

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG DISPLAY CO., LTD.,
Petitioner

v.

WUHAN CHINA STAR OPTOELECTRONICS SEMICONDUCTOR DISPLAY
TECHNOLOGY CO., LTD.
Patent Owner.

Case No. IPR2026-00486
U.S. Patent No. 11,957,031

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 11,957,031**

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LIST OF EXHIBITS¹

Ex. No.	Description
Ex-1001	U.S. Patent No. 11,957,031 (“the ’031 Patent”)
Ex-1002	Declaration of Dr. Michael Lebby
Ex-1003	Curriculum Vitae of Dr. Michael Lebby
Ex-1004	Prosecution History of U.S. Patent No. 11,957,031
Ex-1005	U.S. Patent Publication No. 2022/0061168 to Shin (“Shin”)
Ex-1006	PCT Patent Publication No. WO2022/051943 to Luo (“Luo”)
Ex-1007	U.S. Patent No. 12,507,538 to Lee (“Lee’538”)
Ex-1008	Korean Patent Publication No. 2019/0005703 to Lee
Ex-1009	Translation of Korean Patent Publication No. 2019/0005703 to Lee (“Lee’703”)
Ex-1010	U.S. Patent Publication No. 2019/0096975 to Park (“Park”)
Ex-1011	Korean Patent Application No. 2021/0052532 to Lee
Ex-1012	Translation of Korean Patent Application No. 2021/0052532 to Lee (“Lee’532”)
Ex-1013	INTENTIONALLY LEFT BLANK
Ex-1014	INTENTIONALLY LEFT BLANK
Ex-1015	INTENTIONALLY LEFT BLANK
Ex-1016	INTENTIONALLY LEFT BLANK

¹ Four-digit pin citations that begin with 0 are to the branded numbers added by Samsung in the bottom right corner of the exhibits. All other pin citations are to original page, column, paragraph, or line numbers.

Ex. No.	Description
Ex-1017	INTENTIONALLY LEFT BLANK
Ex-1018	INTENTIONALLY LEFT BLANK
Ex-1019	INTENTIONALLY LEFT BLANK
Ex-1020	Claim mapping table for the '031 Patent
Ex-1021	U.S. Patent No. 10,777,101 to Park (“Park’101”)
Ex-1022	U.S. Patent Publication No. 2024/0269956 to Kang (“Kang”)
Ex-1023	U.S. Patent No. 11,686,883 to Kim (“Kim’883”)
Ex-1024	Gregory P. Crawford, Flexible Flat Panel Displays, Wiley Series in Display Technology (2005) (“Crawford”)
Ex-1025	U.S. Patent Publication No. 2017/0047547 to Son (“Son”)
Ex-1026	Chinese Patent No. 112,786,807 to Zeng
Ex-1027	Chuan X. Xu et al., Foldable AMOLED Display Utilizing Novel COE Structure, 2018 Soc’y Info. Display Dig. Tech. Papers 310 (“Xu”)
Ex-1028	U.S. Patent No. 12,108,621 to Lee (“Lee’621”)
Ex-1029	U.S. Patent No. 10,826,003 to Um (“Um”)
Ex-1030	U.S. Patent No. 11,537,226 to Lee (“Lee’226”)
Ex-1031	U.S. Patent Publication No. 2020/0403039 to Park (“Park’039”)
Ex-1032	Korean Patent Publication No. 2019/0078835 to Lee
Ex-1033	U.S. Patent No. 10,651,246 to Park (“Park’246”)
Ex-1034	U.S. Patent No. 12,527,206 to Onoue (“Onoue”)
Ex-1035	U.S. Patent Publication No. 2019/0221774 to Jeon (“Jeon”)

Ex. No.	Description
Ex-1036	U.S. Patent Publication No. 2017/0262109 to Choi (“Choi”)
Ex-1037	U.S. Patent No. 10,840,476 to Lee (“Lee’476”)
Ex-1038	U.S. Patent No. 9,780,157 to Kwon (“Kwon”)
Ex-1039	Certified translation of Korean Patent Publication No. 2019/0078835 to Lee (“Lee’835”)
Ex-1040	Certified translation of Chinese Patent No. 112,786,807 to Zeng

I. INTRODUCTION

Samsung Display Co., Ltd. (“Petitioner”) requests *inter partes* review (“IPR”) of Claims 1–19 of U.S. Patent No. 11,957,031 (“the ’031 Patent”) (Ex-1001), currently assigned to Wuhan China Star Optoelectronics Semiconductor Display Technology Co., Ltd. (“Patent Owner” or “PO”).

