

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

BOE TECHNOLOGY GROUP CO., LTD.,

Petitioner,

v.

SAMSUNG DISPLAY CO., LTD.,

Patent Owner.

PTAB Case No. IPR2025-01477

U.S. Patent No. 11,500,496 B2

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 11,500,496 B2**

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[illegible]

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EXHIBIT LIST

No.	Exhibit
Ex-1001	U.S. Patent No. 11,500,496 B2
Ex-1002	File History of the '496 patent
Ex-1003	Declaration of Darran Cairns, Ph.D.
Ex-1004	Curriculum Vitae of Darran Cairns
Ex-1005	U.S. Publication No. 2015/0049030 (“Her”)
Ex-1006	U.S. Publication No. 2014/0145979 (“Lee-979”)
Ex-1007	U.S. Patent No. 6,867,549 (“Cok”)
Ex-1008	U.S. Publication No. 2014/0117330 (“Cho”)
Ex-1009	U.S. Publication No. 2014/0002385 (“Ka”)
Ex-1010	U.S. Publication No. 2013/0341651 (“Kim”)
Ex-1011	Jae-Hoon Lee, et al., P-12: A New a-Si:H TFT Pixel Design Compensating Threshold Voltage Degradation of TFT and OLED, SID Symposium Digest of Technical Papers, vol. 35, no. 1, pp. 264–67, 2004 (“Lee-P12”)
Ex-1012	Chinese App. No. CN105320372A (“Hsieh”)
Ex-1013	Complaint <i>Samsung Display Co., Ltd. v. BOE Technology Group Co., Ltd. et al.</i> ; USDC, E.D. Texas, filed April 21, 2025
Ex-1014	U.S. Patent No. 8,289,457
Ex-1015	U.S. Publication No. 2012/0262389
Ex-1016	U.S. Patent No. 9,947,727

No.	Exhibit
Ex-1017	M. Krithikaa, “Touch Screen Technology – A Review,” International Journal of Trend in Research and Development, Volume 3(1), ISSN: 2394-9333 (Jan-Feb. 2016)
Ex-1018	Fawwaz T. Ulaby et al., “Circuit Analysis and Design” Michigan Publishing (2018)
Ex-1019	U.S. Publication No. 2013/0278513
Ex-1020	Li Du, “An Overview of Mobile Capacitive Touch Technologies Trends” (Dec. 2016)
Ex-1021	Todd O’Connor, “mTouch™ Projected Capacitive Touch Screen Sensing Theory of Operation – TB3064,” Microchip (2010)
Ex-1022	ATMEL “Touch Sensors – Design Guide” (Apr. 2009)
Ex-1023	U.S. Publication No. 2015/0021565
Ex-1024	U.S. Publication No. 2015/0261370
Ex-1025	Japanese Patent No. 646348B2 (“Kobayashi”)
Ex-1026	Japanese Patent No. 1984029441A
Ex-1027	Japanese Patent No. 627983B2
Ex-1028	Japanese Publication No. 2138739
Ex-1029	U.S. Patent No. 9,423,830
Ex-1030	U.S. Publication No. 2011/0193793
Ex-1031	SID Website, “P-12: A New a-Si:H TFT Pixel Design Compensating Threshold Voltage Degradation of TFT and OLED,” https://sid.onlinelibrary.wiley.com/doi/10.1889/1.1830965

No.	Exhibit
Ex-1032	Tai et al. “A New Pixel Circuit for Driving Organic Light-Emitting Diode With Low Temperature Polycrystalline Silicon Thin-Film Transistors”; IEEE/OSA Journal Of Display Technology, Vol. 1, No. 1, September 2005
Ex-1033	Chen et al. “New pixel circuits for driving active matrix organic light emitting diodes” B.-T. Chen et al. / Solid-State Electronics 50 (2006) 272–275
Ex-1034	U.S. Patent No. 9,276,055
Ex-1035	U.S. Patent No. 9,029,846
Ex-1036	U.S. Publication No. 2013/0194205
Ex-1037	U.S. Publication No. 2015/0212537
Ex-1038	U.S. Publication No. 2011/0007011
Ex-1039	William S. Wong & Alberto Salleo, “Flexible Electronics: Materials and Applications” Springer (2009)
Ex-1040	Bernard Geffroy, et al. “Review Organic light-emitting diode (OLED) technology: materials, devices and display technologies” 2006 Society of Chemical Industry. Polym Int 55:572–582 (2006), DOI: 10.1002/pi.1974
Ex-1041	U.S. Patent No. 9,911,943
Ex-1042	U.S. Patent No. 9,285,842
Ex-1043	U.S. Publication No. 2016/0109998
Ex-1044	U.S. Publication No. 2004/0164668
Ex-1045	U.S. Patent No. 7,510,454
Ex-1046	U.S. Patent No. 8,970,508

No.	Exhibit
Ex-1047	Michael D. Sangid et al., “The role of grain boundaries on fatigue crack initiation – An energy approach” International Journal of Plasticity (2010)
Ex-1048	Walter D. Pilkey, “Peterson’s Stress Concentration Factors,” Wiley Second Edition (1997)
Ex-1049	Michael B. Heaney, “Electrical Conductivity and Resistivity” Electrical Measurement, Signal Processing, and Displays, CRC Press, 7-1 (2003)
Ex-1050	William D. Callister, Jr. et al. “Materials Science and Engineering; An Introduction,” Wiley (2014)
Ex-1051	Iulian Rosu, “Impedance Matching,” QSL.net
Ex-1052	Catrysse, et al. “Nanopatterned Metallic Films for Use As Transparent Conductive Electrodes in Optoelectronic Devices,” American Chemical Society (2010)
Ex-1053	Askari Mohammad Bagher, “Comparison of LED and OLED” Scholars Journal of Engineering and Technology (SJET), 206 (2016)
Ex-1054	U.S. Publication No. 2016/0313837
Ex-1055	U.S. Patent No. 6,504,202

LISTING OF CHALLENGED CLAIMS

Claim 1
1[pre] A display device comprising:
1[a] a display panel, the display panel comprising:
1[b] a base layer;
1[c] a circuit layer on the base layer;
1[d] an organic light emitting device layer on the circuit layer, and the organic light emitting device layer comprising:
1[d][i] a plurality of first light emitting areas to emit red light;
1[d][ii] a plurality of second light emitting areas to emit green light; and
1[d][iii] a plurality of third light emitting areas to emit blue light,
1[d][iv] wherein, viewed in a plan view, the second light emitting areas are a different size than at least one of the first light emitting areas and the third light emitting areas;
1[e] a thin film encapsulation layer on the organic light emitting device layer, the thin film encapsulation layer comprising an inorganic layer and an organic layer; and
1[f] a touch sensing unit on the display panel, the touch sensing unit comprising:
1[f][i] a first conductive pattern formed directly on a surface of the display panel;
1[f][ii] an insulating layer covering the first conductive pattern; and
1[f][iii] a second conductive pattern on the insulating layer, and having a thickness above the first conductive pattern in a thickness direction of the display device that is greater than a thickness of the first conductive pattern in the thickness direction of the display device, the second conductive pattern comprising:

1[f][iii][A] first touch sensor parts comprising a plurality of metal mesh lines defining a plurality of mesh holes;
1[f][iii][B] second touch sensor parts comprising a plurality of metal mesh lines defining a plurality of mesh holes; and
1[f][iii][C] first connection parts connecting respective ones of the first touch sensor parts,
1[g] wherein, viewed in a plan view, at least one of the plurality of first light emitting areas, at least one of the plurality of second light emitting areas, or at least one of the plurality of third light emitting areas is located within a mesh hole defined by first touch sensor parts such that the metal mesh lines of the first touch sensor parts do not overlap the light emitting areas, and at least one of the plurality of first light emitting areas, at least one of the plurality of second light emitting areas, or at least one of the plurality of third light emitting areas is located within a mesh hole defined by second touch sensor parts such that the metal mesh lines of the second touch sensor parts do not overlap the light emitting area,
1[h] wherein the first conductive pattern comprises electrically conductive second connection parts connecting respective ones of the second touch sensor parts, and
1[i] wherein a conductive contact hole through the insulating layer connects respective ones of the second connection parts and the second touch sensor parts.
Claim 2
2[pre] The display device of claim 1, wherein the thin film encapsulation layer comprises:
2[a] a first inorganic layer;
2[b] an organic layer on the first inorganic layer; and
2[c] a second inorganic layer on the organic layer.

Claim 3
3. The display device of claim 2, wherein the first inorganic layer comprises silicon oxynitride, silicon oxide, or silicon nitride.
Claim 4
4. The display device of claim 2, wherein the display panel further comprises a buffer layer on the thin film encapsulation layer.
Claim 5
5. The display device of claim 4, wherein the buffer layer is formed directly on the second inorganic layer of the thin film encapsulation layer.
Claim 6
6. The display device of claim 2, wherein the second conductive pattern has a thickness above the first conductive pattern in a thickness direction of the display device that is greater than a thickness of the second connection parts in the thickness direction of the display device.
Claim 7
7[pre] The display device of claim 1, wherein, viewed in a plan view:
7[a] each of the first light emitting areas is located within a first mesh hole defined by a plurality of metal mesh lines of first touch sensor parts or a plurality of metal mesh lines of second touch sensor parts;
7[b] each of the second light emitting areas is located within a second mesh hole defined by a plurality of metal mesh lines of first touch sensor parts or a plurality of metal mesh lines of second touch sensor parts;
7[c] each of the third light emitting areas is located within a third mesh hole defined by a plurality of metal mesh lines of first touch sensor parts or a plurality of metal mesh lines of second touch sensor parts; and

7[d] the second mesh hole is a different size than one of the first mesh hole and the third mesh hole.

Claim 8

8. The display device of claim 7, wherein, viewed in a plan view, the second light emitting areas are of a different size than the first light emitting areas and the third light emitting areas, and the first light emitting areas are of a different size than the third light emitting areas.

Claim 9

9. The display device of claim 8, wherein, viewed in a plan view, no more than one first light emitting area is located in a first mesh hole, no more than one second light emitting area is located in a second mesh hole, and no more than one third light emitting area is located in a third mesh hole.

Claim 10

10. The display device of claim 8, wherein the second conductive pattern has a thickness above the first conductive pattern in a thickness direction of the display device that is greater than a thickness of the second connection parts in the thickness direction of the display device.

Claim 11

11. The display device of claim 8, wherein the circuit layer comprises a pixel driving circuit for each light-emitting area comprising a first thin film transistor, a second thin film transistor, a third thin film transistor, a fourth thin film transistor, a fifth thin film transistor, a sixth thin film transistor, a seventh thin film transistor, and a storage capacitor.

Claim 12

12. The display device of claim 1, wherein the base layer is a flexible plastic substrate.

Claim 13
13. The display device of claim 12, wherein the display device is a foldable display device.
Claim 14
14. The display device of claim 12, further comprising an adhesive layer directly on a surface of the base layer and a protective film on the opposite surface of the adhesive layer.
Claim 15
15. The display device of claim 1, wherein the display panel is configured to be flexed along a predetermined axis.
Claim 16
16. The display device of claim 1, further comprising an organic adhesive layer on the touch sensing unit and a window.
Claim 17
17. The display device of claim 1, wherein the circuit layer comprises a pixel driving circuit for each light-emitting area comprising a first thin film transistor, a second thin film transistor, a third thin film transistor, a fourth thin film transistor, a fifth thin film transistor, a sixth thin film transistor, a seventh thin film transistor, and a storage capacitor.

BOE Technology Group Co., Ltd. (“BOE” or “Petitioner”) petitions for *inter partes* review (“IPR”) of claims 1-17 (“Challenged Claims”) of U.S. Patent No. 11,500,496 B2 (“the ’496 patent,” Ex-1001) issued to Samsung Display Co. Ltd.

Over the last two decades, touchscreen displays have become ubiquitous as display designers employ a series of well-trodden principles. First, a display technology is selected—such as liquid crystal display (LCD) with LCD pixels, plasma display, light-emitting diode (LED) display with LED pixels, and organic light emitting diode (OLED) display with OLED pixels—each having its known tradeoffs, with some mandatory features as well as several known design options. Next, a touch technology is chosen—such as those based on resistance, capacitance, or optics—each again with has known tradeoffs, mandatory features, and known design options. Then, the two are combined into a single structure.

The ’496 patent presents itself as a new touchscreen display, but it claims nothing new. Instead, the claims reflect routine combinations of known elements of an OLED display panel with known elements of a capacitive touch panel, embodying a series of well-known design choices selected from known, available options serving the exact purposes for which they were intended in the display industry. Claims 1-17 are not inventions and are not patentable; their subject matter is instead the definition of obvious.

I. GROUNDS FOR STANDING

Petitioner certifies the '496 patent is available for IPR, and Petitioner is not barred or estopped from requesting IPR on the grounds herein. This Petition is filed within one year of service of Patent Owner district court complaint. Ex-1013.

II. IDENTIFICATION OF CHALLENGE

A. Prior Art

This Petition requests cancellation of the Challenged Claims over the following prior art:

Prior Art
U.S. App. No. 2015/0049030 (“Her”); filed Feb. 25, 2014; published Feb. 19, 2015; prior art under at least §102(a)(1) (Ex-1005)
U.S. App. No. 2014/0145979 (“Lee-979”); filed Mar. 14, 2013; published May 29, 2014; prior art under at least §102(a)(1) (Ex-1006)
U.S. Patent No. 6,867,549 (“Cok”); filed Dec. 10, 2002; issued Mar. 15, 2005; prior art under at least §102(a)(1) (Ex-1007)
U.S. App. No. 2014/0117330 (“Cho”); filed September 6, 2013; published May 1, 2014; prior art under at least §102(a)(1) (Ex-1008)
U.S. App. No. 2014/0002385 (“Ka”); filed Jan. 11, 2013; published Jan. 2, 2014; prior art under at least §102(a)(1) (Ex-1009)
U.S. App. No. 2013/0341651 (“Kim”); filed Dec. 5, 2012; published Dec. 26, 2013; prior art under at least §102(a)(1) (Ex-1010)
Jae-Hoon Lee, et al., <i>P-12: A New α-Si:H TFT Pixel Design Compensating Threshold Voltage Degradation of TFT and OLED</i> , SID Symposium Digest of Technical Papers, vol. 35, no. 1, pp. 264–67, 2004 (“Lee-P12”); prior art under at least §102(a)(1) (Ex-1011)

Chinese App. No. CN105320372A (“Hsieh”); filed Sept. 23, 2014; published Feb. 10, 2016; prior art under at least §102(a)(1) (Ex-1012)
Japanese Patent No. JPH0646348B2 (“Kobayashi”); filed May 12, 1986, published June 15, 1994; prior art under at least §102(a)(1) (Ex-1025)

B. Grounds for Challenge

Grounds under 35 USC §103	Claims	Prior Art
1A	1-10, 12	Her in combination with Cok, Cho, with or without Hsieh and/or Kobayashi
1B	11, 17	Her in combination with Cok, Cho (with or without Hsieh and/or Kobayashi) and Lee-P12
1C	13-16	Her in combination with Cok, Cho (with or without Hsieh and/or Kobayashi), and Ka
2A	1-10, 12	Lee-979 in combination with Cok, Kim, with or without Hsieh and/or Kobayashi
2B	11, 17	Lee-979 in combination with Cok, Kim (with or without Hsieh and/or Kobayashi), and Lee-P12
2C	13-16	Lee-979 in combination with Cok, Kim (with or without Hsieh and/or Kobayashi), and Ka

III. '496 PATENT OVERVIEW

A. Technology Background

Touchscreen displays have two primary components: a display panel that displays graphical content, and a touch panel for user input. These two panels can

be formed separately and attached, or their layers integrated together. Ex-1003, ¶¶31-32; Ex-1014, 15:54-63; Ex-1015, ¶2.

Each panel may be based on different underlying technologies. Ex-1003, ¶33. Display panels may use backlit LCD pixels, plasma cells, LED pixels or OLED pixels. *Id.*, ¶¶33-34; Ex-1016, 1:19-28. Touch panels may be based on various sensing mechanism, e.g., capacitive and resistive touch sensing, to sense user's touch, and selected in view of known tradeoffs. Ex-1003, ¶¶7, 33-43; Ex-1016, 1:51-54; Ex-1017, 75-76; Ex-1018, 193.

OLED displays have become increasingly popular due to their superior (physical) flexibility and display properties. Ex-1003, ¶34; Ex-1018, 192-93. These displays operate by arranging diodes of organic material in an array of OLED pixels that produce light when electricity is applied to the diodes. Ex-1003, ¶34; Ex-1018, 90, 92. OLED displays typically include several common layers: (1) a base substrate as the foundation; (2) a circuit layer with (thin-film) transistors (“TFTs”), capacitors, and conductive materials to control operations of each OLED; (3) insulating layers to isolate electrical components; and (5) protective, buffer, and/or encapsulating layers to add structural support to the display, “planarize” non-flat layers for subsequent layer formation, and/or to inhibit degradants from entering sensitive components in the display. Ex-1003, ¶35. OLED panels largely differ in the details when implementing these layers, depending on design considerations such as

manufacturing cost and complexity, display quality, thickness, flexibility, and durability. *Id.*, ¶36.

Capacitive touch sensors generally detect a touch by measuring changes in an electrical field when altered by a conductive element (such as a human finger) and have similarly predominated for several decades. *Id.*, ¶38; Ex-1020, 1-2. These sensors typically have two sets of electrodes oriented in two directions, e.g., an “x” (blue) and “y” (red) directions shown below.

FIGURE 1: EXAMPLE SENSOR – FRONT VIEW

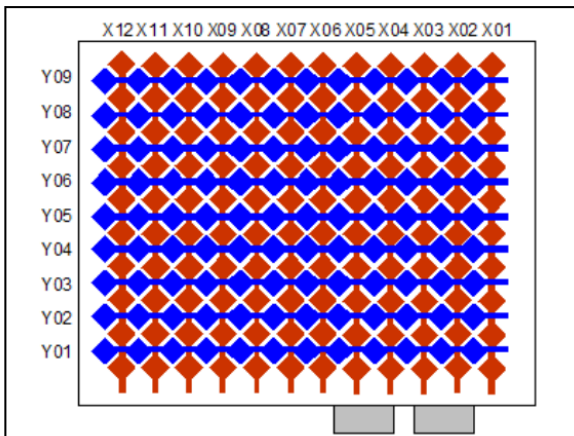
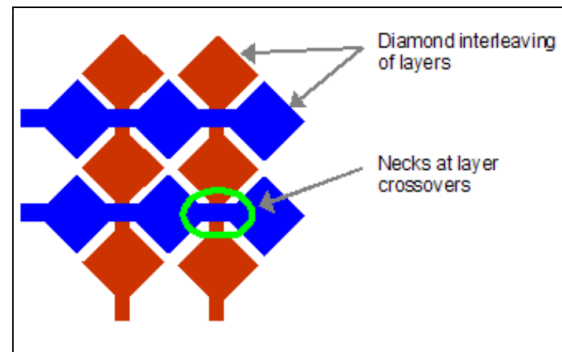


FIGURE 3: DIAMOND ELECTRODE PATTERN ALIGNMENT

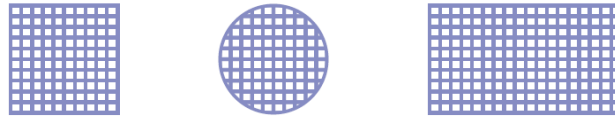


Ex-1021, 1-2; Ex-1020, 1-2, Fig. 1; Ex-1003, ¶38. The electrodes can be made from different materials, such as metal-mesh wires preferably arranged to not block the display’s light, or thin layers of (nearly) transparent metal oxides (such as indium-tin oxide or “ITO”).

Figure 3-2. Common Electrode Shapes



Figure 3-3. Electrodes with 50 Percent Mesh Fills



Ex-1022, 3-2 (p.22); Ex-1003, ¶¶39-40.

The rows/columns of touch-sensing electrodes are physically separated from each other by providing them either on different layers of the touch panel (with insulation in between), or on the same layer with a series of “bridge” or “tunnel” connections where the electrodes would otherwise intersect (like roads with an overpass or underpass). Ex-1020, 1; Ex-1003, ¶41. When a capacitive-touch panel is touched, individual row(s) and column(s) of sensors will sense the change in the electrical field, providing the coordinate of the touch. Ex-1020, 2; Ex-1003, ¶38. Capacitive touch panels may also include other layers, such as additional insulation, or protective or encapsulation layers to inhibit degradants, and may differ as to the electrode’s materials, shapes, and arrangements on different conductive layers, depending on design considerations such as manufacturing cost and complexity, transparency, thickness, flexibility, and durability. Ex-1003, ¶43.

B. The ’496 Patent

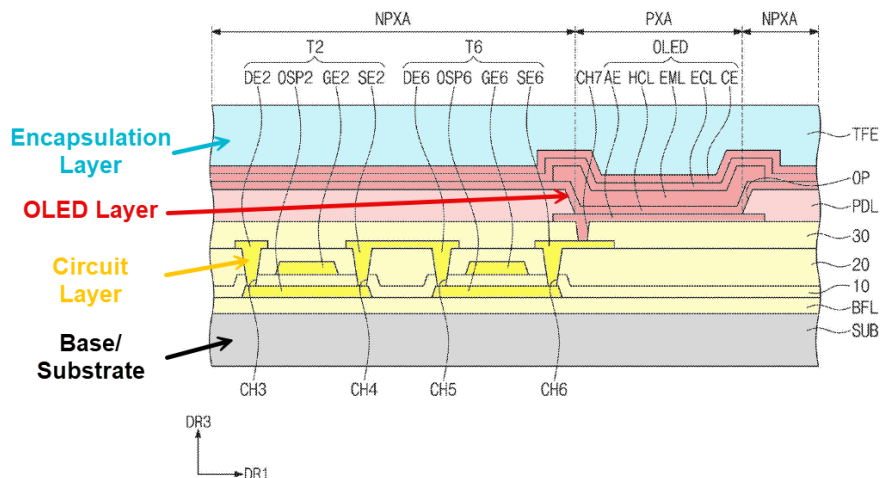
The ’496 patent was filed on January 14, 2020 as a continuation of U.S. Application No. 15/660,827 filed on July 26, 2017 (now U.S. Patent No. 10,541,279B2) and claims priority to Korean patent application 10-2016-0097493

filed on July 29, 2016. Ex-1001, Cover. The effective filing date of each Challenged Claim can be no earlier than July 29, 2016. Ex-1003, ¶¶44-45.

The '496 patent is directed to the arrangement of layers in an OLED-touchscreen display having a “display panel,” and a “touch sensing unit.” Ex-1001, Abstract; Ex-1003, ¶46.

The display panel includes, *inter alia*, a base layer, a circuit layer to funnel electricity to the display’s pixels, an OLED layer to generate light for the display, and a thin-film encapsulation (“TFE”) layer—which can be multi-layered—to seal the display from the environment, as shown below. Ex-1001, 10:15-11:32, 13:36-14:25; Ex-1003, ¶47. The display may also include other buffer, insulating, and protective layers. Ex-1001, 12:38-14:25; Ex-1003, ¶47.

FIG. 6C

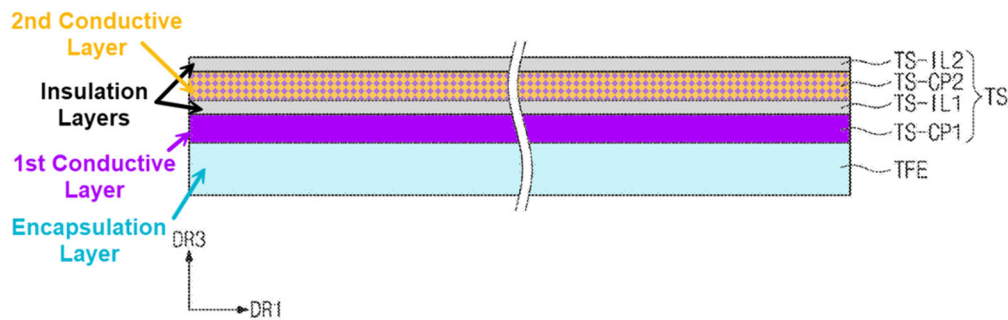


Ex-1001, Fig. 6c (annotated)

The touch-sensing unit (TS) is formed on the display's encapsulation layer, and includes two conductive layers with insulation between them, as shown below.

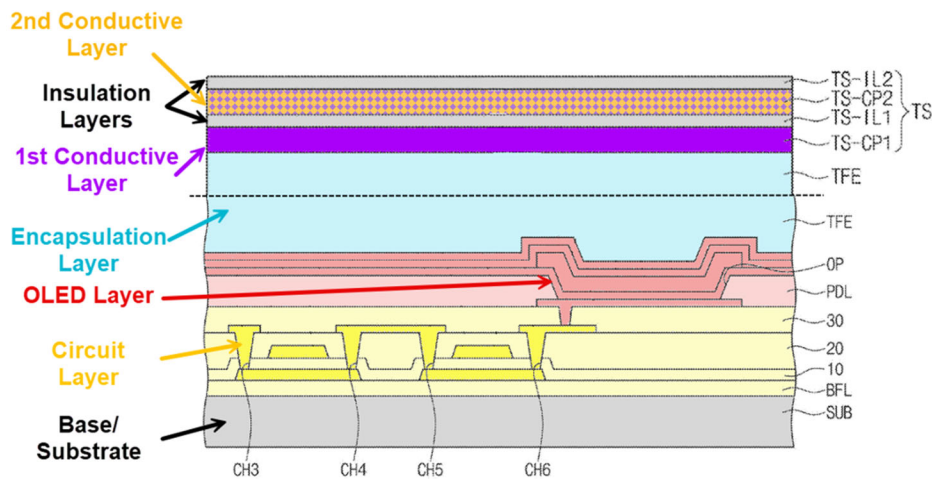
Ex-1001, 8:23-32, 11:22-32, 15:25-17:39, Figs. 6C, 8A-8E; Ex-1003, ¶48.

FIG. 8A



Ex-1001, Fig. 8A (annotated)

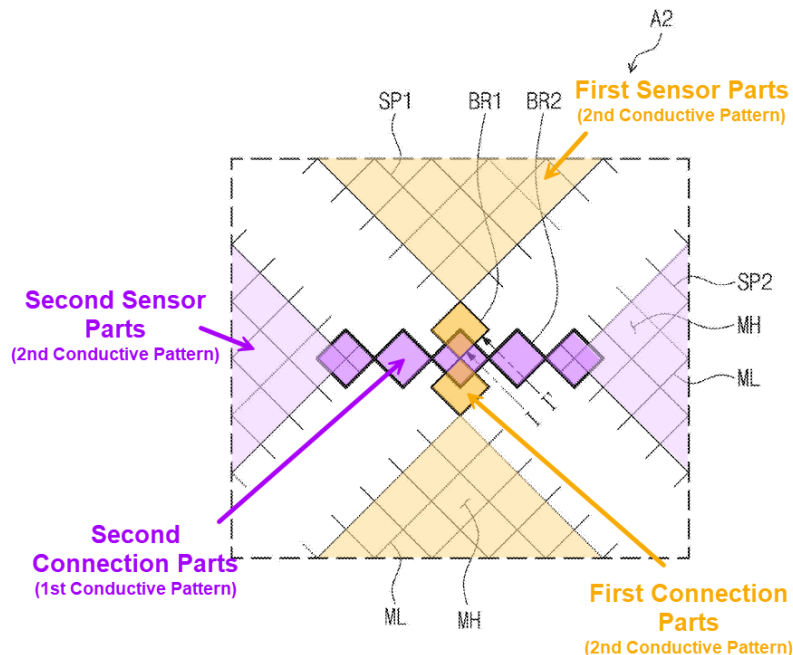
Provided below is an annotated combination of Figures 6C and 8A, showing the display device stacked together:



Ex-1003, ¶48.

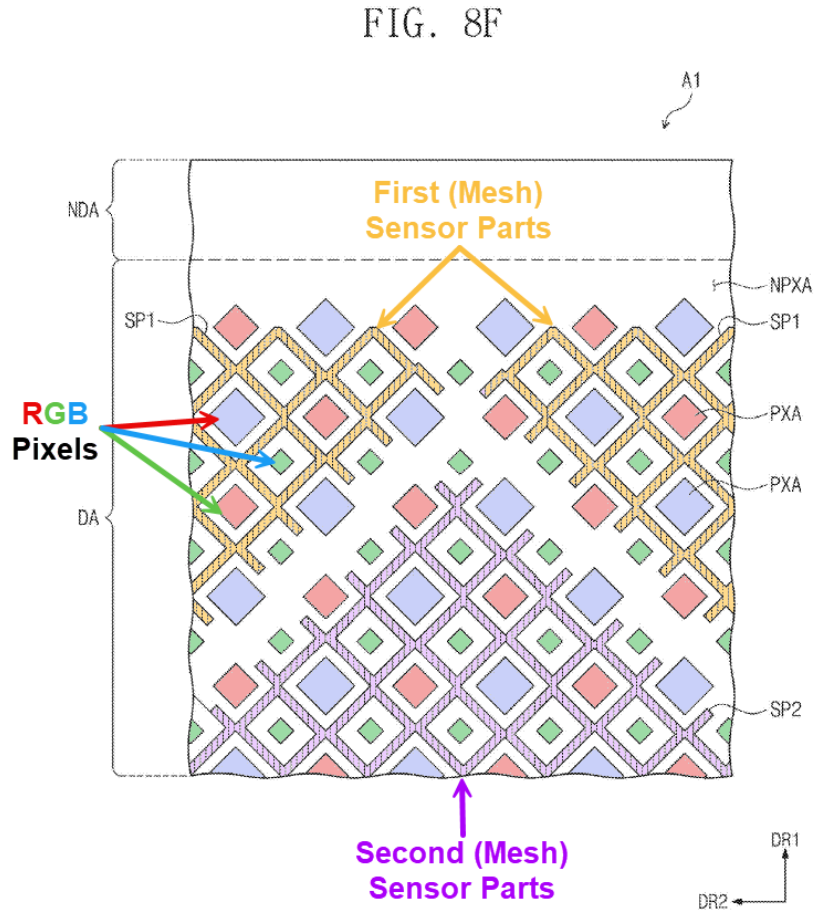
The '496 patent's touch-sensing unit (TS) has two sets of electrodes (TE1/TE2) oriented in different directions (DR1/ DR2), and are made up of two conductive layers (TS-CP1/TS-CP2). Ex-1001, 15:31-49, 16:16-44; Ex-1003, ¶49. Specifically, the second (top) conductive layer (TS-CP2) includes metal-mesh touch sensors (SP1/SP2), as well as the “connection parts” (BR1) for the first touch sensors (SP1). Ex-1001, 16:61-17:14; Ex-1003, ¶¶49-51. The first (bottom) conductive layer (TS-CP1) includes an underpass-type bridge (BR2) to connect the second touch sensors (SP2) to keep the first and second electrodes electrically separated. Ex-1001, 16:61-17:14; Ex-1003, ¶49. Annotated Figure 9 provides a top-down view showing the intersection of the first and second electrodes (BR2 is provided underneath the rest of the parts):

FIG. 9



Ex-1001, Fig. 9 (annotated)

Each sensor part (SP1/SP2) has “mesh lines” (ML) that intersect to form “mesh holes” (MH) aligned with display’s light-emitting areas (PXA) to allow the display’s light to pass through the touch panel. Ex-1001, 17:26-55; Ex-1003, ¶51. Figure 8F below shows a top-down view of the openings in the mesh sensors (SP1/SP2) aligned with the display’s light-emitting areas. Ex-1003, ¶51.



