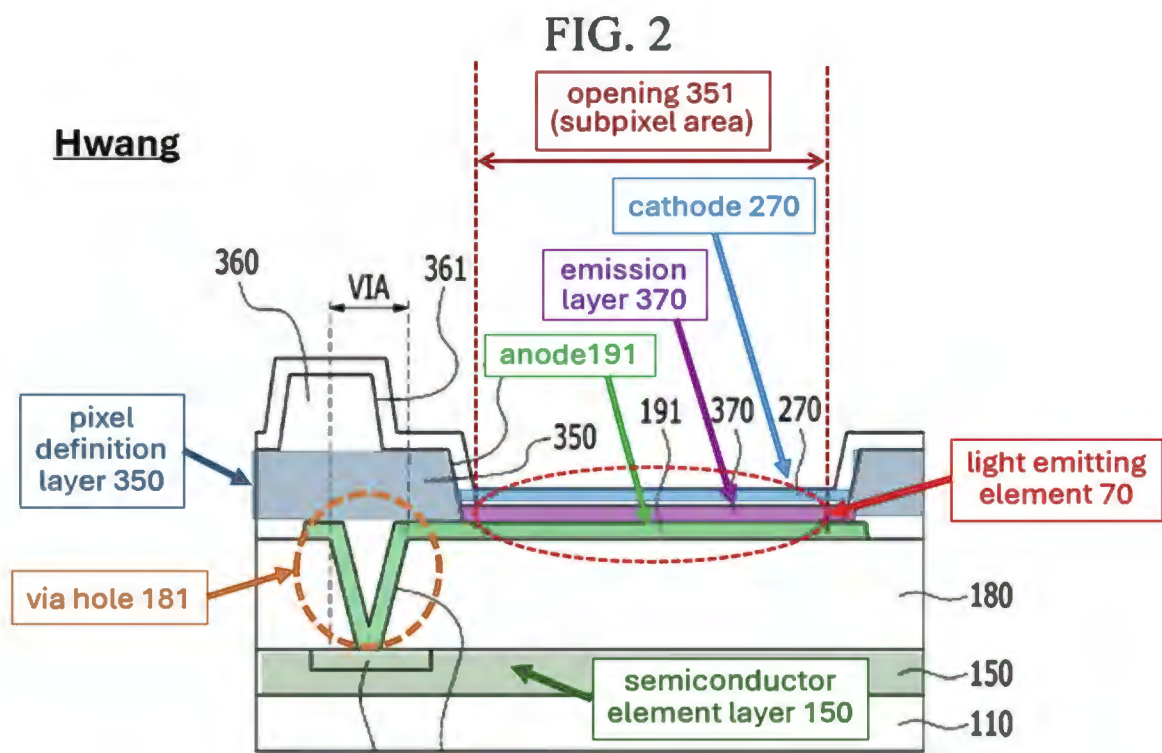
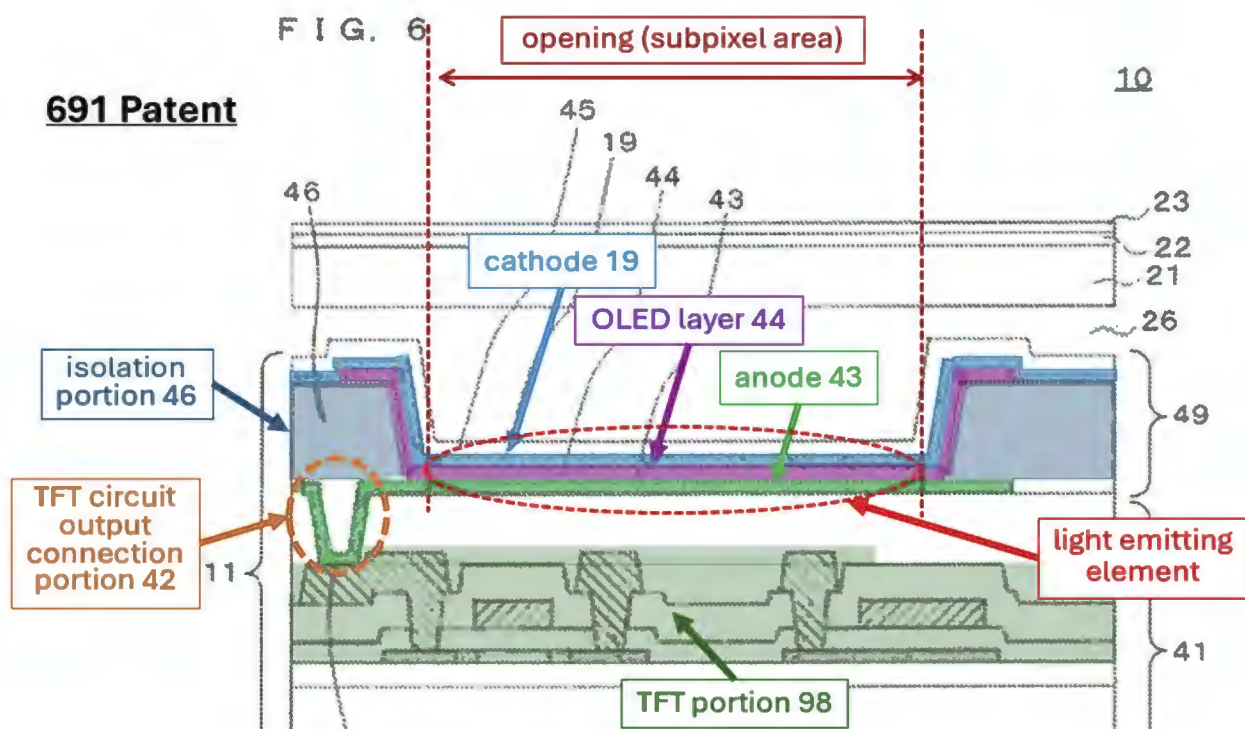


Diagram B (comparing EX1005, FIG. 2 with EX1001, FIG. 6)

236. Hwang, like the '691 patent, discloses an organic light emitting element 70 including an opposed electrode 270 (functioning as a cathode), pixel electrode 191 (functioning as an anode), and organic emission layer 370. EX1005, [0040], FIG. 2; EX1001, 9:18-25 ('691 patent describing a light emitting element with cathode electrode 19, anode electrode 43, and OLED layer 44). Like the '691 patent, Hwang's organic light emitting element 70 emits light through an opening 351 to emit one of three possible colors. EX1005, [0007], [0008], [0041]; EX1001, 9:33-67 ('691 patent describing an opening through which the light emitting element emits light in one of three colors).

237. Like the '691 patent, Hwang's display device includes a semiconductor element layer 150 with various TFTs (e.g., T1, T2, T6) connected to the anode 191 of Hwang's organic light emitting element 70 through a via hole 181. EX1005, [0043]; EX1001, FIGS. 6, 11; 9:5-29; 13:3-8 ('691 patent describing a "TFT portion 98" (included in wiring portion 41) which is connected to the anode 43 of the light emitting element through a "TFT circuit output connection portion 42").

238. For ease of reference throughout the subsequent analysis, and as explained below, Diagram C below summarizes how Hwang-Lee discloses the claimed "*first pixel*" and "*second pixel*" each with different arrangements of a

green subpixel G (“*subpixel of a first color*”), red subpixel R (“*subpixel of a second color*”), and blue subpixel B (“*subpixel of a third color*”).

FIG. 7

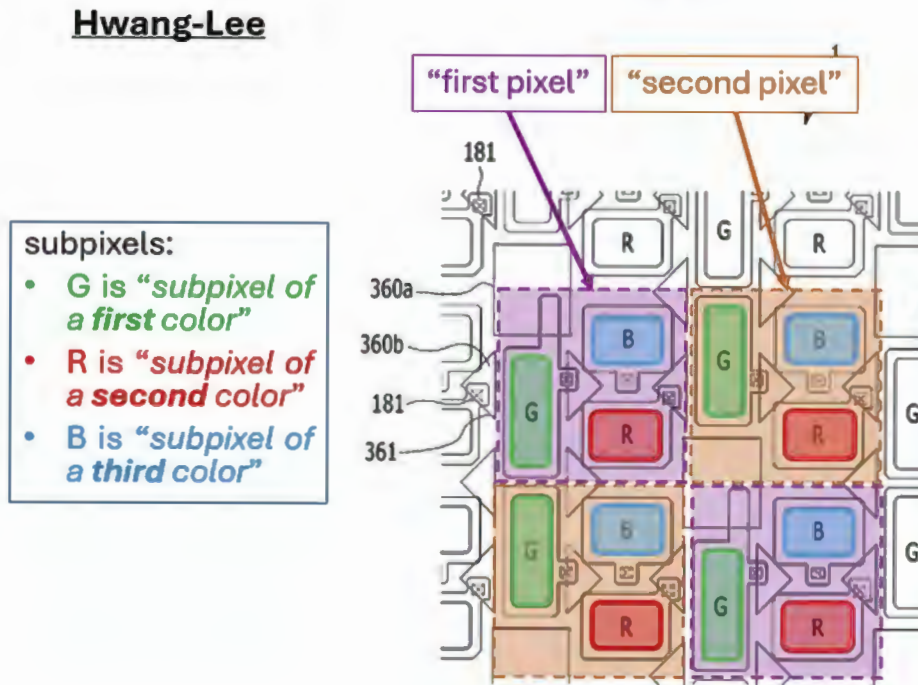


Diagram C (based on EX1005, FIG 7, mapped to claimed elements)

Claim 1:

[1.pre] A display device comprising:

239. Hwang discloses a “display device” such as a “liquid crystal display (LCD), an organic light emitting diode (OLED) display, and an electrophoretic display.” EX1005, Title, Abstract, [0005].

[1.1] a display unit where a plurality of first pixels each including subpixels of three colors and a plurality of second pixels each including subpixels of three colors arranged differently from the subpixels in one of the first pixels are alternately arrayed in a row direction and a column direction, the subpixels of the

three colors including a subpixel of a first color, a subpixel of a second color and a subpixel of a third color;

240. A POSITA would have understood Hwang-Lee to disclose or render obvious the pixel arrangement described in [1.1].

241. As discussed in Section X.C.3 (Hwang and Lee), the Hwang-Lee display device implements (i) unit pixels of a first type (“***a plurality of first pixels***”) each including subpixels of three colors and (ii) unit pixels of a second type (“***a plurality of second pixels***”) each including ***subpixels of three colors*** that are ***arranged differently*** from the subpixels in one of the first pixels.

242. Moreover, as discussed in Section III.C.3, Hwang-Lee’s first pixels and second pixels are ***alternately arrayed in a row direction and a column direction***. EX1005, [0058]-[0059], [0074]-[0076], FIG. 7 (Hwang discloses an alternating arrangement of pixel groupings); EX1006, [0049]-[0051], [0059], FIGS. 1-2 (Lee discloses alternating arrangement of unit pixels of first and second types).

243. Like the ’691 patent, the Hwang-Lee subpixels of three colors include green subpixel “G” (“***subpixel of a first color***”), red subpixel “R” (“***subpixel of a second color***”), and blue subpixel B (“***subpixel of a third color***”). EX1005, [0058]-[0059], [0074]-[0076], FIG. 7; EX1006, [0050]-[0051], [0054], FIGS. 1-2.

244. A comparison of the Hwang-Lee pixel structure with that of the ’691

patent is shown in Diagram D, below. EX1005, FIG. 7 (annotated to show the Hwang-Lee pixels); EX1001, FIG. 4.

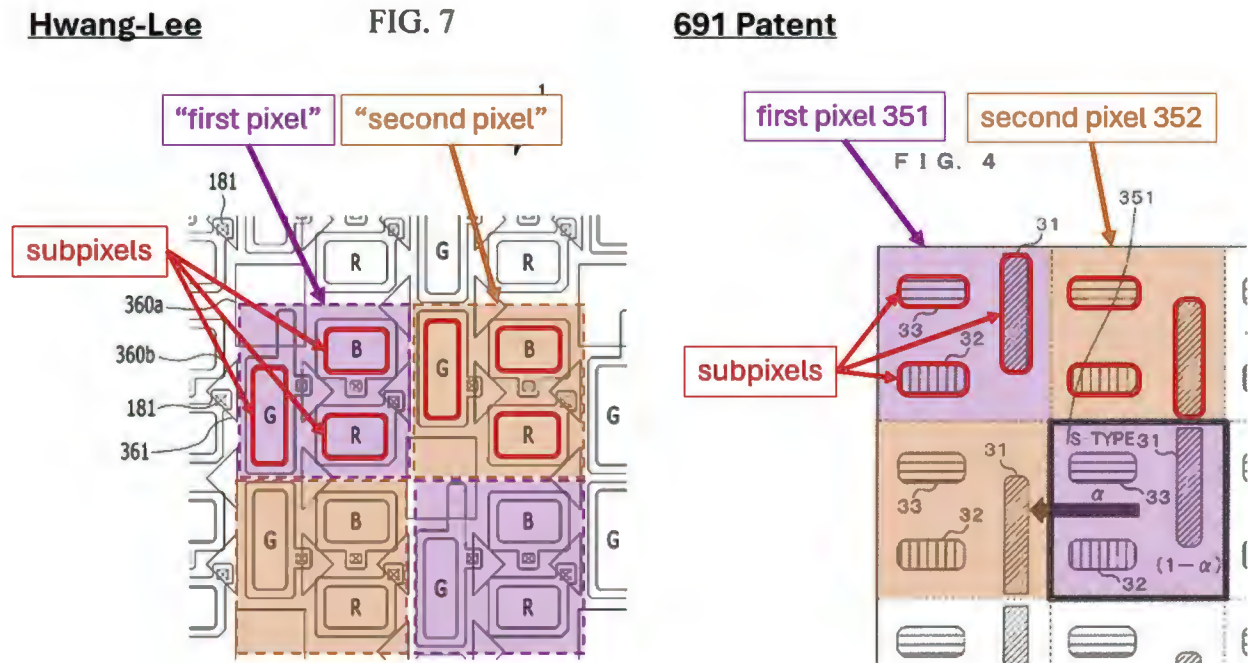


Diagram D (comparing pixel structures of Hwang-Lee and the 691 patent)

245. Therefore, a POSITA would have understood Hwang-Lee to disclose or render obvious [1.1].

[1.2] a thin film transistor (TFT) circuit disposed below each of the subpixels to control the subpixels; and

246. Even if one assumes the '691 patent provides an enabling disclosure of [1.2] with sufficient definiteness (which I certainly do not concede, see Sections X.A.4 and X.B.3), Hwang-Lee provides disclosure that is commensurate with the disclosure that the '691 patent relies on for support of [1.2]. As explained below, Hwang discloses a thin film transistor (TFT) circuit disposed below each of the

sub-pixels to control the subpixels, as recited in [1.2], in a manner commensurate with the disclosure in the '691 patent. For at least this reason, Hwang-Lee renders obvious [1.2]. Moreover, a POSITA would understand it is desirable to locate TFT circuits below the light emitting areas of the subpixel the TFT circuits control as this enables higher resolution displays to be created.

247. To the extent the '691 patent specification discloses a “***TFT circuit disposed below each of the subpixels to control the subpixels,***” it describes a “TFT portion 98” (included in the wiring portion 41) which is connected to the anode 43 of the light emitting element through a “TFT circuit output connection portion 42.” EX1001, FIGS. 6, 11; 9:5-29; 13:3-8.

248. Hwang discloses a similar if not fully equivalent structure. As seen in Diagram B above, Hwang's display device includes a semiconductor element layer 150 with transistors T1, T2, T6 (“***TFT circuit***”) connected to the pixel electrode 191 of Hwang's organic light emitting element 70 through a via hole 181. EX1005, [0043], [0146] (“via hole being formed in a thick insulating layer such as a passivation layer 180 to connect an electrode 151 of a thin film transistor (TFT) arranged below the thick insulating layer 180 to a pixel electrode 191 of a light emitting device arranged above the thick insulating layer 180”), [0039]-[0041].

249. As in the '691 patent, Hwang's transistors T1, T2, T6 in the

semiconductor element layer 150 (“**TFT circuit**”) are disposed below Hwang’s light emitting element 70. EX1005, FIGS. 2, 11. Hwang explains that its transistors T2, T2, T6 function as a “driving transistor T1” and a “switching transistor T2,” which are components included in the fundamental pixel circuitry of a subpixel. EX1005, [0082], [0121], FIGS. 8, 11.

250. Moreover, as in the ’691 patent, Hwang’s driving transistor T1 and switching transistor T2 control the subpixel. EX1005, [0084] (Hwang explaining that its “driving transistor T1 receives the data signal Dm according to a switching operation of the switching transistor T2 to supply a driving current Id to the organic light emitting diode OLED”); EX1001, 13:59-63 (the ’691 patent similarly explains that a “driving TFT is an example of a driving transistor that controls a current flowing to the organic light emitting element” and a “switching TFT is an example of a switch that controls electrical connection between the driving transistor and the organic light emitting element”).

251. Therefore, Hwang-Lee discloses or renders obvious [1.2].

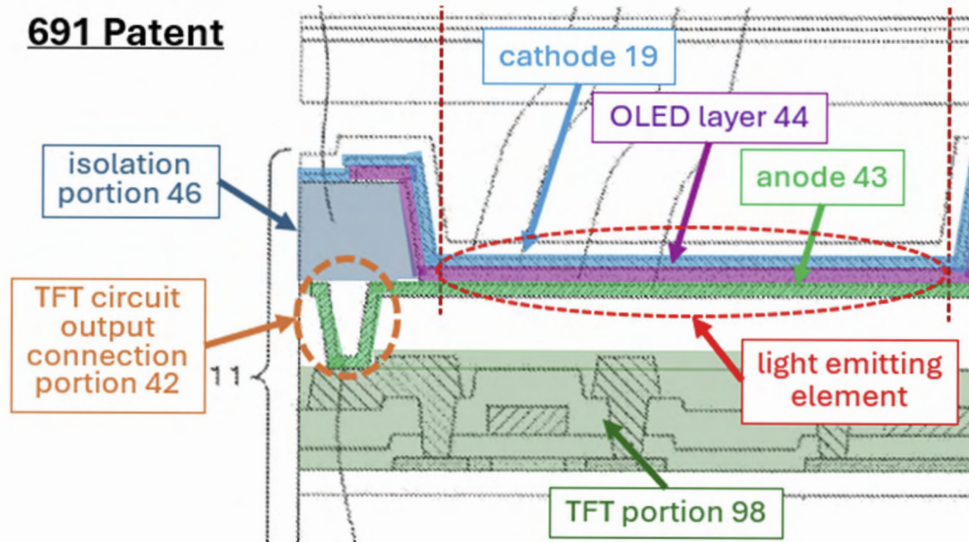
[1.3] at least one connection part that connects the TFT circuit and one of the subpixels;

252. Even if one assumes that the ’691 patent provides an enabling disclosure of [1.3] with sufficient definiteness (which I do not concede, based on my discussion in Section X.A.3 and X.B.2), Hwang-Lee provides disclosure that is

commensurate with the disclosure that the '691 patent relies on for support of [1.3], as explained below, and for at least this reason renders the limitation obvious.

253. The '691 patent specification does not use the term “*connection part*.” EX1001. Instead, the specification describes a “TFT circuit output connection portion 42” that connects the “one anode electrode 43 to one TFT circuit.” EX1001, 9:28-29. The '691 patent describes the TFT circuit output connection portion 42 as receiving “an output of a TFT circuit” and “applying the output to the anode electrode 43.” EX1001, 10:25-28, 9:55-58 (“the TFT circuit output connection portion 42 connected to a subpixel which is to emit light is operated, so that a voltage is applied to the anode electrode 43”).

254. The '691 patent shows, in FIG. 6 (below), anode electrode 43 extending toward the “TFT circuit output connection portion 42” to connect to the underlying TFT portion 98. EX1001, FIG. 6.