II. MANDATORY NOTICES UNDER 37 C.F.R. § 42.8

Real Parties-in-Interest: Petitioner maintains that Petitioner Samsung Display Corporation is the only real party-in-interest in this proceeding. Specifically, petitioner maintains for example that its corporate parent, Samsung Electronics Ltd. does not fund or have the ability to control this proceeding. *See Sun Pharmaceutical Industries, Inc. v. Biofrontera*, PGR2026-00021, Paper 12 (PTAB May 26, 2026). However, out of an abundance of caution and based on the Board’s recent precedent, Petitioner identifies Samsung Electronics Ltd. as its corporate parent.

Related Matters: PO has asserted the ’031 Patent against Petitioner in *Wuhan China Star Optoelectronics Semiconductor Display Technology Co., Ltd. v. Samsung Display Co., Ltd. et al.*, 2:26-cv-228 (E.D. Tex.) (“Samsung litigation”).

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III. FEE AUTHORIZATION

The PTO is authorized to charge any fees due during this proceeding to Deposit Account No. LA500639.

IV. GROUNDS FOR STANDING

Petitioner certifies that the '031 Patent is available for review, and Petitioner is not barred or estopped from requesting review.

V. PRECISE RELIEF REQUESTED

Petitioner requests review and cancellation of Claims 1–19 as unpatentable based on the following grounds, supported by a declaration from Dr. Michael Lebby. Ex-1002 ¶¶1-221 (citing Ex-1001, Exs-1004–1012, Exs-1020–1040); Ex-1003.

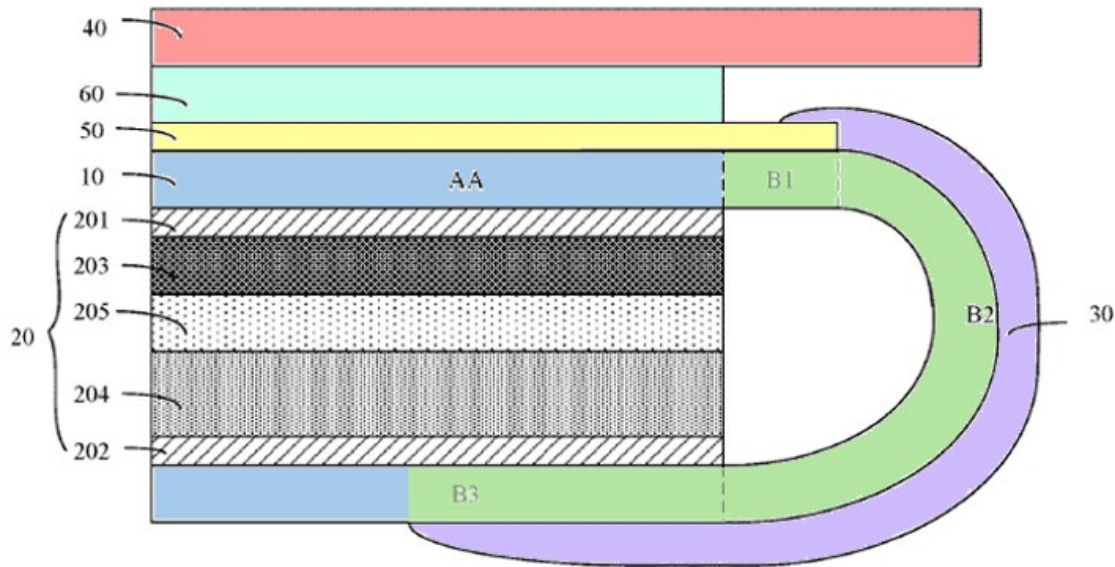
Ground	Summary
1	Claims 1–3, 5, 7, 9–15, and 17–19 are obvious over Shin (Ex-1005)
2	Claims 1–3, 5, 7–15, and 17–19 are obvious over Shin and Luo (Ex-1006)
3–4	Claim 3 is obvious over Shin and Lee’538 (Ex-1007) or Shin-Luo and Lee’538
5–6	Claims 4–6 are obvious over Shin and Lee’703 (Ex-1009) or Shin-Luo and Lee’703
7–8	Claim 16 is obvious over Shin and Park (Ex-1010) or Shin-Luo and Park

VI. THE CHALLENGED PATENT

The ’031 Patent teaches a display device that purportedly “solve[s] a problem of current OLED display panels having the risk of cracking.” Ex-1001, 2:4–6. As shown in annotated Figure 1 below,² the ’031 Patent teaches a display device, which includes flexible screen body 10, color filter 50 (yellow), protective layer 30 (purple), coverplate 40 (red), and optical adhesive 60 (teal), among other components. Ex-1001, 4:32–28, Fig. 1. The ’031 Patent further teaches that “flexible screen body 10 can be divided into a planar area AA [blue]” for displaying and “a bending area [green] extending from the planar area AA ... that cannot display,”

² Throughout, emphasis and annotations are added unless otherwise specified.

which includes “a transitional bending sub-area B1, a bending sub-area B2, and an extending bending sub-area B3.” Ex-1001, 4:33–40.