Ex-1001, Fig. 8F (annotated)

C. Prosecution History

The original claims presented for examination were broader than those that issued. Ex. 1002, 20-23; Ex-1003, ¶¶52-53. Independent claim 1 required only an OLED layer, an encapsulation layer, a buffer layer, and a touch-sensing unit with two conductive layers and insulation, where the second conductive layer was thicker than the first. Ex. 1002, 20-23; Ex-1003, ¶¶53, 58. After two prior-art rejections, (Ex-1002, 115-28, 164-76), the examiner initially allowed the claims after the patentee added more details about the thickness limitation, (*id.*, 369-75 (citing *id.*, 343-46 for reasons for allowance)). Ex-1003, ¶¶54-56.

Rather than allow the claims to issue, the patentee continued prosecution by further amending the claims. Ex-1002, 442-45, 484-92, 524-31; Ex-1003, ¶¶57. Ultimately, the patentee cancelled all existing claims and presented new, far more specific ones by:

- (1) adding base and circuit layers to the display panel;
- (2) specifying the display panel had red, green, and blue light-emitting areas, in which the green pixels were of a different size than the red and blue ones;
- (3) specifying a multi-layered encapsulation member; and
- (4) specifying the structures of the first and second conductive pattern—as well as their relative thicknesses—including that the touch panel

had a mesh structure in which mesh openings were aligned with the light-emitting areas.

Compare Ex-1002, 580-84, *with id.*, 524-31; Ex-1003, ¶58. These narrower newly presented claims issued as the '496 patent without undergoing any prior-art rejection. Ex-1002, 603-09; Ex-1003, ¶59.

IV. LEVEL OF SKILL IN THE ART

As of July 2016, a person of ordinary skilled in the art (“POSITA”) would have had a Bachelor’s degree in electrical engineering, physics, materials science, or a related field, and four years of experience in development, design or manufacturing of semiconductor devices and/or display devices or equivalent work experience. However, additional education towards an advanced degree could substitute for work experience, and vice versa. Ex-1003, ¶¶97-99.

V. DETAILED EXPLANATION OF GROUNDS

A. Ground 1A: Her Combined with Cok and Cho, with or without Hsieh and/or Kobayashi (Claims 1-10, 12).

Claims 1-10 and 12 are obvious in view of (1) Her combined with Cok and Cho, and (2) Her combined with Cok and Cho, further in view of Hsieh and/or Kobayashi.

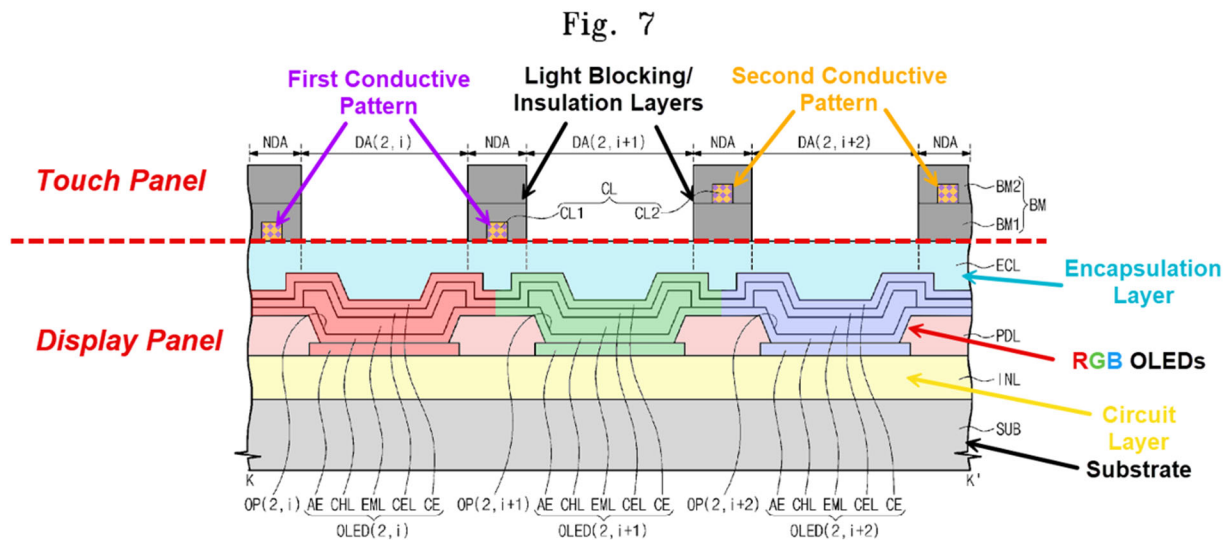
1. Prior Art

a. Her (Ex-1005)

Her was filed on February 25, 2014 and published on February 19, 2015. Ex-1005, Cover. Her constitutes prior art under at least §102(a)(1). Ex-1003, ¶¶60-61.

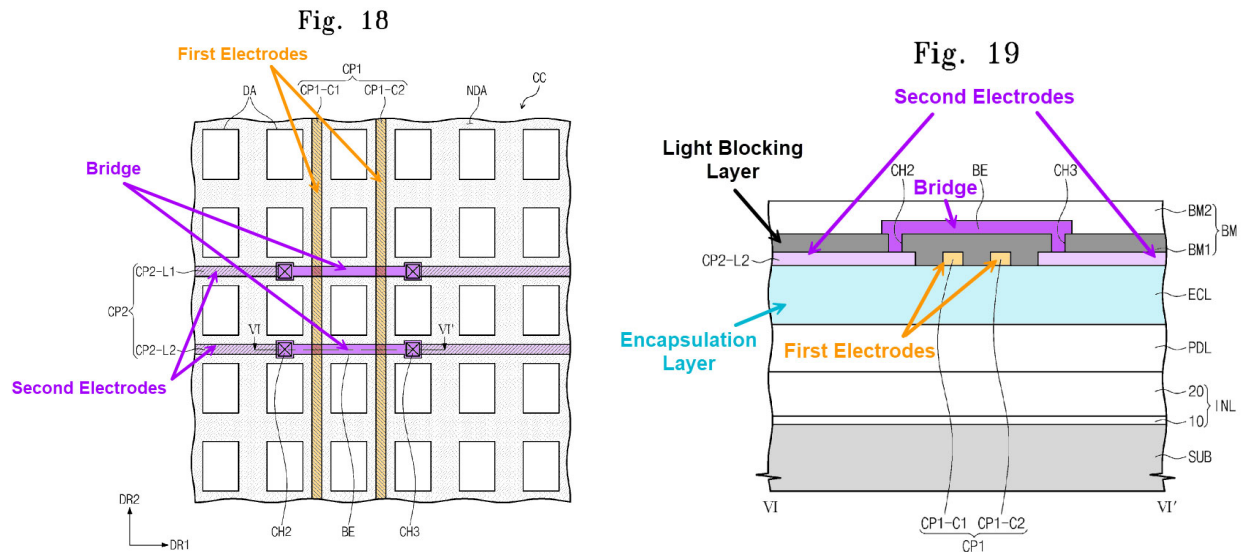
Her discloses an OLED display device comprising an OLED display panel and a touch panel formed directly on the display panel. Ex-1005, Abstract, Fig. 7(annotated below); Ex-1003, ¶62.

Her's OLED-display panel includes a substrate, a circuit layer for controlling the OLED's operation, an OLED layer to produce red, green, and blue light, and a "sealing" layer to encapsulate the OLEDs. Ex-1005, ¶¶49, 51-53, 62, 64, 66-76, 80, Figs. 3-7, 11, 13, 16-17, 21; Ex-1003, ¶63.



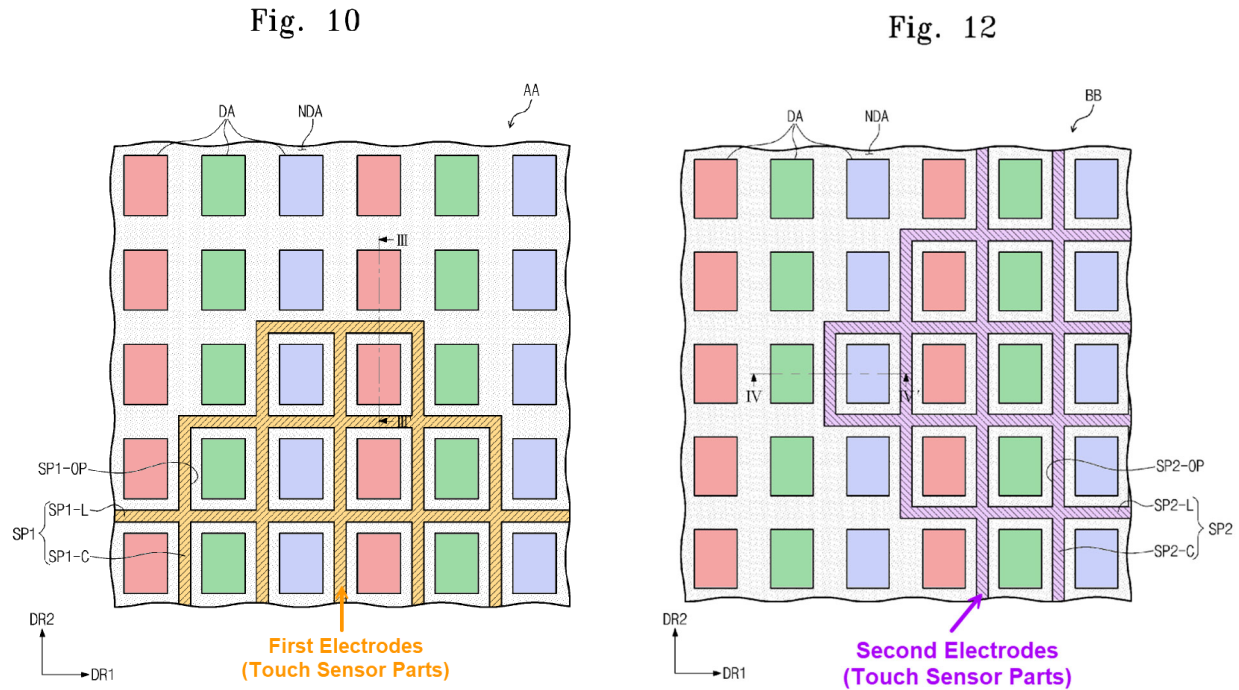
Her's touch panel is on top of the encapsulation layer and includes two sets of touch electrodes extending in x and y directions that can be formed several ways. Ex-1005, ¶¶87-89; Ex-1003, ¶64. For instance, the two sets of touch electrodes can

be “disposed on different layers,” (Ex-1005, ¶¶82-84, 97, Figs. 7, 10-15; Ex-1003, ¶¶64-65), or alternatively “may be disposed on the same layer.” Ex-1005, ¶¶109-10, Figs. 16-19; Ex-1003, ¶¶66-68. When formed on the same layer, the touch-sensor parts of one set of electrodes are connected on the same layer, while the touch-sensor parts of the other set of electrodes are connected using a bridge on a different conductive layer (above or below). Ex-1005, ¶¶114-16, Figs. 18-19; Ex-1003, ¶¶64-68. Her explains that the first and second touch-sensor parts may be formed either directly on the encapsulating layer, or a light-blocking (insulating) layer of the touch panel, and the bridge is formed on the other layer. Ex-1005, ¶¶114-16; Ex-1003, ¶¶67-68.



Ex-1005, Figs. 18-19 (annotated)

Her's touch-sensor parts form a metal mesh, with the wires of the mesh configured to surround the display's light-emitting areas. Ex-1005, ¶¶100, 104, Figs. 10, 12(annotated below); Ex-1003, ¶69.

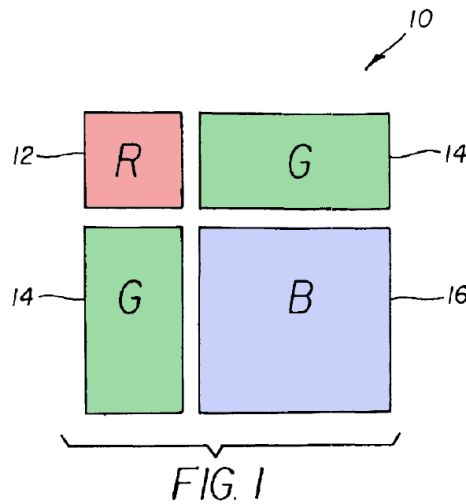


b. Cok (Ex-1007)

Cok was filed on December 10, 2002 and issued on March 15, 2005. Ex-1007, Cover. Cok constitutes prior art under at least §102(a)(1). Ex-1003, ¶¶80-81.

Cok discloses an OLED-display panel in which red, green, and blue light-emitting areas are provided in different numbers and sizes relative to one another to account for the “human visual frequency response to the colors” and differences in efficiency and lifetime degradation of each color. Ex-1007, Abstract; Ex-1003, ¶82. Cok explains that “the human eye is most sensitive to green light”(Ex-1007, 1:24-

39), and thus the apparent resolution of the display can be increased by providing more green light-emitting areas compared to red or blue ones(*id.*, 3:1-11; Ex-1003, ¶83). Moreover, different colored OLEDs produce different amounts of light at a given electrical power (i.e., they have different efficiencies) and degrade at different rates over their lifetime(Ex-1007, 1:50-62, 3:18-24), and thus Cok teaches that high-efficiency or slower-degrading colors can be made smaller in size(*id.*, 3:18-24; Ex-1003, ¶83).



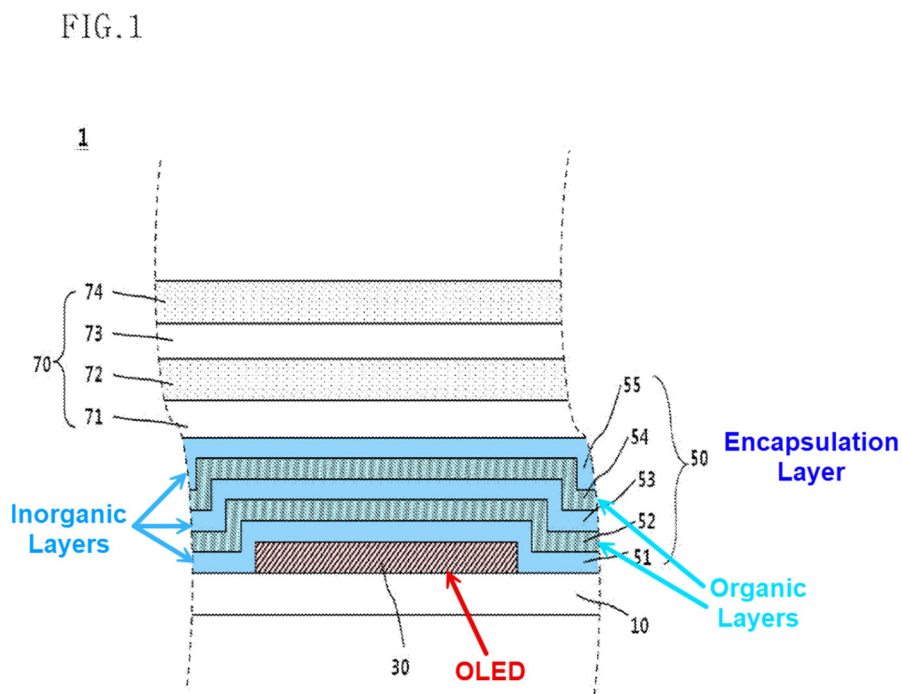
Ex-1007, Fig. 1 (annotated)

Cok also provides equations to calculate the relative numbers and sizes of each different colored light-emitting area based on several design considerations. *Id.*, 3:43-5:6; Ex-1003, ¶84.

c. Cho (Ex-1008)

Cho was filed on September 6, 2013 and published on May 1, 2014. Ex-1008, Cover. Cho constitutes prior art under at least §102(a)(1). Ex-1003, ¶¶85-86.

Cho discloses an OLED-display panel, detailing a well-known, multi-layered encapsulation layer comprising alternating layers of inorganic and organic materials. Ex-1008, Abstract, ¶¶14, 49-53; Ex-1003, ¶87.



Ex-1008, Fig. 1 (annotated)

Cho explains that the inorganic layers “prevent external moisture and oxygen from penetrating into the OLED,” whereas the organic layers “alleviate internal stress of the inorganic material layers...[and] may fill small cracks or pinholes of the inorganic material layers.” Ex-1008, ¶50; Ex-1003, ¶88. Cho explains that such an alternating structure “effectively prevent[s] external moisture and oxygen from

penetrating into the OLED,” thus “minimizing failure” of the display and
“improving durability and reliability.” Ex-1008, ¶57; Ex-1003, ¶88.

2. Claim 1

a. 1[pre]

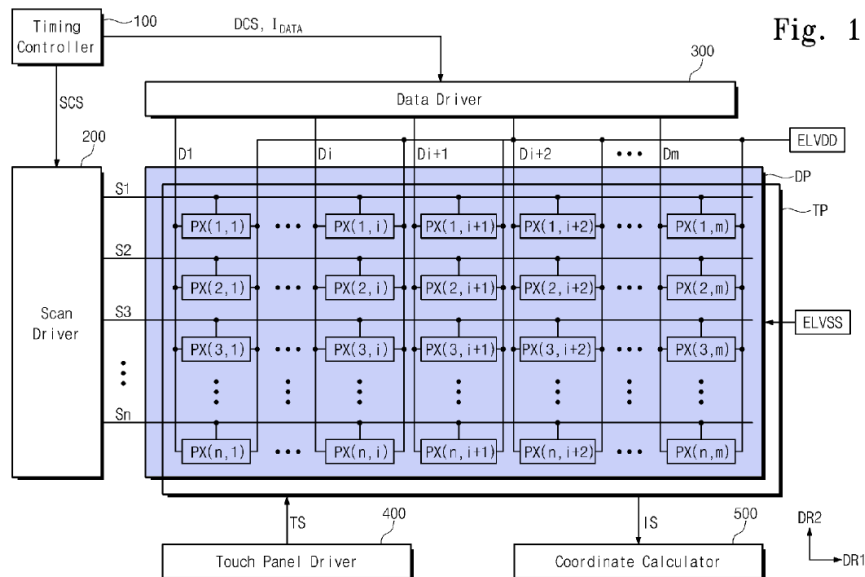
Her discloses this limitation.

Her discloses “an organic light emitting display device.” Ex-1005, Abstract,
¶¶3, 9, 20, 48, Fig. 1; Ex-1003, ¶¶101-102.

b. 1[a]

Her discloses this limitation.

Her’s display device “includes an organic light emitting display panel” (DP).
Ex-1005, Abstract, ¶¶9, 20, 48-78, Figs. 1-7; Ex-1003, ¶¶103-104.

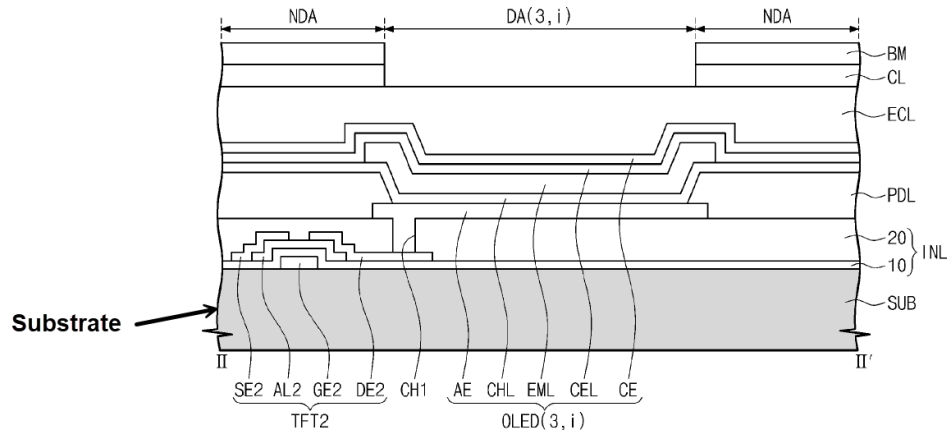


c. 1[b]

Her discloses this limitation.

Her's "display panel DP includes a base substrate" (SUB). Ex-1005, ¶¶49; ¶¶10, 50-51, 68, 70-80, Figs. 4-7, 19; Ex-1003, ¶¶105-106.

Fig. 6



Ex-1005, Fig. 6 (annotated)

d. 1[c]

Her discloses this limitation.

Her discloses a circuit layer (including e.g., TFTs, Cap) on the base layer. Ex-1005, ¶¶49 ("display panel DP includes...a plurality of scan lines...[and] data lines."), 51-53 ("display panel DP receives a first source voltage.... The pixels...are turned on in response to corresponding scan signals....Each of the pixels...may include at least one transistor[and] at least one capacitor"), 63 ("FIG. 3 is an equivalent circuit diagram of a pixel"), 63-74, Figs. 3-7; Ex-1003, ¶¶107-108.

Fig. 3

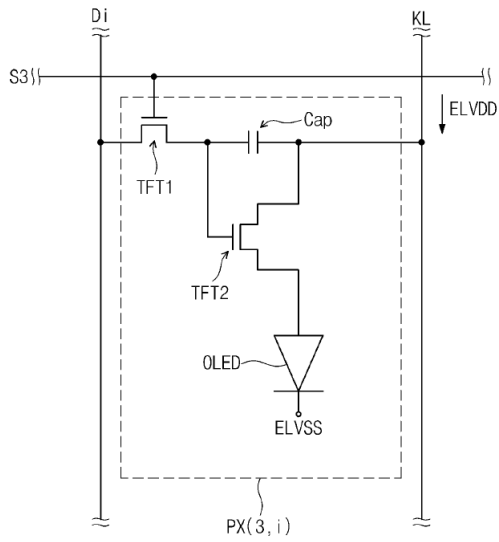


Fig. 4

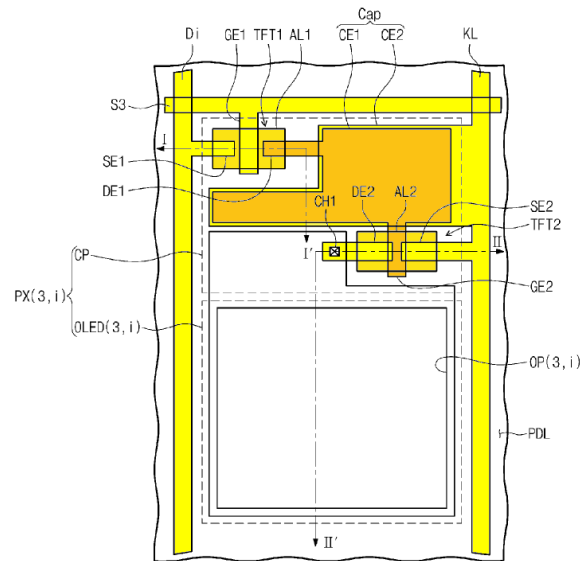
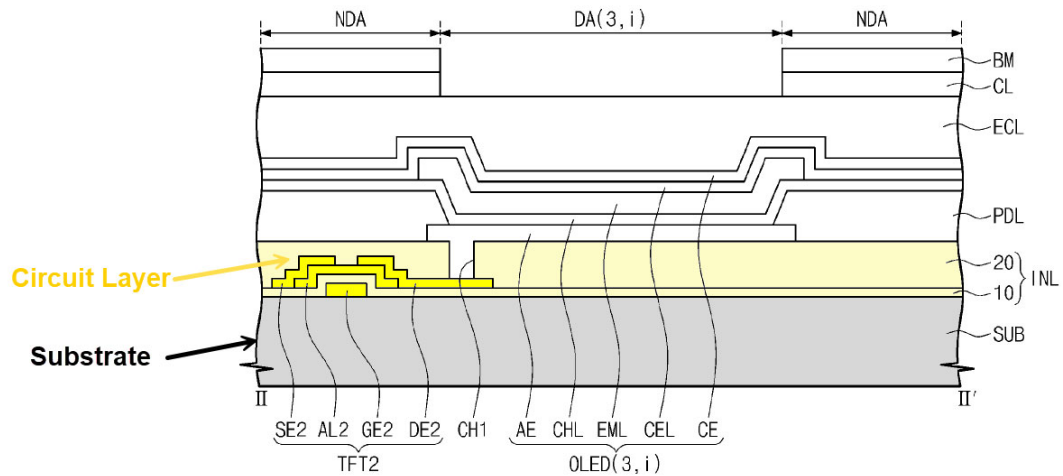


Fig. 6



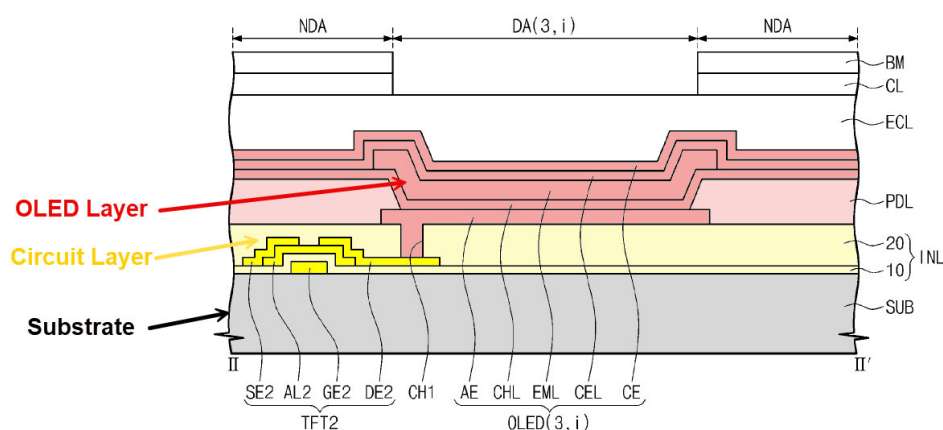
Ex-1005, Figs. 3-4, 6 (annotated)

e. 1[d]

Her discloses this limitation.

Her discloses that “[e]ach of the pixels...may include...an organic light emitting device”(Ex-1005, ¶53) which “is disposed on the second insulating layer” and thus on the circuit layer as claimed(*id.*, ¶74; ¶¶62, 64, 66-67, 69, 74-75, 80, Figs. 5-7, 11, 13, 16-17, 21; Ex-1003, ¶¶109-10).

Fig. 6



Ex-1005, Fig. 6 (annotated)

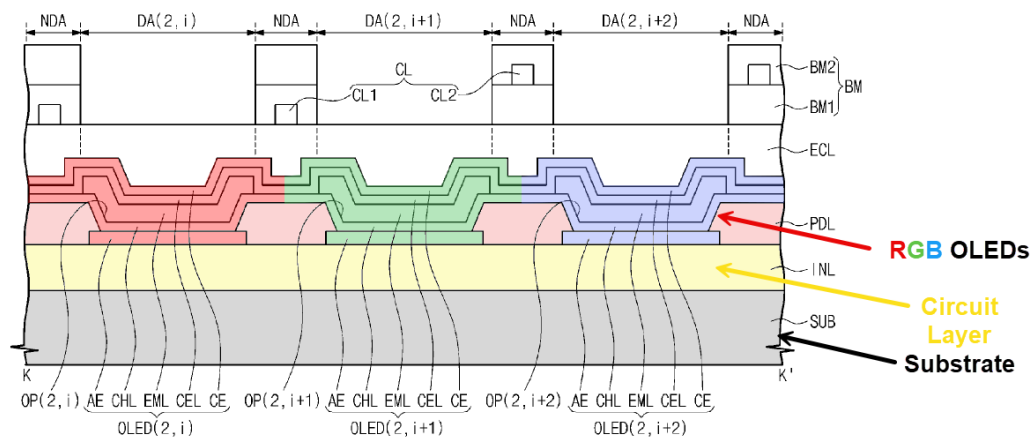
f. 1[d][i]

Her discloses this limitation.

Her discloses that “[t]he organic light emitting display panel includes a plurality of pixels”(Ex-1005, ¶5), and “[e]ach of the pixels...may include...an organic light emitting device”(*id.*, ¶53; ¶¶49, 60, 62, 69, 100, 104, Figs. 1, 2, 10, 12, 14, 18; Ex-1003, ¶¶111-12). Her also discloses “first, second, and third organic light emitting devices...are respectively disposed in the first to third light emitting areas”

that “generate lights having different colors. For instance, the first to third organic light emitting devices...may generate a red light, a green light, and a blue light, respectively.” Ex-1005, ¶¶62, 69, 80, Fig. 7; Ex-1003, ¶112. A POSITA would have understood Her as disclosing a plurality of light-emitting areas for *each* of the blue, green, and red colors, consistent with conventional pixel arrangements. Ex-1003, ¶¶113-14; Ex-1010, Fig. 2, ¶85; Ex-1007, 3:1-11, Figs. 1-7.

Fig. 7



Ex-1005, Fig. 7 (annotated)

g. 1[d][ii]

Her discloses this limitation. §V.A.2.g (1[d][i]); Ex-1003, ¶115.

h. 1[d][iii]

Her discloses this limitation. §V.A.2.g (1[d][i]); Ex-1003, ¶116.

i. 1[d][iv]

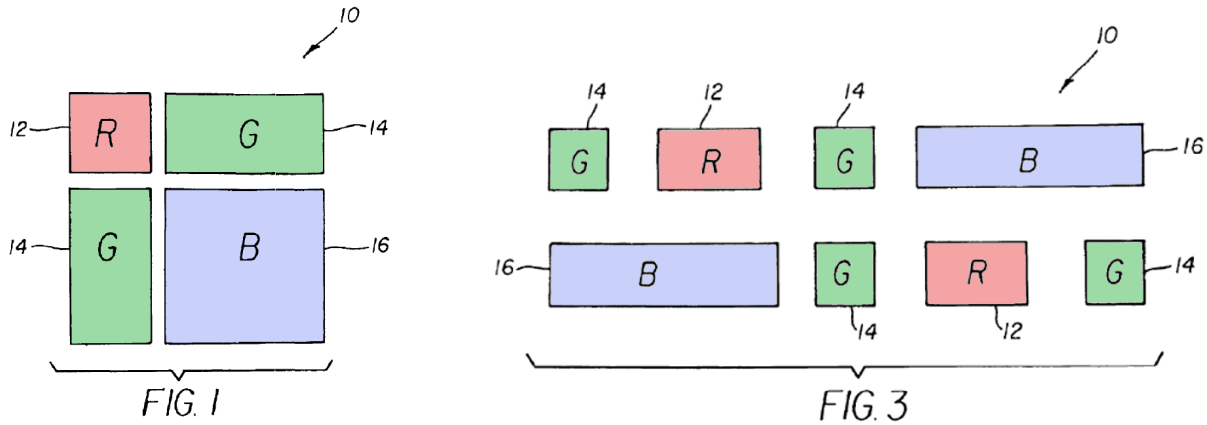
Her and Cok teach or suggest this limitation.

Her discloses red, green, and blue light-emitting areas without expressly specifying their relative sizes. Ex-1003, ¶¶117-18.