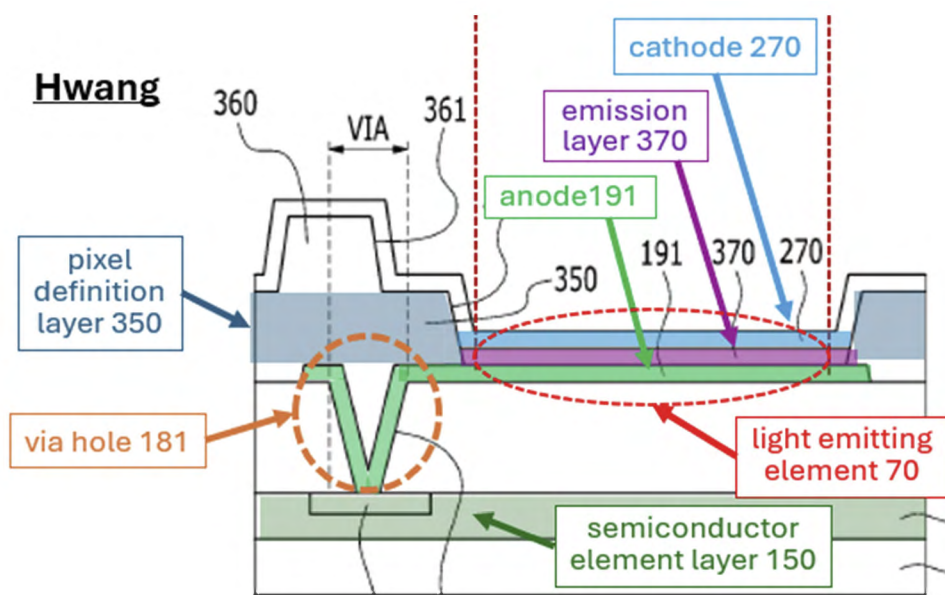


EX1001, FIG. 6 (annotated)

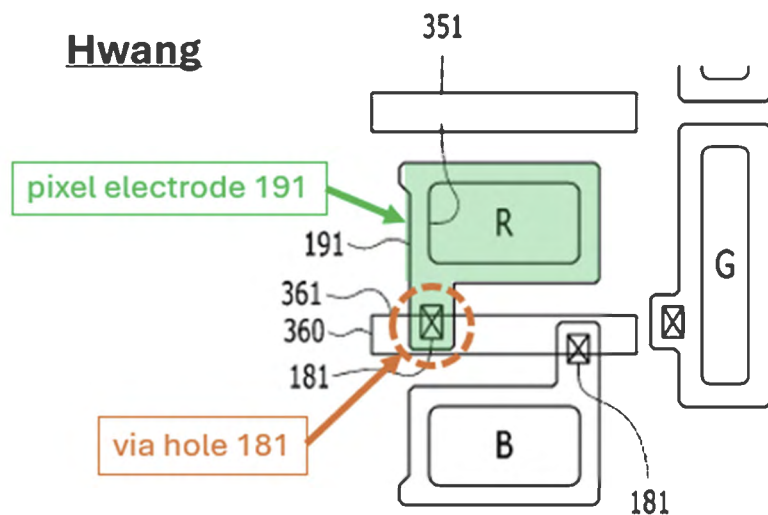
255. The '691 patent explains that the TFT circuit output connection portion 42 and the anode electrode 43 are formed of the same material and manufactured in one step ("step S502" of FIG. 8). EX1001, 10:59-61, FIG. 8. Specifically, "after a vapor deposition apparatus forms a metal film, ...an etching apparatus removes unnecessary portions of the metal film, so that the TFT circuit output connection portion 42 and the anode electrode 43 are formed." EX1001, 10:62-67.

256. Hwang discloses a similar if not analogous structure. As explained above, Hwang's pixel electrode 191 (part of which functions as an anode for light emitting element 70 of a Hwang-Lee subpixel) is "protruded toward" and extends through the "via hole 181" to connect to the underlying semiconductor element layer 150, which includes TFTs such as T1, T2, T6. EX1005, [0043], [0146],

[0039]-[0041], FIGS. 2, 11.

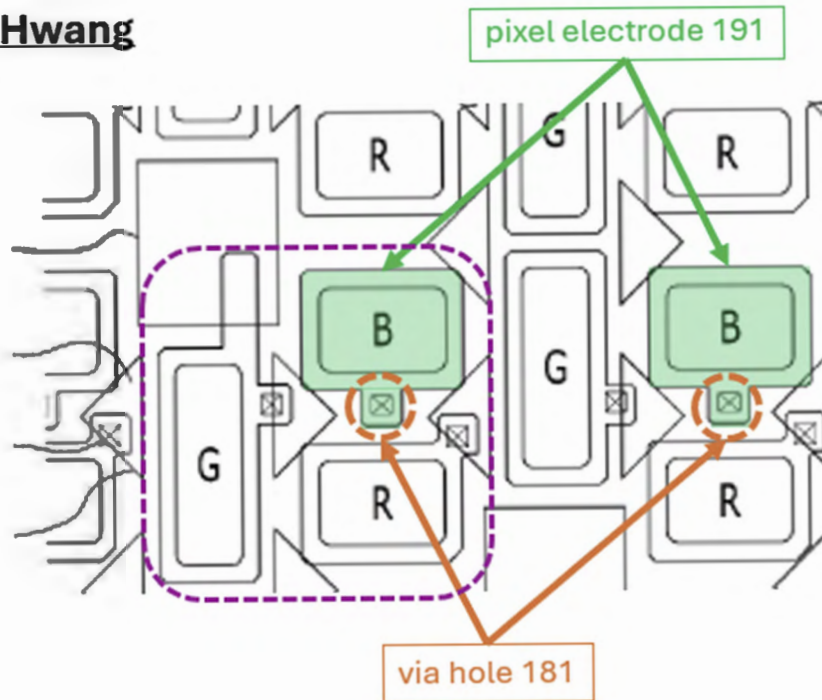


EX1005, FIG. 2 (annotated)



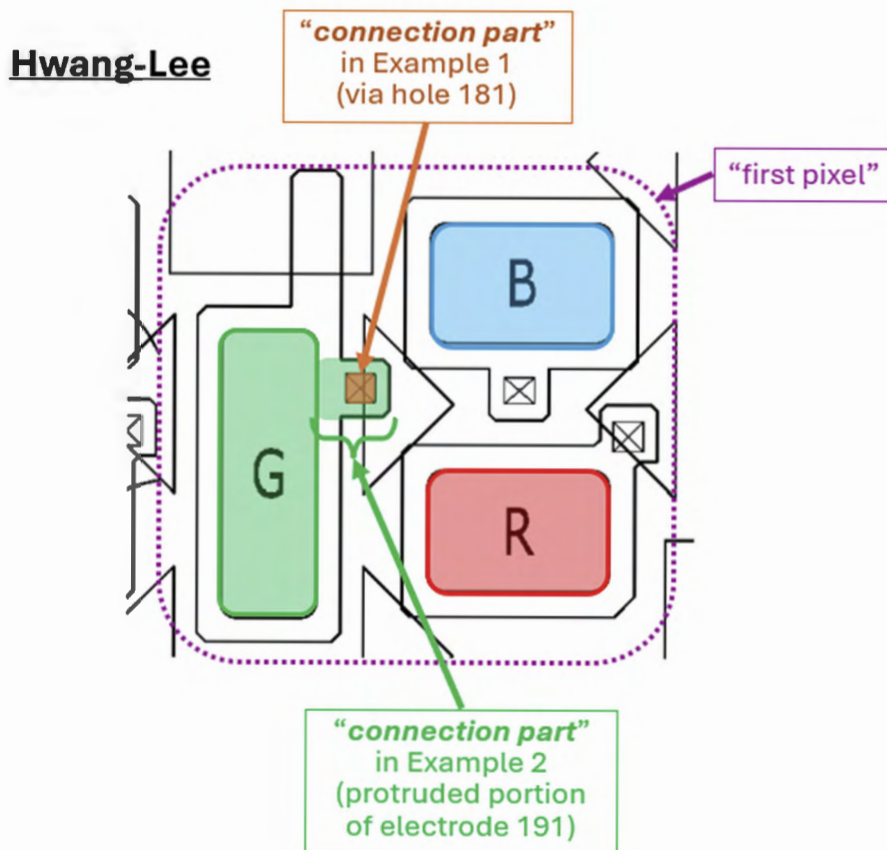
EX1005, FIG. 6 (annotated)

Hwang



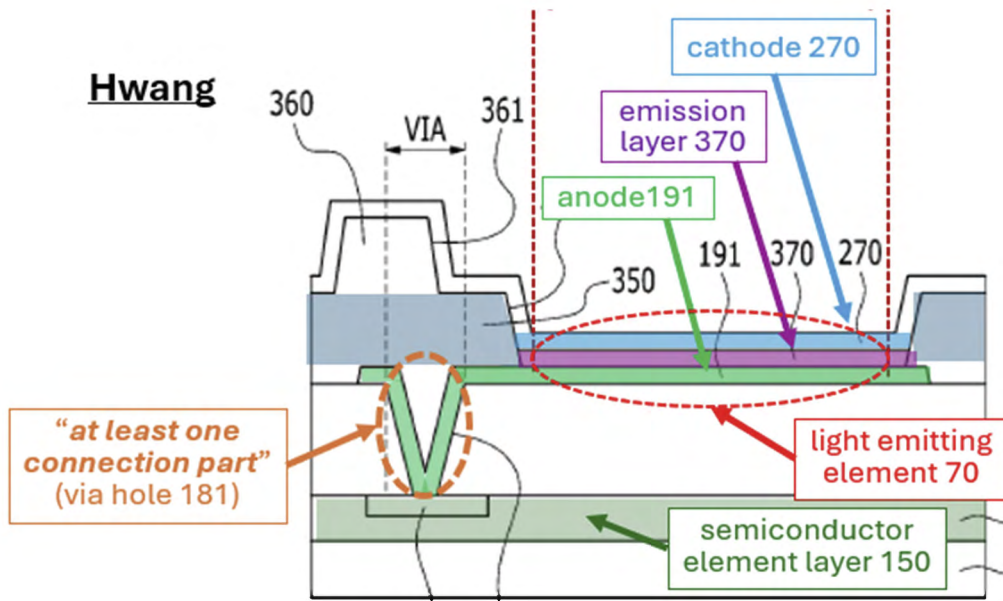
EX1005, FIG. 7 (annotated)

257. Based on Hwang's teachings, a POSITA would have understood that the claimed "*at least one connection part*" is disclosed or rendered obvious by at least two different structures in Hwang. For example, a POSITA would have understood that the claimed "*at least one connection part*" is disclosed or rendered obvious by Hwang's **via hole 181** into which Hwang's electrode 191 protrudes (hereinafter "Example 1") and also by Hwang's **protruded portion of pixel electrode 191** which protrudes into via hole 181 (hereinafter "Example 2"). A comparison of the two is shown below, with reference to Hwang's FIG. 7. In both examples, a POSITA would have found Hwang-Lee to render obvious [1.10] and [1.11], as discussed below.



EX1005, FIG. 7 (annotated)

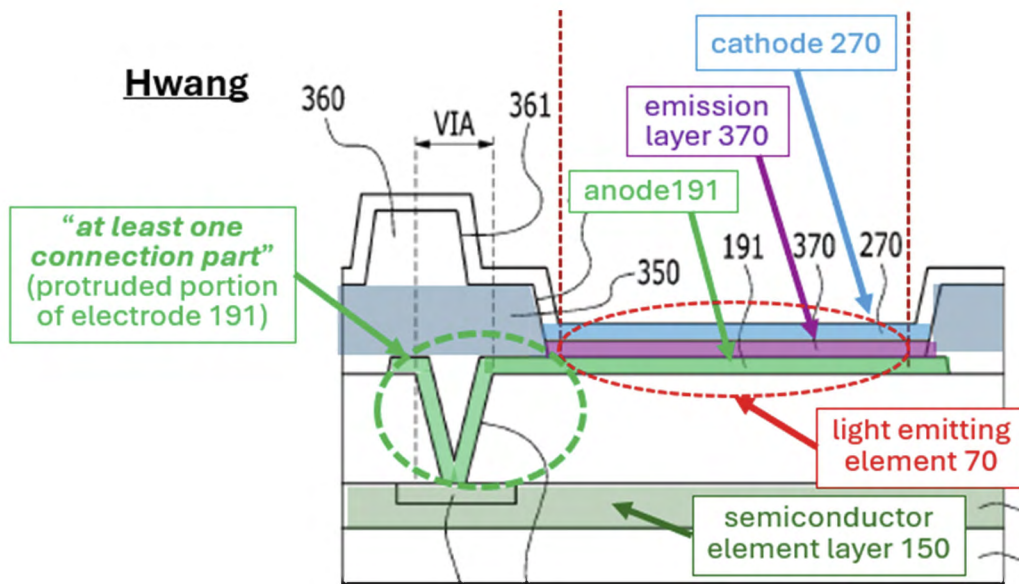
258. In Example 1, a POSITA would have understood that Hwang's **via hole 181** (into which Hwang's electrode 191 protrudes) discloses or renders obvious the claimed "*at least one connection part.*" As seen in Hwang's FIG. 2, below, Hwang's via hole 181 ("*at least one connection part*" in Example 1) connects Hwang's semiconductor layer 150 including TFTs ("*TFT circuit*") and the anode electrode 191 of one of Hwang-Lee's subpixels ("*one of the subpixels*"). EX1005, FIG. 2; *see also* analysis of claim 3 below.



EX1005, FIG. 2 (annotated, Example 1)

259. Based on my personal experience and knowledge, it was well known in the art to implement a via hole, as disclosed in Hwang-Lee, to provide a connection part. Such knowledge is evidenced, for example, in the prosecution history of the '691 patent itself, in which the Examiner rejected the claimed “*at least one connection part*” by citing a “via hole VIA” disclosed in Kim’834, a mapping which Applicant did not contest. EX1002, 3rd office action.

260. In Example 2, a POSITA would have understood that Hwang’s **protruded portion of pixel electrode 191** (protruding toward and into Hwang’s via hole 181) also discloses or renders obvious the claimed “*at least one connection part.*”



EX1005, FIG. 2 (annotated, Example 2)

261. As seen above, Hwang’s protruded portion of pixel electrode 191 (“*at least one connection part*” in Example 2) connects Hwang’s semiconductor layer 150 including TFTs (“*TFT circuit*”) and the remaining non-protruded portion of Hwang’s pixel electrode 191 functioning as an anode under emission layer 370 in light emitting element 70 in one of Hwang-Lee’s subpixels (“*one of the subpixels*”); *see also* analysis of claim 7 below.

262. Additionally it is noted that without a connection part connecting a TFT circuit to the emission area of the subpixel, the subpixel would be inoperable. Therefore a POSITA understands that this is merely described and taught by Hwang-Lee, it is in fact required for the subpixel to operate.

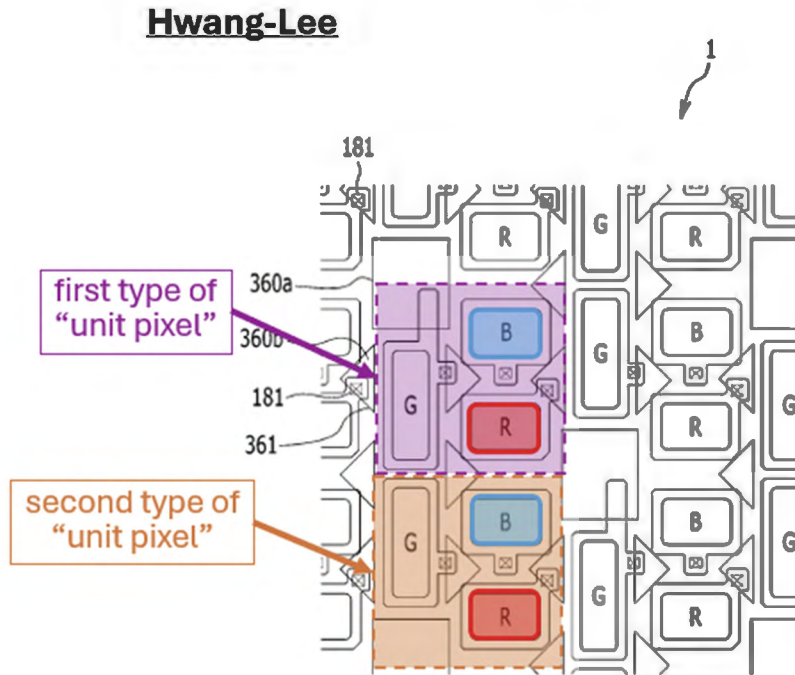
263. Therefore, Hwang-Lee discloses or renders obvious [1.3].

[1.4] wherein in the first pixel and the second pixel adjacent to each other in the column direction, the subpixel of the second color and the subpixel of the third color are arrayed alternately in the column direction,

264. As discussed in Section X.A.2, the “first pixel” in [1.4] refers to a single pixel within “the plurality of first pixels” and presumably the “one” first pixel introduced in [1.1]. Moreover, the “second pixel” in [1.4] lacks antecedent basis and could potentially refer to either of two second pixels that are adjacent to the first pixel in the column direction. Regardless of which interpretation is taken, as explained below, Hwang-Lee discloses “first pixels” and “second pixels” each of which render obvious [1.4].

265. Also, as discussed in Section X.C.3, Hwang-Lee implements a first pixel and a second pixel adjacent to each other in the column direction. In these adjacent pixels, the red subpixel R (“***subpixel of the second color***”) and the blue subpixel B (“***subpixel of the third color***”) are arrayed alternatively in the column direction. EX1005, [0058] (“**the red pixel R and the blue pixel B are alternately arranged in a vertical direction**”).

FIG. 7



EX1005, FIG. 7 (annotated and color added)

266. Therefore, Hwang-Lee discloses or renders obvious [1.4].

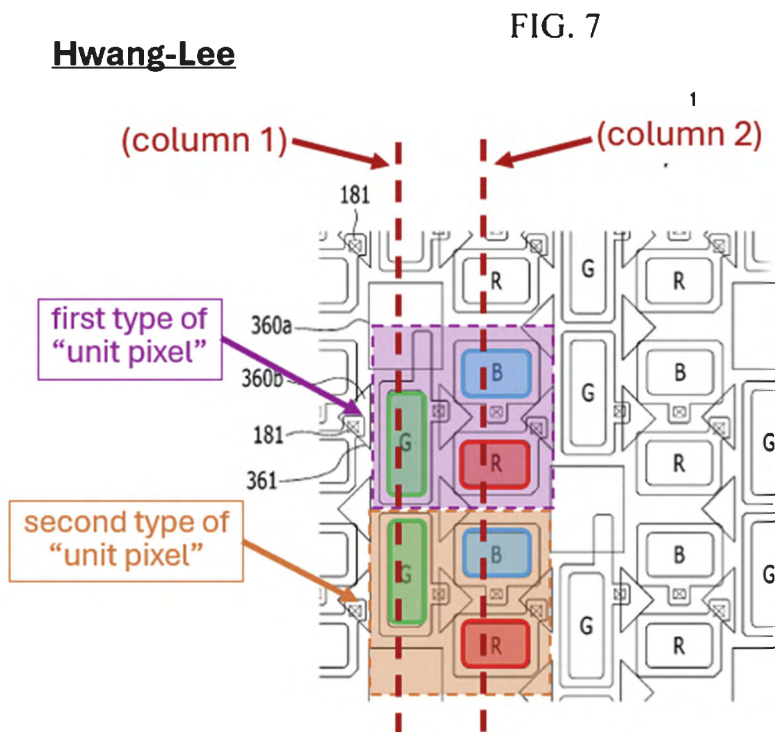
[1.5] a column where the subpixel of the first color in the first pixel and the subpixel of the first color in the second pixel are arrayed in parallel with a column where the subpixel of the second color and the subpixel of the third color are alternately arrayed, the columns being arrayed alternately in the row direction,

267. As discussed in [1.4], Hwang-Lee discloses a “first pixel” and a “second pixel” that are adjacent to each other in the column direction.

268. As shown in annotated FIG. 7 of Hwang, below, Hwang-Lee discloses a column (labeled “column 1”) where a green subpixel G (“***subpixel of the first color***”) in the first pixel and a green subpixel G in the second pixel are arrayed.