Independent Claim 1 recites an arrangement of the device’s components including that color filter 50 is disposed on flexible screen body 10, covering the planar area; protective layer 30 is disposed on flexible screen body 10, covering part of the bending area; and coverplate 40 is disposed on color filter 50, covering the planar area. Ex-1001, Cl. 1, 12:10–23. The claim additionally recites that in an overlapping area of protective layer 30 and coverplate 40, a distance between protective layer 30 and coverplate 40 “is greater than or equal to a default value,” which is “greater than 0.” *Id.* The default value “may be flexibly adjusted according to actual needs” so that “coverplate 40 will not squeeze the protective layer 30,

thereby preventing a risk of cracking the display device.” Ex-1001, 7:1–10; Ex-1002 ¶¶63–64.

VII. PROSECUTION HISTORY OF THE ’031 PATENT

The Examiner did not issue any office actions during prosecution. Ex-1004; Ex-1002 ¶¶65–66.

VIII. LEVEL OF ORDINARY SKILL IN THE ART

A person of ordinary skill in the art (“POSITA”) at the relevant time would have had at least a bachelor’s degree in electrical engineering, materials science, mechanical engineering, or a related field, and two years of experience in the design and/or development of display devices in consumer electronics, including familiarity with OLED displays, flexible display panels, display module structures, adhesives, and/or packaging technologies, with additional education substituting for experience and vice versa. Ex-1002 ¶¶42–46.

IX. PRIORITY DATE

For purposes of this proceeding only, Petitioner applies the earliest alleged priority date of the ’031 Patent: May 20, 2021.³

³ Petitioner respectfully reserves the right to challenge the priority date in other proceedings.

X. CLAIM CONSTRUCTION

Petitioner interprets the claims according to *Phillips*. 37 C.F.R. §42.100(b). To resolve this Petition, Petitioner does not believe that any term requires express construction.⁴ CTPG, 44; Ex-1002 ¶¶47–49.

XI. BRIEF DESCRIPTION OF THE APPLIED PRIOR ART

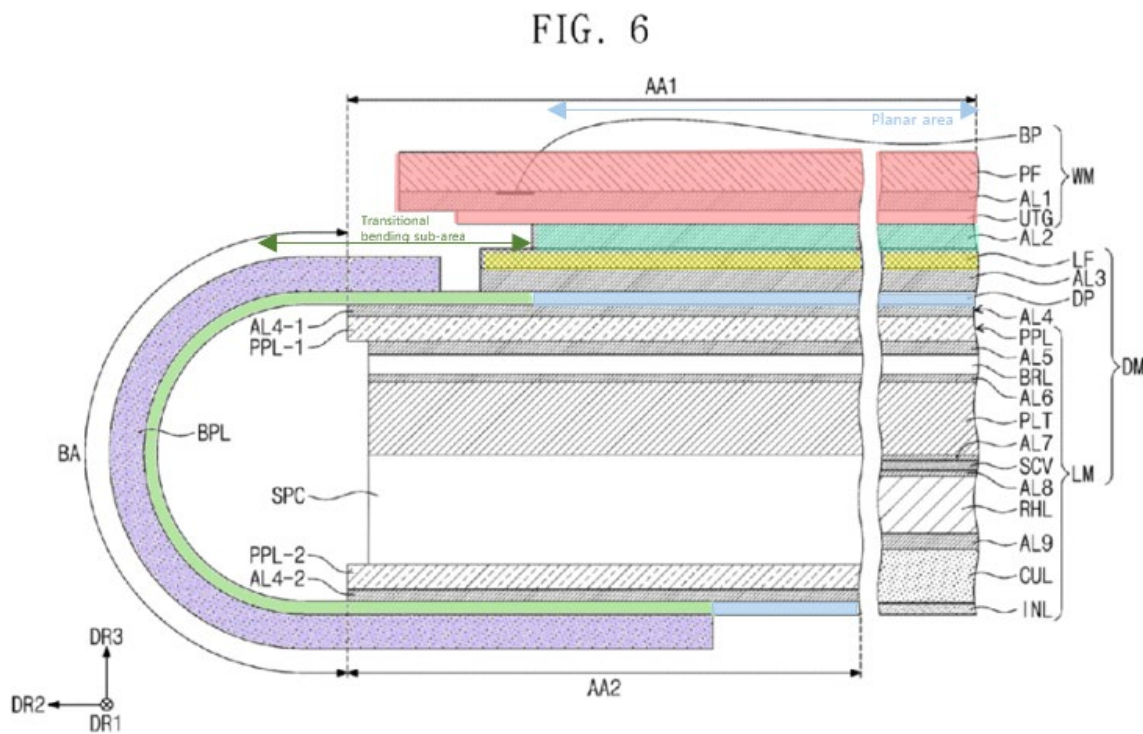
A. Shin (Ex-1005)

Shin was filed April 28, 2021, published February 24, 2022, and is prior art to the '031 Patent under 35 U.S.C. §102(a)(2). Ex-1002 ¶¶67–68.