Providing red, green, and blue light-emitting areas of different relative sizes was well known in the display industry. Ex-1003, ¶119. It was well known that “the efficiency of light production by various OLED light emitters of different colors varies,” and “also suffer from color-dependent age-related degradation.” Ex-1007, 1:50-62, 3:18-24; Ex-1003, ¶119. Thus, “[l]ight emitting elements made with higher efficiency materials can be made smaller than light emitting elements made with lower efficiency materials while producing the same light output.” Ex-1007, 3:18-24, 2:15-29; Ex-1003, ¶120. Alternatively, the size of each colored light-emitting area can be adjusted to control the “white point” of the display—the ratio of colors used to produce white light—or to tailor the display to specific color use cases. Ex-1007, 3:25-33, 4:57-63; Ex-1003, ¶120.

Based on these known considerations, Cok teaches exemplary pixel configurations of red, green, and blue light-emitting areas of different relative sizes. Ex-1007, 4:7-30, Figs. 1, 3; Ex-1003, ¶121.¹

¹ It was also well known that “the human eye is most sensitive to green light and less sensitive to red and blue light.” Ex-1007, 1:23-39, 3:5-11. “Thus by providing more



Ex-1007, Figs. 1, 3 (annotated)

A POSITA would have been motivated to modify Her to provide different-sized light-emitting areas for each (red, green, and blue) color to account for their different efficiency and degradation, and/or to adjust the white point of the display, as taught by Cok (and as was well known in the industry). Ex-1007, 1:23-39, 1:50-62, 2:15-29; Ex-1003, ¶122. A POSITA would have had a reasonable expectation of success in making this modification because it merely involves adjusting the sizes of light-emitting areas Her already discloses, and Cok provides equations to calculate the size of each colored light-emitting area based on several known design considerations. Ex-1007, 3:43-4:6, 4:46-5:6; Ex-1003, ¶123.

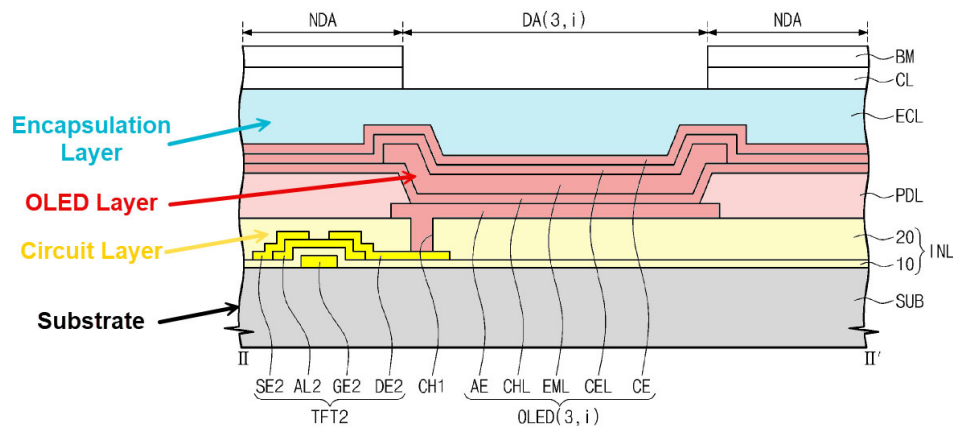
j. 1[e]

Her and Cho teach or suggest this limitation.

green light emitting elements in the patterns, the apparent resolution of the display can be improved.” Ex-1007, 3:1-11, 2:15-29; Ex-1003, ¶83.

Her discloses a sealing layer (ECL) “disposed on the base substrate SUB, covering the organic light emitting device OLED (3,i).” Ex-1005, ¶¶76-79, Fig. 7; ¶¶10, 113-16, Fig. 19. POSITA would have understood that Her’s “sealing” layer is also conventionally called a thin-film “encapsulation” layer. Ex-1003, ¶¶124-25.

Fig. 6



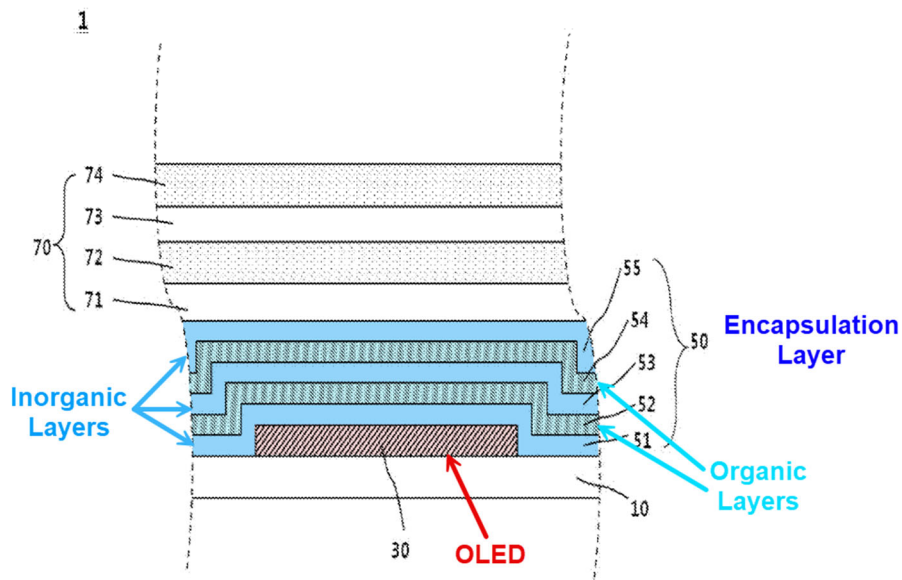
Ex-1005, Fig. 6 (annotated)

Her notes that, traditionally, “sealing layer...may include a plurality of thin layers”(Ex-1005, ¶6), but does not expressly disclose the details of the sealing layer. Ex-1003, ¶125. Thus, POSITA would have been motivated by Her and an understanding of conventional OLED encapsulation layers to implement a suitable layer structure for the sealing layer. Ex-1003, ¶125.

Consistent with Her’s recognition that sealing layers may have “a plurality of thin layers” (Ex-1005, ¶6), it was well-known that alternating layers of inorganic

and organic layers were routinely used to construct encapsulation/sealing layers that prevent oxygen and moisture ingress that can degrade OLEDs. Ex-1003, ¶126; Ex-1008, ¶49; Ex-1006 ¶¶75, 78; Ex-1009, ¶73; Ex-1023, ¶87. Cho, for instance, taught an OLED display panel with an “encapsulation layer” of alternating organic and inorganic material to “prevent oxygen or moisture from penetrating into the OLED.” Ex-1008, ¶49; Ex-1003, ¶¶126, 128.

FIG. 1



Ex-1008, Fig. 1 (annotated)

As Cho (and others) explained, inorganic layers “prevent external moisture and oxygen from penetrating the OLED.” *Id.*, ¶50; Ex-1006, ¶79 (same); Ex-1003, ¶127. Organic layers “alleviate internal stress of the inorganic material layers” and

“may fill small cracks or pinholes of the inorganic material layers.” Ex-1008, ¶50; Ex-1006, ¶80; Ex-1003, ¶127.

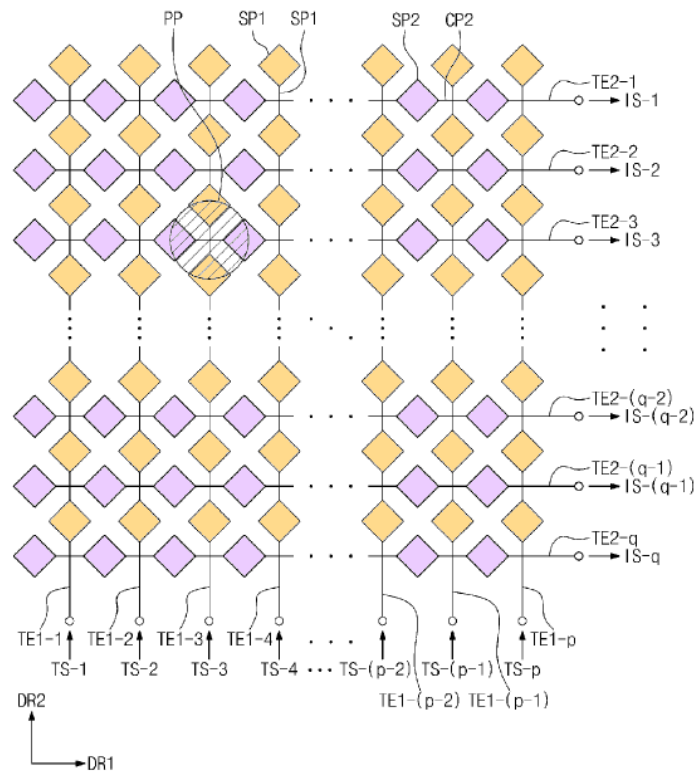
A POSITA would have therefore been motivated to incorporate a sealing/encapsulation layer of alternating inorganic and organic layers in Her’s display device, consistent with Her’s suggestion (Ex-1005, ¶6) and conventional OLED encapsulating layers (such as the one taught by Cho), to protect the OLEDs from external moisture and oxygen(Ex-1003, ¶¶129-30). POSITA would have had a reasonable expectation of success in implementing an encapsulation/sealing layer of alternating inorganic and organic layers—as taught by Cho—because such an alternating configuration was a well-known and conventional means of preventing contaminants from entering the OLEDs of the display panel. Ex-1003, ¶131.

k. 1[f]

Her discloses this limitation.

Her’s “organic light emitting display device...includes...a touch panel [(TP)] disposed on the organic light emitting display panel.” Ex-1005, ¶¶9, 48; Abstract, ¶¶57-58, 77-78, 113-17, Figs. 5-8, 18-19; Ex-1003, ¶¶132-33.

Fig. 8

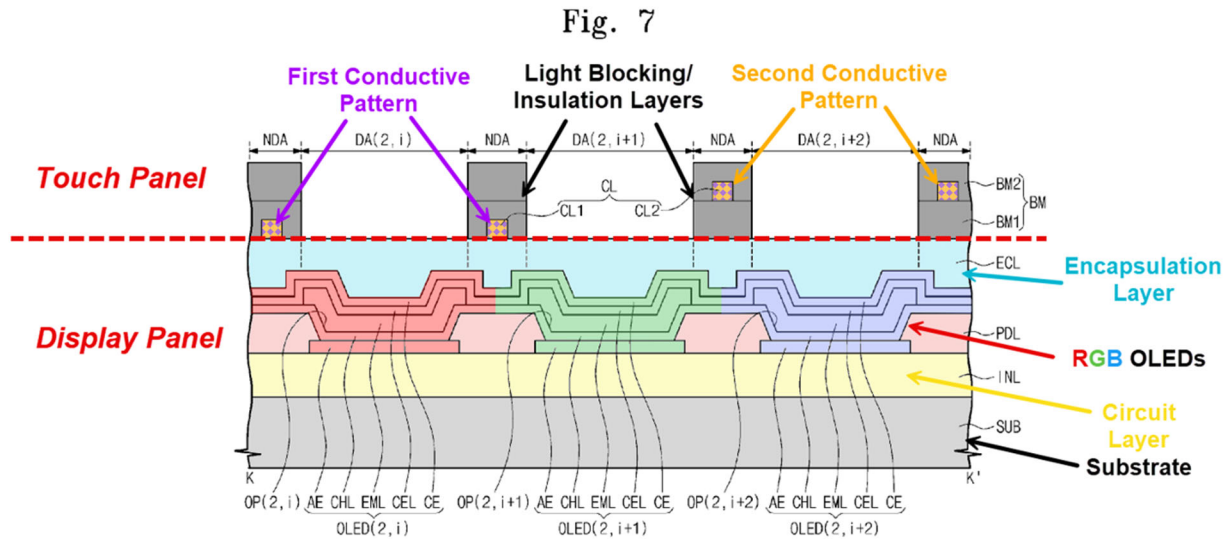


Ex-1005, Fig. 8 (annotated)

I. 1[f][i]

Her discloses this limitation.

Her's touch panel has "[a]t least one conductive layer CL... disposed on the sealing layer ECL" of the display panel. Ex-1005, ¶¶77, 82, Fig. 7; Ex-1003, ¶¶134-37.



Ex-1005, Fig. 7 (annotated)

Although that disclosure alone meets limitation 1[f][i], Her also discloses several touch-panel embodiments, one of which illustrates how the claim is met as a whole. Ex-1003, ¶138. To that end, Her discloses that a first “light blocking layer” is disposed over the first conductive layer, and a second conductive layer is formed on top of the first light-blocking layer. Ex-1005, ¶83, Fig. 7; Ex-1003, ¶64.

Her discloses that each conductive layer comprises at least some part of first and second touch electrodes (TE1/TE2), and electrode has “sensor parts” (SP1/SP2), and “connection parts” (CP1/CP2) that connect adjacent sensor parts together. Ex-1005, ¶¶87-90; Ex-1003, ¶64. Her’s sensor parts and connection parts may be configured in several ways as part of either the first or second conductive layers. Ex-1003, ¶64.

In one embodiment, first touch electrodes (including all first sensor parts and first connection parts) are provided as the first conductive layer (above sealing layer ECL) extending in one direction (DR2), and second touch electrodes (including all second sensor parts and second connection parts) make up the second conductive layer (above the first light blocking layer BM1) extending in another direction (DR1). Ex-1005, ¶¶97-108, Figs. 7, 10-15; Ex-1003, ¶65.

Fig. 14

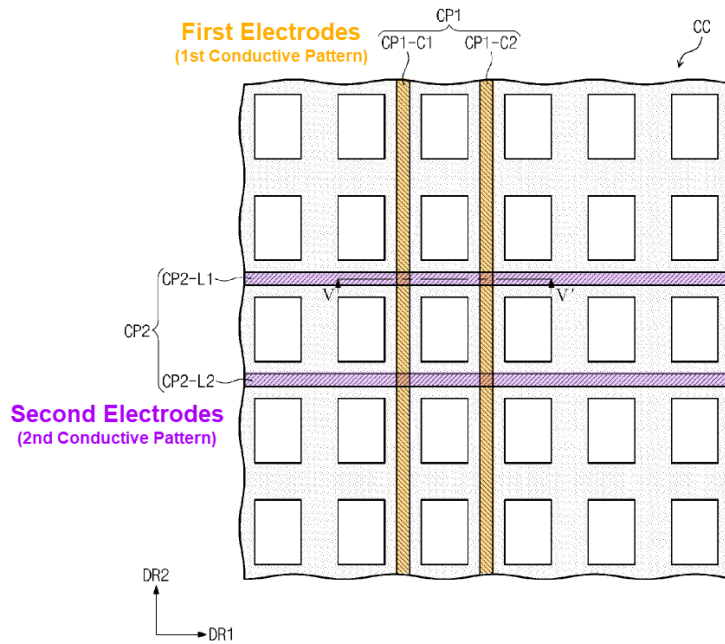
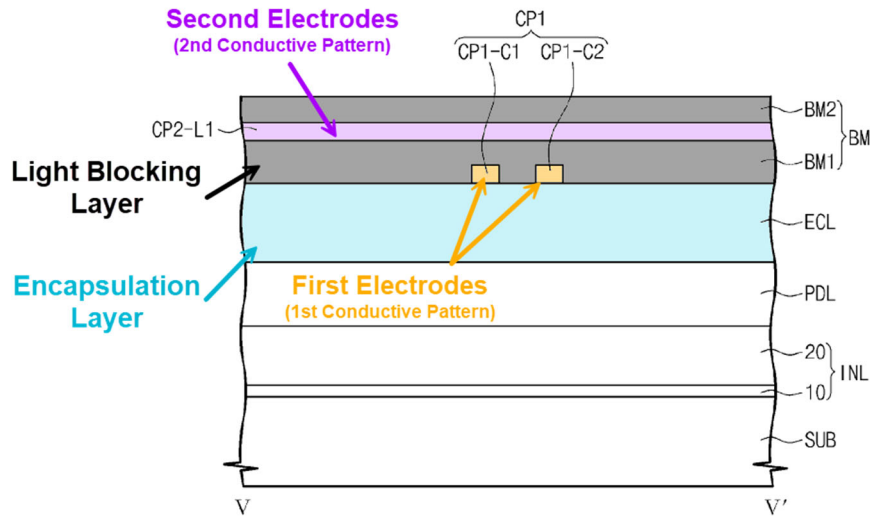


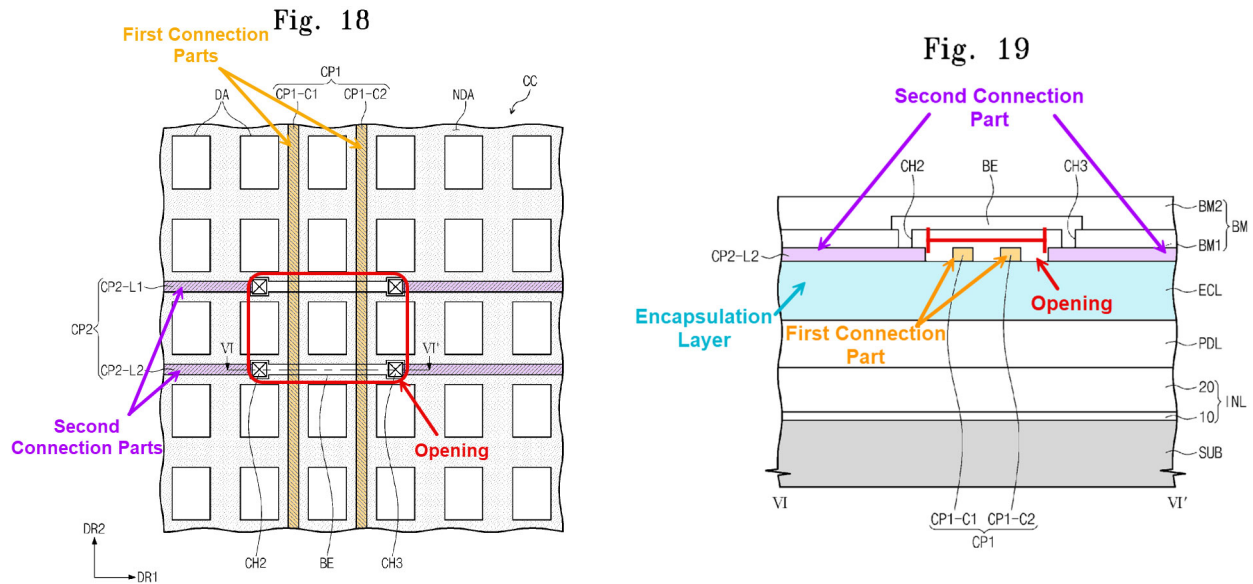
Fig. 15



Ex-1005, Figs. 14-15 (annotated)

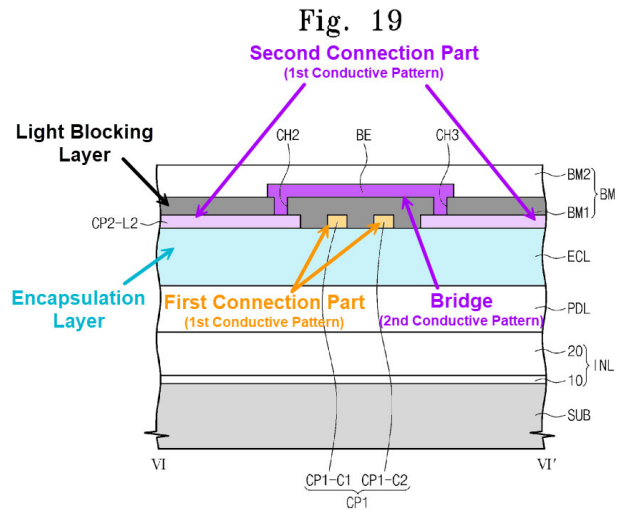
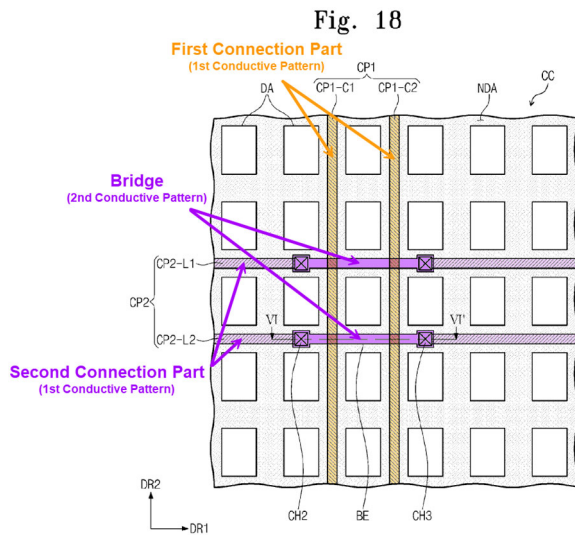
In another embodiment, “a portion of the first touch electrodes [TE1] and a portion of the second touch electrodes [TE2] may be disposed on the same layer.” Ex-1005, ¶110; Ex-1003, ¶66. For instance, “[t]he second sensor parts SP2 of the second touch electrodes [TE2] may be disposed on the same layer as the first touch electrodes [TE1]”; i.e., the first and second touch-sensor parts (SP1/SP2), and first connection part (CP1) are provided on a single conductive layer, and all the first sensor parts (SP1) are connected together by their connection parts (CP1) in one direction (DR2). *Id.*, ¶¶110-14, Figs. 16-19; Ex-1003, ¶66. To connect second sensor parts (SP2) in another direction (DR1), second sensor parts (SP2) are also provided second connection parts (CP2) on the same layer as the first sensor/connection parts (SP1/CP1), but “second connection part CP2 may be open in an area in which the

second connection part CP2 crosses the first connection part CP1.” Ex-1005, ¶115, Fig. 18; Ex-1003, ¶66.



Ex-1005, Figs. 18-19 (annotated)

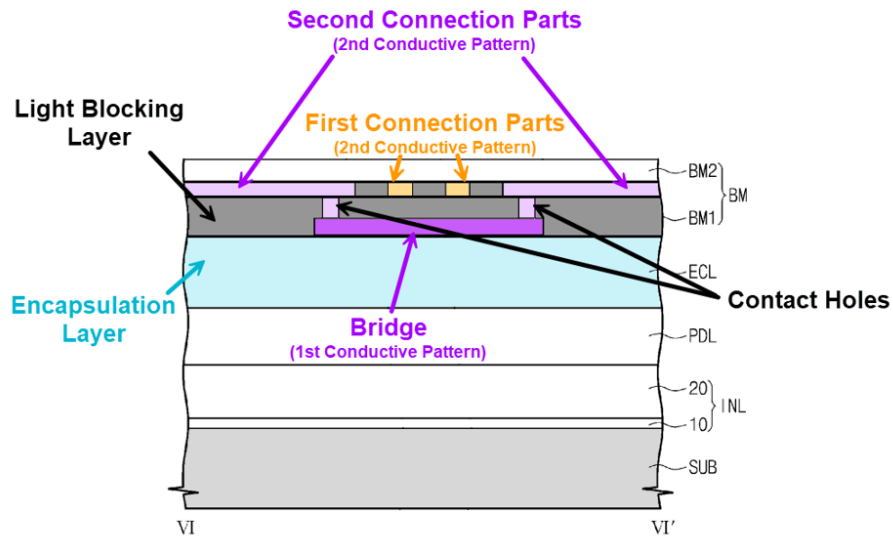
To complete the connection, a “bridge” (BE) is provided on a separate conductive layer. Ex-1005, ¶115; Ex-1003, ¶67. Her explains that, in one embodiment, first and second touch-sensor parts (SP1/SP2) and first and second connection parts (CP1/CP2) are provided on “sealing layer” (ECL) as the first conductive layer, and the bridge is formed on the first light-blocking layer as the second conductive layer in an overpass-type bridge arrangement. Ex-1005, ¶¶110-15; Ex-1003, ¶67.



Ex-1005, Figs. 18-19 (annotated)

Alternatively, in another embodiment, Her reverses the stacking order to provide an underpass-type bridge, explaining that first and second connection parts (CP1/ CP2) can be “disposed on the first light blocking layer...and the bridge BE...may be disposed on the sealing layer ECL” in which “[t]he first light blocking layer BM1 may cover the bridge BE”. Ex-1005, ¶116; Ex-1003, ¶68. Although Her only expressly mentions connection parts (CP1/CP2) being on the first conductive layer, based on Her’s description of Figure 19, a POSITA would have understood that sensor parts (SP1/SP2) are provided on the same conductive layer as their respective connection parts (CP1/CP2); only the bridge is provided on a different conductive layer. Ex-1003, ¶68. Her also does not expressly depict this underpass-type bridge arrangement, but Figure 19 has been modified below to depict it according to Her’s description in paragraph ¶116.

Illustration of Her's ¶116 Embodiment



Ex-1003, ¶¶68, 138.

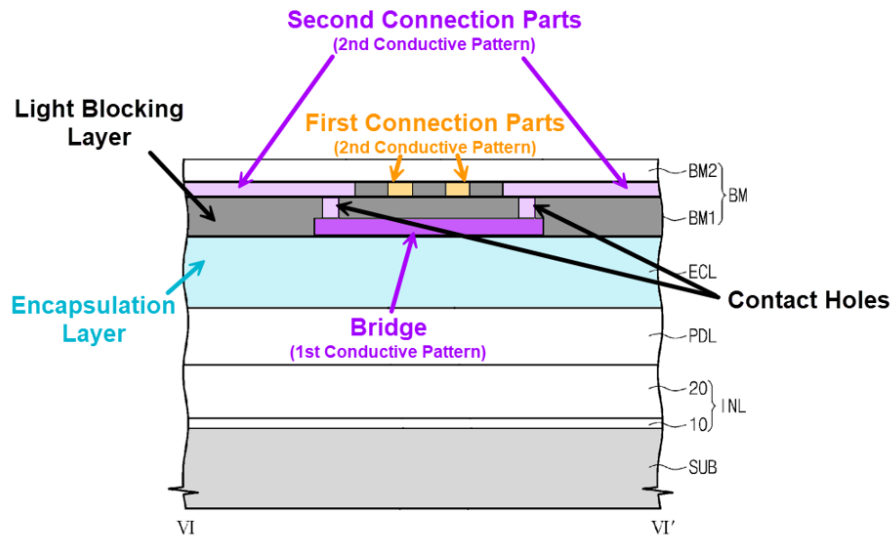
Accordingly, Her discloses a bridge (BE) formed as “a first conductive pattern” directly on a surface (top surface) of sealing layer (ECL) which is part of the OLED display panel. Ex-1003, ¶138.

m. 1[f][ii]

Her teaches or suggests this limitation.

Her's first and second conductive layers (CL1/CL2) are covered by first and second light-blocking layers (BM1/BM2), respectively. Ex-1005, ¶¶79-85, 114-16, Figs. 7, 19; Ex-1003, ¶¶139-40.

Illustration of Her's ¶116 Embodiment



Her explains “[t]he second touch electrodes [are] insulated from the first touch electrodes while crossing the first touch electrodes,” (Ex-1005, ¶¶11, 14, cls. 7, 17), and elsewhere, Her states that “light blocking layer” is “an *insulating* light blocking material,” (*id.*, cl. 14; Ex-1003, ¶140).

Although Her does not *expressly* state that light-blocking layers in each of its touch-sensor embodiments (§V.A.2.1 (1[f][i])) are insulating, a POSITA would have understood that they are. Ex-1003, ¶141. Specifically, the only layer Her discloses between first and second conductive layers (CL1/CL2) is a first light blocking layer (BM1); no separate insulating layer is disclosed. Ex-1005, ¶¶107-16; Ex-1003, ¶141. Moreover, POSITA would have understood that first/second electrodes (TE1/TE2), including all of their respective sensor and connection parts (SP1/CP1, SP2/CP2, and optionally BE) must be electrically insulated from one another to identify a touch

point of a user. Ex-1003, ¶141. A POSITA would have understood, especially for embodiments that use a bridge (BE) to connect second sensor/connection parts (SP2/CP2) that light-blocking layers do not conduct electricity, because Her discloses using holes in the light-blocking layer to create an electrical connection between the bridge and second sensor/connection parts, (Ex-1005, ¶115); if light-blocking layers were not insulating, no hole would be needed to create an electrical connection. Ex-1003, ¶142.

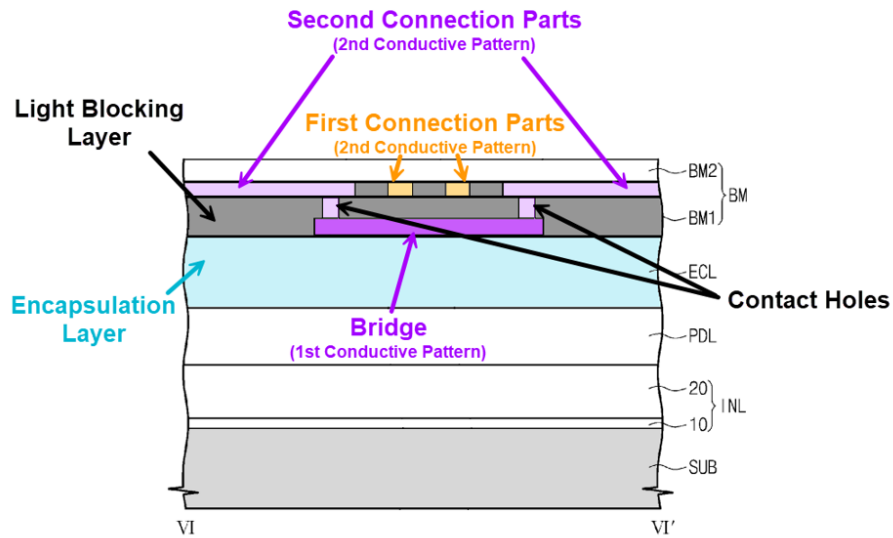
A POSITA would have been motivated regardless to provide Her's light-blocking layers as an insulating material because it was well-known and conventional in the art to provide an insulating material to electrically insulate first and second touch electrodes from one another. Ex-1003, ¶143; Ex-1006, ¶¶82, 110, 121; Ex-1024, ¶¶63, 83.

n. 1[f][iii]

Her, with or without Hsieh and/or Kobayashi, teaches or suggests this limitation.

Her's "second conductive layer CL2 is disposed on the first light blocking layer" which is an insulating layer as claimed (§V.A.2.m (1[f][ii])). Ex-1005, ¶84; Ex-1003, ¶¶144-45. In the underpass-type bridge embodiment (¶116), Her discloses forming a second conductive layer comprising first and second sensor parts (SP1/SP2) and first connection parts (CP1). §V.A.2.l (1[f][i]).

Illustration of Her's ¶116 Embodiment



Ex-1003, ¶146. Although Her does not expressly disclose that the second conductive pattern has a thickness greater than the first conductive pattern, this arrangement would have been an obvious design choice based on several known considerations.

Ex-1003, ¶147.