EX1005, [0058], FIG. 7. This column 1 is parallel with another column (labeled

“column 2”) where red subpixel R (“*subpixel of the second color*”) and blue subpixel B (“*subpixel of the third color*”) are alternately arrayed. EX1005, [0058] (Hwang disclosing that “the green pixel G may be arranged at one side of the red pixel R and the blue pixel B”). Furthermore, these two columns are arrayed alternately in the row direction. EX1005, [0059] (Hwang explaining that “**column of the green pixel G and a column where the red pixel R and the blue pixel B are arranged may be alternately arranged**”).



EX1005, FIG. 7 (annotated and color added)

269. Therefore, Hwang-Lee discloses or renders obvious [1.5].

[1.6] and [1.7]: the subpixel of the first color in one of the first pixels has a biased arrangement and is positioned toward a side of the subpixel of the second color in

an array direction of the subpixel of the second color and the subpixel of the third color that are arrayed alternately, the subpixel of the first color in one of the second pixels has a biased arrangement and is positioned toward a side of the subpixel of the third color in the array direction of the subpixel of the second color and the subpixel of the third color that are arrayed alternately,

270. Limitations [1.6] and [1.7] describe mirror-image arrangements of subpixels in the first pixel and second pixel and are thus analyzed here together.

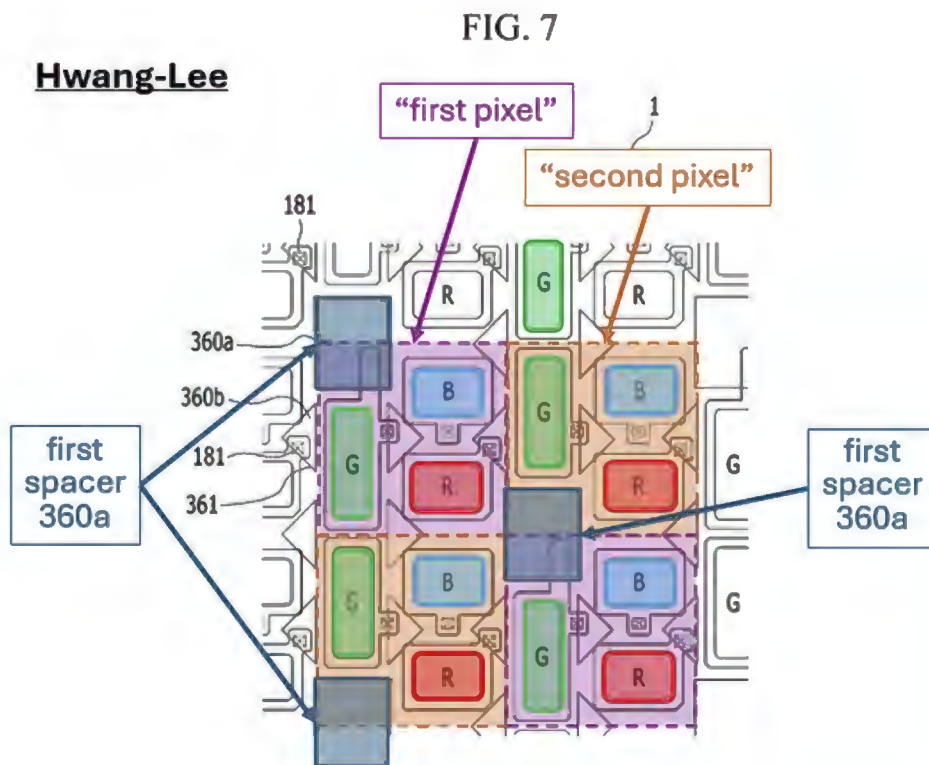
271. In [1.6], as discussed in Section X.A.2 (112), a POSITA would have found unclear whether the claimed “*one of the first pixels*” in [1.6] is the same “*one of the first pixels*” as recited in [1.1] or whether it refers to a different first pixel. Regardless, Hwang-Lee renders obvious [1.6], because all of Hwang-Lee’s “first pixels” are identical and possess the claimed features.

272. In [1.7], as discussed in Section X.A.2 (112), a POSITA would have found unclear whether the claimed “*one of the second pixels*” in [1.7] is the same “*one of the second pixels*” as recited in [1.5] or whether it refers to a different second pixel. Regardless, Hwang-Lee renders obvious [1.7], because all of Hwang-Lee’s “second pixels” are identical and possess the claimed features.

273. Moreover, even if one assumes that the ’691 patent provides an enabling disclosure of the terms “*array direction*” and “*arrayed alternately*” with sufficient definiteness (which I do not concede, based on the discussion in Section X.A.5 and X.B.4 (112)), Hwang-Lee provides disclosure that is commensurate with the disclosure that the ’691 patent relies on for support of [1.6] and [1.7], as

explained below, and for at least this reason renders the limitation obvious.

274. Specifically, a POSITA would have recognized that the same “biased arrangement” described in the ’691 patent is also disclosed in Hwang, due to a specific structural feature in Hwang’s pixel arrangement, namely “spacers” 360 that “maintain an interval of space” between adjacent subpixels. EX1005, [0047]. As shown in FIG. 7, Hwang discloses a first spacer 360a “disposed between the green pixels G that are arranged in one line” along a column, and in particular between every “two green pixels G” along the column. EX1005, [0075], FIG. 7.

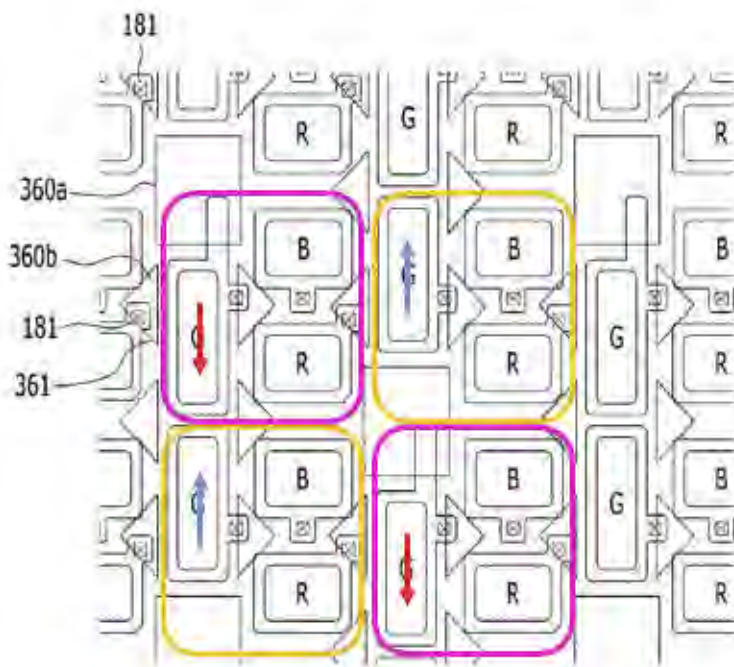


EX1005, FIG. 7 (annotated and color added)

275. By contrast, in the column where the red and blue subpixels (R, B) are

arranged, “the spacer may not be disposed” in that column (instead, a second spacer 360a may be disposed “between” the column of green subpixels G and the column of red and blue subpixels R, B). EX1005, [0076], FIG. 7.

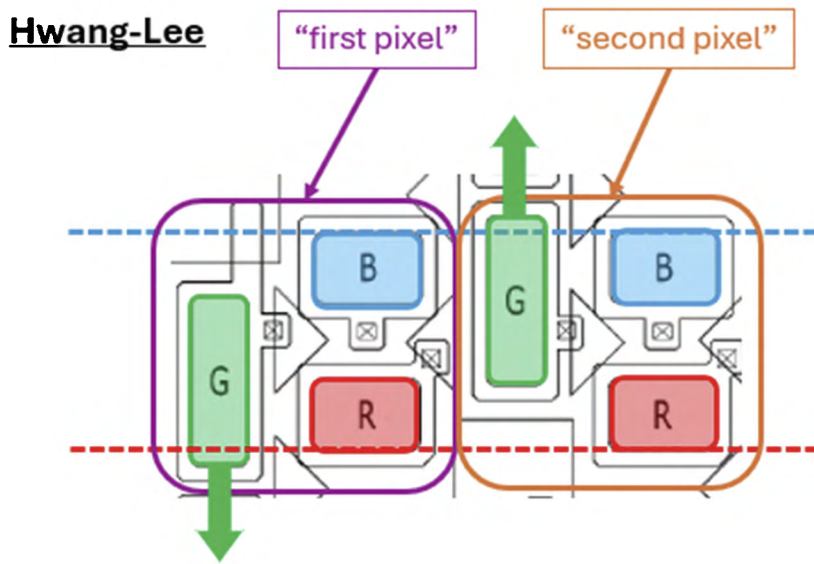
276. Accordingly, the green subpixels G are spaced every “two” apart by first spacers 360a along a column, while the red and blue subpixels R, B do not have any spacers in the column, resulting in a non-uniform clustered arrangement a shown in FIG. 7 In this arrangement, every green subpixel G is positioned either closer toward a side of the red subpixel R or closer toward a side of the blue subpixel B, as I explain below.



EX1005, FIG. 7 (annotated and color added)

277. More precisely, to determine this, a POSITA would have found it

obvious to compare the distances between the top and bottom edges of a green subpixel G with respective top and bottom edges of a red and blue subpixel R, B in the same pixel, as shown below.



EX1005, FIG. 7 (annotated and color added)

278. Furthermore, a POSITA would have understood or found obvious that the first spacers 360a all have uniform sizes and shapes. For example, Hwang explains that spacers 360 are formed using “one photomask” including a “halftone region.” EX1005, [0054], [0134], [0143]. A POSITA would have understood that when using a photomask to fabricate repetitive features such as spacers, and to ensure Hwang’s desire for first spacers 360a “larger than” second spacers 360b (EX1005, 0076), the first spacers 360a would have uniform sizes and shapes.

279. Therefore, in [1.6], a POSITA would have found Hwang-Lee to

disclose or render obvious that the green subpixel G (“*subpixel of the first color*”) in one of the first type of unit pixels (“*one of the first pixels*”) has a biased arrangement and is positioned toward a side of the red subpixel R (“*subpixel of the second color*”) in an array direction of the red subpixel R (“*subpixel of the second color*”) and the blue subpixel B (“*subpixel of the third color*”) that are arrayed alternately.

280. Furthermore, based on the analysis above, in [1.7], a POSITA would have found Hwang-Lee to disclose or render obvious that the green pixel G (“*subpixel of the first color*”) in one of the second type of unit pixels (“*one of the second pixels*”) has a biased arrangement and is positioned toward a side of the blue pixel B (“*subpixel of the third color*”) in the array direction of the red pixel R (“*subpixel of the second color*”) and the blue pixel B (“*subpixel of the third color*”) that are arrayed alternately.

281. Therefore, Hwang-Lee discloses or renders obvious [1.6] and [1.7].

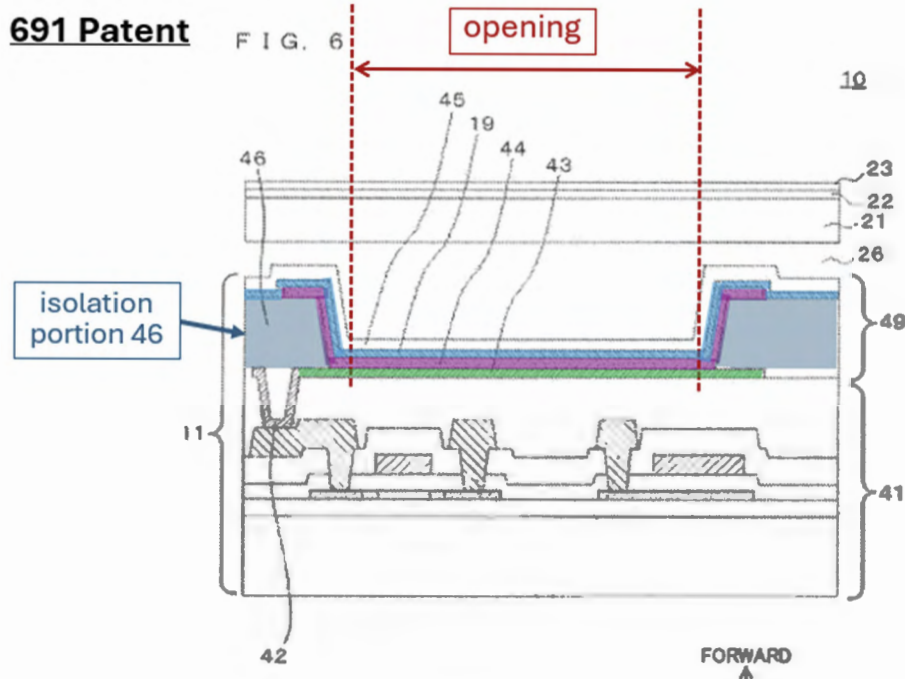
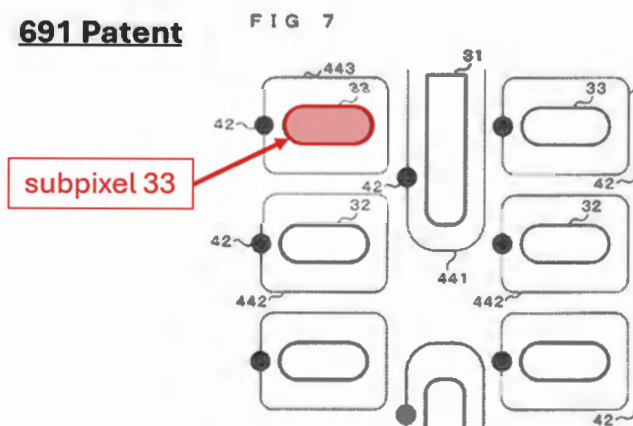
[1.8] and [1.9]: the subpixel of the first color in one of the first pixels has a rectangle or rounded rectangle shape whose long axis is parallel with the direction in which the subpixel of the second color and the subpixel of the third color are arrayed alternately, the subpixel of the first color in one of the second pixels has the rectangle or rounded rectangle shape whose long axis is parallel with the direction in which the subpixel of the second color and the subpixel of the third color are arrayed alternately,

282. Limitations [1.8] and [1.9] describe analogous features of subpixels in the first pixel and second pixel and are thus analyzed here together.

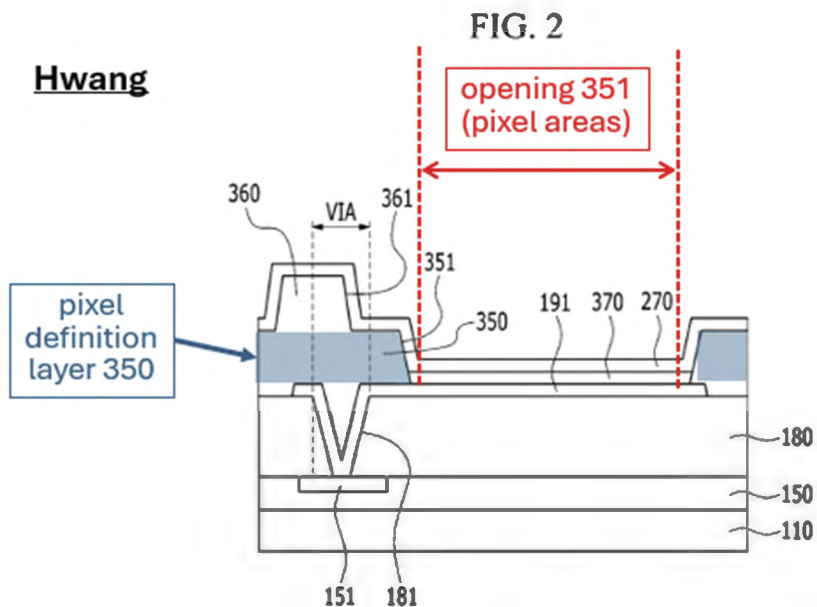
283. In [1.8], as discussed in Section X.A.2 (112), a POSITA would have found unclear whether the claimed “*one of the first pixels*” is the same “*one of the first pixels*” as recited in [1.1] and/or [1.6] or whether it refers to yet another first pixel. Regardless, Hwang-Lee renders obvious [1.8], based on all of Hwang-Lee’s “first pixels” being identical and possessing the claimed features.

284. In [1.9], as discussed in Section X.A.2 (112), a POSITA would have found unclear whether the claimed “*one of the second pixels*” is the same “*one of the second pixels*” as recited in [1.3] and/or [1.6] or whether it refers to yet another second pixel. Regardless, Hwang-Lee renders obvious [1.9], based on all of Hwang-Lee’s “second pixels” being identical and possessing the claimed features.

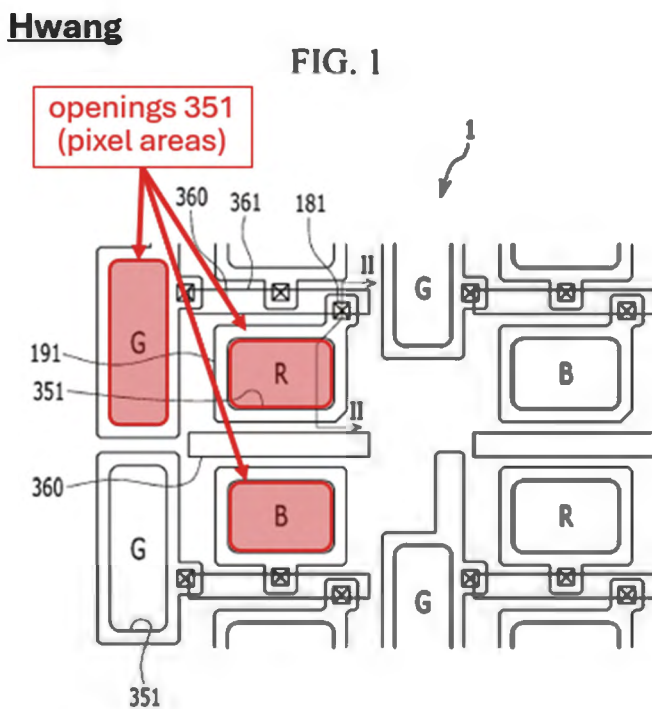
285. The ’691 patent explains, in describing the “shape” of a subpixel, that “isolation portion 46 is an insulating layer having **openings corresponding to the shapes** of the first subpixel 31, the second subpixel 32, and the third subpixel 33 illustrated in FIG. 4.” EX1001, 9:33-36; FIG. 4. As such, the “shape” of each subpixel in the ’691 patent corresponds to the “openings” in the isolation portion 46.



286. Similarly, Hwang defines an “opening 351” in a pixel definition layer 350 through which each of Hwang’s light emitting elements 70 emits light, thus defining a “pixel area” which is a “light-emitting region of each pixel.” EX1005, [0046], FIGS. 1, 2.



EX1005, FIG. 2 (annotated and color added)



EX1005, FIG. 1 (annotated and color added)

287. The “opening 351” in all of Hwang’s plan-view diagrams are

consistently illustrated as having a rectangular shape with rounded corners, as seen in FIG. 1. EX1005, FIGS. 1, 3, 5, 6, 7. Hwang expresses a deliberate choice in the shape of openings 351 illustrated in FIG. 1. In particular, when Hwang describes FIG. 7 as compared to FIG. 1, Hwang explains that “the **shape** and the arrangement of the red pixel R, the **green pixel G**, and the blue pixel B ... may be different.” EX1005, [0074]. Furthermore, in comparing the three subpixels (R, G, B), Hwang only compares two dimensions, “a length of a horizontal direction” and “a length of the vertical direction” of each subpixel. EX1005, [0058]. Based on my knowledge and experience, I understand that it was well known in the art that light-emitting regions of pixels were typically rectangular in shape. *See, e.g.*, Park’531 (EX1007) at [0010], [0043], [0046], [0087] (explaining “[e]ach pixel region P has a **rectangular shape** to have a horizontal length H and a vertical length V”).

288. Hwang also explains that “a length of the vertical direction of the green pixel G” (“**long axis**” of the subpixel of the first color) is “longer than the length of the vertical direction of either of the red pixel R or the blue pixel B.” EX1005, [0058].

289. Furthermore, Hwang discloses that the red subpixel R and the blue subpixel B are “arranged in a vertical direction” (EX1005, [0058]) and that green

subpixels G are “continuously arranged in the vertical direction” (EX1005, [0059]). Hwang further explains that “a column of the green pixel G and a column where the red pixel R and the blue pixel B are arranged may be alternately arranged.” EX1005, [0059].