Shin teaches a “foldable display device and an electronic device including the same.” Ex-1005 ¶2. As shown in annotated Figure 6 below, Shin teaches that its display device comprises display panel DP, which includes “a display area DP-DA [blue] and a non-display area DP-NDA” (Ex-1005 ¶69) and “a first panel area AA1, a second panel area AA2 and a bending area BA which are planar areas distinguished from each other along the second direction DR2” (*id.* ¶91). Moreover, Shin teaches that optical film LF (yellow), which includes “color filters,” is disposed in the first panel area AA1,” covering DP-DA, and coupled to display panel DP. Ex-1005 ¶¶86,

⁴ The Samsung litigation is in its infancy. Petitioner respectfully reserves all rights to raise claim construction and other arguments in district court and will request leave to submit the district court’s claim construction as soon as it becomes available. Additionally, should PO raise express or implied claim construction arguments in its Preliminary Response, Petitioner will respectfully seek a Preliminary Reply to respond. Consolidated Trial Practice Guide (“CTPG”), 44–45.

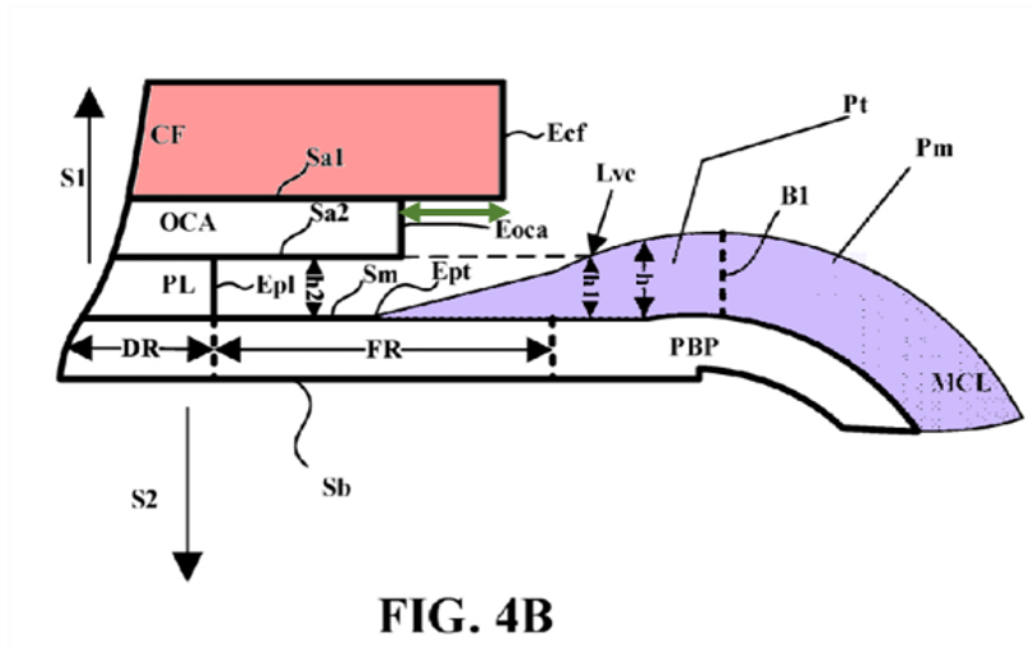
115. Shin further teaches bending protection layer BPL (purple), which is disposed on DP “in at least the bending area BA [green].” Ex-1005 ¶148. Additionally, Shin teaches “window module WM (e.g., window)” (red), which is coupled to LF by second adhesive layer (teal), “defines the front surface of the electronic device ED,” and includes “a thin-film glass substrate UTG, a plastic film PF disposed on ... UTG, a first adhesive layer AL1 coupling ... UTG and ... PF and a bezel pattern BP.” Ex-1005 ¶¶67, 102, 115; *see also id.* ¶103. Shin also teaches that adhesive layer AL2 may “have a thickness of about 35 μm to about 65 μm , e.g., about 50 μm .” Ex-1005 ¶111.



B. Luo (Ex-1006)

Luo was filed September 9, 2020, published March 17, 2022, and is prior art to the '031 Patent under 35 U.S.C. §102(a)(2). Ex-1002 ¶¶69–70.