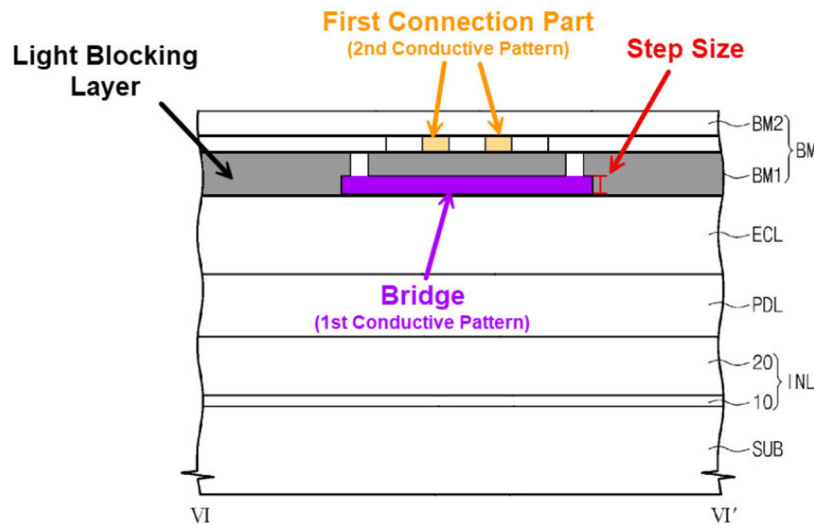
First, it was known in the art that the relative thickness of each conductive layer in a touch panel is a design choice with only three possible options: the first (bottom) conductive pattern could be thinner than, thicker than, or the same thickness as the second (top) conductive pattern. Ex-1003, ¶148. For instance, Hsieh teaches another touch-sensor panel formed from two conductive layers—like Her—and expressly notes that “the thickness of the first conductive layer C1 can be greater than the thickness of the second conductive layer C2.... In another embodiment, the thickness of the first conductive layer C1 can also be smaller than the thickness of

the second conductive layer C2.” Ex-1012, ¶¶72-73. Selecting any of these options, would have been obvious. Ex-1003, ¶148; *Toshiba Samsung Storage Tech. Korea Corp. v. LG Elecs.*, IPR2014-00204, Paper 31, 29 (Mar. 31, 2015) (“there are only three possibilities for the first mode PSA size relative to the second mode PSA size: equal, greater, or less. Choosing one knowing another is an obvious design choice with very predictable results”, citing *KSR v. Teleflex*, 550 U.S. 398, 421 (2007)); *In re Troiel*, 274 F.2d 944, 949 (C.C.P.A. 1960) (“the mere change of the relative size of the co-acting members of a known combination will not endow an otherwise unpatentable combination with patentability”).

Second, when bridges are formed as the first conductive pattern (consistent with Her, §V.A.2.1 (1[f][i])), a POSITA would have been motivated to reduce the thickness of the bridge relative to the touch-sensor parts and connection parts formed as part of the second conductive pattern to reduce the effects caused by the bridge’s step size. Ex-1003, ¶¶149-53. When multiple material layers are formed on top of each other, the thicknesses of components in lower layers create an undesired “step” that propagates to upper layers. Ex-1003, ¶¶150-51. When two wires (like Her’s bridge and first connection parts) cross each other on different material layers and are separated by insulation, the step at the crossing location creates at least three problems: (1) inducing disconnections in the upper wire; (2) thinning of the upper wire from deposition that increases resistance and load; and (3) cracking the

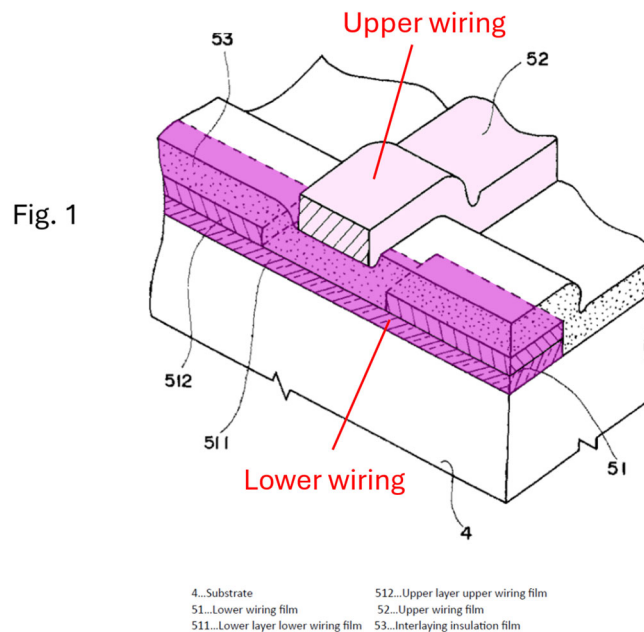
intervening insulation due to stress concentrations at the step. Ex-1003, ¶152; Ex-1025, Fig. 2A, 2-4, Fig. 5; Ex-1026 (thinning upper wire); Ex-1027, Fig. 2A, 1-2; Ex-1028, Fig. 12, 1-2 (disconnections); Ex-1029, 11:48-12:3 (cracking of wiring over a step).

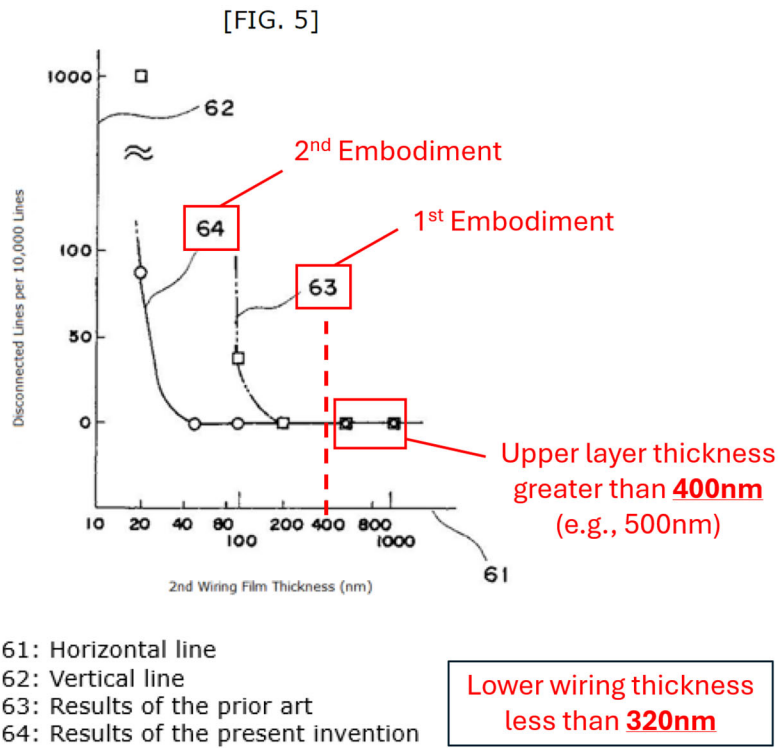
Illustration of Her's ¶116 Embodiment



A POSITA would have understood that there were three ways to address these problems simultaneously, which could all be combined, if desired: (1) reduce the thickness of the lower wire to minimize the step; (2) increase the thickness of the upper wire for better mechanical integrity and step coverage; and/or (3) provide a “planarizing” (flattened) layer between the wires to lessen the step under the upper wire, with a sufficient thickness on top of the lower wire to avoid cracking in the insulation. Ex-1003, ¶154; Ex-1030, ¶52 and FIG. 6 (limiting step size caused by bridge).

Kobayashi, for instance, expressly teaches two embodiments (Fig. 5, curves 63-64) both disclosing two intersecting conductive layers (like Her's touch-sensor connections) where the upper-conductive layers' thickness (e.g., 500nm) are greater than the lower-conductive layers' (e.g., 320nm) at the intersection to reduce the risk of disconnections in the upper conductive layer. Ex-1025, 2-5, Figs. 1, 5; Ex-1003, ¶155.





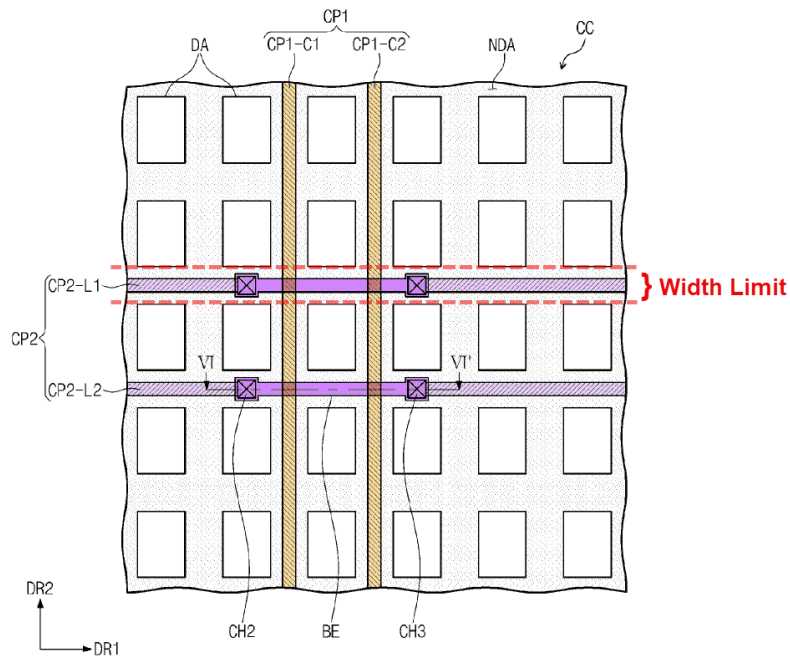
Ex-1025, Figs. 1, 5 (annotated)

A POSITA would have therefore reduced Her's bridge thickness to reduce the step size, increase the thickness of the touch-sensor parts and connection parts to minimize the effects of the bridge's step, or both, producing a thinner first conductive layer than the second. Ex-1003, ¶156.

Additionally, a POSITA would have understood that both electrical resistance and mechanical stress of a sensor are functions of the sensor's cross-sectional area; increasing the cross-sectional area will reduce electrical resistance and improve mechanical strength. Ex-1003, ¶¶157-58. POSITA would have understood that when the sensor is made of an opaque metal material like Her's touch sensors, (Ex-1005,

¶¶101, 105), the width should be constrained to the size of the gap between adjacent light-emitting areas; otherwise, some light emitted by the OLED pixel will be blocked, reducing the display's brightness. Ex-1003, ¶159. The sensor's thickness provided more options for controlling the cross-sectional area than its width. *Id.*

Fig. 18



Ex-1005, Fig. 18 (annotated)

A POSITA would have been motivated to make the touch sensors thicker than the bridge to make the touch sensors more resilient to bending (since they would experience more force than the bridges), to maintain a low resistance over a longer electrical connection, and, if desired, to match the resistance between the touch sensor and the bridge to maximize power transfers between the two. Ex-1003, ¶¶160-62.

At base, selecting the relative thicknesses of the first and second conductive patterns was an obvious design choice with limited options (as evidenced by Hsieh), but POSITA would have been motivated to make, and had a reasonable expectation of making, the second conductive pattern (Her's touch-sensor parts and first connection parts) greater in thickness than the first conductive pattern (Her's bridge) for the reasons taught by Kobayashi and others in the art, which merely required controlling the thickness of each layer. Ex-1003, ¶163.

o. 1[f][iii][A]

Her discloses this limitation.

Her discloses “first sensor parts SP1” and that “first horizontal portions SP1-L [of first sensor parts of the first electrodes] are connected to the first vertical portions SP1-C to form openings SP1-OP. In other words, the first sensor parts SP1 have a mesh shape with the openings SP1-OP.” Ex-1005, ¶¶101-02, Figs. 8, 10; Ex-1003, ¶¶164-65.

Fig. 8
First Sensor Parts

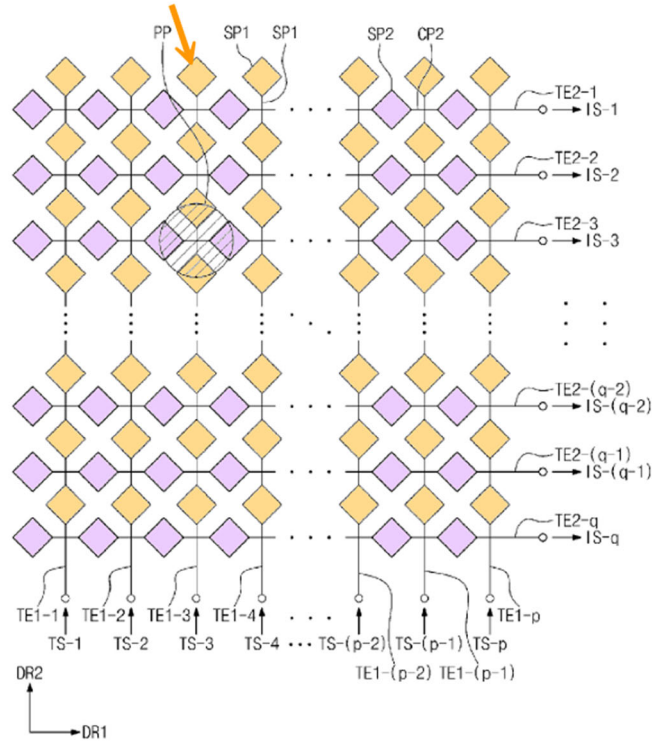
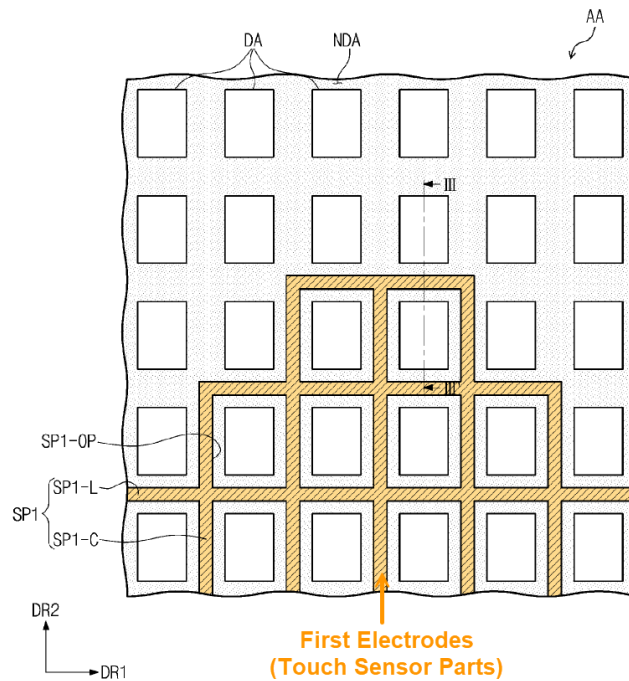
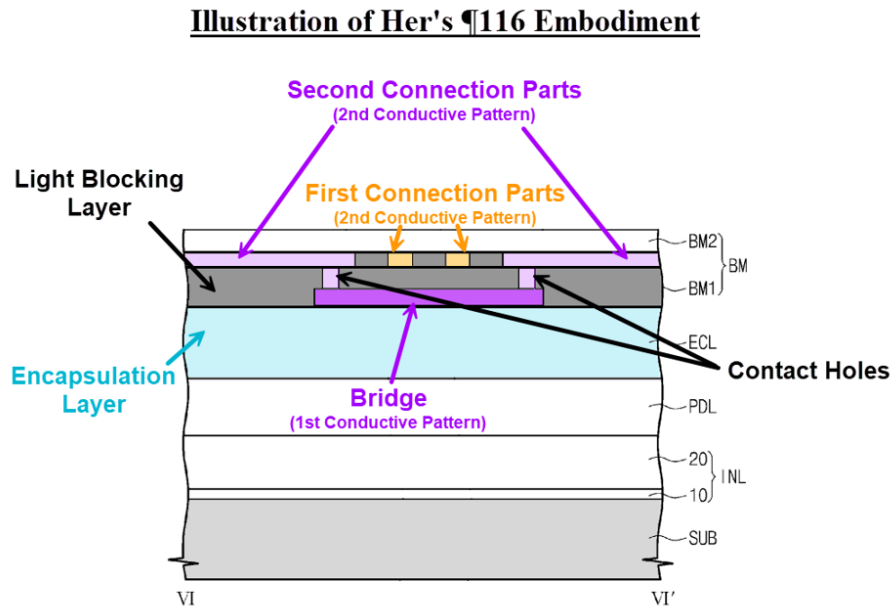


Fig. 10



Ex-1005, Figs. 8, 10 (annotated)

When implementing Her's underpass-type bridge embodiment (§V.A.2.1 (1[f][i])), a POSITA would have understood that first sensor parts (SP1) would be part of the second conductive pattern along with the first connection parts (CP1).



§V.A.2.1 (1[f][i]); Ex-1003, ¶166.

p. 1[f][iii][B]

Her discloses this limitation.

Her discloses “second sensor parts SP2” and that “[t]he second sensor parts SP2” have “second horizontal portions SP2-L [that] are connected to the second vertical portions SP2-C to form the openings SP2-OP,” such that “second sensor parts SP2 have a grid shape with the openings SP2-OP.” Ex-1005, ¶¶104-05, Figs. 8, 12; Ex-1003, ¶¶167-68.

Fig. 8
Second Sensor Parts

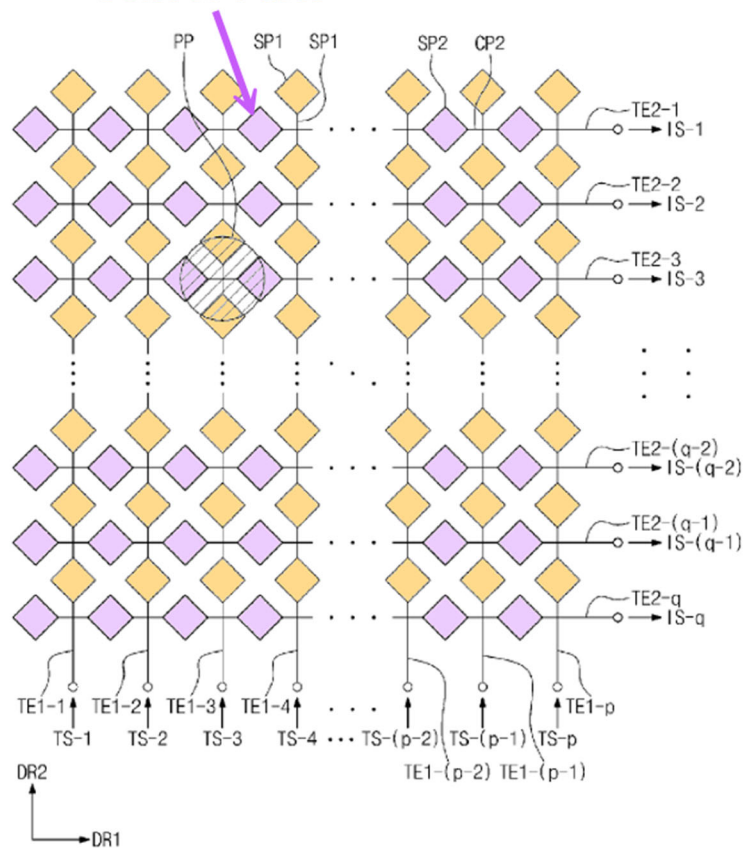
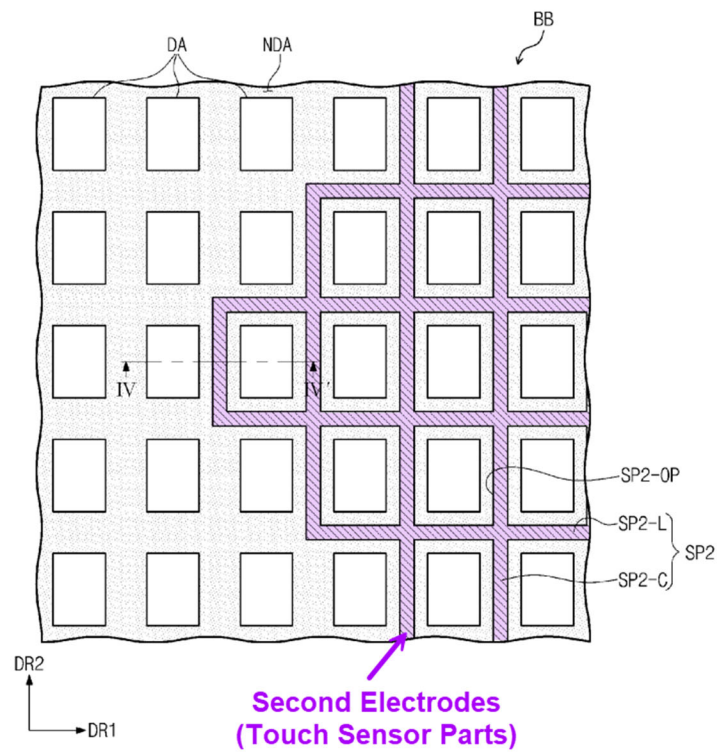


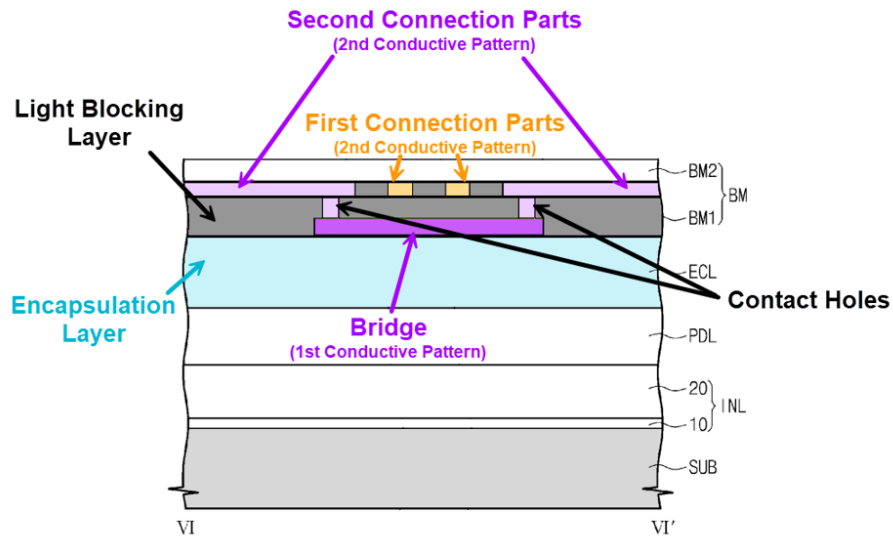
Fig. 12



Ex-1005, Fig. 12 (annotated)

When implementing Her's underpass-type bridge embodiment (§V.A.2.1 (1[f][i])), a POSITA would have understood that second sensor parts (SP2) would be part of the second conductive pattern along with second connection parts (CP2).

Illustration of Her's ¶116 Embodiment

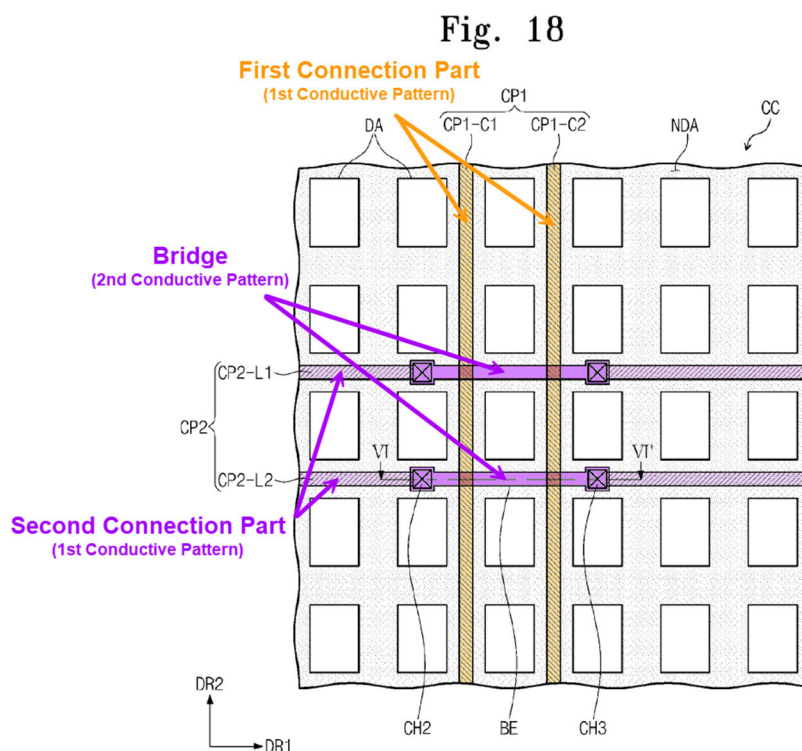


§V.A.2.1 (1[f][i]); Ex-1003, ¶169.

q. 1[f][iii][C]

Her discloses this limitation.

Her discloses “first connection parts CP1 connects vertices of the two adjacent first sensor parts”(Ex-1005, ¶90), and that “first connection part CP1 includes two vertical parts CP1-C1 and CP1-C2”(Ex-1005, ¶114, Fig. 18; Ex-1003, ¶¶170-71).



Ex-1005, Fig. 18 (annotated)

Although Her’s Figure 18 shows first connection parts on the first conductive layer, Her also discloses in the underpass-type bridge embodiment that “first connection part CP1...may be disposed on the first light blocking layer”(id., ¶116), e.g., as part of the second conductive pattern. Ex-1003, ¶172; §V.A.2.1 (1[f][i]).

r. 1[g]

Her discloses this limitation.

Her discloses that “first sensor parts SP1” and “second sensor parts SP2” “overlap the non-light emitting area NDA disposed adjacent to the corresponding light emitting areas DA.” Ex-1005, ¶¶11, 14, 82, 84, 100, 104; Ex-1003, ¶¶173-74.

Her also discloses “first to third organic light emitting areas DA(2,i) to DA(2,i+2)...generate lights having different colors,” such as red, green, and blue. Ex-1005, ¶¶80, 102, 105; Ex-1003, ¶174. Her further shows that each light-emitting area is located within the opening of sensor-part mesh lines, and sensor-part mesh lines do not overlap light-emitting areas to improve aperture ratio. Ex-1005, ¶77, Figs. 10-13; Ex-1003, ¶174.

Although Her’s figures do not label light-emitting areas (DA) as first, second, and third light-emitting areas, a POSITA would have understood that a plurality of first, second, and third light-emitting areas would be within mesh openings. Ex-1003, ¶175. A POSITA would have understood that, conventionally, first (red), second (green), and third (blue) light-emitting areas are repeated in a pattern to form a display. Ex-1003, ¶175; Ex-1010, ¶¶58-60, Fig. 2. For instance, Figures 10 and 12 have been annotated to show a conventional arrangement of different colored light-emitting areas relative to mesh openings of first and second touch-sensor parts:

Fig. 10

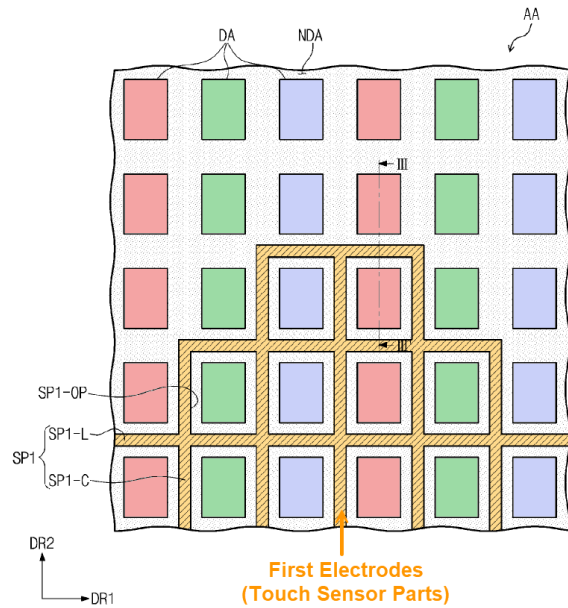
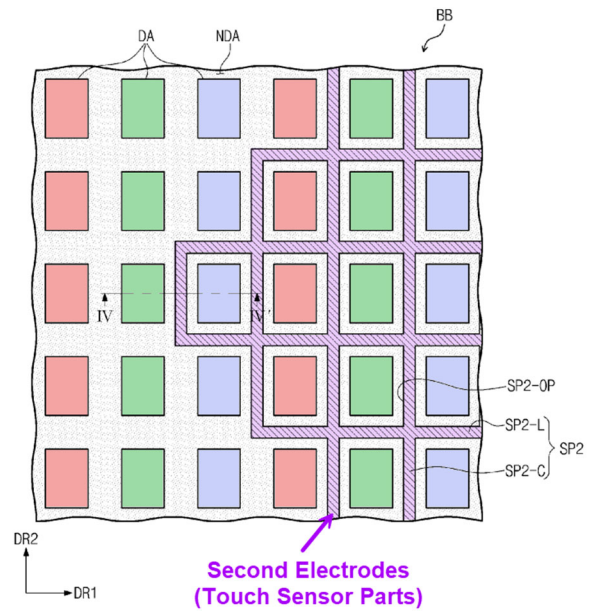


Fig. 12



Ex-1005, Figs. 10, 12 (annotated)

Ex-1003, ¶¶176-77.

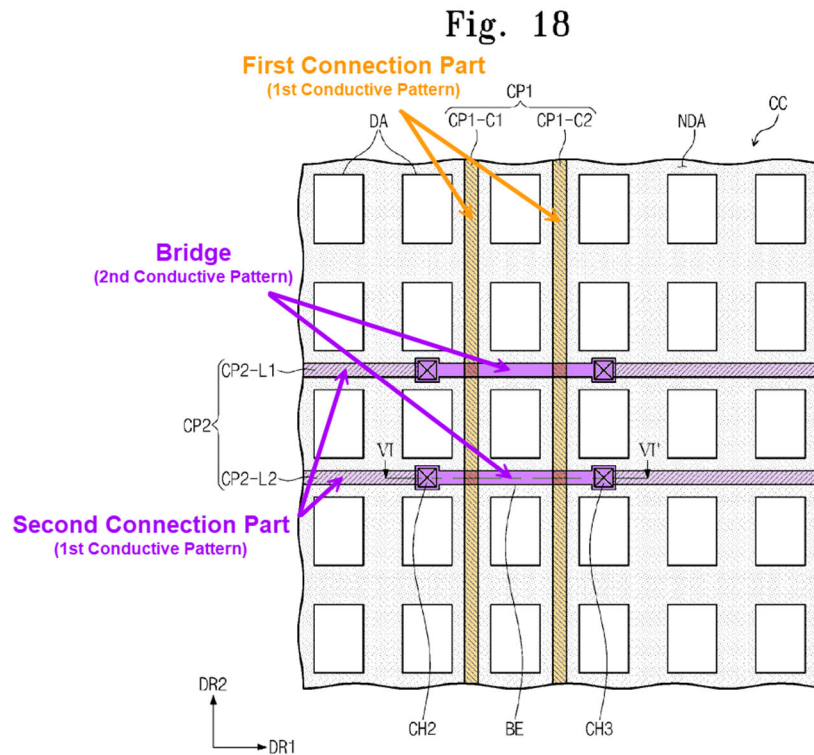
A POSITA would have understood Her as disclosing at least one first (red), second (green), and third (blue) light-emitting areas is located within a mesh hole defined by each first and second touch-sensor part such that the metal mesh lines of first and second touch-sensor parts do not overlap light-emitting areas. Ex-1003, ¶178.

s. 1[h]

Her discloses this limitation.