290. Therefore, in [1.8], a POSITA would have found Hwang-Lee to disclose or render obvious that the green subpixel G (“*subpixel of the first color*”) in one of the first type of unit pixels (“*one of the first pixels*”) has a rectangle or rounded rectangle shape whose length along the vertical direction (“*long axis*”) is parallel with the direction in which the red subpixel R (“*subpixel of the second color*”) and the blue subpixel B (“*subpixel of the third color*”) are arrayed alternately.

291. Moreover, in [1.9], a POSITA would have found Hwang-Lee to disclose or render obvious that the green subpixel G (“*subpixel of the first color*”) in one of the second type of unit pixels (“*one of the second pixels*”) has a rectangle or rounded rectangle shape whose length along the vertical direction (“*long axis*”) is parallel with the direction in which the red subpixel R (“*subpixel of the second color*”) and the blue subpixel B (“*subpixel of the third color*”) are arrayed alternately.

292. Therefore, Hwang-Lee discloses or renders obvious [1.8] and [1.9].

[1.10] and [1.11]: the at least one connection part of the subpixel of the first color in one of the first pixels is one connection part and is biased from a middle of a long axis of the subpixel of the first color toward an end of the long axis when viewed from the row direction, the at least one connection part of the subpixel of the first color in one of the second pixels is one connection part and is biased from a middle of a long axis of the subpixel of the first color toward an end of the long axis when viewed from the row direction,

293. Limitations [1.10] and [1.11] describe analogous features of subpixels in the first pixel and second pixel and are thus analyzed here together.

294. In [1.10], as discussed in Section X.A.2 (112), a POSITA would have found unclear whether the claimed “*one of the first pixels*” is the same “*one of the first pixels*” as recited in [1.1], [1.6], and/or [1.8] or whether it refers to yet another first pixel. Regardless, Hwang-Lee renders obvious [1.10], based on all of Hwang-Lee’s “first pixels” being identical and possessing the claimed features.

295. In [1.11], as discussed in Section X.A.2 (112), a POSITA would have found unclear whether the claimed “*one of the second pixels*” is the same “*one of the second pixels*” as recited in [1.3], [1.6], and/or [1.8], or whether it refers to yet another second pixel. Regardless, Hwang-Lee renders obvious [1.11], based on all of Hwang-Lee’s “second pixels” being identical and possessing the claimed features.

296. Moreover, even if one assumes that the ’691 patent provides an enabling disclosure of the term “*the at least one connection part*” with sufficient definiteness (which I do not concede, *see* Section X.A.3 and X.B.2 (112)), Hwang-

Lee provides disclosure that is commensurate with the disclosure that the '691 patent relies on for support of [1.10] and [1.11], as explained below, and for at least this reason renders the limitation obvious.

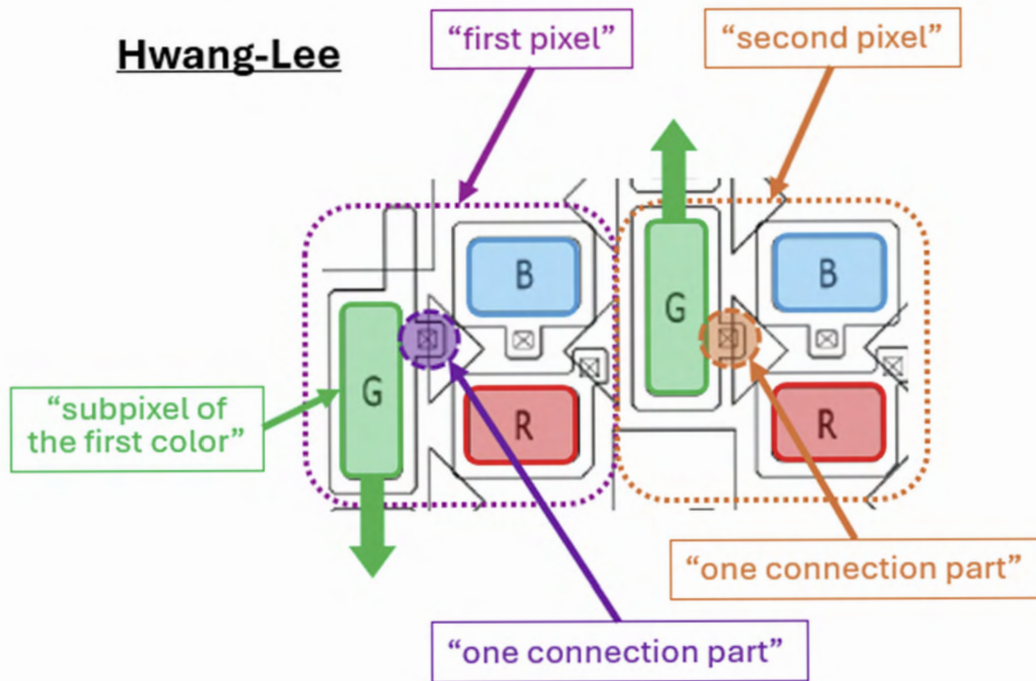
297. As explained for [1.3], a POSITA would have understood that the claimed “*at least one connection part*” is disclosed or rendered obvious by at least two example structures in Hwang, namely Hwang’s **via hole 181** into which Hwang’s electrode 191 protrudes (Example 1) and Hwang’s **protruded portion of pixel electrode 191** which protrudes into via hole 181 (Example 2). In both examples, a POSITA would have found Hwang-Lee to render obvious [1.10] and [1.11], as discussed below.

298. *Example 1*

299. A POSITA would have recognized that in Hwang-Lee’s first type of unit pixel (“*one of the first pixels*”), there is only one via hole 181 (“*one connection part*” in Example 1) for Hwang-Lee’s green subpixel G (“*the subpixel of the first color*”).

300. Moreover, as discussed below, a POSITA would have found obvious that in Hwang-Lee’s first type of unit pixel (“*first pixel*”), Hwang’s via hole 181 (“*one connection part*” in Example 1) is biased from a middle of a long axis of Hwang’s green subpixel G (“*subpixel of the first color*”) toward an **upper end** of

the long axis when viewed from the row direction, as shown in Hwang's FIG. 7 below, thus rendering obvious [1.10].

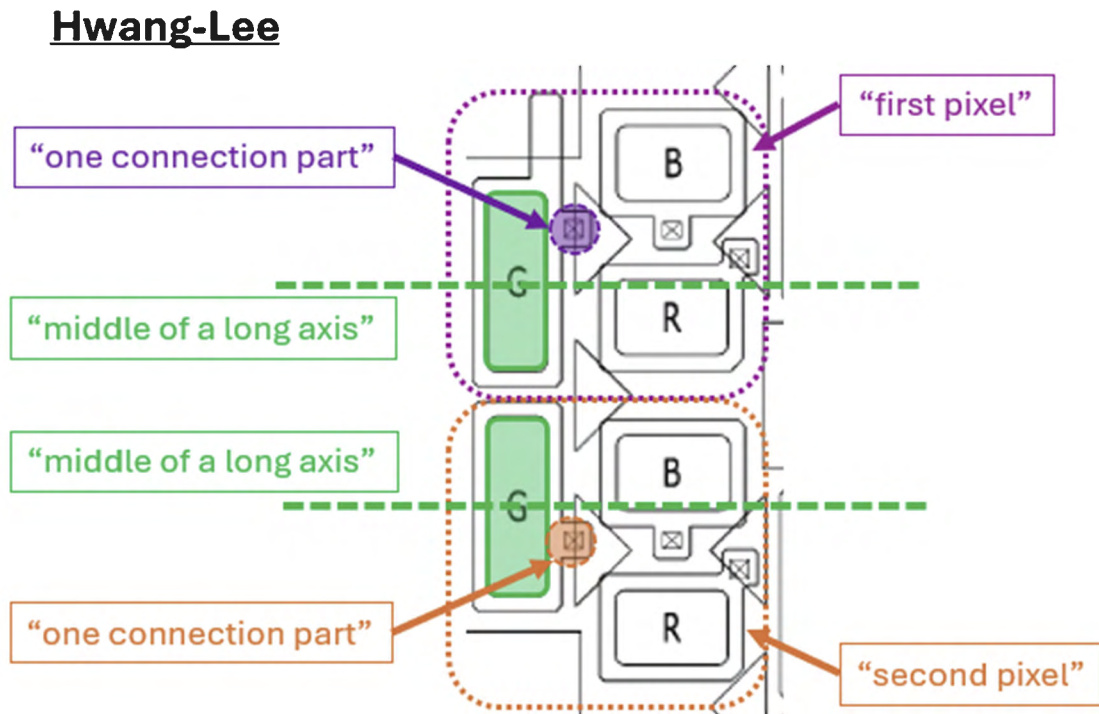


EX1005, FIG. 7 (annotated)

301. Specifically, as discussed for [1.6], a POSITA would have understood Hwang-Lee to render obvious that, in the first pixel, the green subpixel G (*"subpixel of the first color"*) has a biased arrangement and is positioned toward a side of the red subpixel R (*"subpixel of the second color"*). As such, a POSITA would have understood that Hwang's green subpixel G (*"subpixel of the first color"*) would have its via hole 181 (*"one connection part"* in Example 1) positioned toward an upper end of subpixel G to ensure that the via hole 181 is positioned in a space between the adjacent red and blue subpixels, as shown in

annotated FIG. 7 below.

302. To determine this, a POSITA would have found it obvious to compare the vertical position of Hwang's via hole 181 ("**one connection part**" in Example 1) with respect to a mid-point of the green subpixel G, as shown below.



EX1005, FIG. 7 (annotated)

303. In doing so, a POSITA would have found Hwang-Lee to render obvious that the via hole 181 ("**at least one connection part**" in Example 1) of the green subpixel G ("**subpixel of the first color**") in one of the first type of unit pixels ("**one of the first pixels**") is only one via hole 181 ("**one connection part**" in Example 1) and is biased from a middle of a long axis of the green subpixel G

(“*subpixel of the first color*”) toward an end of the long axis when viewed from the row direction, thus rendering obvious [1.10].

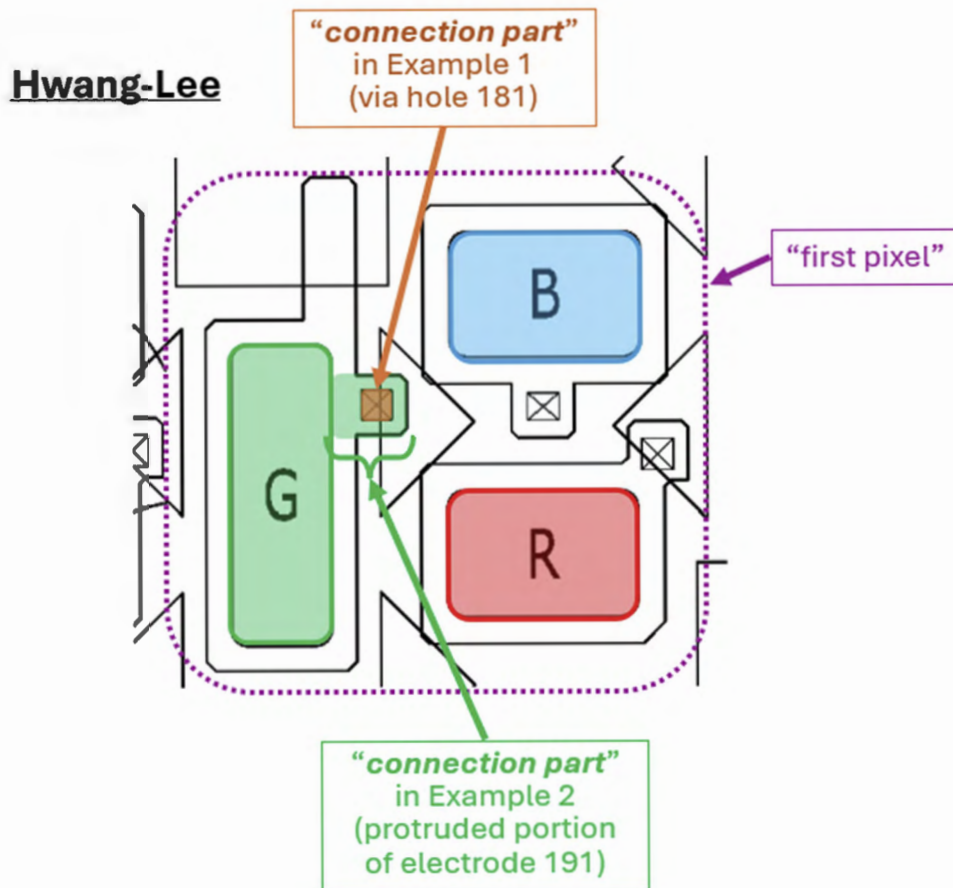
304. Analogously, for [1.11], the arrangements of Hwang-Lee’s green subpixel G and its via hole 181 in the first pixel and second pixel are mirror images, and a POSITA would have found Hwang-Lee to render obvious that the via hole 181 (“*at least one connection part*” in Example 1) of the green subpixel G (“*subpixel of the first color*”) in one of the second type of unit pixels (“*one of the second pixels*”) is only one via hole 181 (“*one connection part*” in Example 1) and is biased from a middle of a long axis of the green subpixel G (“*subpixel of the first color*”) toward an end of the long axis when viewed from the row direction, thus rendering obvious [1.11].

305. Therefore, a POSITA would have found Hwang-Lee to render obvious [1.10] and [1.11] in Example 1.

306. **Example 2**

307. As explained for [1.3], in Example 2, Hwang’s protruded portion of pixel electrode 191 also renders obvious the claimed “*at least one connection part*”. Moreover, a POSITA would have recognized that Hwang’s protruded portion of pixel electrode 191 (“*at least one connection part*” in Example 1) is arranged at **the same position** as Hwang’s via hole 181 into which Hwang’s

protruded portion of electrode 191 extends (“*at least one connection part*” in Example 2). EX1005, FIG. 7.



EX1005, FIG. 7 (annotated)

308. Therefore, for reasons similar to those discussed in regard to Example 1, a POSITA would have found Hwang-Lee to render obvious [1.10] and [1.11] in Example 2.

[1.12]: a biased position where the connection part of the subpixel of the first color in the first pixel is disposed with respect to the middle of the long axis of the subpixel of the first color in the first pixel when viewed from the row direction is relatively different from a biased position where the connection part of the

subpixel of the first color in the second pixel is disposed with respect to the middle of the long axis of the subpixel of the first color in the second pixel when viewed from the row direction,

309. As discussed in Section X.A.2 (112), the “first pixel” in [1.12] is unclear as to which of the various first pixels referenced earlier in the claim it refers. Regardless, as explained below, Hwang-Lee discloses “first pixels” each of which disclose or render obvious [1.12].

310. Moreover, even if one assumes that the ’691 patent provides an enabling disclosure of the term “*relatively different*” with sufficient definiteness (which I do not concede, based on the discussion in Section X.A.1 and X.B.1 (112)), Hwang-Lee provides disclosure that is commensurate with the disclosure that the ’691 patent relies on for support of [1.12], as explained below, and for at least this reason renders the limitation obvious.

311. As discussed for [1.3], [1.10], [1.11], a POSITA would have understood that the claimed “*connection part*” is disclosed or rendered obvious by at least two example structures in Hwang, namely Hwang’s **via hole 181** into which Hwang’s electrode 191 protrudes (Example 1) and Hwang’s **protruded portion of pixel electrode 191** which protrudes into via hole 181 (Example 2). In both examples, a POSITA would have found Hwang-Lee to render obvious [1.12], as discussed below.

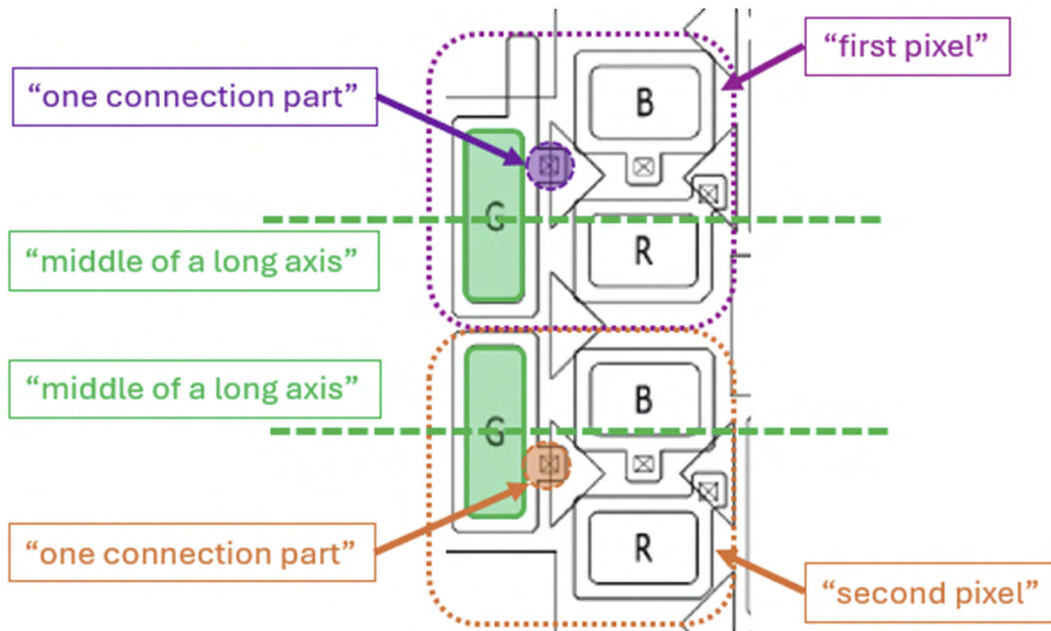
312. As discussed for [1.10] and [1.11], in Hwang-Lee’s first and second

pixels, each of Hwang's via 181 ("**connection part**" in Example 1) and Hwang's protruded portion of electrode 191 ("**connection part**" in Example 2) is biased from a middle of a long axis of Hwang's green subpixel G ("**subpixel of the first color**") in opposite directions, i.e., biased toward an **upper end** of the long axis in the **first pixel** and biased toward a **lower end** of the long axis in the **second pixel**.

313. Therefore, in Example 1, a POSITA would have found Hwang-Lee to render obvious that a biased position where Hwang's via 181 ("**connection part**" in Example 1) of green subpixel G ("**subpixel of the first color**") in the first pixel is disposed with respect to the middle of the long axis of green subpixel G ("**subpixel of the first color**") in the first pixel when viewed from the row direction is **relatively different** from a biased position where Hwang's **via 181** ("**connection part**" in Example 1) of green subpixel G ("**subpixel of the first color**") in the second pixel is disposed with respect to the middle of the long axis of green subpixel G ("**subpixel of the first color**") in the second pixel when viewed from the row direction.