Luo teaches a display apparatus having a structure for eliminating interference “by defining critical parameters including at least one of the first shortest distance Ds1, the second shortest distance Ds2, the third shortest distance Ds3, or the fourth shortest distance Ds4.” Ex-1006 ¶77. Specifically, as shown in annotated Figure 4B below, Luo teaches that “fourth shortest distance Ds4 [designated by the green arrow] between the orthographic projection of the edge Eoca ... on the plane ... of the display portion DP and the orthographic projection of the edge Ecf of the cover window CF [red] adjacent to the tapered portion Pt on the plane ... of the display portion DP is equal to or greater than a second value.” Ex-1006 ¶68. Luo further teaches that “the second value is equal to a bonding tolerance of the optically clear adhesive layer OCA,” which may be “in a range of 100 μm to 200 μm ” such that, for example, “fourth shortest distance Ds4 is equal to or greater than 150 μm .” Ex-1006 ¶69. Luo also teaches that “not only the interference between the *cover window CF [red]* and the *coating layer MCL [purple]* can be eliminated, but also other defects such as cover window depression, bending portion cracking, and light leakage.” Ex-1006 ¶77.



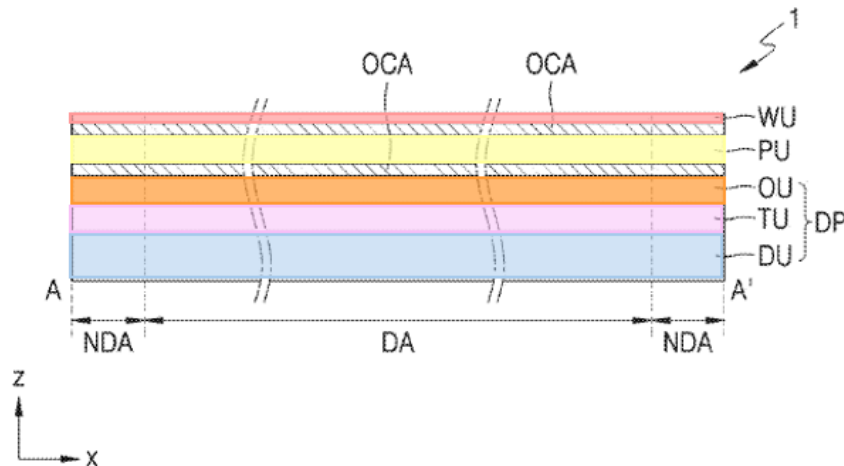
C. Lee'538 (Ex-1007)

Lee’538 was filed January 24, 2022, claims priority to Korean Patent Application No. 2021/0052532 (“Lee’532”) filed April 22, 2021, and issued December 23, 2025. A certified translation of Lee’532 (Ex-1011) is attached as Ex-1012. Lee’538 is prior art to the ’031 Patent under 35 U.S.C. §102(a)(2). Ex-1002 ¶¶71–73.

Lee’538 teaches a display apparatus, which includes “display layer DU,” “touch sensing layer TU,” “optical functional layer OU,” “polarization layer PU,” and a window layer WU.” Ex-1007, 6:33–36. As shown in annotated Figure 2A below, Lee’538’s touch sensing layer TU (pink) is disposed between display layer DU (blue) and optical functional layer OU (orange). Ex-1007, Fig. 2A. Moreover,