Her discloses “second connection parts CP2 [that] connects two adjacent second sensor parts...SP2.” Ex-1005, ¶89; Ex-1003, ¶¶179-80. Her also discloses

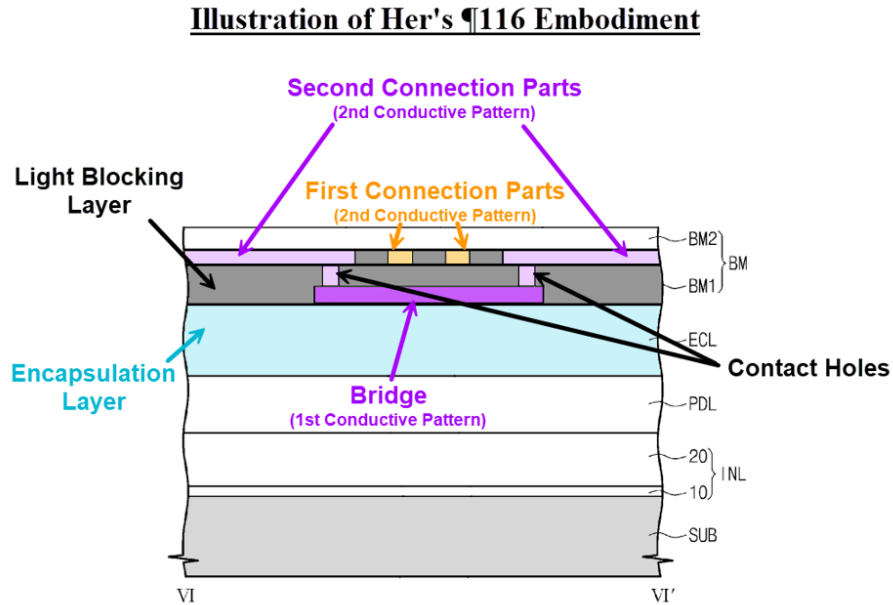
second connection parts include “a bridge BE” disposed on a different layer than first and second touch-sensor parts. Ex-1005, ¶¶114-15; Ex-1003, ¶180.



Ex-1005, Fig. 18 (annotated)

Her discloses that “first...and the second connection part CP2 may be disposed on the first light blocking layer BM1 and the bridge BE may be disposed on the sealing layer ECL” in which “first light blocking layer BM1 may cover the bridge BE.” Ex-1005, ¶116; Ex-1003, ¶180. Although Her uses the term “second connection parts CP2” to refer to a portion of the second electrode formed as part of the second conductive pattern, when implementing Her’s underpass-type bridge embodiment (§V.A.2.1 (1[f][i])), POSITA would have understood that the bridge (BE) would be

equated to the “second connection part” as claimed, which is formed as part of the first conductive pattern.



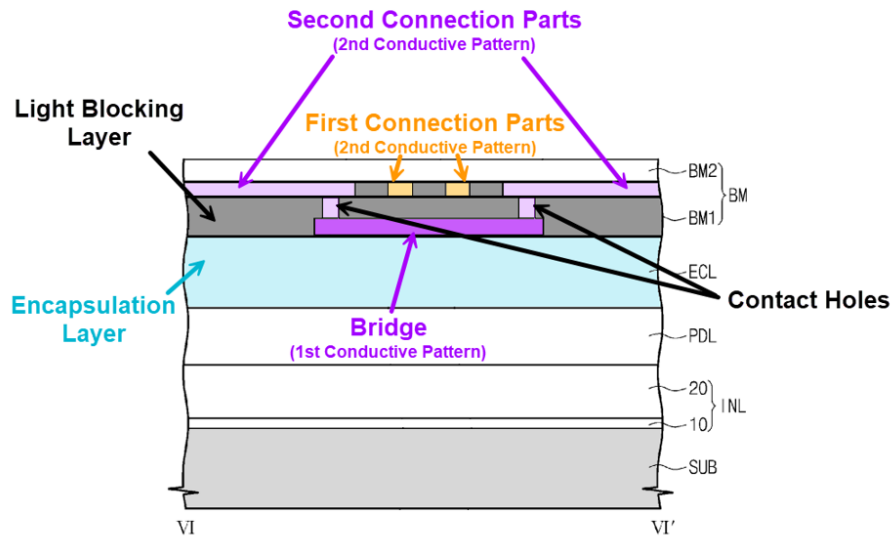
§V.A.2.1 (1[f][i]); Ex-1003, ¶181.

t. 1[i]

Her discloses this limitation.

Her discloses that “[t]he bridge BE connects the portions of the second connection part CP2, which are disconnected from each other, through a second contact hole CH2 and a third contact hole CH3, which are formed through the first light blocking layer BM1.” Ex-1005, ¶115; Ex-1003, ¶¶182-83.

Illustration of Her's ¶116 Embodiment



A POSITA would have understood that first light-blocking layer BM1 is an insulating layer and that contact holes pass through that layer for both the overpass-type or underpass-type bridge embodiments described by Her. Ex-1003, ¶184; §§V.A.2.1-V.A.2.m (1[f][i]-1[f][ii]).

3. Claim 2

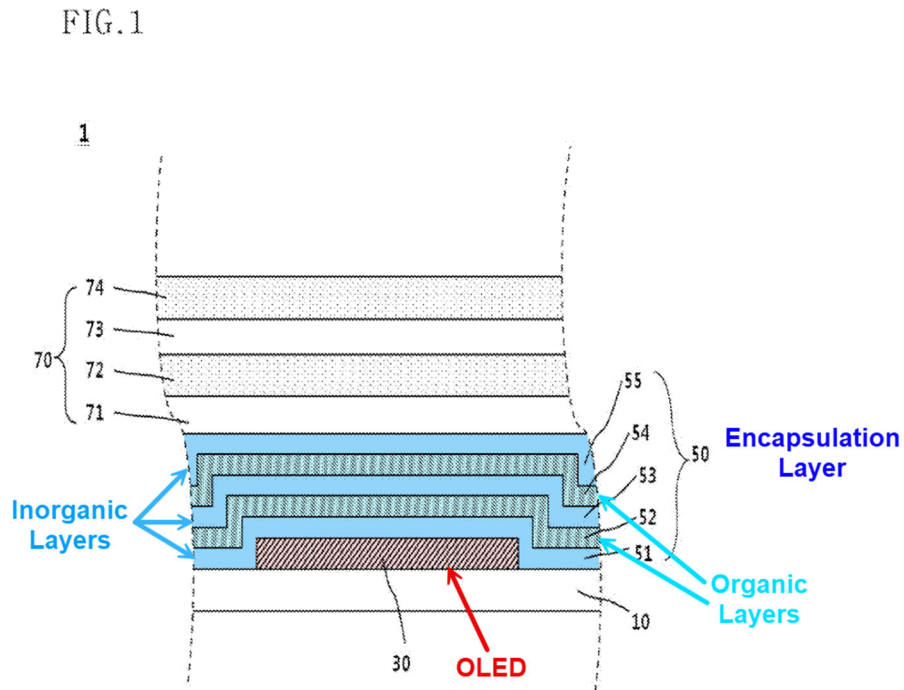
a. 2[pre]

Although Her recognizes sealing/encapsulation layer is traditionally multilayered(Ex-1005, ¶6), Her and Cho teach or suggest this limitation. §V.A.2.j (1[e]); Ex-1003, ¶185.

b. 2[a]

Her and Cho teach or suggest this limitation.

Cho teaches an encapsulation layer for an OLED display panel with a first inorganic layer (51). Ex-1008, ¶¶49-52, Fig. 1; Ex-1003, ¶¶186-87.



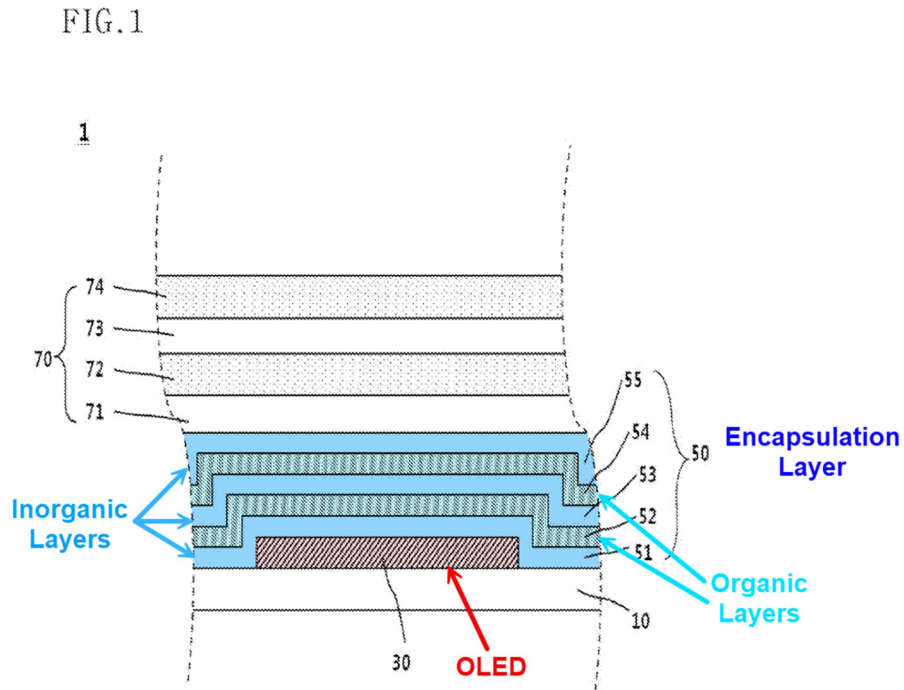
Ex-1008, Fig. 1

A POSITA would have been motivated to implement and had a reasonable expectation of success in implementing an encapsulation layer in Her's display panel that included a first inorganic layer (51) to prevent oxygen and moisture from penetrating into the OLED, as taught by Cho and as was well-known in the art. Ex-1003, ¶188; §V.A.2.j (1[e]).

c. 2[b]

Her and Cho teach or suggest this limitation.

Cho teaches an encapsulation layer for an OLED display panel with an organic layer (52) formed on the first inorganic layer (51). Ex-1008, ¶¶49-52, Fig. 1; Ex-1003, ¶¶189-90.



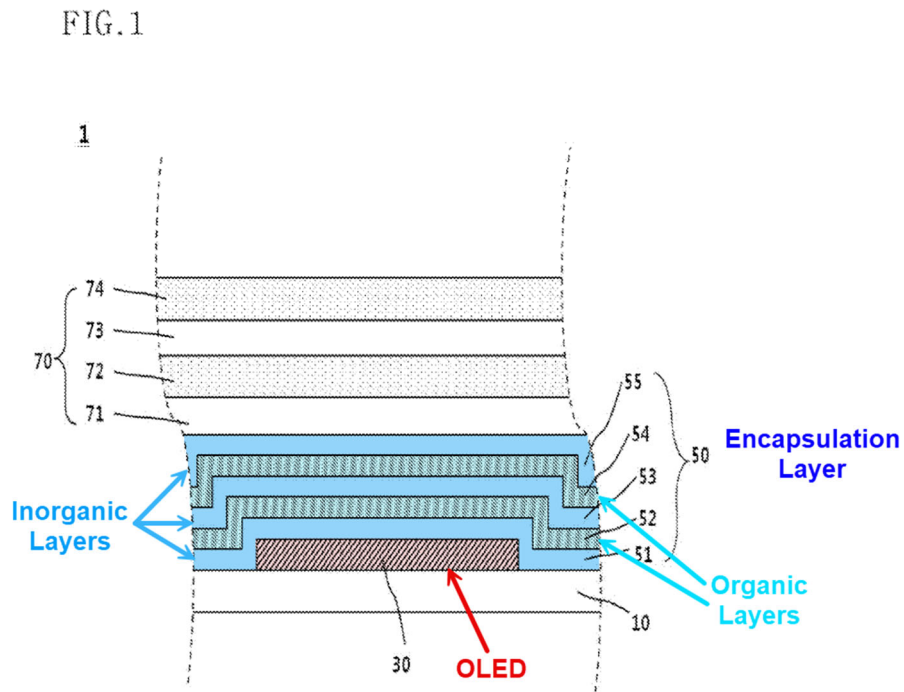
Ex-1008, Fig. 1 (annotated)

A POSITA would have been motivated to implement and had a reasonable expectation of success in implementing an encapsulation layer in Her's display panel that included an organic layer (52), as taught Cho, to alleviate internal stress of and/or fill any defects in inorganic layers. Ex-1003, ¶191; §V.A.2.j (1[e]).

d. 2[c]

Her and Cho teach or suggest this limitation.

Cho teaches an encapsulation layer for an OLED display panel with a second inorganic layer (53) formed on organic layer (52). Ex-1008, ¶¶49-52, Fig. 1; Ex-1003, ¶¶192-93.



Ex-1008, Fig. 1 (annotated)

A POSITA would have been motivated to implement and had a reasonable expectation of success in implementing an encapsulation layer for Her that included a second inorganic layer (53) to prevent oxygen and moisture from penetrating into the OLED, as taught Cho and as was well-known in the art. Ex-1003, ¶194; §V.A.2.j (1[e]).

4. Claim 3

Her and Cho teach or suggest this limitation.

Cho's first inorganic layer comprises "silicon nitride,...silicon oxide,...[or] silicon oxynitride (SiNO)" among other known options. Ex-1008, ¶52; Ex-1003, ¶¶195-96. These materials were well-known inorganic-material layers in an encapsulation layer. Ex-1006, ¶79; Ex-1023, ¶97; Ex-1003, ¶196.

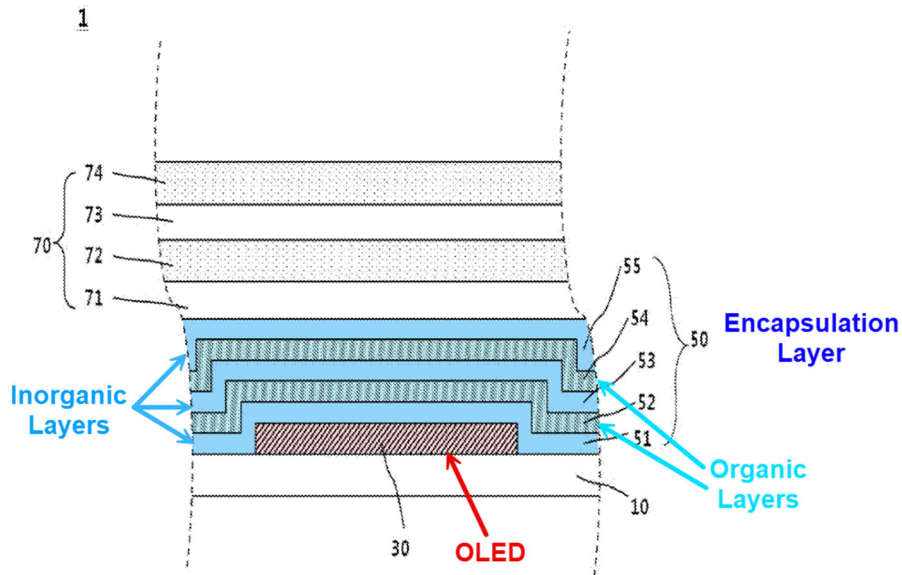
A POSITA would have been motivated to implement and had a reasonable expectation of success in implementing an encapsulation layer in Her's display panel that included a first inorganic layer (51) of silicon oxynitride, silicon oxide, or silicon nitride, as these were all well-known inorganic materials for encapsulation layers to prevent oxygen and moisture from penetrating into the OLED, as taught Cho and as was well-known in the art. Ex-1003, ¶197; §V.A.2.j (1[e]).

5. Claim 4

Her and Cho teach or suggest this limitation.

The '496 patent describes the buffer layer on the encapsulation layer as being another layer of, e.g., inorganic material, of the same type as the encapsulation layers. Ex-1001, 11:22-32("An inorganic layer may be located on the thin film encapsulation layer" and "[t]he inorganic layer may be a buffer layer."); Ex-1003, ¶¶198-200. Cho teaches that, in addition to first inorganic, organic, and second inorganic layers (51, 52, 53), additional layers may be formed directly on second inorganic layer (53). Ex-1008, ¶¶49-52, Fig. 1(showing additional organic layer (54) and inorganic layer (55)); Ex-1003, ¶201.

FIG. 1



Ex-1008, Fig. 1 (annotated)

Cho also teaches that any number and configuration of layers can be used, including “a stack of four layers, a stack of six layers, and various other types of stacks,” and multiple inorganic layers may be stacked together. Ex-1008, ¶49; Ex-1003, ¶201. Thus, Cho teaches that additional organic *or* inorganic layers may be formed directly on top of second inorganic layer (53). Ex-1003, ¶201. A POSITA would have appreciated that adding more inorganic layers would improve the encapsulation layer’s barrier properties, and these additional layers could be considered either part of the “encapsulation layer,” or a separate “buffer” layer, because these are merely different labels for the same structure. *Id.*

Therefore, a POSITA would have understood that Her and Cho teach or suggest forming additional inorganic and/or organic layers on the encapsulation layer as a further buffer, consistent with the '496 patent. Ex-1003, ¶202.

6. Claim 5

Her and Cho teach or suggest this limitation. §V.A.5 (cl. 4); Ex-1003, ¶203.

7. Claim 6

Her teaches or suggests this limitation (because the first conductive pattern *is* the second connection parts—Her's bridge (BE)). §§V.A.2.n (1[f][iii]), V.A.2.s (1[h]); Ex-1003, ¶204.

8. Claim 7

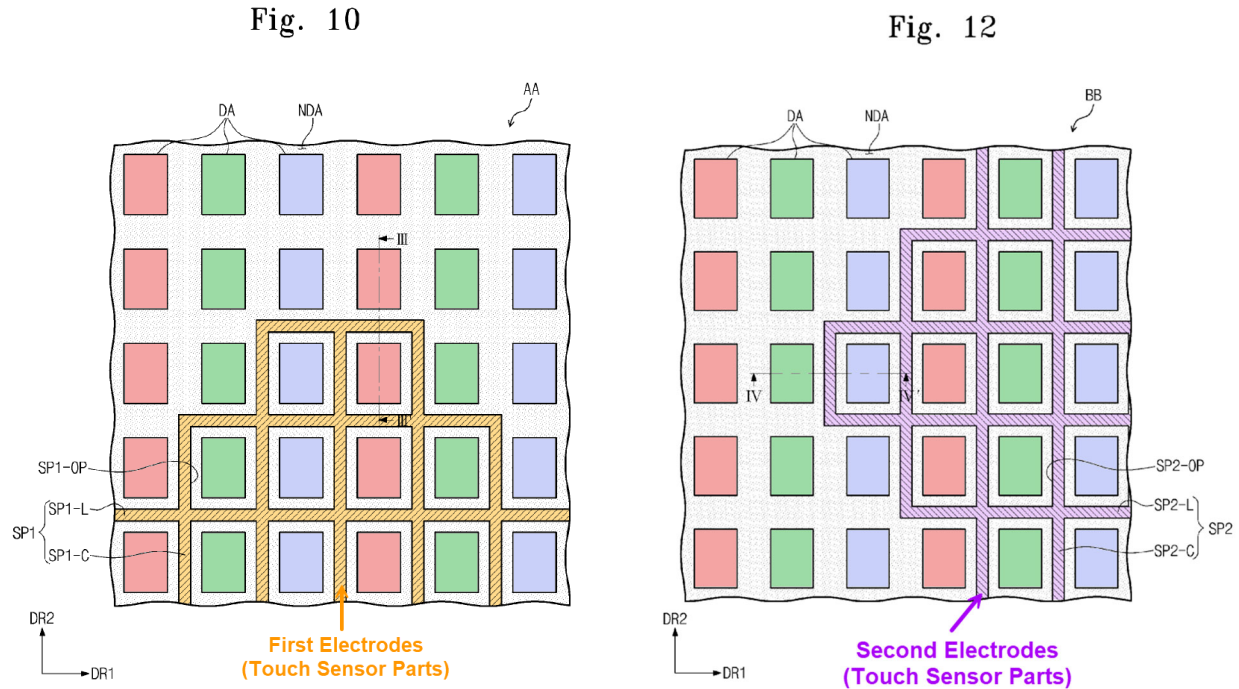
a. 7[pre]

Her, Cok, and Cho teach or suggest this limitation. §V.A.1 (cl. 1); Ex-1003, ¶205.

b. 7[a]

Her teaches or suggests this limitation.

Her's plurality of first (red) light-emitting areas is located in a first mesh hole of either first or second touch-sensor parts. §§V.A.2.f (1[d][i]), V.A.2.r (1[g]); Ex-1003, ¶¶206-08.



Ex-1005, Figs. 10, 12 (annotated)

c. 7[b]

Her teaches or suggests this limitation.

Her's plurality of second (green) light-emitting areas is located in a second mesh hole of either first or second touch-sensor parts. §§V.A.2.g (1[d][ii]), V.A.2.r (1[g]), V.A.8.b (7[a]); Ex-1003, ¶¶209-10.

d. 7[c]

Her teaches or suggests this limitation.

Her's plurality of third (blue) light-emitting areas is located in a third mesh hole of either first or second touch-sensor parts. §§V.A.2.h (1[d][iii]), V.A.2.r (1[g]), V.A.8.b (7[a]); Ex-1003, ¶¶211-12.

e. 7[d]

Her and Cok teach or suggest this limitation.

Her and Cok teach a display panel in which the second (green) light-emitting area is a different size than the first (red) and third (blue) light-emitting areas. §V.A.2.i (1[d][iv]); Ex-1003, ¶¶213-14.

A POSITA would have found it obvious that, when providing different-sized first, second, and third light-emitting areas, mesh holes would be sized commensurate with light-emitting areas. Ex-1003, ¶¶215-16. Otherwise, if the size of mesh holes did not match the size of light-emitting areas, metal mesh would cover parts of different-sized light-emitting areas, reducing the display’s “aperture ratio” and brightness. Ex-1005, ¶77; Ex-1003, ¶215.

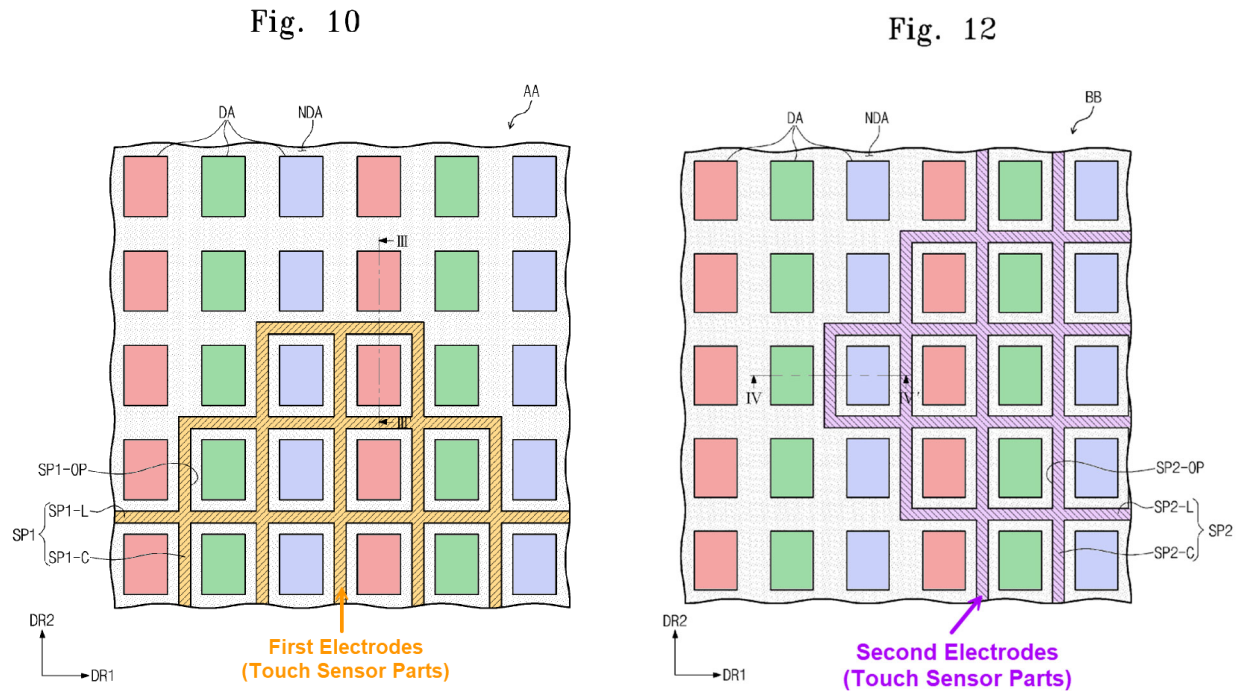
9. Claim 8

Her teaches or suggests this limitation. §V.A.2.i (1[d][iv]); Ex-1003, ¶217.

10. Claim 9

Her discloses this limitation.

Her shows that no more than one light-emitting area is located in each mesh hole. Ex-1005, Figs. 10, 12; ¶¶100, 104; Ex-1003, ¶¶218-19.



Ex-1005, Figs. 10, 12 (annotated)

11. Claim 10

Her teaches or suggests this limitation. §§V.A.2.n (1[f][iii]), V.A.7 (cl.6); Ex-1003, ¶220.

12. Claim 12

Her discloses this limitation.

Her's "base substrate may include...a plastic substrate....A plastic substrate may be used as the base substrate for a flexible display panel." Ex-1005, ¶50; Ex-1003, ¶¶221-22.

B. Ground 1B: Her Combined with Cok, Cho (with or without Hsieh and/or Kobayashi), and Lee-P12 (Claims 11, 17).

Claims 11 and 17 are obvious in view of (1) Her combined with Cok, Cho, and Lee-P12 and (2) Her combined with Cok, Cho, and Lee-P12, further in view of Hsieh and/or Kobayashi.

1. Prior Art

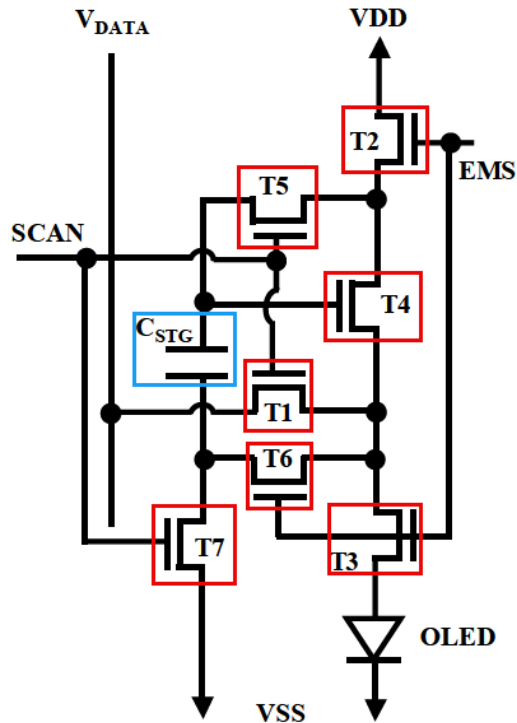
a. Lee-P12 (Ex-1011)

Lee-P12 was published in SID Digest in 2004. Ex-1011, 264. Lee-P12 constitutes prior art under at least §102(a)(1).² Ex-1003, ¶¶89-90.

Lee-P12 teaches that “[w]hen a conventional 2-TFT pixel circuit is applied to AM-OLED [active matrix OLED] panel, the OLED current varies due to degradation of threshold voltage.” Ex-1011, 264; Ex-1003, ¶¶91-92. Rather than use a traditional 2-TFT pixel circuit, Lee-P12 teaches a different pixel circuit that

² Lee-P12 was publicly available and accessible before the earliest possible effective date of the ’496 patent (July 29, 2016). Lee-P12 was published in SID Digest in May 2004 (Ex-1031, 1), posted on the SID website on July 5, 2012 (*id.*) and was cited by at least seven others in the industry between 2005 and 2013, demonstrating that those in the art knew where to find it. *Id.*, 2-4 (Citing Literature); Ex-1032, 100 (article published in 2005), 103 (citing Lee-P12); Ex-1033, 272 (article published in 2006), 275 (citing Lee-P12).

“compensates threshold voltage degradation” by using a circuit with “six switching a-Si:H TFTs and one driving a-Si:H TFT (T4), [and] one storage capacitor,” as shown below.



Ex-1011, 265, Fig. 3 (annotated); Ex-1003, ¶92. Lee-P12 shows how this design “successfully compensates the threshold voltage degradation of TFTs and OLED” compared to conventional 2-TFT circuits. Ex-1011, 266-67; Ex-1003, ¶92.

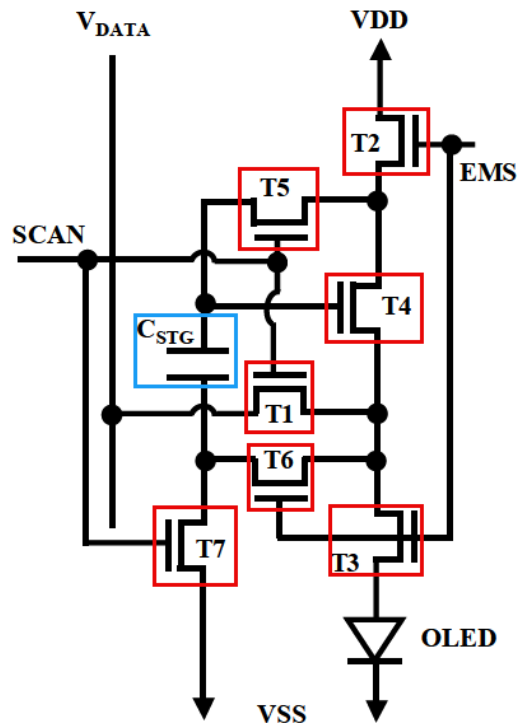
2. Claim 11

Her and Lee-P12 teach or suggest this limitation.

Her discloses that each pixel “may include at least one transistor,” (Ex-1005, ¶53), and describes one embodiment of a two-transistor and one-capacitor-per-OLED system, (*id.*, ¶¶64-67, Fig. 3; Ex-1003, ¶¶223-24). Her does not expressly

disclose a circuit layer comprising seven transistors and one storage capacitor. Ex-1003, ¶225.

However, others in the art had recognized that “[w]hen a conventional 2-TFT pixel circuit” like Her’s “is applied to AM-OLED panel, the OLED current varies due to degradation of threshold voltage,” and that various methods have been proposed “to compensate [for] the problem of an inherent threshold voltage shift” in a 2-TFT circuit system. Ex-1011, 264; Ex-1003, ¶¶224-25. Lee-P12 proposed one solution by utilizing a circuit layer comprising “six switching a-Si:H TFTs and one driving a-Si:H TFT, [and] one storage capacitor,” among other features. Ex-1011, 265; Ex-1003, ¶225. Lee-P12’s circuit diagram is provided below, with transistors identified in red, and the capacitor identified in blue.



Ex-1011, Fig. 3 (annotated); Ex-1003, ¶225. According to Lee-P12, this seven-TFT and one-capacitor circuit “successfully compensates the threshold voltage degradation of TFTs and OLED,” and “may be suitable for large-size and low-cost AM-OLED panel[s].” Ex-1011, 267; Fig. 9 (comparing seven-TFT circuit to two-TFT circuit); Ex-1003, ¶225.

A POSITA would have been motivated to replace Her’s exemplary two-TFT-per-pixel circuit layer with other circuit layers, such as Lee-P12’s seven-TFT-per-pixel circuit layer, to compensate for threshold voltage degradation known to impact two-TFT circuit layers like Her’s. Ex-1003, ¶226. POSITA would have had a reasonable expectation of success in making this modification because Lee-P12 provided the circuit diagram necessary to make the modification, and does not suggest any novel manufacturing methods are required to produce the modified circuit compared to two-TFT systems. Ex-1003, ¶226.

3. Claim 17

Her and Lee-P12 teach or suggest this limitation. §V.B.2 (cl. 11); Ex-1003, ¶227.

C. Ground 1C: Her Combined with Cok, Cho (with or without Hsieh and/or Kobayashi), and Ka (Claims 13-16).

Claims 13-16 are obvious in view of (1) Her combined with Cok, Cho, and Ka, and (2) Her combined with Cok, Cho and Ka, further in view of Hsieh and/or Kobayashi.