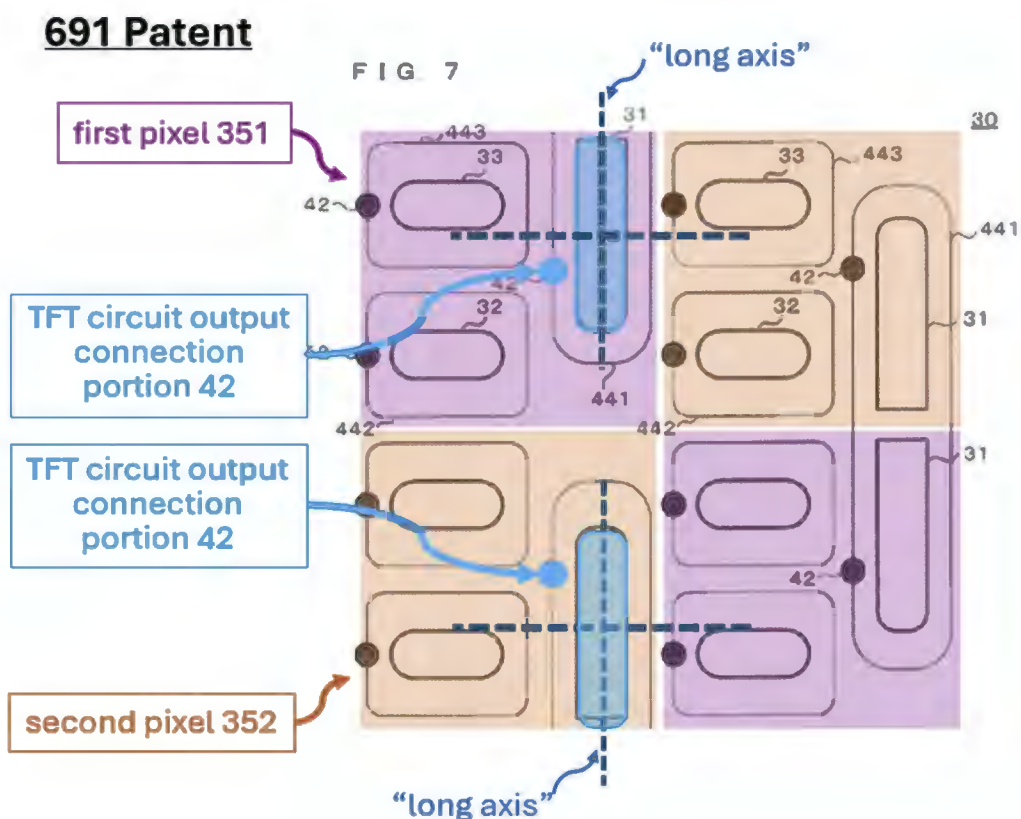
314. Similarly, in Example 2, a POSITA would have understood that applying the same analysis as above with Hwang's protruded portion of pixel electrode 191 ("**connection part**" in Example 2) instead of Hwang's via hole 181 ("**connection part**" in Example 1) would yield the same result.

Hwang-Lee



EX1005, FIG. 7 (annotated)

315. This is consistent with how the '691 patent describes [1.12], as illustrated in FIG. 7 (below) which shows "TFT circuit output connection portion 42" (in first and second pixels) arranged in *relatively different* (mirror image) positions with respect to the middle of a long axis of the respective subpixels of the first color (31). EX1001, FIG. 7.



EX1001, FIG. 7 (annotated)

316. Therefore, a POSITA would have found Hwang-Lee to render obvious [1.12].

[1.13]: a position where the connection part is disposed with respect to the subpixel of the second color, a position where the connection part is disposed with respect to the subpixel of the third color and a position where the connection part is disposed with respect to the subpixel of the first color in the first pixel are relatively same as a position where the connection part [is disposed]³ with respect to the subpixel of the second color, a position where the connection part is disposed with

³ Limitation [1.13] is presented here with a correction of an apparent typographical error that appears in the '691 patent.

respect to the subpixel of the third color and a position where the connection part is disposed with respect to the subpixel of the first color in the second pixel, and

317. As discussed in Section X.A.2 (112), the “second pixel” in [1.13] is unclear as to which of the various second pixels referenced earlier in the claim it refers. Regardless of which interpretation is taken, as explained below, Hwang-Lee discloses “second pixels” each of which disclose or render obvious [1.13].

318. Moreover, even if one assumes that the ’691 patent provides an enabling disclosure of the term “*relatively same*” with sufficient definiteness (which I do not concede, based on the discussion in Section X.A.1 and X.B.1 (112)), Hwang-Lee provides disclosure that is commensurate with the disclosure that the ’691 patent relies on for support of [1.13], as explained below, and for at least this reason renders the limitation obvious.

319. In addition, I note that [1.13] in the ’691 patent appeared to have a typographical error in missing the phrase “*is disposed*” (as noted in the Listing of Challenged Claims section).

320. As discussed for [1.3], [1.10], [1.11], a POSITA would have understood that the claimed “*connection part*” is disclosed or rendered obvious by at least two example structures in Hwang, namely Hwang’s **via hole 181** into which Hwang’s electrode 191 protrudes (Example 1) and Hwang’s **protruded portion of pixel electrode 191** which protrudes into via hole 181 (Example 2). In

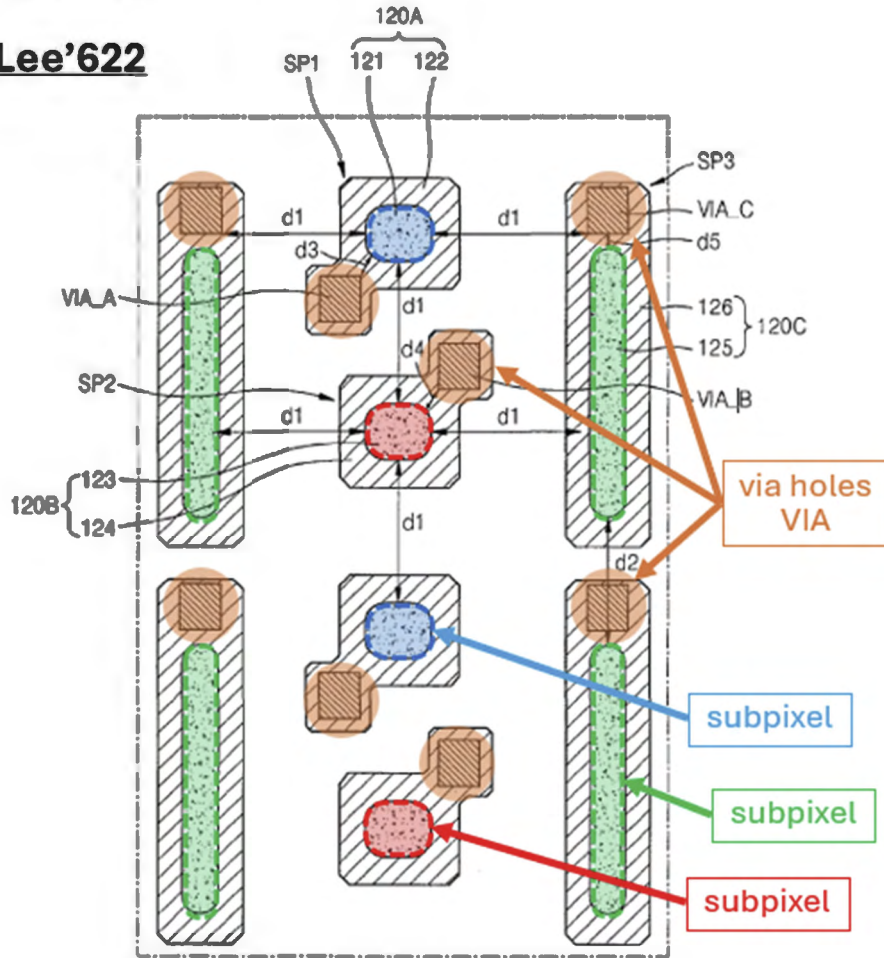
both examples, a POSITA would have found Hwang-Lee to render obvious [1.13], as discussed below.

321. As discussed for [1.10] and [1.11], each Hwang-Lee subpixel has a “pixel electrode 191” that is “protruded toward a space between” the subpixels, thereby being connected to electrode 151 of semiconductor element through the via hole 181.” EX.1005, [0038], [0039], [0043], [0044], FIG. 7. As disclosed in Hwang, that this is true for “each” of Hwang-Lee’s subpixels regardless of its specific positioning arrangement. EX1005, [0044].

322. Furthermore, Lee provides further details of the well-known feature of implementing “via holes” to be in relatively same positions with respect to sub-pixels, in each unit pixel. EX1006, [0116], [0120]-[0126], FIGS. 6, 10-13.

FIG. 10

Lee'622



EX1006, FIG. 10 (annotated)

323. For example, Lee provides details of specific distances of spacing between via holes and corresponding sub-pixels. EX1006, FIGS. 10-11, [0120]-[0122] ("first via hole VIA_A of the first sub-pixel SP1 is formed at a position that is spaced apart by a third distance d3 in a downward direction of a third axis (z-axis), that is, in a left downward diagonal direction with respect to the first axis (x-axis) and the second axis (y-axis), from the outermost edge of the first emissive

layer 121...”). A POSITA would have understood, based on the disclosure in Lee, that the dimensions shown and described in FIG. 10 are applicable to both pixels (first pixel and second pixel) shown in FIG. 10.

324. Based on my knowledge and experience, a POSITA would have understood that it was well known in the art to have a specific and consistent arrangement of via holes (also referred to as “contact holes” in the art) for different pixels, rather than having them differ across different pixels. *See, e.g.*, Kim’856 (EX1010), [0014], FIGS. 3-5 (describing details of a specific and consistent arrangement of contact holes in each pixel).

325. Therefore, in Example 1, a POSITA would have found Hwang-Lee to render obvious that a position where Hwang’s via 181 (“*connection part*” in Example 1) is disposed with respect to the Hwang-Lee red subpixel R (“*subpixel of the second color*”), a position where Hwang’s via 181 (“*connection part*” in Example 1) is disposed with respect to the Hwang-Lee blue subpixel B (“*subpixel of the third color*”) and a position where Hwang’s via 181 (“*connection part*” in Example 1) is disposed with respect to the Hwang-Lee red green G (“*subpixel of the first color*”) in the first pixel are relatively same as a position where Hwang’s via 181 (“*connection part*” in Example 1) [is disposed] with respect to the Hwang-Lee red subpixel R (“*subpixel of the second color*”), a position where Hwang’s via

181 (“*connection part*” in Example 1) is disposed with respect to the Hwang-Lee blue subpixel B (“*subpixel of the third color*”) and a position where Hwang’s via 181 (“*connection part*” in Example 1) is disposed with respect to the Hwang-Lee Green subpixel G (“*subpixel of the first color*”) in the second pixel.

326. Similarly, in Example 2, a POSITA would have understood that applying the same analysis as above with Hwang’s protruded portion of pixel electrode 191 (“*connection part*” in Example 2) instead of Hwang’s via hole 181 (“*connection part*” in Example 1) would yield the same result.

327. For at least these reasons, a POSITA would have found Hwang-Lee to render obvious [1.13]

[1.14]: in a pixel array including the first pixel and the second pixel arrayed in the column direction, the connection part of the subpixel of the first color is disposed between a column where the subpixel of the second color and the subpixel of the third color are alternately arrayed and a column where the subpixel of the first color arranged in parallel with the column where the subpixel of the second color and the subpixel of the third color are alternately arrayed.

328. As discussed in Sections X.A and X.B (112), in [1.14], it is unclear as to which “one” of the first pixels “the first pixel” refers to, and which “one” of the second pixels “the second pixel” refers to. Similarly, it is unclear which “subpixel” the “the subpixel of the first color” refers to. Moreover, [1.14] does not specify if “the connection part” is for a subpixel of a first pixel or a second pixel, much less provide clarity as to which of the six uses of “the connection part” in

limitation [1.13] it refers. Regardless, as explained below, Hwang-Lee discloses “first pixels,” “second pixels,” “subpixels of the first color,” and “connection parts” each of which disclose or render obvious [1.14].

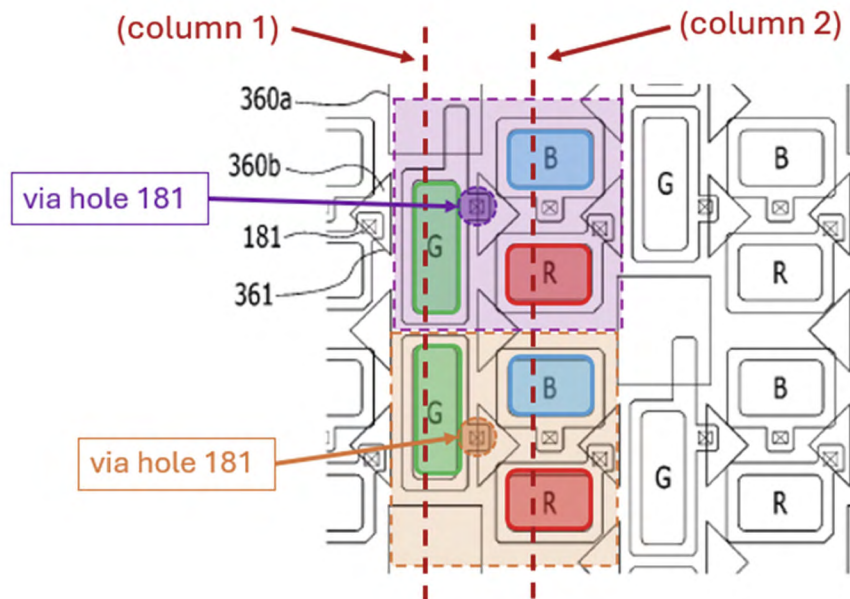
329. As discussed for [1.1], Hwang-Lee discloses a pixel array including a first type of unit pixel (“*first pixel*”) and a second type of unit pixel (“*second pixel*”) that are arrayed in the column direction.

330. In addition, as discussed for [1.3], [1.10], [1.11], a POSITA would have understood that the claimed “*connection part*” is disclosed or rendered obvious by at least two example structures in Hwang, namely Hwang’s **via hole 181** into which Hwang’s electrode 191 protrudes (Example 1) and Hwang’s **protruded portion of pixel electrode 191** which protrudes into via hole 181 (Example 2). In both examples, a POSITA would have found Hwang-Lee to render obvious [1.14], as discussed below.

331. In Example 1, as seen in FIG. 7, Hwang’s via 181 (“*connection part*” in Example 1) of the Hwang-Lee green subpixel G (“*subpixel of the first color*”) is **disposed between:** (A) a column where a red subpixel R (“*subpixel of the second color*”) and blue subpixel B (“*subpixel of the third color*”) are alternately arrayed and (B) a column where green subpixels G (“*subpixel of the first color*”) are arranged in parallel with the column where red subpixel R and blue subpixel B

(“*subpixel of the second color*” and “*subpixel of the third color*”) are alternately arrayed. EX1005, [0039], [0041], [0049], [0058], FIG. 7.

Hwang-Lee



EX1005, FIG. 7 (annotated)

332. Similarly, in Example 2, a POSITA would have understood that applying the same analysis as above with Hwang’s protruded portion of pixel electrode 191 (“*connection part*” in Example 2) instead of Hwang’s via hole 181 (“*connection part*” in Example 1) would yield the same result.

333. Therefore, Hwang-Lee discloses or renders obvious [1.14].

Claim 2: The display device according to claim 1, wherein the subpixel includes an anode electrode, and the at least one connection part is a portion that connects an output of the TFT circuit and the anode electrode.

334. As discussed for [1.3], [1.10], [1.11], a POSITA would have

understood that the claimed “*at least one connection part*” is disclosed or rendered obvious by at least two example structures in Hwang, namely Hwang’s **via hole 181** into which Hwang’s electrode 191 protrudes (Example 1) and Hwang’s **protruded portion of pixel electrode 191** which protrudes into via hole 181 (Example 2). In both examples, a POSITA would have found Hwang-Lee to render obvious [2.1].

335. In Example 1, Hwang explains that “pixel electrode 191” of light emitting element 70 “may function as an **anode** and is electrically connected through a via hole (181)” (“*at least one connection part*” in Example 1) which “enables current or voltage applied from the thin-film transistor (TFT) circuit to be transmitted to the pixel electrode.” EX1005, [0039]-[0044].

336. Furthermore, Hwang discloses with regard to FIG. 11 that the “drain electrode of the driving transistor T6 is electrically connected to the anode 191 of the organic light-emitting diode (OLED) through the via hole 181” (“*at least one connection part*” in Example 1). EX1005, [0084].

337. Similarly, in Example 2, a POSITA would have understood that applying the same analysis as above with Hwang’s protruded portion of pixel electrode 191 (“*at least one connection part*” in Example 2) instead of Hwang’s via hole 181 (“*at least one connection part*” in Example 1) would yield the same

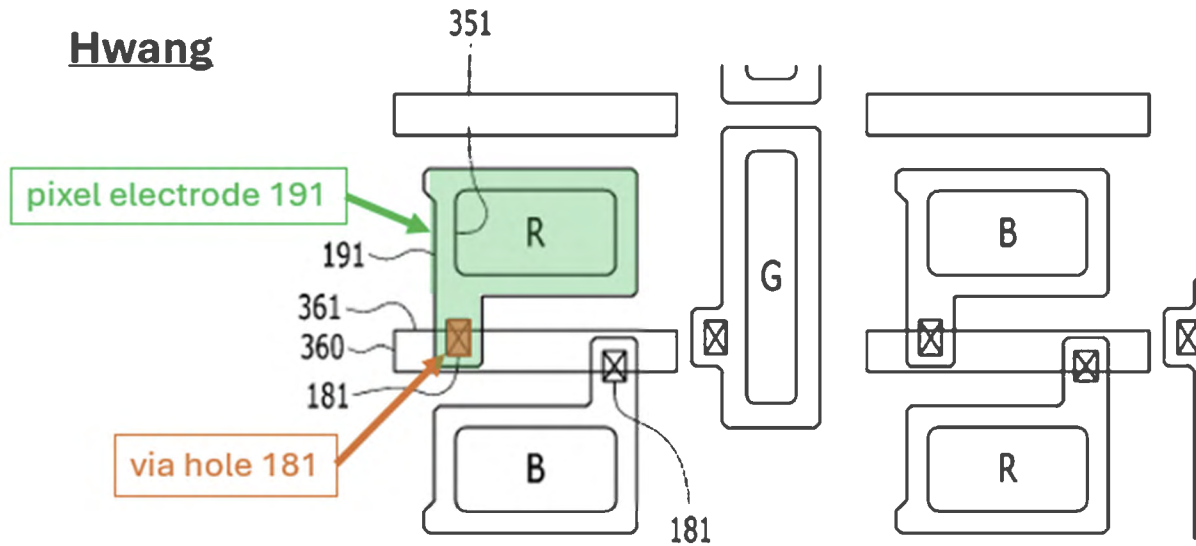
result, at least because Hwang's protruded portion of pixel electrode 191 extends into Hwang's via hole 181. EX1005, FIGS. 2, 11.

338. Therefore, a POSITA would have understood Hwang-Lee to render obvious [2.1].

Claim 3: The display device according to claim 2, wherein a position where the at least one connection part is disposed overlaps with the anode electrode in a plan view.

339. As discussed for [1.3], [1.10], [1.11], a POSITA would have understood that the claimed "***at least one connection part***" is disclosed or rendered obvious at least by Hwang's **via hole 181** into which Hwang's electrode 191 protrudes (Example 1).

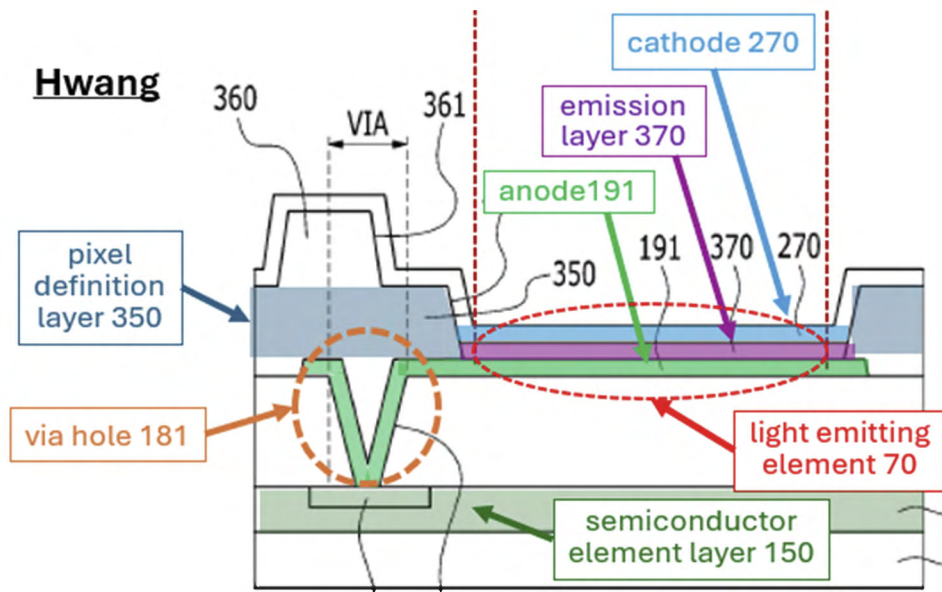
340. As shown in FIGS. 1, 6, and 7, a position where Hwang's via hole 181 ("***at least one connection part***" in Example 1) is disposed overlaps Hwang's pixel electrode 191 ("***anode electrode***") in a plan view.