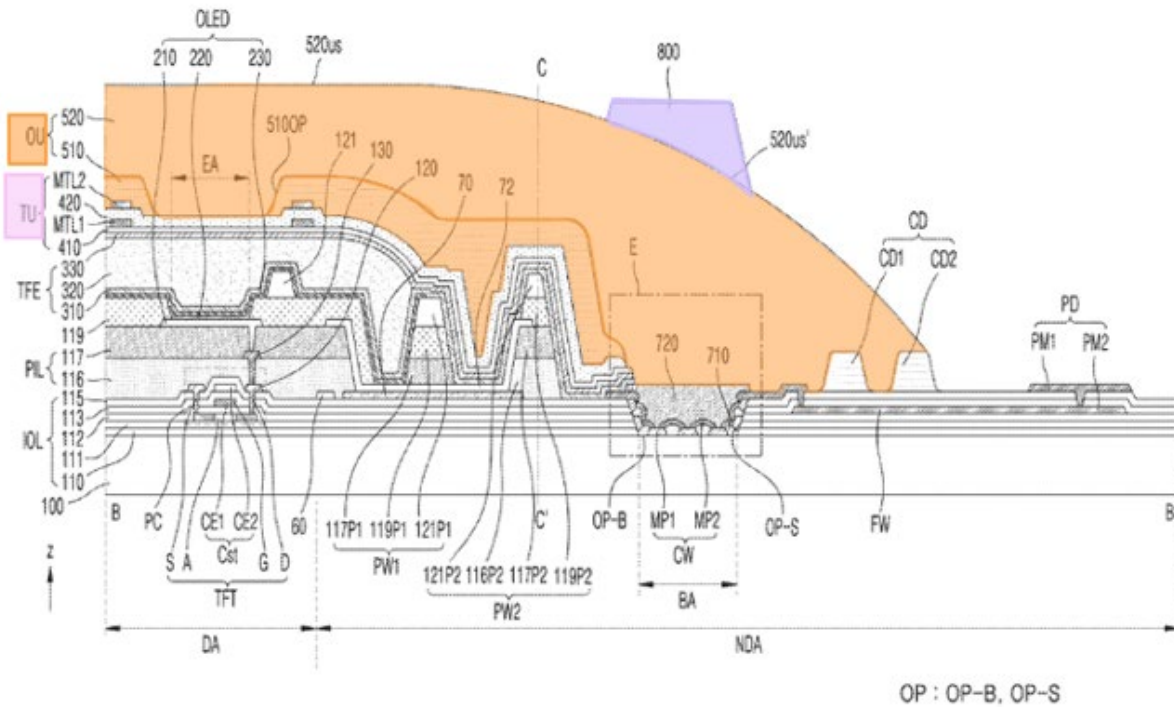
Lee'538's polarization layer PU (yellow) is disposed between the OU and WU layers. *Id.*

FIG. 2A



As shown in annotated Figure 6 below, Lee'538 teaches that “optical functional layer OU may be disposed on the touch sensing layer TU” and includes first layer 510 and second layer 520 (orange) “arranged on the first layer 510.” Ex-1007, 15:39–44, Fig. 6. Both first layer 510 and second layer 520 include “an insulating material” and second layer 510 “extend[s] over the peripheral area NDA while covering the bending area BA.” Ex-1007, 11:40–41, 15:43–59. Lee'538 further teaches stress reduction layer 800 (purple), which is “disposed on the second layer 520,” “arranged to correspond to the bending area BA,” and includes “an organic insulating material.” Ex-1007, 19:18–22.

FIG. 6

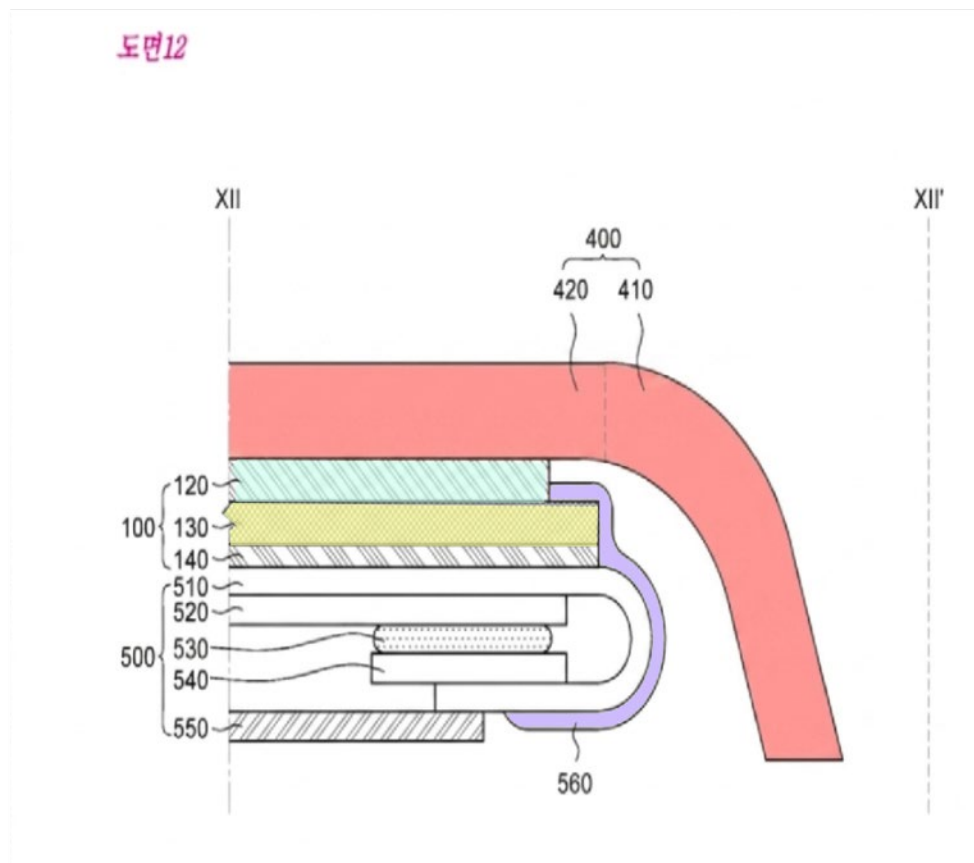


D. Lee'703 (Ex-1009)

Lee'703 was filed December 26, 2017, published January 16, 2019, and is prior art to the '031 Patent under 35 U.S.C. §102(a)(1). A certified translation of Lee'703 (Ex-1008) is attached as Ex-1009. Ex-1002 ¶¶74–75.