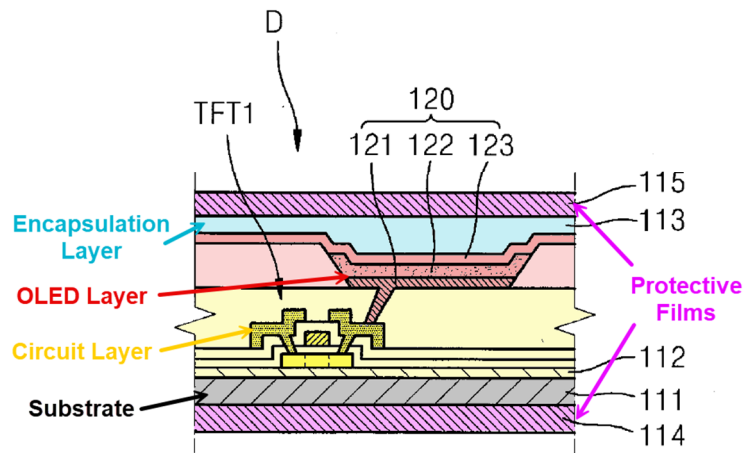
1. Prior Art

a. Ka (Ex-1009)

Ka was filed on January 11, 2013 and published on January 2, 2014. Ex-1009, Cover. Ka constitutes prior art under at least §102(a)(1). Ex-1003, ¶¶93-94.

Ka discloses a flexible OLED display panel that includes a variety of features and is specifically configured to be foldable. Ex-1009, Abstract, ¶¶68-70; Ex-1003, ¶95. For instance, Ka discloses an OLED panel with a flexible substrate, a circuit layer, an OLED layer, and an encapsulation layer of alternating inorganic and organic layers. Ex-1009, Abstract, ¶¶66-73, Figs. 6-8; Ex-1003, ¶95. But Ka also discloses a number of additional layers for the display panel, including “protective films” on the top and bottom of the display to “reinforce a structural strength of the flexible display panel”(Ex-1009, ¶74), and a “transparent protection window” to “protect[] the flexible display panel 100 from external shock or scratches” and “maintaining a shape of the flexible display pane”(id., ¶118). Ex-1003, ¶95.

FIG. 7



Ex-1009, Fig. 7 (annotated)

Moreover, Ka discloses features to make the display panel foldable along predetermined axes. Ex-1009, ¶¶58-60, 70, 77-122 (describing various configurations to enable bending the display panel along an axis), Figs. 1-2, 5-6, 8-22, 25-27; Ex-1003, ¶96.

FIG. 8

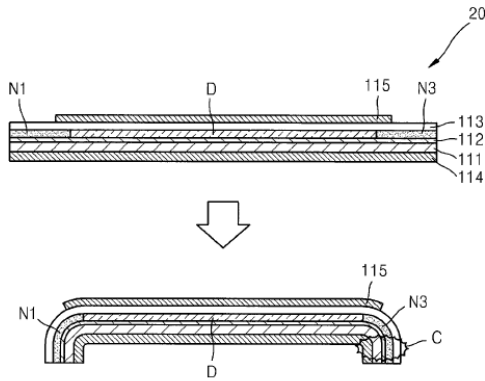


FIG. 9

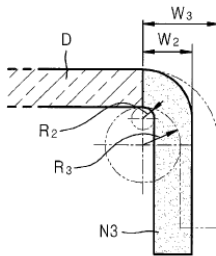
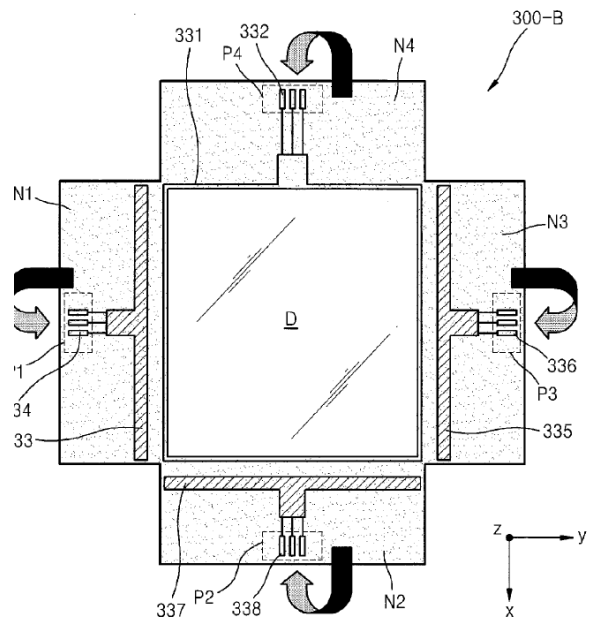


FIG. 19



Ex-1009, Figs. 8-9, 19

2. Claim 13

Her and Ka teach or suggest this limitation.

Her discloses that a “plastic substrate may be used as the base substrate for a flexible display panel.” Ex-1005, ¶50; Ex-1003, ¶¶228-29. Her does not, however, expressly state that the flexible display device is “foldable.” Ex-1003, ¶229.

A POSITA would have appreciated that a flexible display would be “foldable” because a flexible display can accommodate some radius of curvature, even if large. Ex-1003, ¶¶230-31.

But it was also well-known in the art to configure a flexible display device to be foldable along pre-determined axes to either hide non-display areas of the display from the user, or provide larger displays in smaller, foldable form factors. Ex-1003, ¶¶230, 232. For instance, Ka teaches a display device with: (1) an OLED display panel comprising a flexible substrate, circuit layer, OLEDs, and an encapsulation layer(Ex-1009, ¶¶66-70); and (2) a touch panel with “wiring regions” for the touch sensors(*id.*, ¶¶110-14). Ka’s display device is specifically configured to “fold” along pre-determined axes to hide non-display areas from the user. *Id.*, Abstract, ¶¶8, 28-30, 58-60, 112-13, Figs. 1, 2, 6, 8-13, 15-18, 20-22, 25-27; Ex-1003, ¶232. However, it was also well-known in the art that the display area itself could also be configured to be “foldable” as well. Ex-1003, ¶233; Ex-1034, Abstract, 1:51-58, 2:12-23, 7:6-39, 8:1-49, 11:10-23, 11:60-13:15, Figs. 1A-2B; *id.*, Fig. 4B (showing display and touch panel layers similar to Her), Figs. 5A-5B, 8A-8B, 11A-11B (showing some customizations of the display and touch panels to improve folding).

To the extent Her’s flexible display is not inherently “foldable,” a POSITA would have been motivated to configure Her’s display to be foldable along a predetermined axis in some way—to fold non-display regions to hide them from users, or to provide a larger display in a smaller form factor. Ex-1003, ¶234. POSITA would have had a reasonable expectation of success in making Her’s display

“foldable” because the prior art taught numerous ways to modify display devices like Her’s to make them more foldable. Ex-1003, ¶235.

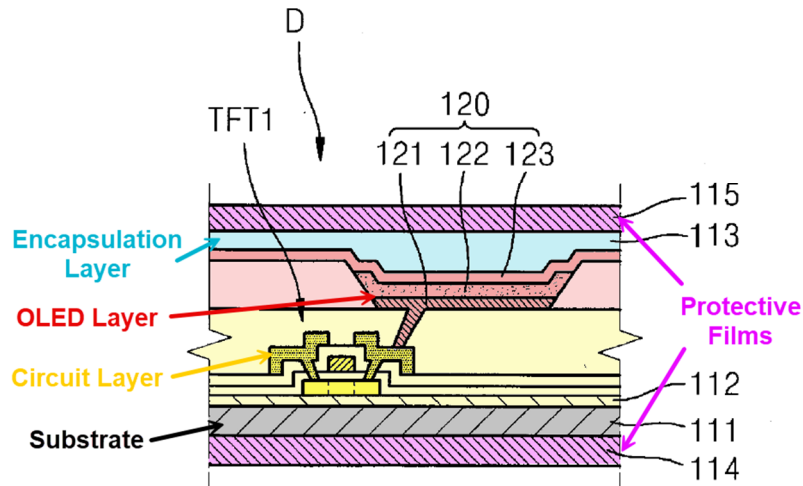
3. Claim 14

Her and Ka teach or suggest this limitation.

Her is silent on whether there are layers of the display panel below the substrate/base layer. Ex-1005, ¶¶49-50. However, others in the art provided other material layers above and below the substrate for various reasons. Ex-1003, ¶¶236-37.

Ka, for instance, teaches a flexible OLED display panel that includes a “first protective film 114...located on one side of the flexible substrate 111. An adhesive may be injected between the flexible substrate 111 and the first protective film 114.” Ex-1009, ¶74, Fig. 6; ¶66; Ex-1003, ¶238. Ka also teaches a second protective film 115 above the encapsulation layer. Ex-1009, ¶74, Fig. 6; ; Ex-1003, ¶238.

FIG. 7



Ex-1009, Fig. 7 (annotated)

Ka discloses these protective films are provided to at least “reinforce a structural strength of the flexible display panel”(Ex-1009, ¶74), and specifically “reducing or preventing wirings from cracking due to a bending stress”(id., ¶124; Ex-1003, ¶238).

A POSITA would have been motivated to modify and had a reasonable expectation of success in modifying Her to incorporate a protective film on the back surface of the substrate, applied using an adhesive, to reinforce the flexible display and reduce the risk of fracturing electrical wirings due to bending. Ex-1003, ¶239.

4. Claim 15

Her and Ka teach or suggest this limitation. §V.C.1 (cl. 13); Ex-1003, ¶240.

5. Claim 16

Her and Ka teach or suggest this limitation.

Her discloses a touch panel with a top-most layer of a second light-blocking material. Ex-1005, ¶85, Fig. 19. Her does not, however, expressly disclose any additional layers of the display device above the touch panel. Ex-1003, ¶241-42.

A POSITA would have understood that additional layers would be provided above the light-blocking material to provide users a planar surface to interact with the touch panel. Ex-1003, ¶243. For instance, Ka teaches a transparent protection window 150 may be adhered to the display panel, or a touch panel if included, to “protect[] the flexible display panel 100 from external shock or scratches and... maintain[] the shape of the flexible display panel.” Ex-1009, ¶¶118-19; Ex-1003, ¶243.

A POSITA would have been motivated to provide at least one additional material layer including a protection window like Ka’s on top of Her’s touch panel to protect the display from external shock and scratches, and provide users a planar surface to interact with as part of the touch-sensitive display. Ex-1003, ¶244. Indeed, providing a final protection window was well-known in the art. *Id.*; Ex-1016, 8:20-35; Ex-1035, 8:13-35; Ex-1036, ¶¶71, 87-88. A POSITA would have understood that, without additional layers on top of Her’s touch panel, users would be touching a non-planar, light-blocking material that covers the touch panel’s conductive elements, exposing them to damage. Ex-1003, ¶244. Thus, POSITA would have appreciated that Her’s display device would include at least an additional planarizing

layer to cover the second light-blocking material, and a protection window for users to touch. Ex-1003, ¶244.

Moreover, although Ka discloses using an adhesive, but does not expressly specify an *organic* adhesive, a POSITA would have been motivated to use an organic adhesive to add a protection window to Her's touch panel because organic adhesives were well known in the art to attach protective windows. Ex-1003, ¶245; *xompare* Ex-1001, 8:57-65 (noting optical clear adhesive (OCA) or pressure sensitive adhesive (PSA), or polyurethane-, polyacryl-, polyester-, or poly epoxy-based adhesives are exemplary organic adhesives), *with, e.g.*, Ex-1035, 8:13-35 (attaching window using optical clear adhesive), Ex-1036, ¶87 (noting window can be attached to touch panel using a “rubber-based adhesive, acryl-based adhesive, vinylether-based adhesive...urethane-based adhesive, pressure sensitive adhesive”).

D. Ground 2A: Lee-979 Combined with Kim and Cok, with or without Hsieh and/or Kobayashi (Claims 1-10, 12).

Claims 1-10 and 12 are obvious in view of (1) Lee-979 combined with Kim and Cok, and (2) Lee-979 combined with Kim and Cok, further in view of Hsieh and/or Kobayashi.

1. Prior Art

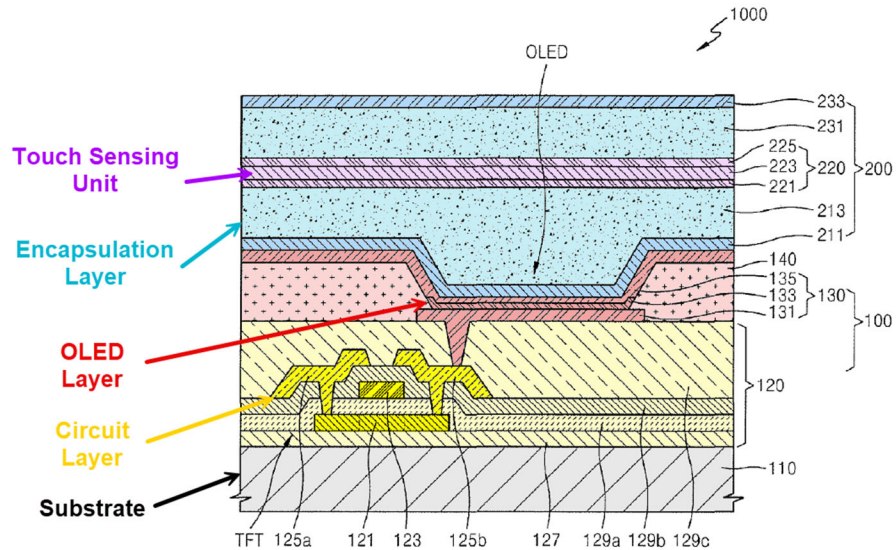
a. Lee-979 (Ex-1006)

Lee-979 was filed on March 14, 2013 and published on May 29, 2014. Ex-1006, Cover. Lee-979 constitutes prior art under at least §102(a)(1). Ex-1003, ¶¶70-71.

Lee-979 discloses an OLED-display device comprising an OLED-display panel with an integrated touch panel. Ex-1006, Abstract; Ex-1003, ¶72.

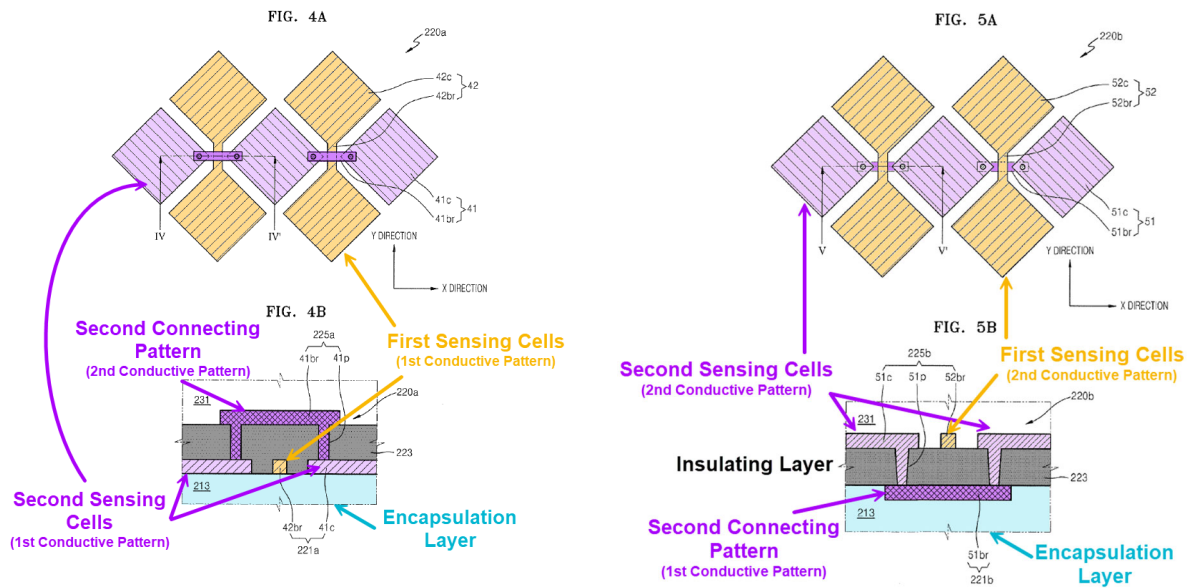
Lee-979's display device includes a substrate, a circuit layer, and an OLED layer that produces different colored light (red, green, blue). Ex-1006, ¶¶48-50, 52-64, Figs. 1-2; Ex-1003, ¶73. Lee-979 also discloses that the display panel is encased in a multi-layered encapsulation layer(Ex-1006, ¶¶75-80, 87-93, Figs. 1-3B; Ex-1003, ¶73), with a touch-sensing unit disposed within the multilayered encapsulation layer(Ex-1006, ¶¶81-86, 94, Figs. 1-3B; Ex-1003, ¶73).

FIG. 2



Ex-1006, Fig. 2 (annotated)

Lee-979's touch-sensing unit comprises two touch electrodes extending in different (x, y) directions that can be formed various ways. Ex-1006, ¶¶101-123; Ex-1003, ¶74. Specifically, Lee-979 discloses the two electrodes have first and second sensing cells formed on either a first or second conductive layer, and second sensing cells are connected via a bridge on a different conductive layer. Ex-1006, ¶¶101-12, Figs. 4A-C(describing overpass-type bridge), 113-23, Figs. 5A-C(describing underpass-type bridge); Ex-1003, ¶74.



Ex-1006, Figs. 4A-4B, 5A-5B (annotated)

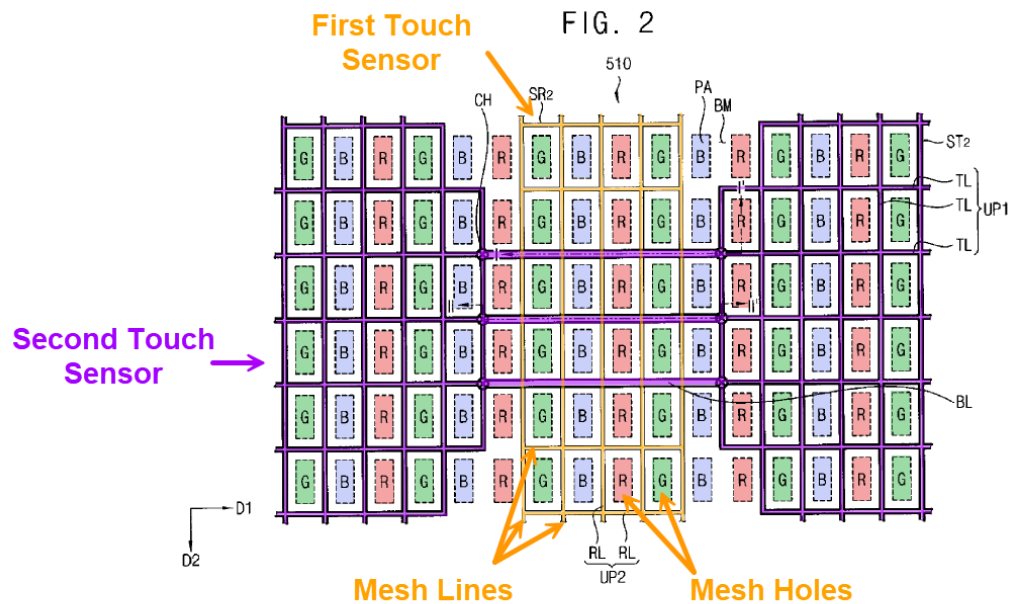
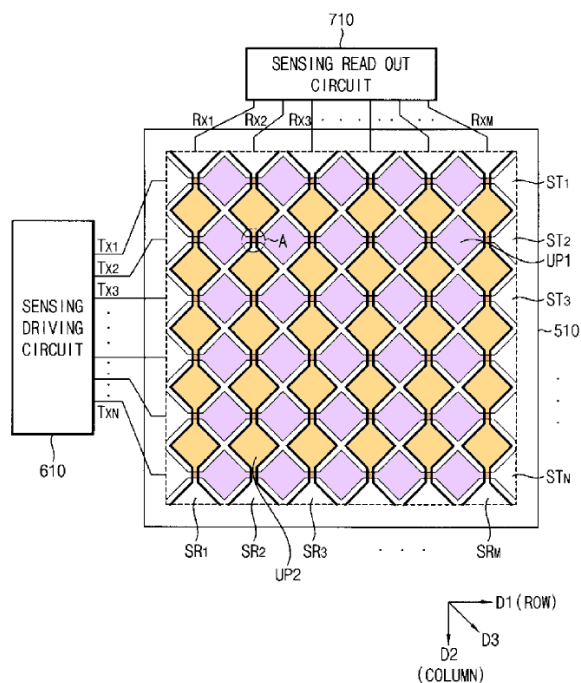
b. Kim (Ex-1010)

Kim was filed on December 5, 2012 and published on December 26, 2013.

Kim constitutes prior art under at least §102(a)(1). Ex-1003, ¶¶75-76.

Kim teaches a touch-screen display (including an OLED display) that forms two touch-sensor electrodes, oriented in different directions, out of metal mesh, and one set of sensors is connected using an underpass- or overpass-type bridge (like Lee-979). Ex-1010, Abstract, ¶¶12, 16, 53, 60, 64, 79-80, 87, 90-92, Figs. 1-4C; Ex-1003, ¶¶77-78. Kim teaches the metal-mesh sensors' wiring is placed in gaps between adjacent (red, green, blue) light-emitting areas to not obstruct light-emitting areas. Ex-1010, ¶¶77-80, Fig. 2; Ex-1003, ¶¶78-79.

FIG. 1



Ex-1010, Figs. 1-2 (annotated)

2. Claim 1

a. 1[pre]

Lee-979 discloses this limitation.

Lee-979 discloses “[a]n organic light emitting display apparatus.” Ex-1006, Abstract, ¶¶3, 11, 13, Figs. 1-3B; Ex-1003, ¶¶246-47.

b. 1[a]

Lee-979 discloses this limitation.

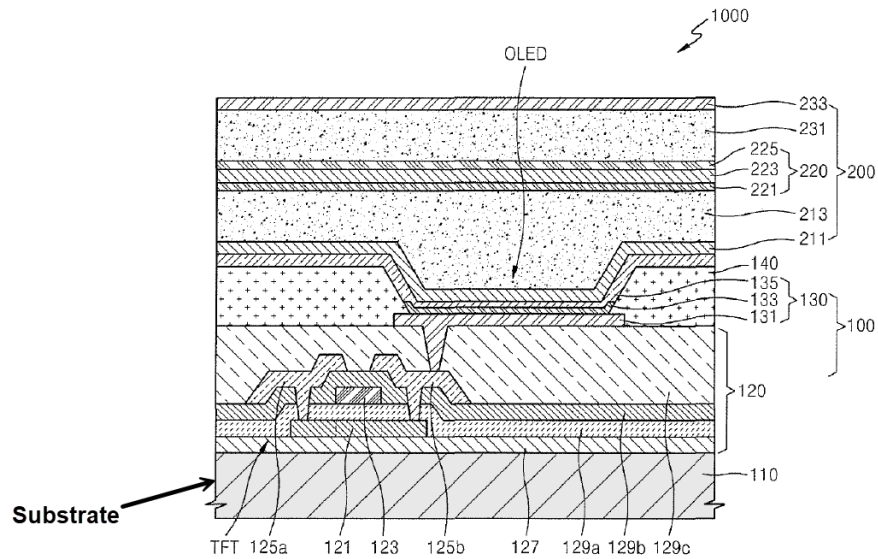
Lee-979’s display device includes “a substrate; an organic light emitting diode (OLED) layer on the substrate; and a thin film encapsulation layer on the OLED layer”(Ex-1006, ¶13), which a POSITA would have understood to be a “display panel”(Ex-1003, ¶¶248-51; Ex-1006, Abstract, ¶¶14, 29, 48-49).

c. 1[b]

Lee-979 discloses this limitation.

Lee-979’s “organic light emitting display apparatus 1000...includes a substrate 110.” Ex-1006, ¶49; ¶¶14, 29, 50, 52, Figs. 1-3B; Ex-1003, ¶¶252-53.

FIG. 2



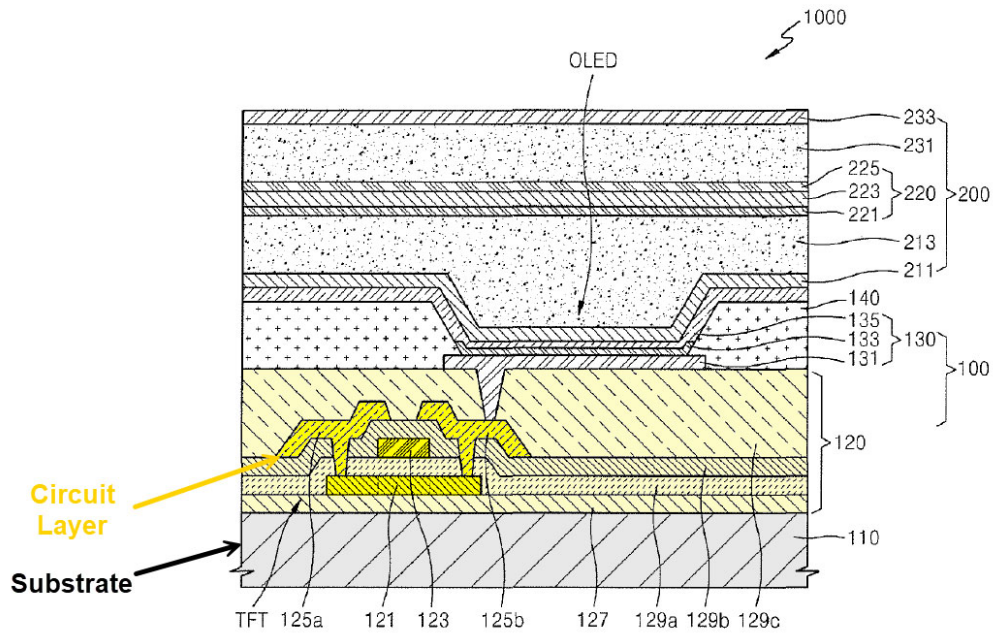
Ex-1006, Fig. 2 (annotated)

d. 1[c]

Lee-979 discloses this limitation.

Lee-979 discloses a device/wiring layer (120) on the base-layer substrate (110) to channel electricity to pixels of the display panel. Ex-1006, ¶¶52(“A display unit 100 may be disposed on an upper surface of the substrate 110.”), 53-55(“display unit 100 includes a device/wiring layer 120 including the TFT array”); ¶¶56-61(describing circuit-layer components), Figs. 1-3B; Ex-1003, ¶¶254-55.

FIG. 2



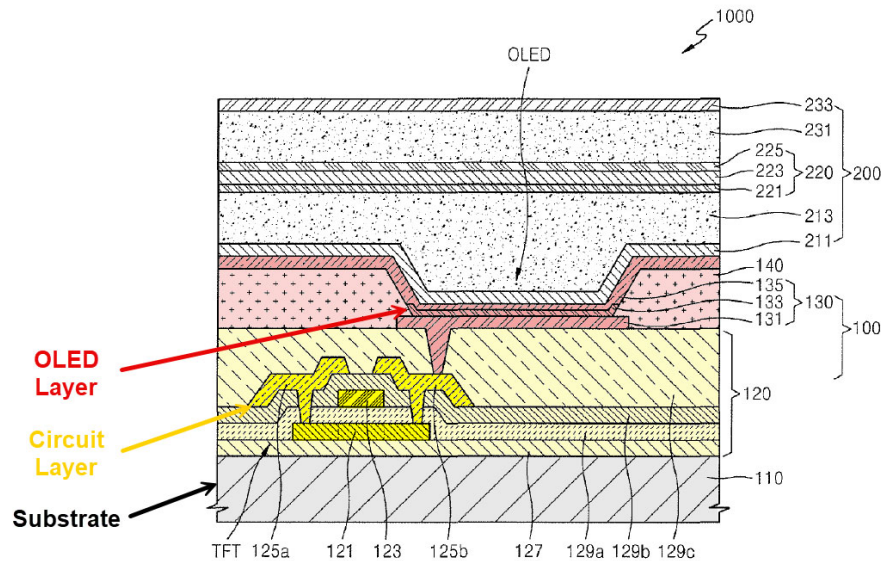
Ex-1006, Fig. 2 (annotated)

e. 1[d]

Lee-979 discloses this limitation.

Lee-979 discloses “an OLED layer 130 including an OLED array”(Ex-1006, ¶54), “disposed on the device/wiring layer 120”(id., ¶73; ¶¶62-74 (describing OLED-layer components), Figs. 1-3B; Ex-1003, ¶¶256-57).

FIG. 2



Ex-1006, Fig. 2 (annotated)

f. 1[d][i]

Lee-979 discloses this limitation.

Lee-979 discloses that “[t]he display unit 100 includes a plurality of pixels arranged as a matrix. Each of the pixels includes an OLED and an electronic device electrically connected to the OLED.” Ex-1006, ¶53; Ex-1003, ¶¶258-59. Lee-979 explains that “[w]hen a voltage is applied...[t]he intermediate layer 133 may emit...blue light, green light, red light, or white light,” but if the intermediate layer 133 emits white light, the display “may further include blue, green, and red color filters for displaying color images.” Ex-1006, ¶¶64-65; Ex-1003, ¶259. A POSITA would have understood Lee-979 as disclosing a plurality of light-emitting areas for

each blue, green, and red colors, consistent with conventional pixel arrangements.

Ex-1003, ¶260; Ex-1010, Fig. 2, ¶¶85; Ex-1007, 3:1-11, Figs. 1-7.

g. 1[d][ii]

Lee-979 discloses this limitation. §V.D.2.f (1[d][i]); Ex-1003, ¶261.

h. 1[d][iii]

Lee-979 discloses this limitation. §V.D.2.f (1[d][i]); Ex-1003, ¶262.

i. 1[d][iv]

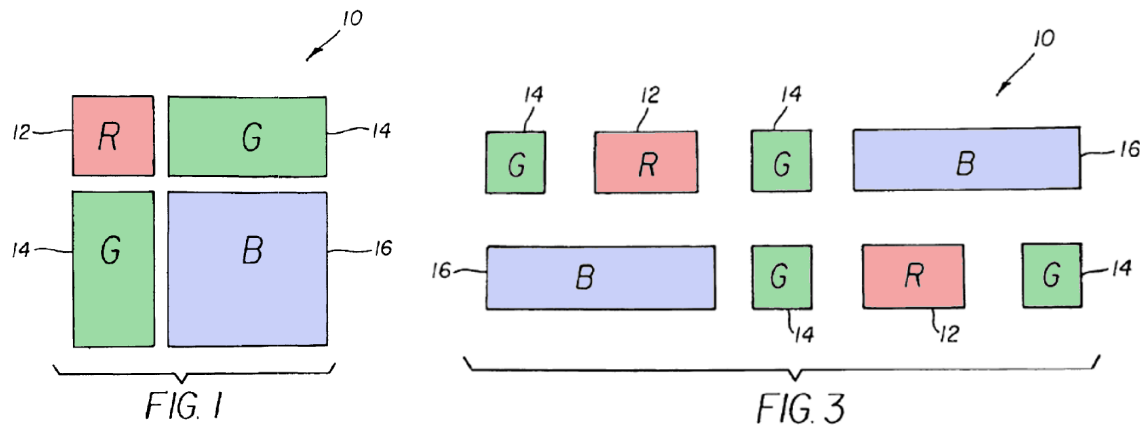
Lee-979 and Cok teach or suggest this limitation.