EX1005, FIG. 6 (annotated)

341. Hwang explains that the “pixel electrode 191” (“*anode electrode*”) is “protruded toward a space between the pixels, thereby being connected to the electrode 151 of the semiconductor element through the via hole 181” (“*at least one connection part*” in Example 1). EX1005, [0043], FIGS. 1, 6, 7.

342. A POSITA would have understood that this overlap in the plan view is due to Hwang’s anode electrode 191 (“*anode electrode*”) extending into Hwang’s via hole 181 (“*at least one connection part*” in Example 1) as shown in the cross-section view of FIG 6. EX1005, FIG. 2.



EX1005, FIG. 2 (annotated)

343. Therefore, a POSITA would have understood Hwang-Lee to render obvious [3.1].

Claim 4: The display device according to claim 1, wherein the TFT circuit includes an identical circuit arrangement pattern for the subpixels of the first to third colors.

344. As discussed for claim 1, Hwang-Lee discloses or renders obvious the display device according to claim 1.

345. Hwang discloses an “equivalent circuit diagram” in FIG. 8 for a subpixel, and further discloses in FIGS. 9-10 a “layout view of a plurality of transistors and capacitors” for a subpixel. EX1005, [0080], [0081], [0099]. Hwang also discloses in FIGS. 11-15 a cross-sectional view of the driving transistor T6 of a subpixel. EX1005, [0120].

346. A skilled artisan would have understood that Hwang’s disclosures above are applicable to each of Hwang-Lee’s subpixels.

347. Furthermore, Lee provides explicit description an identical circuit arrangement pattern for the subpixels of the first to third colors. In particular, Lee provides a plan view of a pixel circuit and explains the pixel circuit arrangement is “equally applied” to any of the red, green, and blue sub-pixels. EX1006, [0083], FIG. 7.

FIG. 7

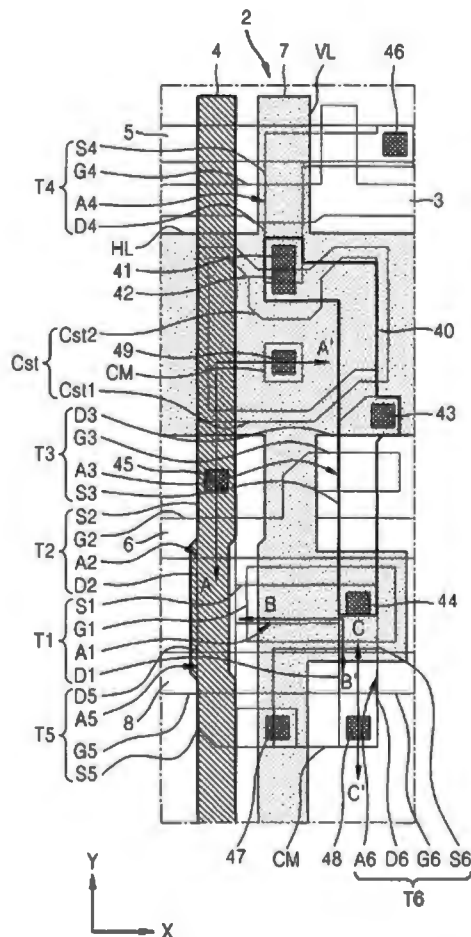
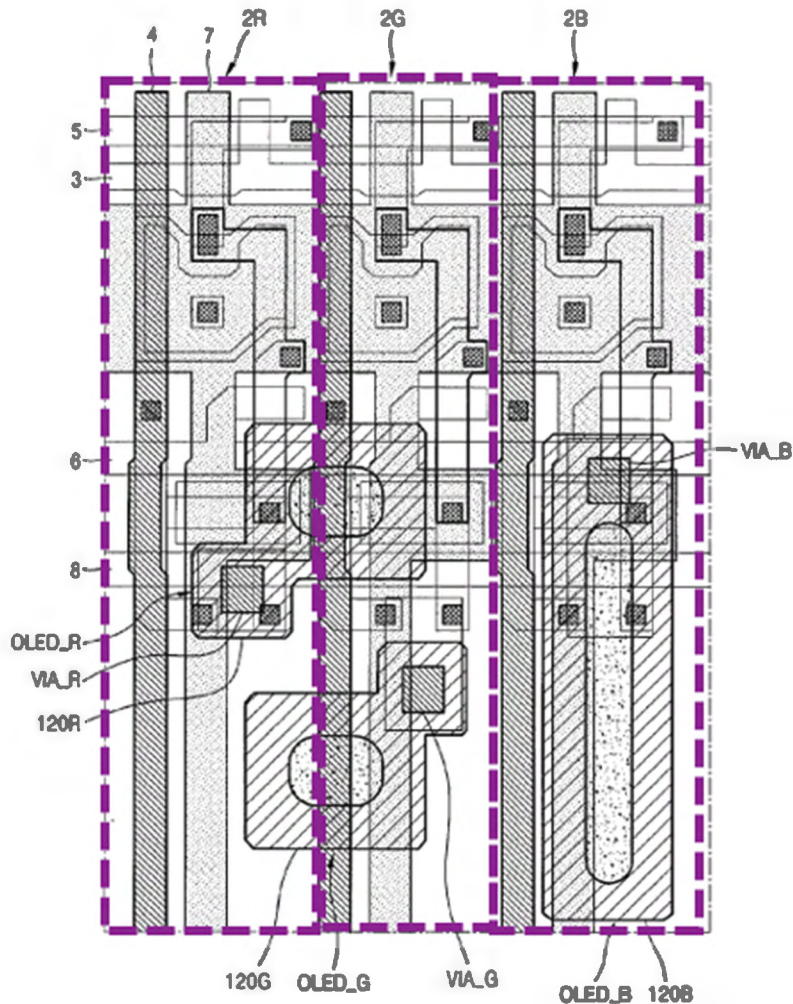


FIG. 6



EX1006, FIGS. 6, 7 (annotated and color added)

348. This is again understood by a POSITA to be highly desirable as it means that each subpixel will have the same operating characteristics.

349. Therefore, a POSITA would have understood Hwang-Lee to render obvious [4.1].

Claim 5: The display device according to claim 1, wherein in one of the first pixels and one of the second pixels that are adjacent to each other in the row

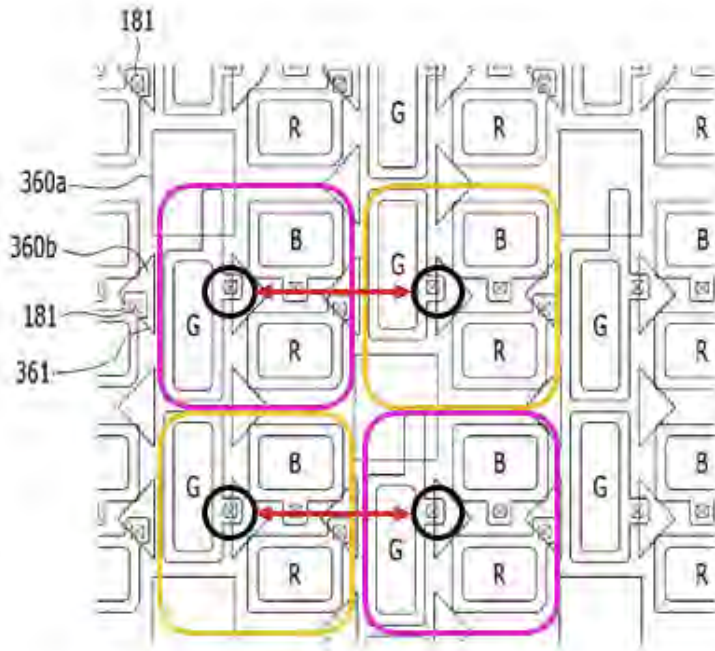
direction, a distance between a first connection part of the at least one connection part for the subpixel of the first color in the one of the first pixels and a second connection part of the at least one connection part for the subpixel of the first color in the one of the second pixels are consistent in the display unit independent of the biased arrangements of the subpixels.

350. As discussed for claim 1, Hwang-Lee discloses or renders obvious the display device according to claim 1.

351. Based on the discussion for [1.3], [1.10], [1.11], a POSITA would have understood that each of the claimed “*first connection part*” and “*second connection part*” in [5.1] is disclosed or rendered obvious by at least two example structures in Hwang, namely Hwang’s **via hole 181** into which Hwang’s electrode 191 protrudes (Example 1) and Hwang’s **protruded portion of pixel electrode 191** which protrudes into via hole 181 (Example 2). Each of Hwang-Lee’s unit pixels implements these structures, and in both examples above, a POSITA would have found Hwang-Lee to render obvious [5.1], as discussed below.

352. In Example 1, a POSITA would have understood Hwang-Lee to render obvious that, in one of the first pixels and one of the second pixels that are adjacent in the row direction, a distance between (A) Hwang’s **via 181** (“*first connection part*” in Example 1) for a green subpixel G (“*subpixel of the first color*”) in one of Hwang-Lee’s first pixels and (B) Hwang’s **via 181** (“*second connection part*”) for a green subpixel G (“*subpixel of the first color*”) in one of Hwang-Lee’s second pixels are consistent in the display unit, independent of the

biased arrangements of the subpixels.



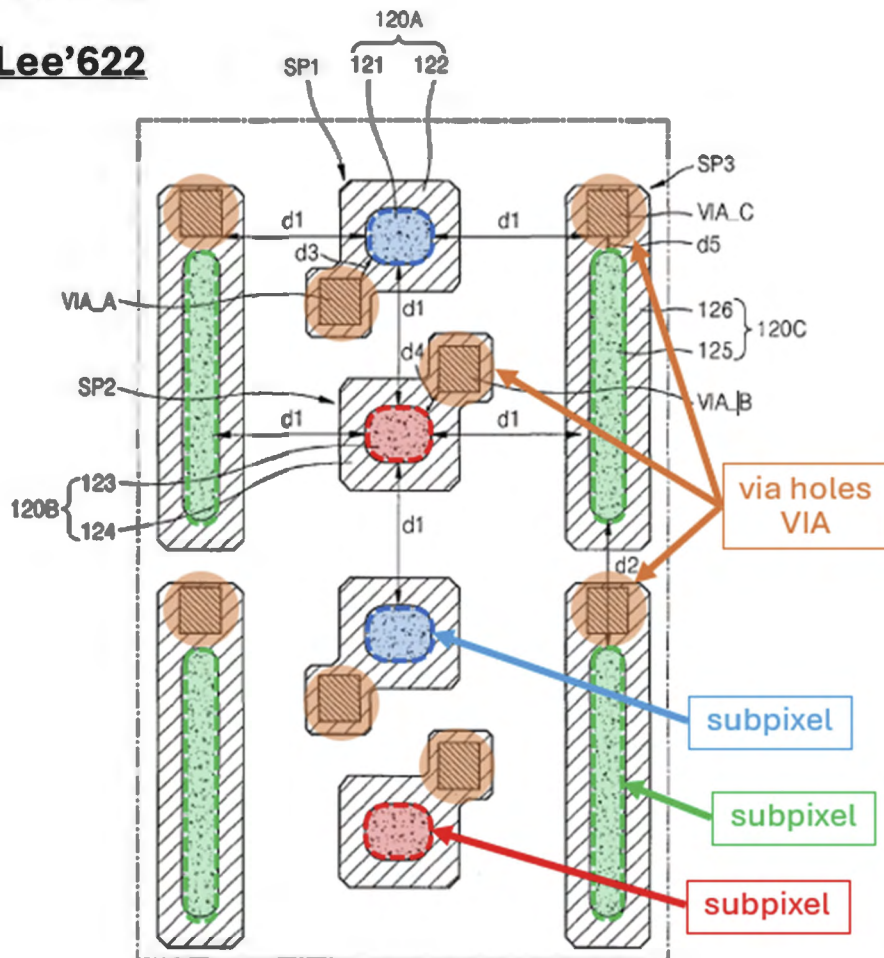
EX1005, FIG. 7 (annotated)

353. In particular, a POSITA would have understood that Hwang's pixel arrangement follows a repetitive pattern, and that Hwang's **via 181** ("*first/second connection part*" in Example 1) of same-color subpixels between adjacent pixels in the row direction follow the same pattern.

354. As such, a POSITA would have found obvious that regardless of how different subpixels are specifically positioned in a pixel, the distance between Hwang's **via 181** ("*first/second connection part*" in Example 1) of same-color subpixels in adjacent pixels is consistently maintained. EX1005, [0099], [0120], [0139].

355. Explicit evidence of this is found in Lee, which discloses specific distances between via holes of same-colored subpixels in row-adjacent pixels. For example, Lee specifies, in FIG. 10, the same distance “d1” between via holes of the longer subpixel in row-adjacent pixels. EX1006, [0117]-[0119], [0129]. [0135].

FIG. 10
Lee'622



EX1006, FIG. 10 (annotated)

356. In particular, Lee emphasizes that “**the first distance d1 ... between each of subpixels of different colors may be maintained**” and explains a benefit

that “by maintaining the substantially constant distance between each of the subpixels, a shadowing effect in which a boundary between each of adjacent organic layers becomes vague during processes of forming the sub-pixels may be reduced.” EX1006, [0135].

357. Similarly, in Example 2, a POSITA would have understood that applying the same analysis as above with Hwang’s protruded portion of pixel electrode 191 (“*connection part*” in Example 2) instead of Hwang’s via hole 181 (“*connection part*” in Example 1) would yield the same result, at least because Hwang’s protruded portion of pixel electrode 191 extends into Hwang’s via hole 181 and is therefore arranged at the same position. EX1005, FIGS. 2, 11.

358. Therefore, a POSITA would have understood Hwang-Lee to render obvious [5.1].

Claim 6: The display device according to claim 1, wherein a first square not crossing the subpixels encloses a region including the subpixels of three colors included in one of the first pixels and excluding other subpixels, a second square not crossing the subpixels encloses a region including the subpixels of three colors included in one of the second pixels and excluding other subpixels, and the first square and the second square are arranged without overlapping each other.

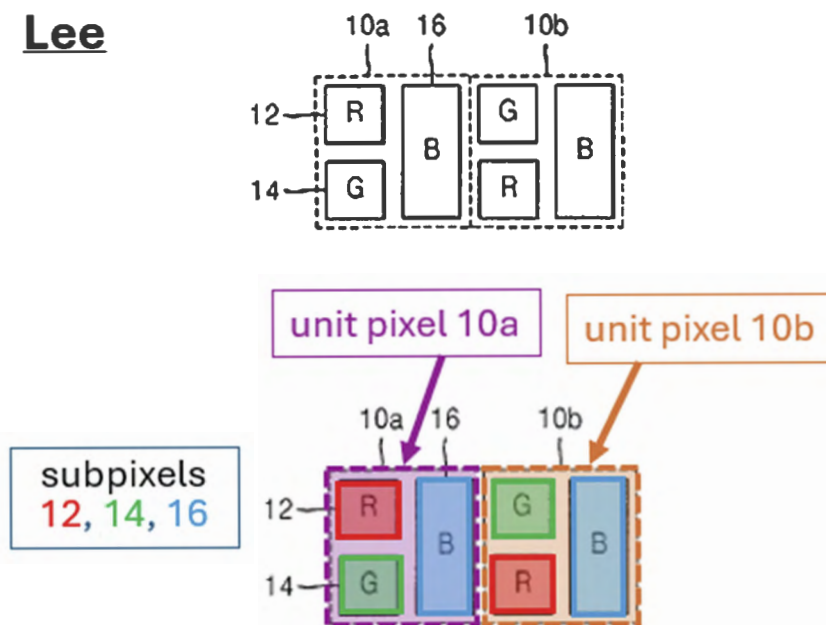
359. As discussed for claim 1, Hwang-Lee discloses or renders obvious the display device according to claim 1.

360. Regarding the claimed “*first square*” and “*second square*,” the ’691 patent explains that a “boundary line” of a pixel is merely “virtual” and is not an

actual “member” that exists in reality. EX1001, 7:27-38.

361. Lee expressly discloses and delineates boundaries of unit pixels 10a (“*first pixels*”) and unit pixels 10b (“*second pixels*”) formed of first through third sub-pixels 12, 14, and 16 (“*subpixels of three colors*”).” EX1006, [0049]-[0053], FIGS. 2, 6.

362. Specifically, the boundaries of Lee’s first and second unit pixels 10a, 10b do not cross any of the subpixels 12, 14, 16. EX1006, FIGS. 2, 6. Moreover, the boundaries of Lee’s first and second unit pixels 10a, 10b each enclose a respective region including respective subpixels 12, 14, 16 included in the unit pixel, while excluding other subpixels. *Id.* And, the boundaries of Lee’s first and second unit pixels 10a, 10b do not overlap each other. *Id.*



EX1006, FIG. 2 (showing both annotated and un-annotated versions)

363. Moreover, the terminology in the art regarding standard display devices typically assumed that pixels are arranged in a square pattern. A so-called 1080p (or 1080i) display has a screen resolution of 1920 x 1080 pixels and an aspect ration (ratio of physical dimenions) of 16:9. The resolution (1920 x 1080) is an exact multiple of the 16:9 physical dimension aspect ratio. Therefore it follows that the pixels are in a square pattern and a square can be be drawn around each pixel without overlapping an adjacent pixel.

364. Therefore, a POSITA would have understood Hwang-Lee to render obvious [6.1], [6.2], and [6.3].

Claim 8: The display device according to claim 1, wherein the TFT circuit and one of the subpixels are connected by only one of the at least one connection part.

365. As discussed in [1.3], [1.10], [1.11], a POSITA would have understood that the claimed “***at least one connection part***” in [8.1] is disclosed or rendered obvious by at least two example structures in Hwang, namely Hwang’s **via hole 181** into which Hwang’s electrode 191 protrudes (Example 1) and Hwang’s **protruded portion of pixel electrode 191** which protrudes into via hole 181 (Example 2). In both examples, a POSITA would have found Hwang-Lee to render obvious [8.1], as discussed below.

366. In Example 1, as explained for [1.4], Hwang describes a “via 181”

(“*at least one connection part*” in Example 1) that connects “pixel electrode 191” of one subpixel to the “electrode 151 of the semiconductor element.” EX1005, [0043], FIGS. 2, 11.

367. Hwang’s FIGS. 2, 7, and 11 show **only one** “via 181” (“*only one of the at least one connection part*” in Example 1) that connects each subpixel to the semiconductor element (TFT T6). EX1005, FIGS. 2-7.

368. Based on my personal knowledge and experience, a POSITA at the time of the ’691 patent would have understood that display devices typically implemented only one connection between a subpixel and its pixel circuitry. Moreover, a POSITA would have generally been motivated to simplify and reduce the number of steps involved in manufacturing a display device. With this understanding and motivation, a POSITA would have understood that including additional via holes, in addition to “via 181,” for the purpose of connecting a subpixel to the semiconductor element (TFT T6) would have been unnecessary and inefficient. For at least these reasons, a POSITA would have understood and found obvious that, in Hwang-Lee, the TFT circuit and one of the subpixels are connected by only one of the at least one connection part, as shown in Hwang’s FIGS. 2, 7, and 11.

369. Similarly, in Example 2, a POSITA would have understood that

applying the same analysis as above with Hwang's protruded portion of pixel electrode 191 ("*connection part*" in Example 2) instead of Hwang's via hole 181 ("*connection part*" in Example 1) would yield the same result, at least because Hwang's protruded portion of pixel electrode 191 extends into Hwang's via hole 181 and contacts Hwang's semiconductor element layer 150 ("*the TFT circuit*"). EX1005, FIGS. 2, 11.

370. Therefore, a POSITA would have understood Hwang-Lee to render obvious [8.1].

D. Ground 2 – Combination of Hwang-Lee and Park'531 Renders Obvious Claim 7

371. Below, I additionally cite the disclosure of Park'531 for the limited and specific feature that an OLED layer of a subpixel can be disposed above and overlap a connection part that connects the subpixel to a TFT circuit. While this particular feature of Park'531 relates only to the structure of a single subpixel, Park'531 also discloses an arrangement of multiple sub-pixels that shares numerous similarities with Hwang and Lee. As such, a POSITA would have naturally turned to the disclosure of Park'531 for additional details that would be applicable to the Hwang-Lee combination.