Lee'703 teaches “a polarizer and an organic light-emitting display device equipped therewith.” Ex-1009, Abstract. As shown in annotated Figure 12 below, Lee'703 teaches that “polarizer (100) and the organic light-emitting display panel (500) are disposed inside the cover glass (400) [red].” Ex-1009 ¶106, Fig. 12. Specifically, Lee'703 teaches that “polarizer (100) is disposed beneath the planar surface portion (420) of the cover glass (400)” and comprises first adhesive layer

(120) (teal), polarizing layer (130) (yellow), and second adhesive layer (140). Ex-1009 ¶108. Lee’703 further teaches that display panel (500) includes coating layer (560) (purple), which “may be disposed on a portion of the upper surface of the polarizing layer (130).” Ex-1009 ¶¶110, 117. Lee’703 also teaches that coating layer (560) “is composed of an insulating material,” “intended to prevent moisture penetration and wiring cracks,” and covers “at least the bent region.” Ex-1009 ¶116.

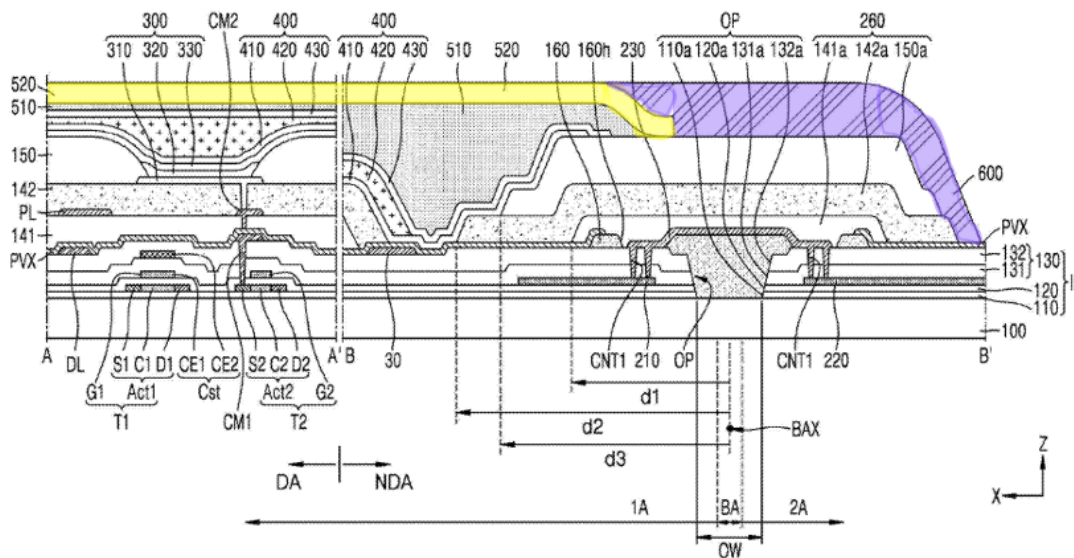


E. Park (Ex-1010)

Park was filed January 12, 2018, published March 28, 2019, and is prior art to the ’031 Patent under 35 U.S.C. §102(a)(1). Ex-1002 ¶¶76–77.

Park teaches a display apparatus comprising display area DA including pixels P, which “may emit, for example, a red light, a green light, a blue light or a white light through the OLED.” Ex-1010 ¶¶57–58. As shown in annotated Figure 3 below, Park also teaches a color filter 520 (yellow), which clarifies emission color and reduces “the reflection of external light due to the inclusion of a matrix of a color corresponding to the color of each pixel and a black matrix.” Ex-1010 ¶¶92–93, Fig. 3. Park further teaches a bending protection layer 600 (purple), which is disposed on the surface of color filter 520. Ex-1010 ¶130.

FIG. 3



XII. DETAILED EXPLANATION OF THE UNPATENTABILITY GROUNDS

A. Ground 1: Claims 1–3, 5, 7, 9–15, and 17–19 Are Obvious over Shin

1. Independent Claim 1

a. 1[pre]: A display device, comprising:

Shin teaches⁵ the preamble, to the extent it is limiting. Ex-1002 ¶¶78–79.

Shin teaches a “foldable *display device*.” Ex-1005 ¶2. Figures 1A–1B below depict “perspective views” of an embodiment of Shin’s display device. Ex-1005, Figs. 1A-1B.