Although Lee-979 discloses red, green, and blue light-emitting areas, Lee-979 does not expressly disclose their relative sizes. Ex-1003, ¶¶263-64.

Providing red, green, and blue light-emitting areas of different relative sizes was well known in the display industry. Ex-1003, ¶265. It was well-known that “the efficiency of light production by various OLED light emitters of different colors varies,” and “also suffer from color-dependent age-related degradation.” Ex-1007, 1:50-62, 3:18-24; Ex-1003, ¶265. Thus, “[l]ight emitting elements made with higher efficiency materials can be made smaller than light emitting elements made with lower efficiency materials while producing the same light output.” Ex-1007, 3:18-24, 2:15-29; Ex-1003, ¶266. Alternatively, each colored light-emitting area’s size can be adjusted to control the “white point” of the display—the ratio of colors used

to produce white light—or to tailor the display to specific color use cases. Ex-1007, 3:25-33, 4:57-63; Ex-1003, ¶266.

Based on these known considerations, Cok teaches exemplary pixel configurations of red, green, and blue light-emitting areas of different relative sizes. Ex-1007, 4:7-30, Figs. 1, 3; Ex-1003, ¶267.³



Ex-1007, Figs. 1, 3 (annotated)

A POSITA would have been motivated to modify Lee-979 to provide different-sized light-emitting areas for each (red, green, and blue) color to account for their different efficiency and degradation, and/or to adjust the white point of the display, as taught by Cok (and as was well known in the industry). Ex-1007, 1:23-39, 1:50-62, 2:15-29; Ex-1003, ¶268. A POSITA would have had a reasonable expectation of success in making this modification because it merely involves

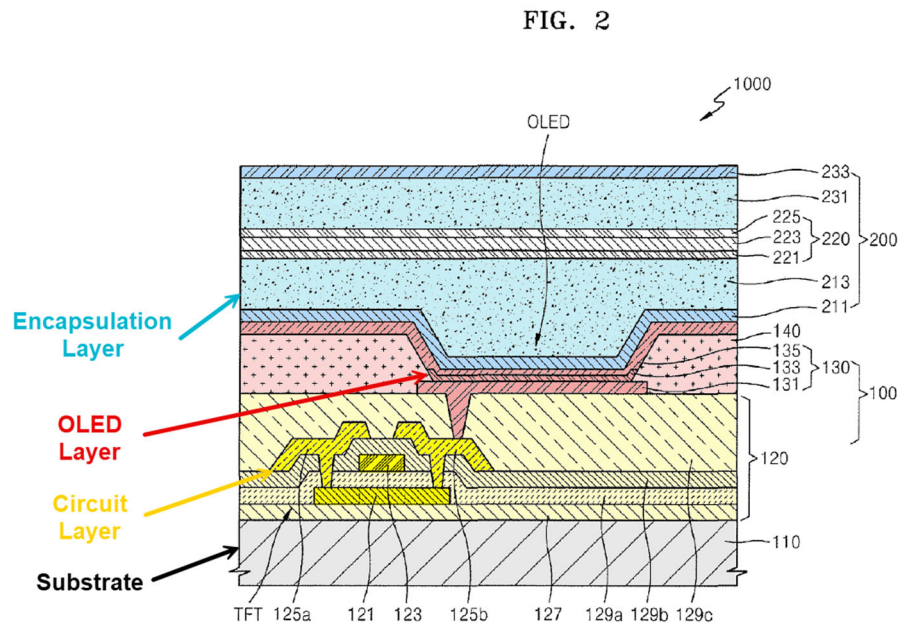
³ See also n.1, *supra*.

adjusting the sizes of light-emitting areas Lee-979 already discloses, and Cok provides equations to calculate the size of each colored light-emitting area based on several known design considerations. Ex-1007, 3:43-4:6, 4:46-5:6; Ex-1003, ¶269.

j. 1[e]

Lee-979 discloses this limitation.

Lee-979 discloses “a thin film encapsulation layer on the OLED layer including: a plurality of inorganic layers; a plurality of organic layers stacked with the inorganic layers.” Ex-1006, ¶¶29, 75 (“thin film encapsulation layer 200 is a unit for sealing the display...in which a plurality of inorganic layers and a plurality of organic layers are stacked (e.g., alternately stacked).”); ¶¶78-80, 89-92; Ex-1003, ¶¶270-71.

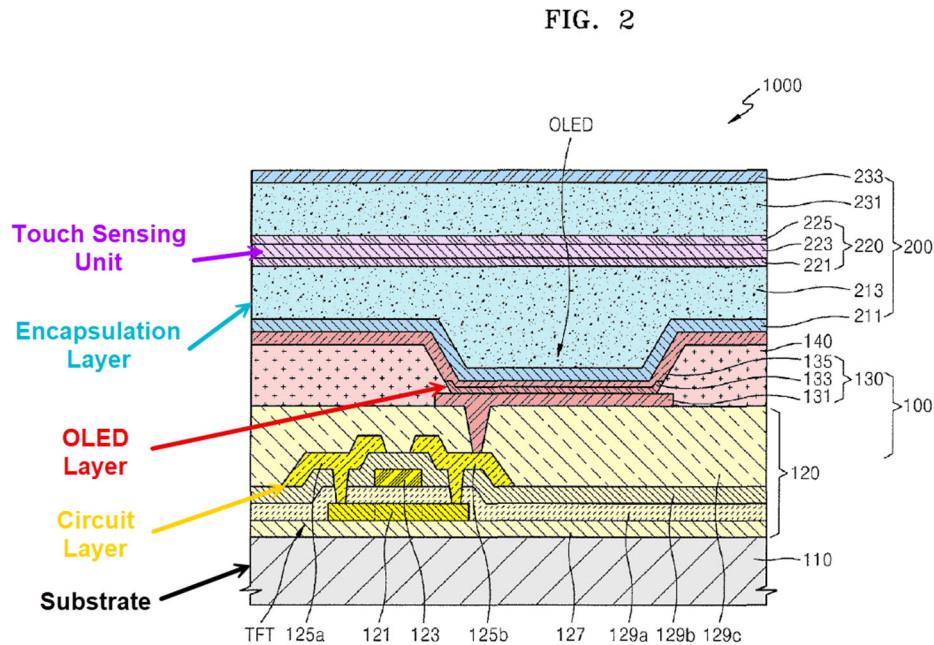


Ex-1006, Fig. 2 (annotated)

k. 1[f]

Lee-979 discloses this limitation.

Lee-979’s “thin film encapsulation layer 200 may include a touch sensing layer 220.” Ex-1006, ¶¶49, 81-82 (“a first touch conductive layer 221 and a second touch conductive layer 225 are disposed in the thin film encapsulation layer 200”), Figs. 1-5C; Ex-1003, ¶¶272-73.



Ex-1006, Fig. 2 (annotated)

A POSITA would have understood that Lee-979’s touch sensing layer (220) is “on” the display panel as described in the ’496 patent. Ex-1003, ¶274. The term “display panel” is merely a label for a plurality of layers that are intended to generate graphical content, and the ’496 patent notes that the term “on” means one component “can be directly on, connected to, or coupled to the other element,” even with other

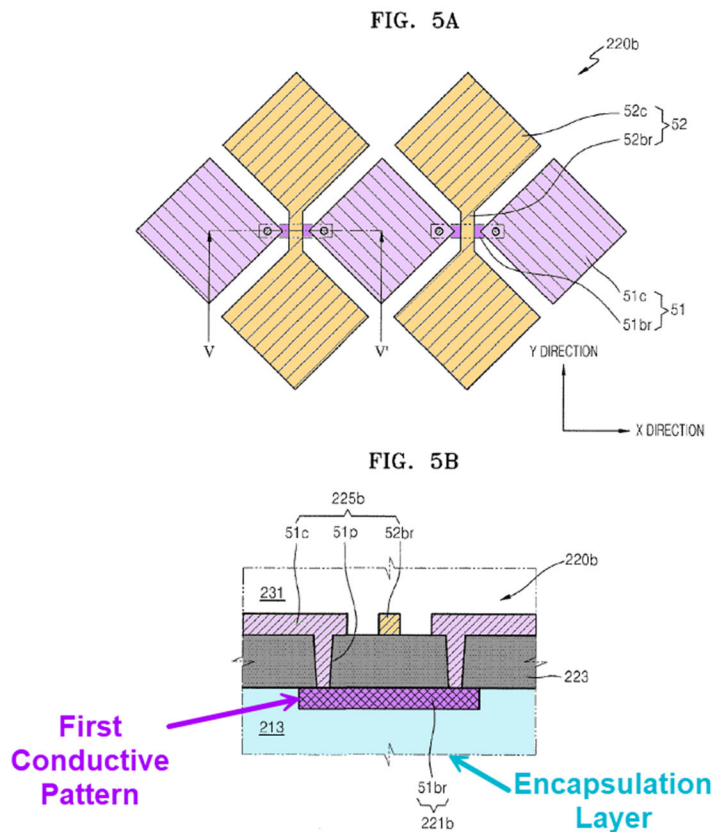
“intervening elements, layers, regions, or components.” Ex-1001, 4:61-66; Ex-1003, ¶274. Thus, POSITA would have understood Lee-979’s touch-sensing layer(220) as being “on” the display panel that includes substrate (110), circuit layer (120), OLED layer(130), and at least some layers of a multilayered encapsulation layer (e.g., 211, 213). Ex-1003, ¶274.

Even if the claims require the touch panel be placed on *top* of a “display panel” with an encapsulation layer, the term “encapsulation layer” is also a generic label that often refers to a plurality of different material layers that can be defined many ways. Ex-1003, ¶275. For instance, Lee-979’s “display panel” could be considered to end with upper surface of organic layer (213), on which touch-sensor unit (220) is formed, and then organic and inorganic layers (231/233) would have been considered separate “barrier” or “protective” layers rather than part of the same “encapsulation layer” (200) as those below touch-sensor unit(220). Ex-1003, ¶276. In other words, even if 496 patent and Lee-979 differ in the specific labels applied to their layers, they identify the same structures. Ex-1003, ¶276. Moreover, forming touch sensors directly on encapsulation layers was well-known in the art. Ex-1003, ¶276; Ex-1019, ¶¶16, 70.

I. 1[f][i]

Lee-979 discloses this limitation.

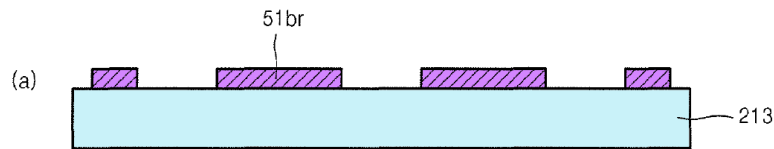
Lee-979's "first touch conductive layer 221b may be formed on the first organic layer 213." Ex-1006, ¶120; ¶¶113-17, Figs. 5A-C. A POSITA would have understood that "first organic layer 213" is "a surface of the display panel," as claimed, because at least encapsulation layers 211 and 213 would be understood as part of the "display panel." Ex-1003, ¶¶277-78; §V.A.2.k (1[f], explaining different labels for same structures).



Ex-1006, Figs. 5A-5B (annotated)

Lee-979 shows the first step of forming the touch-sensor unit involves forming the first conductive pattern directly on encapsulation layer 213:

FIG. 5C



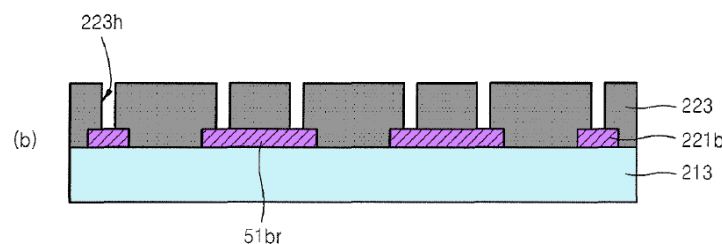
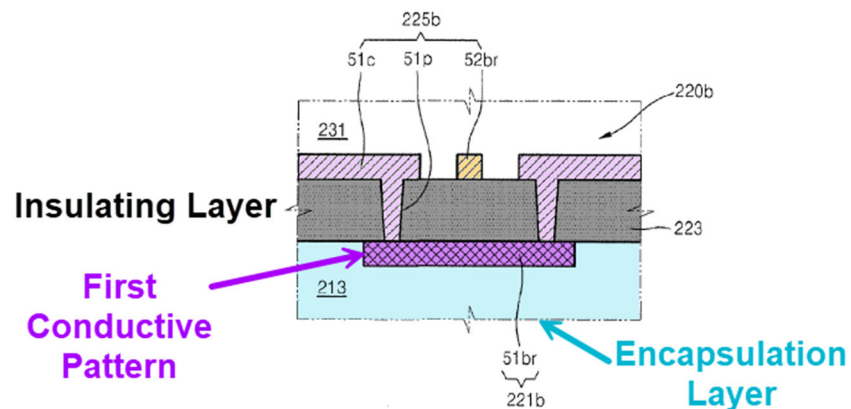
Ex-1006, ¶120, Fig. 5C(annotated); Ex-1003, ¶279.

m. 1[f][ii]

Lee-979 discloses this limitation.

Lee-979 discloses that “second inorganic layer 223 may be formed on the first touch conductive layer 221b,” and that “second inorganic layer 223 may be formed of an inorganic insulating material”(Ex-1006, ¶121, Figs. 5A-C; Ex-1003, ¶¶280-81), and Lee-979 shows forming the insulating layer on the first conductive pattern.

FIG. 5B

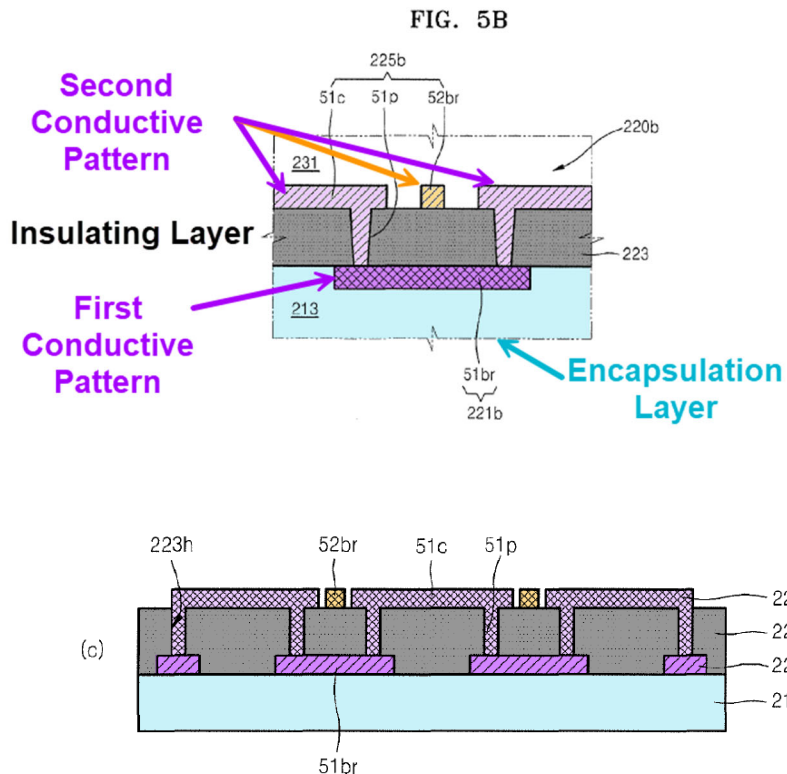


Ex-1006, Figs. 5B-5C (excerpted, annotated)

n. 1[f][iii]

Lee-979, with or without Hsieh and/or Kobayashi, discloses or suggests this limitation.

Lee-979 discloses “second touch conductive layer 225b may be formed on the second inorganic layer 223”(Ex-1006, ¶122, Figs. 5A-C; Ex-1003, ¶¶282-83), and Lee-979 shows forming the second conductive pattern on the insulating layer.



Ex-1006, Figs. 5B-C (excerpted, annotated)

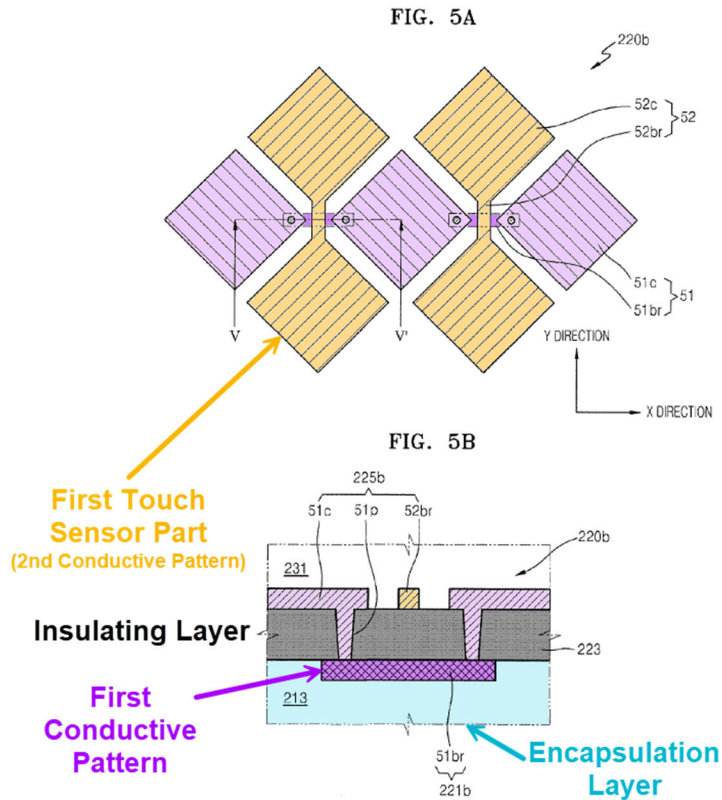
Although Lee-979 does not expressly disclose that the second conductive pattern has a thickness greater than the first conductive pattern, two modifications

to Lee's second conductive pattern would have been apparent. First, as discussed below, it would have been obvious to make Lee's second conductive pattern out of a metal mesh, rather than a transparent conductive material (like ITO) that Lee-979 discloses. §V.D.2.o (1[f][iii][A], *infra*); Ex-1003, ¶284. Upon making this modification, making the second conductive layer comprising metal-mesh sensors thicker than the bridge would have been an obvious design choice, for the same reasons discussed in Ground 1 in view of at least Hsieh and Kobayashi (limited number of options, lower resistivity/higher conductivity across the sensor, improved mechanical durability, minimizing step size). Ex-1003, ¶284; §V.A.2.n (Ground 1, 1[f][iii]). For those same reasons, a POSITA would have been motivated to make the second conductive pattern (e.g., Lee-979's touch-sensor parts and first connection parts) greater in thickness than the underlying first conductive pattern (e.g., Lee-979's bridge). Ex-1003, ¶284.

o. 1[f][iii][A]

Lee-979 and Kim teach or suggest this limitation.

Lee-979 discloses that “second touch conductive layer 225b may include...the second sensing cells 52c,” or first touch-sensor parts as claimed. Ex-1006, ¶122, Figs. 5A-C; Ex-1003, ¶¶285-86.



Ex-1006, Figs. 5A-B (annotated)

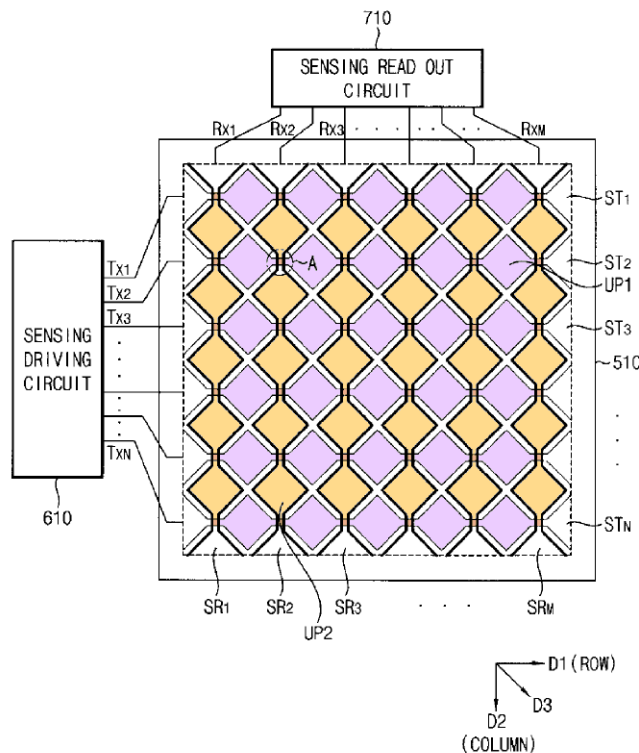
Lee-979 does not, however, disclose that second sensing cells (52c) comprise a plurality of metal-mesh lines defining a plurality of metal-mesh holes. Instead, Lee-979 discloses that second sensing cells may be made of a “transparent conductive material,” (Ex-1006, ¶122)—such as ITO or other well-known transparent-conductive materials(*id.*, ¶83)—which were known to be (nearly) transparent, solid films (not lines with holes) that cover light-emitting areas of the display(Ex-1003, ¶287).

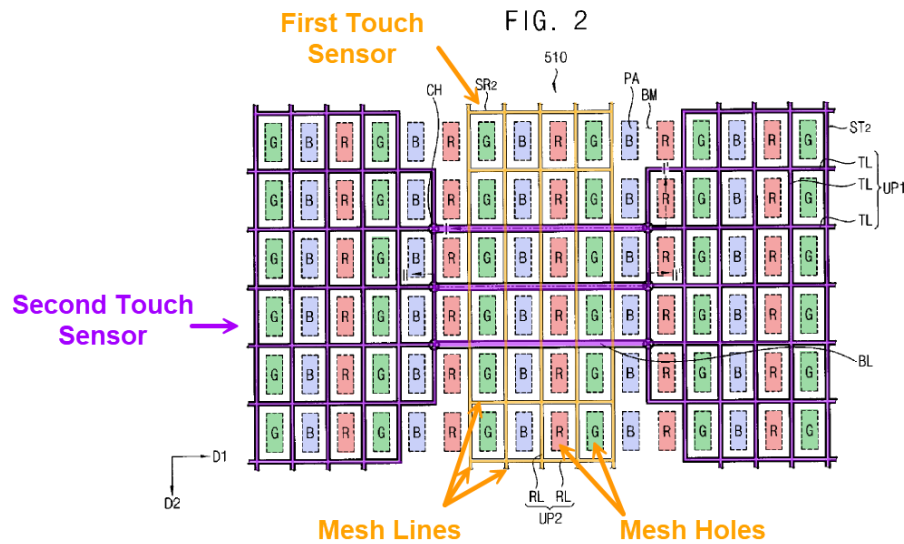
Although transparent conductive materials such as ITO were a well-known touch-sensor material, they were also known to have significant drawbacks when used in flexible displays like Lee-979's. Ex-1006, ¶76; Ex-1003, ¶288. Transparent conductive materials were considered "not appropriate to be implemented in a flexible display because they are less flexible than typical metal materials[,]. . . have higher surface resistance than that of metal materials, . . . [and] detection sensitivity of a touch location [was considered] lower [than metal materials]." Ex-1024, ¶¶9-10; Ex-1037, ¶¶4-5 (materially same); Ex-1003, ¶288. As an alternative, those in the art used touch sensors made of metal wires due to their improved electrical and mechanical properties. Ex-1003, ¶289; Ex-1024, ¶¶9-10; Ex-1037, ¶¶6-7; Ex-1038, ¶¶5-6, 17. But because metal is opaque and blocks light from the display, the metal was often provided as a mesh with thin lines to form openings that allowed light from the display to pass through. Ex-1003, ¶289; Ex-1024, ¶¶9-10; Ex-1037, ¶¶6-7.

Kim teaches such a metal-mesh touch sensor. Specifically, Kim teaches a touch panel with a touch-sensor electrode oriented in one direction with a "first unit pattern UP1 [that] includes a plurality of driving lines TL, which are connected to each other as via a mesh shape" with openings, and are positioned to "overlap with a black matrix pattern BM" so as to not block the underlying red, green, and blue pixels. Ex-1010, ¶57, Figs. 1-2; Ex-1003, ¶290. Kim's touch panel also provides a second touch-sensor electrode oriented in another direction with a "second unit

pattern UP2 [that] includes a plurality of sensing lines RL, which may be connected to each other, such as via the mesh shape.” Ex-1010, ¶58, Figs. 1-2; Ex-1003, ¶290. Moreover, just like Lee-979, Kim teaches that electrodes may have a diamond shape, and first and second electrodes cross each other (with first electrodes using a bridge). Ex-1010, ¶¶58-60, Figs. 1-2; Ex-1003, ¶290. Kim’s Figure 1 provides a zoomed-out view of the touch sensors, and Kim’s Figure 2 provides a zoomed-in view of the intersection of first and second touch-sensor electrodes, both of which are annotated below. Ex-1003, ¶290.

FIG. 1





Ex-1010, Figs. 1-2 (annotated)

A POSITA would have been motivated to modify and had a reasonable expectation of success in modifying Lee-979's touch sensors to use metal mesh like Kim, rather than transparent-conductive layer (like ITO), because they were known alternative materials and structures for touch sensors, such that the modification would be no more than: (1) a simple substitution of one known element (a metal-mesh touch sensor aligned with pixels to appear materially transparent) for another (a transparent conductive layer touch sensor) to obtain predictable results (a conductive, materially transparent touch sensor for a display); or (2) applying one known technique (forming a metal mesh touch sensor aligned with pixels to appear materially transparent) over another (forming a transparent conductive material touch sensor covering a pixel) to improve a similar device in the same way (a

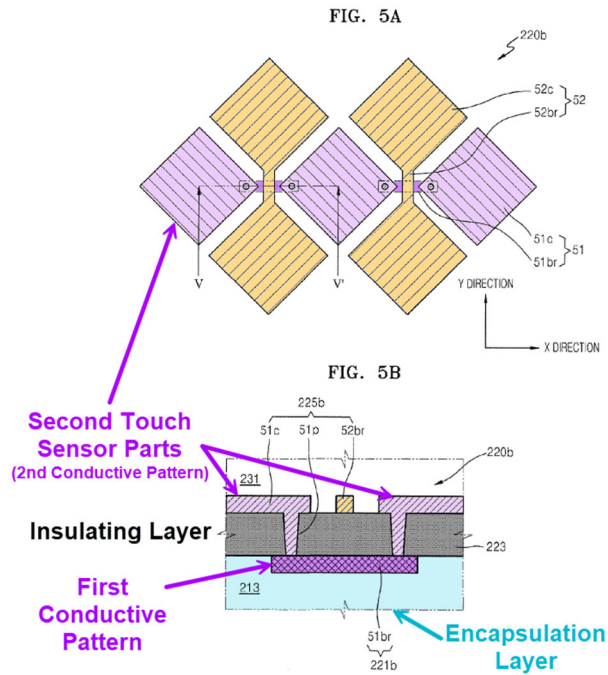
(flexible) display unit with a touch sensor). Ex-1003, ¶291; *KSR*, 550 U.S. at 416, 417, 421; *In re Lackey*, 371 F. App'x 80, 82 (Fed. Cir. 2010).

Regardless, a POSITA would have been especially motivated to make this modification because POSITA would have understood that metal-mesh sensors provided improved electrical conductivity and mechanical durability compared to transparent-conductive layers like ITO, and were especially well-suited for flexible displays. Ex-1003, ¶¶292-93; Ex-1024, ¶¶9-10; Ex-1037, ¶¶4-5.

p. 1[f][iii][B]

Lee-979 and Kim teach or suggest this limitation.

Lee-979 discloses that “second touch conductive layer 225b may include the first sensing cells 51c,” or second touch-sensor parts as claimed. Ex-1006, ¶122, Figs. 5A-C; Ex-1003, ¶¶294-95.



Ex-1006, Figs. 5A-B (annotated)

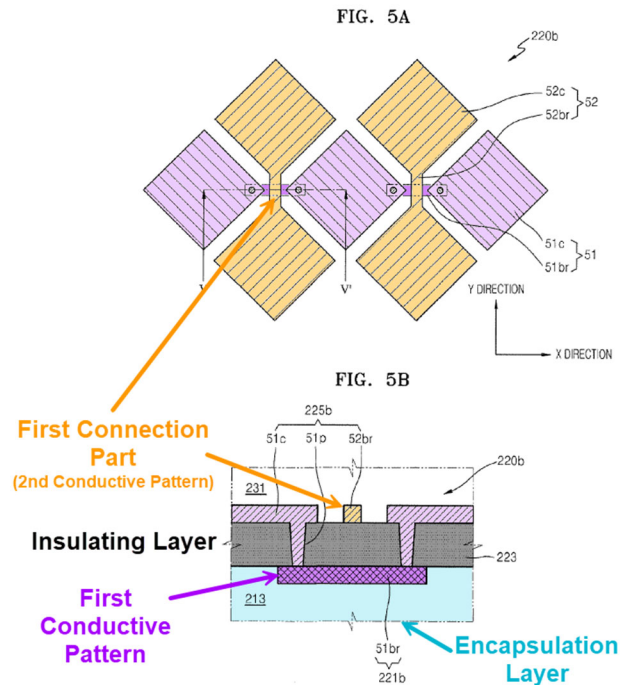
Although Lee-979 discloses first sensing cells are also a transparent-conductive material (like ITO), a POSITA would have been motivated to modify and had a reasonable expectation of success in modifying Lee-979's transparent-conductive material to instead use a metal mesh for the same reasons as Lee-979's second sensing cells (or first touch-sensor parts as claimed). Ex-1003, ¶296; §V.D.2.o (1[f][iii][A]).

q. 1[f][iii][C]

Lee-979, alone or combined with Kim, discloses this limitation.

Lee-979 discloses that “second touch conductive layer 225b may include...the second connecting patterns 52br,” or first connection parts as claimed. Ex-1006,

¶122, Figs. 5A-C; Ex-1003, ¶¶297-98. Lee-979 also shows first connection parts (52br) connect first touch-sensor parts (52c), and may even “be integrally formed with each other.” Ex-1006, ¶106, Fig. 5A; Ex-1003, ¶298. Kim provides the same arrangement (RL) for metal-mesh sensors, and thus would not change Lee-979’s connections when using metal-mesh sensors. Ex-1010, ¶52, Fig. 2; Ex-1003, ¶¶298-99.



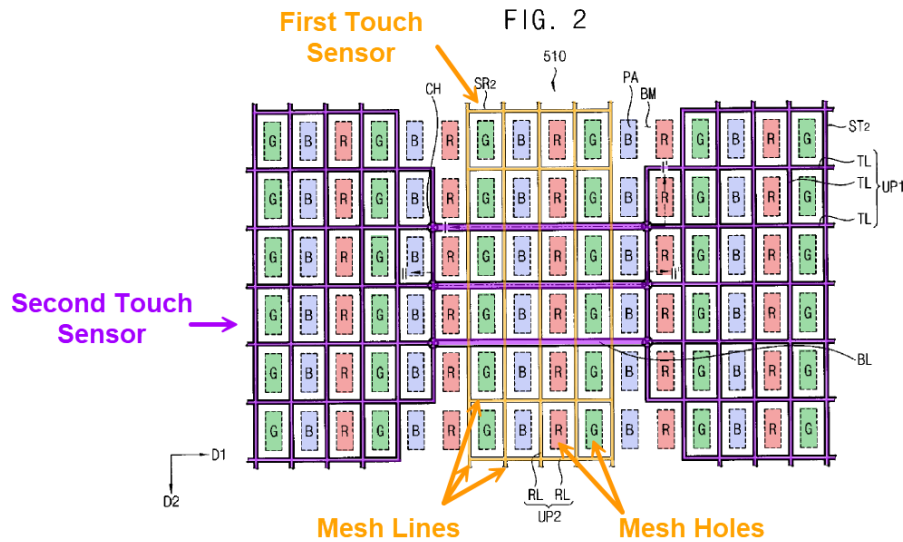
Ex-1006, Figs. 5A-B (annotated)

r. 1[g]

Lee-979 and Kim teach or suggest this limitation.