Claim 7: The display device according to claim 1, wherein the OLED layer is disposed above the at least one connection part, and a position where the at least one connection part is disposed overlaps with the OLED layer in a plan view.

372. As discussed for claim 1, Hwang-Lee discloses or renders obvious the display device according to claim 1.

373. The term “the OLED layer” in claim 7 lacks antecedent basis and is, thus, indefinite. To the extent the ’691 patent specification discloses an “***OLED layer***,” it describes “OLED layer 44” as part of a subpixel, and arranged “disposed between the anode electrode 43 and the cathode electrode 19.” EX1001, 9:18-24, FIG. 6.

374. Hwang-Lee-Park’531 discloses an analogous structure. As discussed in Section X.C.1 and X.C.2, Hwang’s “emission layer 370” is disposed between Hwang’s “pixel electrode 191 which is an anode” and “opposed electrode 270” which can “function as a cathode.” EX1005, [0040], [0138], FIG. 11.

375. Like the ’691 patent’s OLED layer 44, Hwang’s emission layer 370 includes an “organic material” that can emit “three primary colors of red R, green G, and blue B” and is “made with multiple layers including an emission layer and at least one of a hole injection layer (HIL), a hole transport layer (HTL), an electron transport layer (ETL), and an electron injection layer (EIL).” EX1005, [0041], [0138]; EX1001, 9:37-42, 13:9-26.

376. Furthermore, in the Hwang-Lee-Park’531 combination, as discussed

in Section III.D.2, a POSITA would have understood that the actual emissive material deposited to form Hwang's emission layer 370 would have a larger area than pixel-defining opening 351, to allow for manufacturing variability or tolerances when depositing emission layer 370, thus reducing the risk of a short circuit between the anode and cathode of emitting element 70. Indeed, this is the scenario shown in Park's 531 (e.g., FIG. 5), where emitting layer 132 extends past the opening 128a by covering a portion of bank 128, which defines the boundaries of the opening 128a. EX1007, FIG. 5. An example of the expanded emission layer 370 of Hwang-Lee-Park's 531 is shown in Diagram F, below (based on FIG. 2 of Hwang).

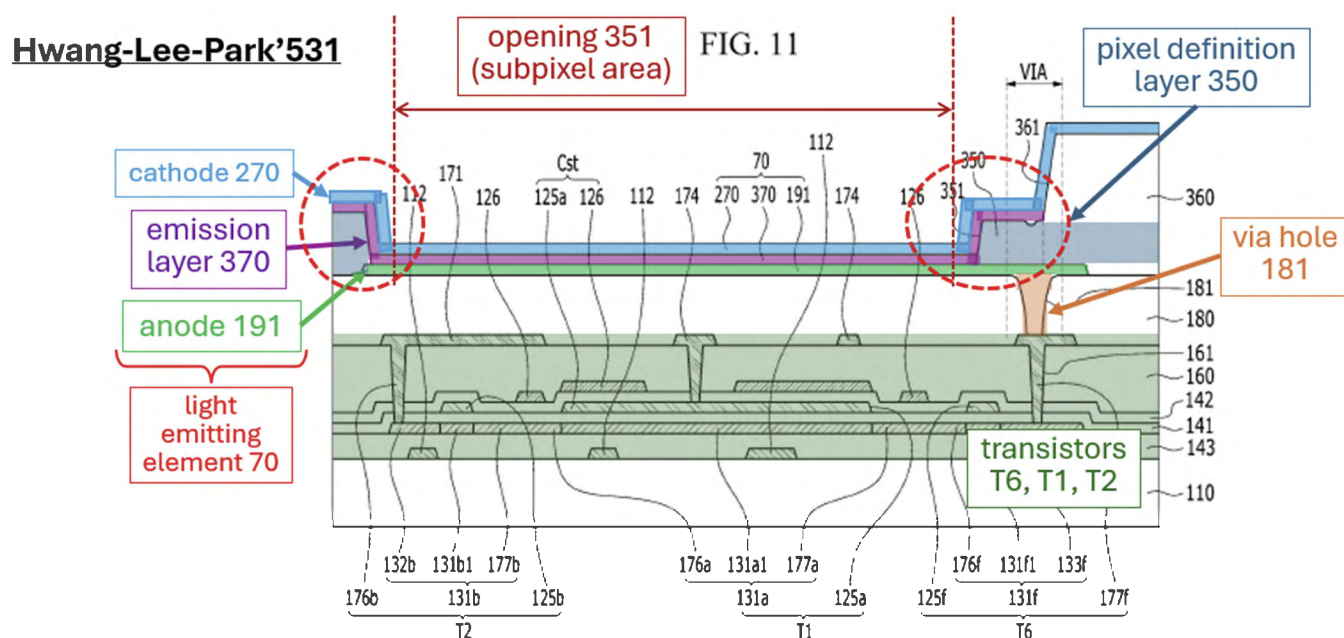
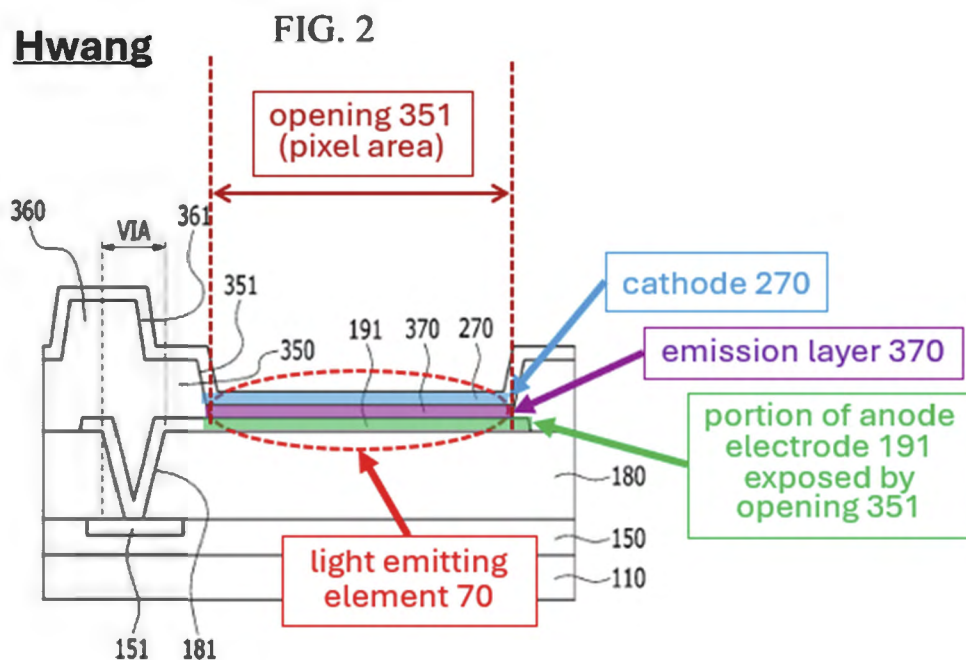


Diagram F (Hwang-Lee-Park's 531)

377. Furthermore, as discussed in [1.3], [1.10], [1.11], a POSITA would have understood that the claimed “*at least one connection part*” in [7.1] and [7.2] is disclosed or rendered obvious at least by Hwang’s **protruded portion of pixel electrode 191** which protrudes into via hole 181 (Example 2).

378. Specifically, Hwang’s protruded portion of pixel electrode 191 (which protrudes into via hole 181) extends from the portion of Hwang’s pixel electrode 191 that is exposed by Hwang’s opening 351. EX1005, [0044], [0046], [0132], [0136], FIG. 2. Hwang explains that “opening 351 of the pixel definition layer 350 may define a pixel area that is an emitting region of each pixel.” EX1005, [0046], [0137], FIG. 2.



EX1005, FIG. 2 (annotated)

379. The portion of Hwang's pixel electrode 191 exposed by this opening 351 has, formed on it, an "emission layer 370" and an "opposed electrode 270." *Id.* Hwang refers to this structure as "light emitting element 70." EX1005, [0136], FIG. 2.

380. Hwang explains that, in the light emitting element 70, the pixel electrode 191 can "function as an anode" and the opposed electrode 270 can "function as a cathode." EX1005, [0040]. Specifically, Hwang explains that "[a]n electron injected from the cathode and a hole injected from the anode are coupled with each other in the light emitting layer to form an exciton, and the exciton emits light while discharging energy." EX1005, [0008].

381. In view of Hwang's teachings, a POSITA would have understood that the "anode" property of pixel electrode 191 arises due to the electron-hole interactions between the **"portion of the pixel electrode 191 that is exposed at the opening 351"** (functioning as an anode), the emission layer 370, and the opposed electrode 270 (functioning as a cathode) resulting in emission of light. EX1005, [0008], [0040], [0136], FIG. 2. Consequently, a POSITA would have known that the portion of pixel electrode 191 **not** exposed by the opening 351, and **not** in contact with the emission layer 370, was typically **not** characterized as an "anode" for the light emitting element 70.

382. This understanding is evidenced in Lee. Like Hwang, Lee describes an “an opening for exposing a part of the pixel electrode 120” (similar or analogous to Hwang’s pixel electrode 191) and Lee explains that “pixel electrode 120 includes an “**emission portion**” that is exposed by an opening, and a “**non-emission portion**” that is not exposed. EX1006, [0112]. Lee further discloses that a “via hole VIA is disposed in the non-emission portion of the pixel electrode 120.” *Id.*

383. Park’531 provides further evidence of these two distinct portions of a pixel electrode (emission and non-emission portions), in particular describing an “**effective emitting portion**” of light emitting as emitting layers as “corresponding to the **overlapped portions** of the first and second **electrodes 130 and 138.**” EX1007, [0013]. Park’531 explains the “important fact” that when determining measurements such as “an aperture ratio” of emitting layers, only the “**exposed area** of the first **electrode 130 through the opening 128a** of the bank 128” should be considered, and “[a]ccordingly, the red, green and blue **emitting layers 132, 134 and 136 corresponding** to the **opening 128a** of the bank 128 **are shown in FIG. 3.**” EX1007, [0070].

384. Thus, a POSITA would have understood, based on the combined teachings of Hwang, Lee, and Park’531, that Hwang’s pixel electrode 191 includes

an emission portion and non-emission portion, where (i) the emission portion of pixel electrode 191 is exposed by Hwang's opening 351 and contacts the emission layer 370 to function as an anode in the light emitting element 70 and (ii) the non-emission portion of pixel electrode 191 is not exposed by Hwang's opening 351 and does not function as an anode in the light-emitting element 70, and instead covers Hwang's via hole 181.

385. A POSITA would have further understood that the non-emission portion of Hwang's pixel electrode 191 can function as a connection part, connecting the emission portion of Hwang's pixel electrode 191 (functioning as an anode electrode) with the underlying semiconductor element layer 150. See, e.g., Kim'856 (EX1010), FIG. 2, [0050] (which describes a "connection line 111" that connects an "anode electrode" of an "organic light emitting diode 113" a "driving TFT 112").

386. Therefore, in limitations [7.1] and [7.2], a POSITA would have understood that the claimed "*at least one connection part*" is disclosed or rendered obvious at least by Hwang's **protruded portion of pixel electrode 191** (Example 2) which protrudes into via hole 181 to contact Hwang's semiconductor element layer 150. A POSITA would have understood that this protruded portion of pixel electrode 191 would correspond to what Lee describes as the "non-emission

portion” of the pixel electrode. EX1006, [0112].

387. In this Example 2, a POSITA would have found obvious that, as a result of the larger area of the emission layer 370 in Hwang-Lee-Park’531 extending outside the opening 351, the larger emission layer 370 would overlap the portion of Hwang’s pixel electrode 191 that is outside the opening 351, i.e., Hwang’s protruded pixel electrode 191 (“*at least one connection hole*” in Example 2) which protrudes into via hole 181, as shown in Diagram F.

388. Moreover, although Hwang discloses a “spacer 360” that is “arranged between the pixel areas and **does not overlap the emission layer 370** (EX1005, [0048]), Hwang explains that “spacer 360 does not completely cover the via hole” and instead “only overlaps the portion” or “may not overlap” the via hole. EX1005, [0073], [0078], [0133]-[0135]. As shown in the cross section view of Diagram G, Hwang’s spacer 360 only extends to cover a portion of via hole 181.

389. Hwang also illustrates an example where the spacer does not overlap a via hole 181 at all. EX1005, FIG. 7.

390. Therefore, a POSITA would have found obvious that the Hwang-Lee-Park’531 emission layer 370 (“*the OLED layer*”) is disposed above Hwang’s protruded portion of pixel electrode 191, i.e., non-emissive portion of pixel electrode 191 (“*the at least one connection part*” in Example 2) and that a position

where this non-emissive portion of the pixel electrode 191 (“*the at least one connection part*”) is disposed overlaps with emission layer 370 (“*the OLED layer*”) in a plan view.

391. For at least these reasons, a POSITA would have understood Hwang-Lee-Park’531 to render obvious [7.1] and [7.2].

XI. CONCLUSION

392. For all the reasons I have noted in the foregoing paragraphs, claims 1-8 of the ‘691 patent are obvious in view of the references discussed above.

393. I currently hold the opinions set expressed in this declaration. But my analysis may continue, and I may acquire additional information and/or attain supplemental insights that may result in added observations.

APPENDIX A

Skills Summary

- Successful Management and Team building with personnel at levels ranging from Sr. Scientists and Engineers to Technicians/Operators. Maximum Department size >100; Budget >\$25 million/yr.
- Strong New Product Development background; over 100 new SSL products taken from concept to manufacturing, including regulatory, Energy Star certification and DLC certification.
- Excellent communication skills sales and sale support experience as evidenced by development of new 8+ figure accounts for LED die, packages and applications. Proven ability to match customer demands/needs/desires with existing products.
- Comprehensive technical background in the full range of semiconductor and LED production technologies including MOCVD hardware/process, fabrication, LED chip/package test/reliability, optical design, thermal management, color conversion, SSL fixture/lamp design/integration and reliability.
- Direct Design and Development experience of LEDs (structures, die, packages) and SSL fixtures/components using TracePro and SolidWorks.
- Extensive experience in development of industry test and measurement standards.

Employment**CTO; EB Designs & Technology Parker, CO****2014 –**

- Design and development of innovative solid-state lighting technology and designs, with a primary focus on optical design, thermal design and production/assembly technologies.
- Manage technology roadmap and draft IP disclosures/patent filings.
- Provide technical support and conduct research/technology development for clients in the field of solid-state lighting. This work additionally includes serving as an expert witness.
- Developed the first method able to predict chromaticity shift of LED products over time. Method is being used as the basis for a new industry standard: IES TM-35-19 "Projecting Long-Term Chromaticity Coordinate Shift of LED Packages, Arrays and Modules."
- Developed the method for interpolating between drive currents for flux maintenance lifetime for LED based products that is being implemented in IES TM-21-19 "Projecting Long Term Lumen, Photon and Radiant Flux Maintenance of LED Light Sources."

CTO; QuarkStar, LLC Las Vegas, NV**2016 – 2023**

- Manage technology roadmap and draft IP disclosures/patent filings.
- Developed technology to stabilize color shift over time of LED lighting products.
- Negotiated first IP licensing technology with a major European lighting company. Technology was used to develop a premium downlight product line.
- Managed transition from R&D to manufacturing. Products provided the majority of artificial lighting for a \$500 million expansion at the Museum of Fine Art Houston.
- Developed technology and oversaw product design for L-Prize concept phase. Resulting design was one of four winners at this stage of the L-Prize competition.

Director of Engineering; HeathCo, LLC Bowling Green, KY**2013 – 2014**

- Managed Engineering Department Staff (11 domestic, 14 international); Responsibilities included preparation and administration of the department budget (\$3.5 million annual). The department was charged with developed advanced technology/products related to: Solid State Lighting, Sensors, Notifications and Control Products and included regulatory/certifications for UL, FCC, Energy Star and DLC.
- Developed technology, IP and product roadmaps for all three business units (Lighting, Sensors, Notifications). Provided solid state lighting technology support for The Chamberlain Group.
- Additional responsibilities included establishing career development paths and training goals for all members of the department.
- Key accomplishments:

- Led team for product recall issue dating back to 2006. Reduced recall scope (# units) by >80% and financial exposure by >85% through detailed investigation and analysis of production records and analysis of excess and obsolete inventory.
- Completed review for entire product portfolio to comply with new cUL bi-lingual language requirements. Project required warning requirement changes to physical components (tooling), warning labels, documents and packaging on >400 products.

Elec Tech International Zhuhai, Guangdong Province, P.R. China

Chief Engineer ETi Lighting Research Institute

VP Research & Development ETi Solid State Lighting

2011 – 2013

- Managed Engineering and R&D staff for newly formed vertically integrated LED company (107 Engineering, Scientists, Designers); responsibilities included preparation and administration of the department budget (>\$25 million annual)
- Worked directly with President and CEO of the company to develop IP and product roadmaps for all LED based lighting products/projects for markets in the US, Europe, Japan and China.
- Trained engineering staff on semiconductor growth/fabrication technologies, and semiconductor layer materials characterization techniques
- Key accomplishments:
 - Developed capability for fast turn functional prototypes (<2 weeks from concept to operating units). This was an improvement over the prior process that required 6+ weeks for a working prototype. Prior to this the company lost ~50% of all opportunities that required functional prototypes.
 - Supported product development and production ramps that enabled the company to increase sales from ~\$10 million to >\$40 million in one year.
 - Developed proprietary linear lamp technology capable of >1000 lumens/ft with a wall plug efficacy >100 lm/W, CRI>80 and L70>50,000 hrs (Ta = 25°C). Technology allows the same base units to be installed in fixtures as a replacement tube or used as individual luminaires with transverse spacing criteria ranging from 1.6 – 2.9.

Lighting Science Group Corporation Satellite Beach, FL

2010 - 2011 VP of Research

- Assembled and managed research and development teams for projects related to solid state lighting.
- Direct responsibility for design/development of customized photometric and radiometric characterization equipment.
- Direct responsibility for modeling and determining product and component lifetimes based on optical, thermal, mechanical and electrical analysis with respect to intended operating environments.
- Served as company representative on industry standards committees related to SSL technology (LM79, LM80, TM21, etc.)
- Key accomplishments:
 - Developed advanced LED models for product development and production control; including advanced color control schemes for multi-color applications. Methods capable of predicting average chromaticity to within a combined $\Delta xy \leq 0.002$; production variation < 2 step MacAdam ellipse.
 - Developed and characterized wavelength conversion materials, methods and technology. Work included development of optics and materials for L-Prize entry.

2008 – 2010 Product Development Manager

- Tasked with developing Solid State Lighting products including: optical, mechanical and thermal design, design and process FMEA, oversight of initial production, development of quality system documents and requirements for internal production and out-sourced components. Projects ranged from individual efforts to team of 10+ employees
- Served as the primary technical resource for all OEM customers.
- Managed group responsible for all product certifications and standards requirements including UL, FCC, CE, Energy Star and DLC as well as IES lighting requirements for outdoor products.
- Responsible for development, calibration and maintenance of photometric equipment in development and production areas.
- Key accomplishments:
 - Completed fast track development and launch of OEM SSL acorn retrofit product (<5 months). Product exceeded all customer requirements including: lumen output, efficacy, thermal resistance and size. Developed second generation product with >100% increase in light output with now cost increase.

- Completed design of Streetlight family (4 products) in 4 month time span. Products achieved >90 lumens/Watt efficacy at thermal stability with projected L₇₀ lifetimes >80,000 hours at T_a=40°C (continuous).
- Development replacement lamp family line (6 primary lamp types, 100+ variations). Product family included the first replacement LED lamps to achieve Energy Star certification. Product variations developed for LSG brand name and 3 OEM customers. Altogether the family accounted for >50% of the Energy Star certified LED lamps as of December 2011.