Although Lee-979 does not disclose a metal-mesh touch sensor with light-emitting areas located within the sensor's mesh holes, Kim does. Ex-1010, ¶¶57-60,

Figs. 1-2; §V.D.2.o (1[f][iii][A]); Ex-1003, ¶300-01. Kim shows a plurality of red, green, and blue light-emitting areas each located within the sensor's mesh holes.



Ex-1010, Fig. 2 (annotated)

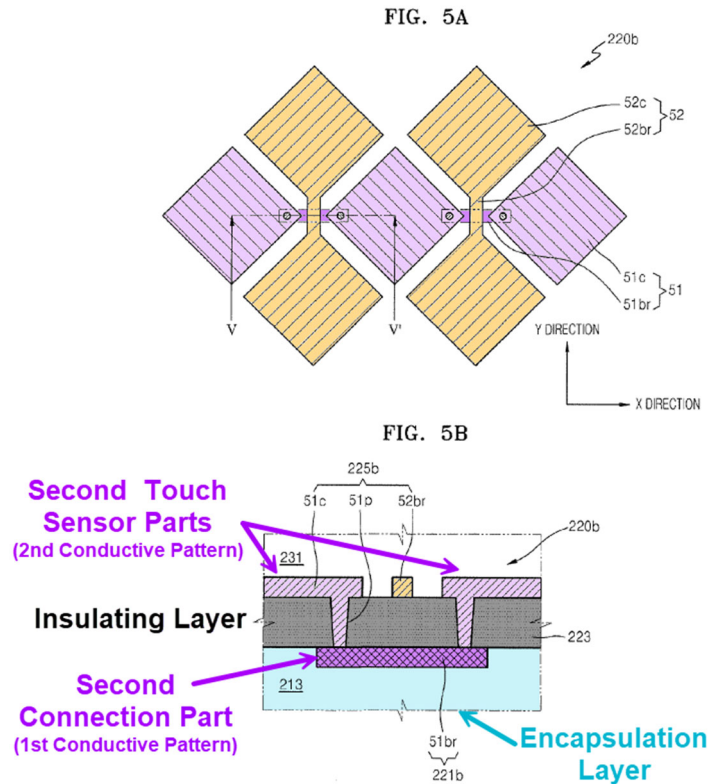
Upon modifying Lee-979 to include an opaque metal-mesh sensor rather than a transparent-conductive material, (§V.D.2.o (1[f][iii][A])), a POSITA would have been motivated to align (and had a reasonable expectation of success in aligning) the mesh holes with Lee-979's light-emitting areas to avoid blocking light from light-emitting areas from exiting the display. Ex-1003, ¶¶302-03; §V.D.2.o (1[f][iii][A]).

s. 1[h]

Lee-979 discloses this limitation.

Lee-979's "first touch conductive layer 221b may include the first connecting patterns 51br," or second connection parts as claimed. Lee-979 also shows second

connection parts (51br) connect second touch-sensor parts (51c). Ex-1006, ¶120, Figs. 5A-C; ¶¶115, 117; Ex-1003, ¶¶304-05.



Ex-1006, Figs. 5A-B (annotated)

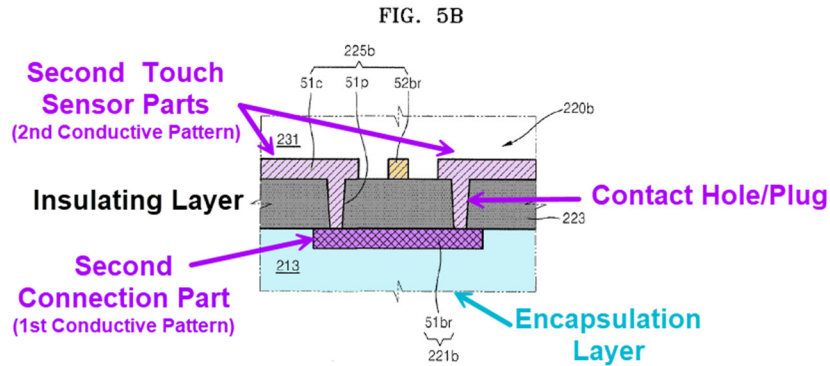
Kim provides the same arrangement (BL) for metal-mesh sensors, and thus would not change Lee-979's connections when using metal-mesh sensors. Ex-1010, ¶12, 60, 90-92, Figs. 2-3; Ex-1003, ¶306.

t. 1[i]

Lee-979 discloses this limitation.

Lee-979's "second inorganic layer 223 may include the contact holes 223h partially exposing upper surfaces of the first connecting pattern 51br." Ex-1006,

¶121; Ex-1003, ¶¶307-08. Lee-979 also discloses “contact plugs 51_p [for] burying (or filling) the contact holes 223_h.” *Id.*, ¶122. Lee-979 shows the contact hole and plug connects second connection parts (51_{br}) to second touch-sensor parts (51_c) through insulating layer (223). *Id.*, Figs. 5B-C; Ex-1003, ¶308.



Ex-1006, Fig. 5B (annotated)

Kim provides the same when using metal mesh. Ex-1010, ¶82; Ex-1003, ¶309.

3. Claim 2

a. 2[pre]

Lee-979 discloses this limitation. §V.D.2.j (1[e]); Ex-1003, ¶310.

b. 2[a]

Lee-979 discloses this limitation.

Lee-979 discloses encapsulation-layer embodiments that differ in the order and number of organic and inorganic layers. Ex-1006, ¶¶49, 75-78, 87-93, Figs. 1-3B; Ex-1003, ¶¶311-12. Regardless, Lee-979 discloses both embodiments have a first inorganic layer (211). Ex-1006, ¶¶49, 75-78, 87-93, Figs. 1-3B; Ex-1003, ¶312.

FIG. 1

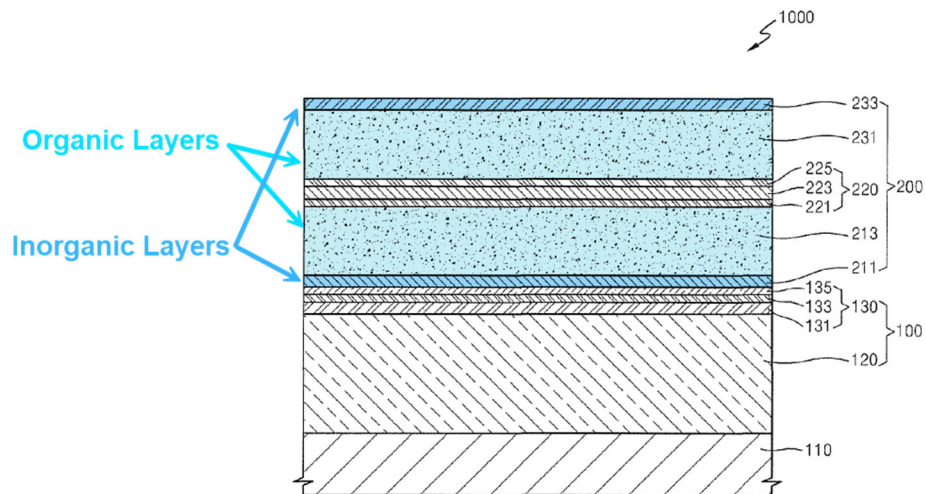
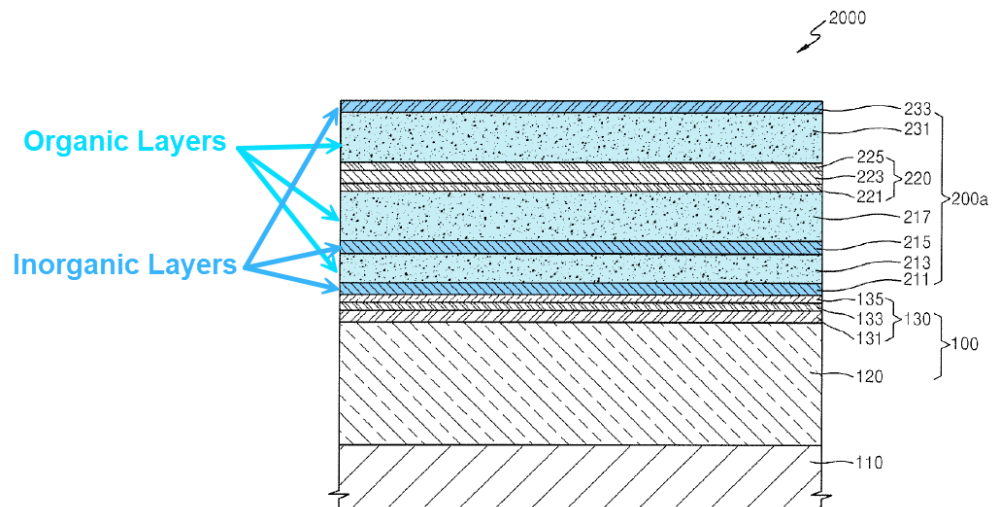


FIG. 3A



Ex-1006, Figs. 1, 3A (annotated)

c. 2[b]

Lee-979 discloses this limitation.

Lee-979 discloses both embodiments have an organic layer (213) on inorganic layer (211). Ex-1006, ¶¶49, 75-78, 87-93, Figs. 1-3B; Ex-1003, ¶¶313-14.

d. 2[c]

Lee-979 discloses this limitation.

Lee-979 discloses an embodiment with an inorganic layer (215) on organic layer (213). Ex-1006, ¶¶49, 75-78, 87-93, Figs. 1-3B; Ex-1003, ¶¶315-16.

4. Claim 3

Lee-979 discloses this limitation.

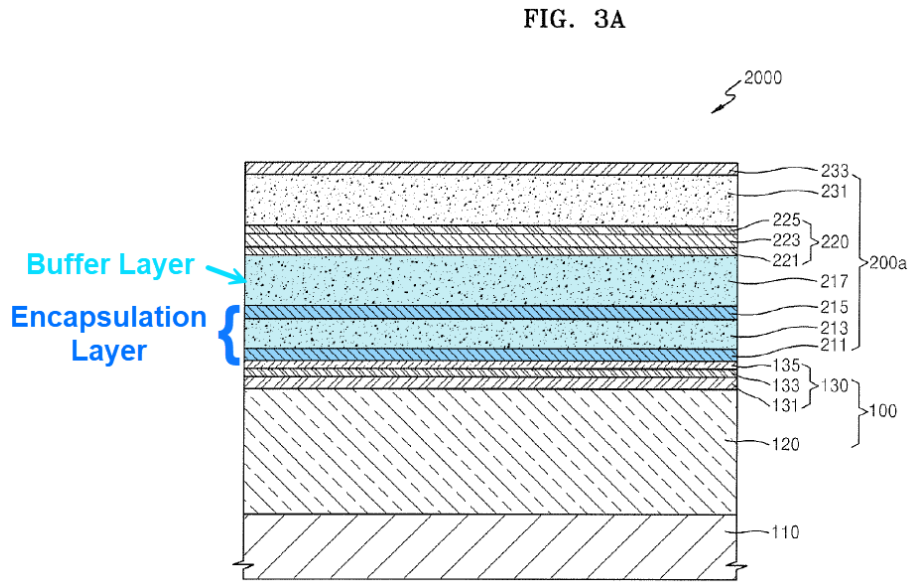
Lee-979's "inorganic layers 211, 223, and 233 may be formed of...silicon oxide, or silicon nitride." Ex-1006, ¶79; Ex-1003, ¶¶317-18.

5. Claim 4

Lee-979 discloses or suggests this limitation.

The '496 patent describes the buffer layer on the encapsulation layer as another layer of material of the same type as the encapsulation layers. Ex-1001, 11:22-32 ("An inorganic layer may be located on the thin film encapsulation layer" and "[t]he inorganic layer may be a buffer layer"); Ex-1003, ¶¶320-21.

Lee-979 discloses an embodiment in which a buffer layer (217) of organic material is provided on the encapsulation layer. Ex-1006, ¶90; Ex-1003, ¶322; §V.A.2.k (1[f], "encapsulation layer" provides different labels for same structures).



Ex-1006, Fig. 3A (annotated)

To the extent the “buffer” layer must be an inorganic material(Ex-1001, 11:22-32), Lee-979 teaches that any number and configuration of layers can be used, including any number and order of organic or inorganic layers. Ex-1006, ¶¶91-92; Ex-1003, ¶323. Lee-979 also discloses that “touch sensing layer 220 may be directly disposed on the inorganic layer 215 *or another inorganic layer may be disposed between the touch sensing layer 220 and the organic layer 217.*” *Id.*, ¶93 (emphasis added); Ex-1003, ¶323. A POSITA would have been motivated by Lee-979’s disclosure to provide a “buffer” layer of inorganic material either directly on second inorganic layer (215) or organic layer (217) as obvious design choices to improve the barrier properties of the encapsulating layers. Ex-1003, ¶323.

6. Claim 5

Lee-979 discloses or suggests this limitation. §V.D.5 (cl. 4); Ex-1003, ¶324.

7. Claim 6

Lee-979 teaches or suggests this limitation. §V.D.2.n (1[f][iii]); Ex-1003, ¶325.

8. Claim 7

a. 7[pre]

Lee-979 and Cok and Kim teach or suggest this limitation. §V.D.2 (cl. 1); Ex-1003, ¶326.

b. 7[a]

Lee-979 and Kim teach or suggest this limitation. §V.D.2.r (1[g]); Ex-1003, ¶327.

c. 7[b]

Lee-979 and Kim teach or suggest this limitation. §V.D.2.r (1[g]); Ex-1003, ¶328.

d. 7[c]

Lee-979 and Kim teach or suggest this limitation. §V.D.2.r (1[g]); Ex-1003, ¶329.

e. 7[d]

Lee-979, Cok and Kim teach or suggest this limitation.

Lee-979 and Cok teach a display panel in which the second (green) light-emitting area is a different size than the first (red) and third (blue) light-emitting areas. Ex-1003, ¶¶330-31; §V.D.2.i (1[d][iv]). And Lee-979 and Kim teach a display

device with metal-mesh touch sensors that have openings aligned with each of a plurality of (red, green, and blue) light-emitting areas. Ex-1003, ¶331; §§V.D.2.o (1[f][iii][A]), V.D.2.p (1[f][iii][B]), V.D.2.r (1[g]).

A POSITA would have found it obvious that, when providing different-sized first, second, and third light-emitting areas, mesh holes would be sized commensurate with light-emitting areas. Ex-1003, ¶¶332-33. Otherwise, if the mesh holes' size did not match the size of the light-emitting area, the metal mesh would cover parts of the different-sized light-emitting areas, reducing the display's brightness. Ex-1003, ¶332.

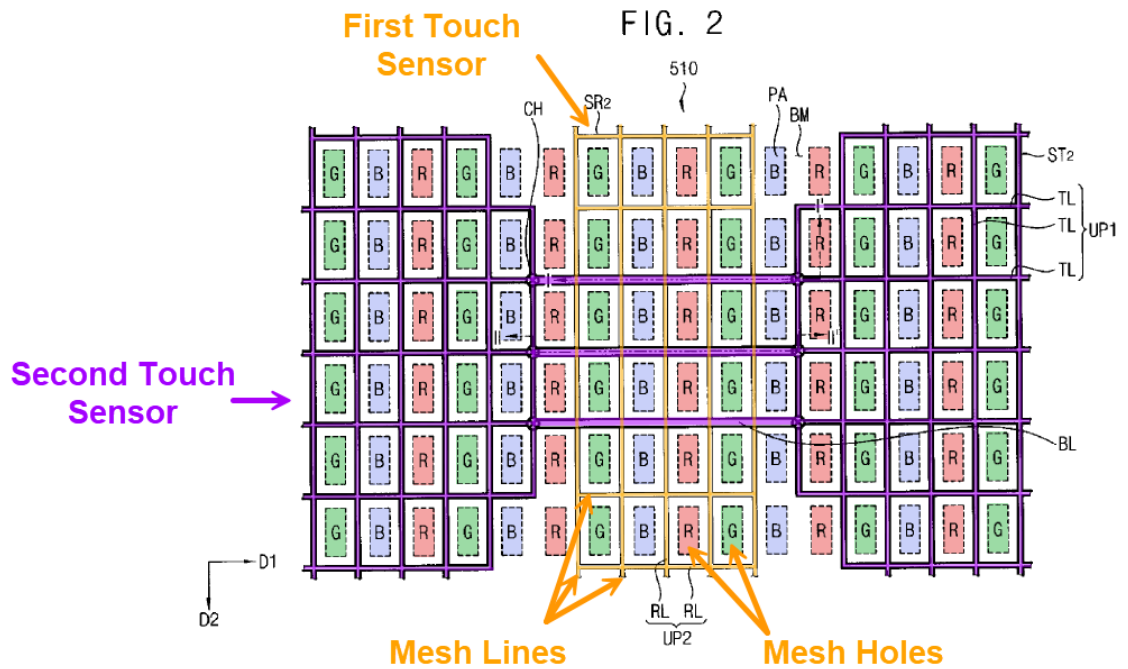
9. Claim 8

Lee-979 teaches or suggests this limitation. §V.D.2.i (1[d][iv]); Ex-1003, ¶334.

10. Claim 9

Lee-979 and Kim teach or suggest this limitation.

Kim shows that no more than one light-emitting area is located in each mesh hole(Ex-1010, Fig. 2), and a POSITA would have found it obvious to modify Lee-979 to implement a metal-mesh touch sensor consistent with Kim(§V.D.2.o (1[f][iii][A]), Ex-1003, ¶¶335-36).



Ex-1010, Fig. 2 (annotated)

11. Claim 10

Lee-979 teaches or suggests this limitation. §V.D.2.n (1[f][iii]); Ex-1003, ¶337.

12. Claim 12

Lee-979 discloses this limitation.

Lee-979 discloses that “[t]he substrate 110 may be a flexible substrate.” Ex-1006, ¶50; ¶¶22, 76, cl. 10; Ex-1003, ¶¶338-39.

E. Ground 2B: Lee-979 Combined with Kim, Cok (with or without Hsieh and/or Kobayashi), and Lee-979-P12 (Claims 11, 17).

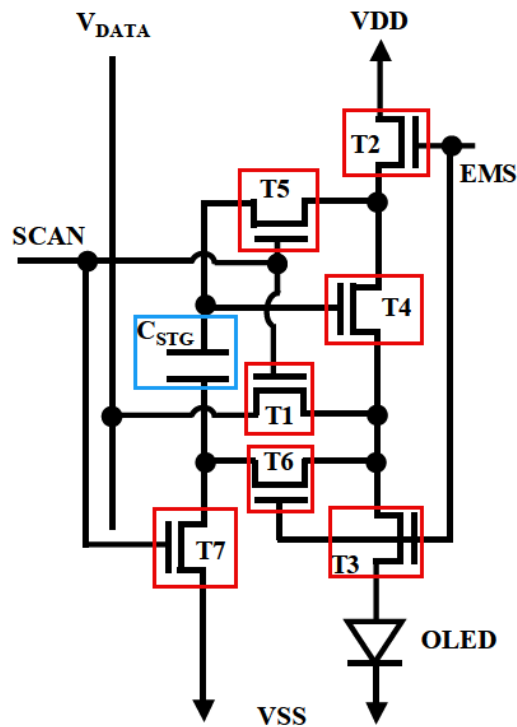
Claims 11 and 17 are obvious in view of (1) Lee-979 combined with Kim, Cok, and Lee-P12, and (2) Lee-979 combined with Kim, Cok, and Lee-P12, further in view of Hsieh and/or Kobayashi.

1. Claim 11

Lee-979 and Lee-P12 teach or suggest this limitation.

Lee-979 discloses that “[t]he electronic device may include at least two [thin-film transistor] TFTs including a driving TFT and a switching TFT, and a storage capacitor.” Ex-1006, ¶53. Lee-979 does not expressly disclose an active matrix with a circuit layer comprising seven transistors and one storage capacitor. Ex-1003, ¶¶340-41.

However, others in the art had recognized that “[w]hen a conventional 2-TFT pixel circuit” like Lee-979’s “is applied to AM-OLED panel, the OLED current varies due to degradation of threshold voltage,” and that various methods have been proposed “to compensate [for] the problem of an inherent threshold voltage shift” in a 2-TFT circuit system. Ex-1011, 264; Ex-1003, ¶342. Lee-979 proposed one solution by utilizing a circuit layer comprising “six switching a-Si:H TFTs and one driving a-Si:H TFT, [and] one storage capacitor,” among other features. *Id.*, 265; Ex-1003, ¶342. Lee-979’s circuit diagram is provided below, with transistors identified in red, and the capacitor identified in blue.



Ex-1011, Fig. 3 (annotations added); Ex-1003, ¶342. Lee-P12’s seven-TFT and one-capacitor circuit “successfully compensates the threshold voltage degradation of TFTs and OLED,” and “may be suitable for large-size and low-cost AM-OLED panel[s].” Ex-1011, 267; Fig. 9 (comparing seven-TFT circuit with two-TFT circuit); Ex-1003, ¶342.

A POSITA would have been motivated to modify Lee-979’s exemplary two-TFT-per-pixel circuit layer with other circuit layers, such as Lee-P12’s seven-TFT-per-pixel circuit layer, to compensate for threshold voltage degradation known to impact two-TFT circuit layers like Lee-979’s. Ex-1003, ¶343. POSITA would have had a reasonable expectation of success in making this modification because Lee-P12 provided the circuit diagram necessary to make the modification, and does not

suggest any novel manufacturing methods are required to produce the modified circuit compared to two-TFT systems. Ex-1003, ¶343.

2. Claim 17

Lee-979 and Lee-P12 teach or suggest this limitation. §V.E.1 (cl. 11); Ex-1003, ¶344.

F. Ground 2C: Lee-979 Combined with Cok, Kim (with or without Hsieh and/or Kobayashi), and Ka (Claims 13-16).

Claims 13-16 are obvious in view of (1) Lee-979 combined with Kim, Cok, and Ka, and (2) Lee-979 combined with Kim, Cok, and Ka, further in view of Hsieh and/or Kobayashi.

1. Claim 13

Lee-979 and Ka teach or suggest this limitation.

Lee-979 discloses the display device may be “flexible.” Ex-1006, ¶¶76-77, 86, 124; Ex-1003, ¶¶345-46. Lee-979 does not, however, expressly state that the flexible display device is “foldable.” Ex-1003, ¶346.

A POSITA would have appreciated that a flexible display would be “foldable” because a flexible display can accommodate some radius of curvature, even if large. Ex-1003, ¶¶347-48. But it was also well-known in the art to configure a flexible display device to be foldable along pre-determined axes to either hide non-display areas of the display from users, or provide larger displays in smaller, foldable form factors. Ex-1003, ¶349. For instance, Ka teaches another display device with: (1) an

OLED display panel comprising a flexible substrate, circuit layer, OLEDs, and an encapsulation layer(Ex-1009, ¶¶66-70); and (2) a touch panel with “wiring regions” for the touch sensors(*id.*, ¶¶110-14; Ex-1003, ¶349). Ka’s display device is specifically configured to “fold” along pre-determined axes to hide non-display areas from users. Ex-1009, Abstract, ¶¶8, 28-30, 58-60, 112-13, Figs. 1, 2, 6, 8-13, 15-18, 20-22, 25-27; Ex-1003, ¶349. However, it was also well-known in the art that the display area could also be configured to be “foldable.” Ex-1003, ¶350; Ex-1034, Abstract, 1:51-58, 2:12-23, 7:6-39, 8:1-49, 11:10-23, 11:60-13:15, Figs. 1A-2B; Fig. 4B (showing display and touch panel layers similar to Lee-979), Figs. 5A-5B, 8A-8B, 11A-11B(showing customizations of display and touch panels to improve folding).

Additionally, a POSITA would have been motivated to configure Lee-979’s display to be foldable along a predetermined axis in some way—to fold non-display regions to hide them from users, or to provide a larger display in a smaller form factor. Ex-1003, ¶351. POSITA would have had a reasonable expectation of success in making Lee-979’s display “foldable” because the prior art taught numerous ways to modify display devices like Lee-979’s to make them more foldable. Ex-1003, ¶352.

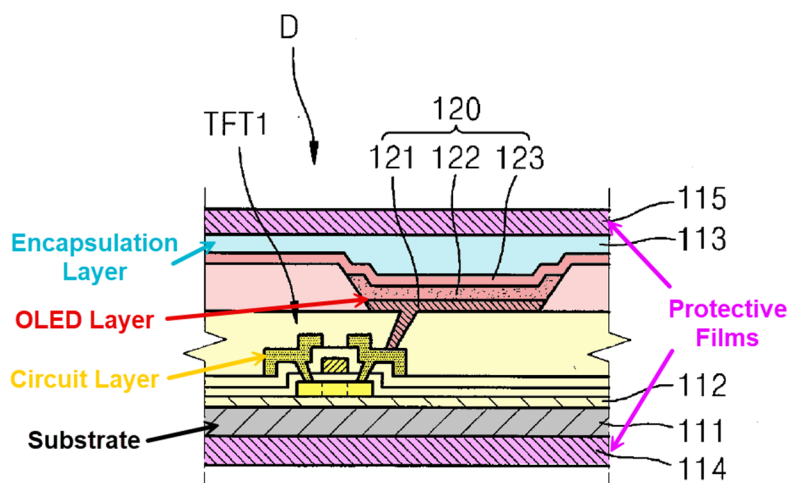
2. Claim 14

Lee-979 and Ka teach or suggest this limitation.

Lee-979 does not expressly disclose layers of the display panel below substrate/base layer. Ex-1006, ¶¶49-50; Ex-1003, ¶¶353-54. However, others in the art provided other material layers above and below the substrate for various purposes. Ex-1003, ¶354.

Ka, for instance, teaches a flexible OLED display panel that includes a “first protective film 114...located on one side of the flexible substrate 111. An adhesive may be injected between the flexible substrate 111 and the first protective film 114.” Ex-1009, ¶74, Fig. 6; ¶66; Ex-1003, ¶355. Ka also teaches a second protective film 115 above the encapsulation layer. Ex-1009, ¶74, Fig. 6; Ex-1003, ¶355.

FIG. 7



Ex-1009, Fig. 7 (annotated)

Ka discloses these protective films are provided to at least “reinforce a structural strength of the flexible display panel”(Ex-1009, ¶74), and specifically “reducing or preventing wirings from cracking due to a bending stress”(id., ¶124; Ex-1003, ¶355).

A POSITA would have been motivated to modify and had a reasonable expectation of success in modifying Lee-979 to incorporate additional protective films on the back surface of the substrate, applied using an adhesive, to reinforce the flexible display and reduce the risk of fracturing electrical wirings due to bending. Ex-1003, ¶356.

3. Claim 15

Lee-979 and Ka teach or suggest this limitation. §V.F.1 (cl. 13); Ex-1003, ¶357.

4. Claim 16

Lee-979 and Ka teach or suggest this limitation.

Lee-979 discloses an embodiment with an “optical member 240,” or a “window” as claimed, disposed on top of the display device to “restrain[] external light from being reflected, thereby improving visibility and contrast of the [display].” Ex-1006, ¶¶99-100, Fig. 3B. Lee-979 does not, however, expressly disclose optical member 240 is attached to the display device using an organic adhesive. Ex-1003, ¶¶358-59.

Offering a “window” on top of a display, attached using an organic adhesive, was well-known in the art. Ex-1003, ¶360; Ex-1016, 8:20-35; Ex-1035, 8:13-35; Ex-1036, ¶¶71, 87-88; *see generally* Ex-1009, ¶¶118-19(attaching window with an adhesive, generally). A POSITA would have been motivated to use an organic adhesive to add a protection window to Lee-979’s touch panel because such adhesives were well-known in the art to attach windows. Ex-1003, ¶360; *Compare* Ex-1001, 8:57-65(noting optical clear adhesive (OCA) or pressure sensitive adhesive (PSA), or polyurethane-, polyacryl-, polyester-, or poly epoxy-based adhesives are exemplary organic adhesives) Ex-1035, 8:13-35 (attaching window using optical clear adhesive), Ex-1036, ¶87 (noting window can be attached to touch panel using a “rubber-based adhesive, acryl-based adhesive, vinyl ether-based adhesive...urethane-based adhesive, pressure sensitive adhesive”).

VI. CONCLUSION

The Challenged Claims, claims 1-17, are unpatentable.

VII. MANDATORY NOTICES

A. Real Party in Interest

Petitioner BOE Technology Group Co., Ltd. identifies the following parties as all real parties in interest for the purpose of this Petition:

1. Mianyang BOE Optoelectronics Technology Co., Ltd.,
2. Ordos Yuansheng Optoelectronics Co., Ltd.,

3. Chengdu BOE Optoelectronics Technology Co., Ltd.,
4. Chongqing BOE Optoelectronics Technology Co., Ltd.,
5. Wuhan BOE Optoelectronics Technology Co., Ltd.,
6. Yunnan Invensight Optoelectronics Technology Co., Ltd. f/k/a BMOT
f/k/a Kunming BOE Display Technology, and
7. BOE Technology America, Inc. (“BOE”).

B. Related Matters

To the best of Petitioner’s knowledge, the ’496 patent has been involved in the following matters:

- *Samsung Display Co. v. BOE Technology Group Co.*, No. 2:25-cv-00426-JRG (E.D. Tex.).

C. Notice of Counsel and Service Information

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Petitioner consents to electronic service. All services and communications to the attorneys listed above may be sent to:

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D. Power of Attorney

A power of attorney is filed herewith according to 37 C.F.R. §42.10(b).

Respectfully submitted,

/ *Bing Ai* /

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Date: August 31, 2025

CERTIFICATE OF WORD COUNT UNDER 37 CFR §42.24(d)

Pursuant to 37 C.F.R. §42.24(a), Petitioner hereby certifies that portions of the above-captioned Petition for *inter partes* review of U.S. Patent No. 11,500,496 B2, in accordance with and reliance on the word count provided by the word-processing system used to prepare this Petition, that the number of words in this paper is 13,900. Pursuant to 37 C.F.R. §42.24(a), this word count is in compliance and excludes the table of contents, table of authorities, mandatory notices under §42.8, certificate of service, certificate of word count, appendix of exhibits, and any claim listing. This word count was prepared using Microsoft Word.

Respectfully submitted,

/ *Bing Ai* /

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Attorney for Petitioner

Date: August 31, 2025
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CERTIFICATE OF SERVICE

The undersigned hereby certifies that true copies of the Petition for *inter partes* review of U.S. Patent No. 11,500,496 B2 and supporting materials (Exhibits and Power of Attorney) were served via USPS Priority Mail Express delivery on the Patent Owner at the correspondence address of record as listed at the USPTO's Patent Center at the time of this filing:

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Date: August 31, 2025