2004 - 2008 Toyoda Gosei North America Troy, MI

Sales Manager

- Primary responsibility for developing new and managing existing LED die and package customers for the Eastern region of North America. This required extensive communications with existing and potential customers to determine best fit products for their applications/requirements.
- Additional responsibility for search for and identifying new market opportunities for existing or newly developed products.
- Served as the primary technical resource for all customers in North/South America and Europe; provide engineering support for customers developing LED packages and LED lighting products.
- Pioneered introduction of LEDs into large format display applications.
- Key accomplishments:
 - Secured two new 8 figure accounts in a new market niche. These customers designated as the only two priority customers for Toyoda Gosei world-wide. Sales ramped from \$0 to >\$100 million/yr in less than 18 months.
 - Secured sole supplier status for LED backlights in Apple - 9.9" (iPad), 15.4", 17" and 22" displays. This was the culmination of an 18 month campaign with the Apple Display group to find the best fit product for their requirement and to train Apple personnel on potential technical barriers/issues with their application.
 - Addressed Microsoft concerns about blue light hazards related to development of a next generation optical mouse. After three months, I was able to conclusively show to Microsoft that it would be impossible for 14mil die products to present a photo-biological hazard under both IEC 62471 and IEC 60825.
 - Awarded business for all passenger lighting on the B787 Dreamliner. This award was made by Diehl which controls all lighting for Boeing, Airbus and Embraer and was achieved within 4 months of first contact with Diehl. At the time of first contact Diehl had no knowledge of Toyoda Gosei and had been working with 4 LED companies for over 12 months on the project.

2003 – 2004 Beeman Lighting Sarasota, FL

Director of Solid-State Lighting Engineering

- Tasked with leading development of solid-state lighting systems and materials with primary focus on chip on board applications and devices. Product lines included RGB landscape lighting and minimal environmental impact fixtures and novel display/artwork fixtures.
- Managed all IP issues (competitor analysis, IP roadmap, patentability analysis).
- Worked with existing and potential customers to ensure new products meet or exceed requirements and expectations.
- Key accomplishment
 - Developed RGB LED based landscape light with minimal environmental impact. This was accomplished by establishing a research project with FAU and included studies that conclusively showed the products had no impact on the behavior of sea turtle hatchlings.

2003 University of South Florida Tampa, FL

Intellectual Property Manager

- Managed IP portfolio of over 100 active patents and applications for University faculty/staff. Key portfolio items included: anti-cancer bioactive compounds, dendrimer synthesis and application technology, and spectral analysis of biological materials (blood analysis, surface and soluble protein analysis).
- Tasked with enhancing University reputation and revenue through negotiation of licensing agreements for IP
- Key accomplishments:

- Negotiated license agreement for evaluation of new anti-cancer compounds derived from cold water tunicates.
- Assembled team that included 3 corporate and 2 academic partners for the DARPA SUVOS program. This task was completed in one month and the resulting proposal was ranked 2nd overall out of a field of 34 entries and was noted by the reviewers as the only proposal to address each and every portion of the RFP.

1998 – 2003 Uniroyal Optoelectronics Tampa, FL

Director of Intellectual Property, University Relations & Government Contracts (2001 – 2003)

- Concurrent assignment as Sr. Epi Scientist.
- Tasked with establishing IP roadmap and track patent landscape related to MOCVD growth, chip/package design and applications for LED technology.
- Reviewed all production and R&D activities to identify potential IP. This included drafting initial disclosures and working with external counsel for patent filings and responses to office actions. Activities with external counsel further included development of opinions of non-infringement.
- Oversight and management of a \$3.4 million multi-campus research program.
- Monitor and track RFP notices for externally funded research related to the company's core technology development roadmap.
- Key accomplishments:
 - Developed opinions of non-infringement with external counsel for 10 LED patents that had been the subject of numerous infringement suits against Tier 1 LED companies.
 - Assembled team that included 3 corporate and 2 academic partners for the DARPA SUVOS program. This task was completed in one month and the resulting proposal was ranked 2nd overall out of a field of 34 entries and was noted by the reviewers as the only proposal to address each and every portion of the RFP.

Team Leader, Epitaxial Materials & Characterization (1999 – 2001)

- Concurrent assignment as Sr. Epi Scientist.
- Oversaw start up and qualification of Epitaxial Growth & Characterization areas; role included training of Sr. Scientists, Engineers and Technicians for both areas in theory, application, process and maintenance procedures.
- Managed Epitaxial Growth & Characterization areas for production of InGaN and AlInGaP LED wafers. This included preparation and administration of the department budget (~\$25 million annual) as well as setting department performance goals (total good wafers, wafer yield, performance improvements and unit production costs).
- Coordinate inventory levels with purchasing department to minimize value of inventory necessary to support production plan. Additionally, negotiated key raw material specifications and prices.
- Served as Sr. member of Quality Team responsible for ISO9001 certification. Certification was achieved within a 12 month time span.
- Key accomplishments:
 - Completed process qualifications for all MOCVD systems within 3 months of CapEx delivery and established initial production yields 15% higher than the benchmark process transferred to UOE.
 - Managed departmental expansion and quality system efforts that allowed >250% increase in production capacity.
- Managed start up and qualification of Epitaxial Growth & Characterization areas; role included training of Engineers and technicians for both areas in theory, application, process and maintenance procedures.

Sr. Epi Scientist (1999 – 2003)

- Primary responsibility for MOCVD hardware and process modifications necessary to support performance improvements, yield enhancements and cost reductions.
- Served as primary technology liaison with customers and investors. Provided support to customers on package and fixture design and integration.
- Tasked with technical oversight of all photometric/radiometric characterization.
- Responsible for LED chip and package optical/thermal design including wavelength conversion materials. Developed LED package solutions for small format, full color backlight applications.
- Key accomplishments:
 - Resolved gold corrosion issue in Fab area. Also eliminated transparent contact failure mechanism. Combined efforts increased fabrication yield by >30%.

- Modified hardware and epitaxial growth process to increase throughput of Epitaxial Growth & Characterization areas by 80% (9 hour to 5 hour cycle time), while cutting unit cost by >30%. Also reduced surface and interfacial roughness by a factor of >3x while improving thickness uniformity from 4% to <2%, using DOE methods. Designed additional hardware modifications that further increased throughput by another 20%.
- Developed new test methods to verify performance of LED structures prior to Fabrication. Methods allowed verification of optical power to within 15% and wavelength within 2 nm prior to beginning of fabrication.

Staff Engineer (1998 – 1999)

- Designed/specified Epitaxial Growth & Characterization areas. This responsibility included specification and selection of all CapEx equipment for the Epitaxial Growth and Characterization areas and managing the construction, CapEx equipment installation and start up.
- Additional responsibilities included determining initial product cost and throughput based on installed CapEx tool base.
- Key accomplishments:
 - Implemented and validated new ammonia delivery system that allowed multiple MOCVD systems to draw from the same cylinder and eliminated downtime for cylinder changes. Implemented new exhaust management process for arsine/phosphine waste stream, extending maintenance interval by >300%.
 - Developed zero assumption cost and throughput models for LED facility. Cost estimate for 18 months post-start up proved accurate to within 10% of actual costs.

1996 – 1998 Emcore Corporation Somerset, NJ

Process Engineer

- Responsible for installation, materials demonstration and production process qualification and transition into manufacturing of MOCVD systems in an ISO9000 manufacturing environment (6 systems in 18 months).
- Tasked with identifying cost reduction and throughput/yield enhancements for epitaxial growth processes.
- Member of internal Quality System audit team.
- Key accomplishments:
 - Developed MOCVD Tool Qualification Procedure for benchmarking and qualifying all MOCVD systems installed for internal corporate use as well as at customer locations world-wide.
 - Completed Manufacturing Readiness Review for AlGaAs/Ge solar cell process in ~25% of standard time. Resulted in 3 year, \$15 million supply contract for company.
 - Scaled up and transferred of InSb magneto resistor process to a higher throughput system (single wafer D-180 to five wafer E-300). Increased wafer yield by from 65% to >95%.
 - Developed industry's first comprehensive cost and throughput model for epitaxial growth processes. The model typically allowed cost reductions of 10-20% and throughput increases of >10%.

1990 AT&T Bell Labs

Holmdel, NJ

Visiting Researcher

- Designed and built custom MOCVD/Mass spec system. System allowed tracking of precursor molecules, reaction intermediates and products over 12+ orders of magnitude of concentration.
- Implemented program to evaluate novel precursors for use in growth and doping of III-V and II-VI compound semiconductors. Data used to determine reaction and decomposition mechanisms for metal-organic sources. Successfully identified grow conditions for novel carbon doping source (norbornadiene) for III-V materials.

1989 Shell Oil Norco, LA

Process Engineer

- Developed and implemented new system for determining optimal time to clean heat exchangers on crude oil distillation column based on global economic metrics of unit and detailed process simulations.
- System exceeded system cost savings target of \$50,000/year by ~3 orders of magnitude. Project resulted in corporate-wide savings of >\$500 million/year. Cumulative corporate savings exceed \$20 billion.

Education

Ph.D. in Chemical Engineering
BSE in Chemical Engineering

University of Florida 1997
Tulane University 1989

- Graduate work focused on development of optoelectronic devices, including novel silicon based visible LEDs and sulfide based TFELD structures.
- Developed the world's first crystalline silicon based visible light LED. Utilized DOE methods to identify process conditions to allow first growth of epitaxial silicon on ZnS epi layers.
- Tested and verified efficacy of novel precursors for p-type doping of ZnSe materials in LED structures.
- Responsible for modification, operation and maintenance of MOCVD system for growth of wide bandgap compound semiconductor materials.
- Trained incoming post docs and graduate students in theory, operation and maintenance of MOCVD systems. Group comprised ~20 students and 6 post docs.

References **Available on request**

Curricula Vitae

University of Florida, Department of Chemical Engineering Advisory Board

Member 1998 – 2023

Chair 2007 – 2009, 2017 – 2023

University of Florida, Dean's Advisory Board, College of Engineering

Member 2007 – 2009, 2017 - 2023

Professional Societies:

- CIE, CIE US National Committee Board of Directors
- CORM (Council for Optical Radiation Measurement)– Board of Directors
- SPIE (International Society for Optics and Photonics)
- Optica (formerly OSA – Optical Society of America)
- SID (Society for Information Display)
- MRS (Materials Research Society)
- Illuminating Engineering Society (Member of Science Advisory Panel, Member of Executive Board of Test Procedures Committee, Chair of Projection and Reliability Sub-Committee, Member of Light Sources Committee, Secretary of Color Committee)
- American Society of Horticultural Science (ASHS)
- American Society of Agricultural and Biological Engineers (ASABE)
- SAE (Society for Automotive Engineering)

Testing and Standards Development:

- 30+ years experience testing LED components and fixtures
- 18 years experience developing LED testing standards, technical coordinator ANSI/IES LM-86: Measuring Luminous Flux and Color Maintenance of Remote Phosphor components; technical coordinator: ANSI/IES TM-21: Projecting Long-Term Lumen, Photon, and Radiant Flux Maintenance of LED Light Sources; technical coordinator ANSI/IES TM-28: Projecting Long-Term Luminous Flux Maintenance of LED Lamps and Luminaires ; co-technical coordinator ANSI/IES LM-79: Optical and Electrical Measurements of Solid-State Lighting Products
- Developed the modeling method that enabled prediction of color shift of LED based products that is used in ANSI/IES TM-35: Projecting Long-Term Chromaticity Shift of LED Packages, Arrays, and Modules
- Work Group member on over a dozen ANSI/IES Test standards (Test Procedures Committee, Color Committee, Photobiology Committee, Light Sources Committee)

Conference Chair

LED Measurement and Standards, San Diego, CA October 2-3 (2008).

Patents (Granted)

1 US 7,093,956 "Method of Lighting for Protecting Sea Turtles." D. Miller, E. Bretschneider, issued August 22, 2006.

- 2 US D650,519 "Pole for a Street Light Luminaire." F. Maxik, D. Henderson, E. Bretschneider, A. Widjaja, K. Bowen, J. Sundin, E. Peiniger, issued December 13, 2011.
- 3 US 8,157,413 "Light Fixture and Associated LED Board and Monolithic Optic." F. Maxik, Z. Gibler, E. Bretschneider, D. Henderson, A. Widjaja, issued April 17, 2012.
- 4 US D673,323 "Light Fixture." F. Maxik, D. Henderson, E. Bretschneider, A. Widjaja, K. Bowen, J. Sundin, E. Peiniger, issued December 25, 2012.
- 5 US 8,360,607 "Lighting Unit with Heat Dissipating Chimney." E. Bretschneider, Z. Berkowitz, R. Sosnick, L. Pattison, P. Pattison, issued January 29, 2013.
- 6 US 8,408,725 "Remote Wavelength Conversion Device and Associated Methods." F. Maxik, E. Bretschneider, R. Soler, D. Bartine, issued April 2, 2013.
- 7 US D681,874 "Light Fixture." F. Maxik, D. Henderson, E. Bretschneider, A. Widjaja, K. Bowen, J. Sundin, E. Peiniger, issued May 7, 2013.
- 8 US 8,439,515 "Remote Lighting Device and Associated Methods." F. Maxik, R. Soler, D. Bartine, E. Bretschneider, issued May 14, 2013.
- 9 US 8,465,167 "Color Conversion Occlusion and Associated Methods." F. Maxik, E. Bretschneider, R. Soler, D. Bartine, issued June 18, 2013.
- 10 US 8,491,165 "Lighting Unit Having Lighting Strips with Light Emitting Elements and a Remote Luminescent Material." E. Bretschneider, Z. Berkowitz, R. Sosnick, L. Pattison, P. Pattison, issued July 23, 2013.
- 11 US 8,492,995 "Wavelength Sensing Lighting System and Associated Methods." F. Maxik, E. Bretschneider, P. Medelius, D. Bartine, R. Soler, G. Flickinger, issued July 23, 2013.
- 12 US 8,506,118 "Light Fixture and Associated LED Board and Monolithic Optic." F. Maxik, Z. Gibler, E. Bretschneider, D. Henderson, A. Widjaja, issued August 13, 2013.
- 13 US 8,515,289 "Wavelength Sensing Lighting System and Associated Methods for National Security Application." F. Maxik, D. Bartine, P. Medelius, E. Bretschneider, issued August 20, 2013.
- 14 US 8,547,391 "High Efficacy Lighting Signal Converter and Associated Methods." F. Maxik, R. Soler, D. Bartine, R. Zhou, V. Bastien, M. Regan, E. Grove, E. Bretschneider, issued October 1, 2013.
- 15 US 8,616,715 "Remote Light Wavelength Conversion Device and Associated Methods." F. Maxik, E. Bretschneider, P. Medelius, D. Bartine, R. Soler, G. Flickinger, issued December 31, 2013.
- 16 TWI 428,542 "Lighting Unit Having Lighting Strips with Light Emitting Elements and a Remote Luminescent Material." E. Bretschneider, Z. Berkowitz, R. Sosnick, L. Pattison, P. Pattison, issued March 1, 2014.
- 17 US 8,680,457 "Motion Detection System and Associated Methods Having at Least One LED of a Second Set of LEDs to Vary Its Voltage." F. Maxik, issued March 25, 2014.
- 18 US 8,686,641 "Tunable LED Lamp for Producing Biologically Adjusted Light." F. Maxik, D. Bartine, R. Soler, E. Grove, E. Bretschneider, issued April 1, 2014.
- 19 US 8,684,566 "Light Emitting Unit With Indirect Light Source." E. Bretschneider, Z. Berkowitz, R. Sosnick, L. Pattison, M. Pattison, issued April 1, 2014.

- 20 US 8,702,259 "Color Conversion Occlusion and Associated Methods." F. Maxik, E. Bretschneider, R. Soler, D. Bartine, issued April 22, 2014.
- 21 US 8,818,202 "Wavelength Sensing Lighting System and Associated Methods for National Security Applications.: F. Maxik, D. Bartine, P. Medelius, E. Bretschneider, issued August 26, 2014.
- 22 US D715,467 "LED Linear Replacement Lamp Design." E. Bretschneider, Z Berkowitz, R. Sosnick, issued October 14, 2014.
- 23 US 8,866,839 "High Efficacy Lighting Signal Converter and Associated Methods." F. Maxik, R. Soler, D. Bartine, M. Regan, E. Grove, E. Bretschneider, issued October 21, 2014.
- 24 US 8,941,329 "Tunable LED Lamp for Producing Biologically-Adjusted Light." F. Maxik, D. Bartine, R. Soler, E. Grove, E. Bretschneider, issued January 27, 2015.
- 25 US 9,024,536 "Tunable LED Lamp for Producing Biologically-Adjusted Light and Associated Methods." F. Maxik, D. Bartine, R. Soler, E. Grove, E. Bretschneider, issued May 5, 2015.
- 26 US 9,125,275 "Wavelength Sensing Lighting System and Associated Methods." F. Maxik, E. Bretschneider, P. Medelius, D. Bartine, R. Soler, G. Flickinger, issued September 1, 2015.
- 27 US 9,172,199 "Electrical Fixture Connection." T. Birdwell, E. Bretschneider, J. Fitzgibbon, B. Moore, S. Tylicki, issued October 27, 2015.
- 28 US 9,289,574 "Three-channel Tuned LED Lamp for Producing Biologically-Adjusted Light." F. Maxik, D. Bartine, R. Soler, E. Grove, E. Bretschneider, issued March 22, 2016.
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Expert Witness:

- Zhenzhen Ronglida Technology Co. Ltd. v **Pathway IP LLC** IPR2025-01231 (declaration)
- **Feit Electric Company, Inc.** v Elong International USA Inc. and Xiamen Longstar Lighting Co. Ltd., Northern District of Texas 3:24-cv-01089 (declaration)
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- Optolum, Inc. v **Cree, Inc.** Middle District of North Carolina 1:17-cv-00687 (declaration, deposition, testimony)
- Nichia Corporation v **Feit Electric Company, Inc.** Central District of California 2:20-cv-00359 (declaration)
- Nichia Corporation v **Karimex Electronic Components LTDA.**, 2nd Business Court of Sao Paulo lawsuit nos. 1114629-97.2019.8.26.0100, 1114618-68.2019.8.26.0100, 1114607-39.2019-8.26.0100 (affidavit)
- Cao Lighting, Inc. v **Feit Electric Company, Inc.** Central District of California 2:20-cv-04926 (declaration)
- **Ideal Industries Lighting LLC, d/b/a Cree Lighting** v RAB Lighting IPR2021-00646, 00655 (declaration)
- L&L Candle Company LLC v **Decoware Int'l Inc.** IPR2020-01233 (declaration)
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- Seoul Semiconductor Co. Ltd; Seoul Viosys Co. Ltd v **Bed Bath and Beyond Inc.** Central District of California 2:18-cv-03837 (declaration)
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- Cao Lighting, Inc. v **Light Efficient Design**, Northern District of Illinois Eastern Division, 1:17-cv-07359 (declaration, deposition)
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- DMF, Inc, v **AMP Plus, Inc. d/b/a ELCO Lighting and ELCO Lighting, Inc.** Central District of California 2:18-cv-07090 (declaration, deposition, trial testimony)

- **Biofrontera** v Sun Pharmaceutical Industries, Inc. IPR2024-00874 (declaration)
- **Scott Chaverri; Mito Red Light, Inc.** v Platinum LED Lights LLC; Platinum LED Holdings LLC; Mark Sawyer; Michelle Sawyer; Michael Volkin; Jane Doe Volkin; Volkinator Enterprises, Inc. District of Arizona 2:21-cv-01700 (declaration)
- **Mito Red Light, Inc.** v Joovv, Inc. IPR2024-00621 (declaration)
- Seoul Semiconductor Co., Ltd.; Seoul Viosys Co., Ltd. v **Feit Electric Co., Inc.** Central District of California 2:22-cv-05097 (declaration)
- Signify North America Corporation and Signify Holding B.V. v **Menard Inc.** Northern District of Ohio 1:22-cv-01447 (declaration)
- **Everlight Electronics Co., Ltd.** v Amazon.com, Inc.; Amazon.com Services LLC Western District of Texas Waco Division 6:21-cv-00906 (declaration)
- **Everlight Electronics Co., Ltd.** v Walmart Inc. Western District of Texas Waco Division 6:23-00439 (declaration)
- DS Advanced Enterprises, Ltd v **Lowe's Home Centers, LLC** Southern District of California 3:23-cv-01335 (declaration)

Technology Consultations:

- QuarkStar, Inc. 2015 – 2022
- EIE Materials/EIE Materials 2016-2019
- Lighting Science Group 2014 - 2018
- LTF Technology 2018-2019
- Mito Red Light LLC 2025-
- UF Health 2025-