FIG. 1A

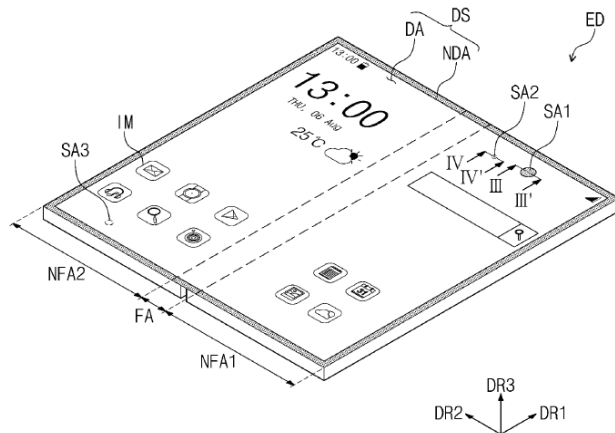
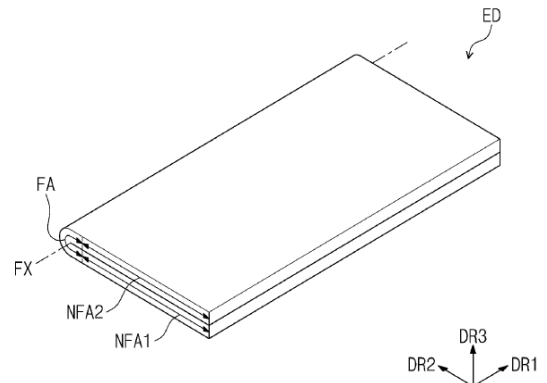


FIG. 1B

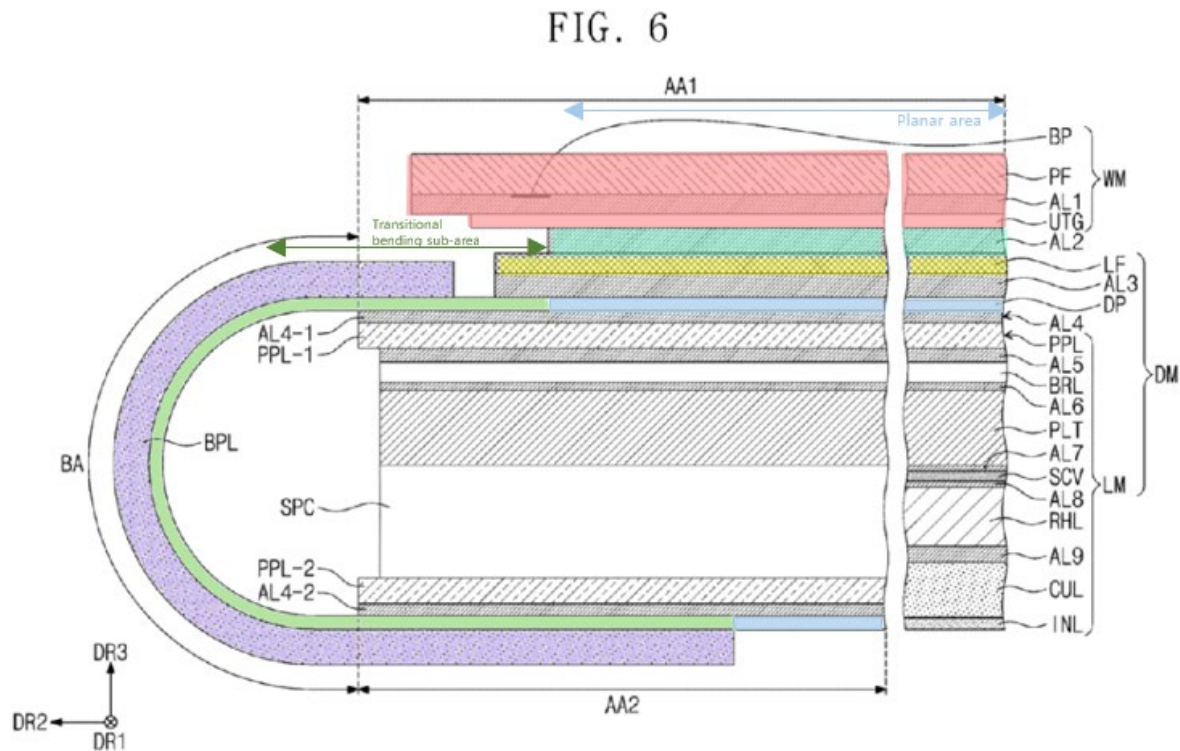


b. 1[a]: a flexible screen body comprising a planar area and a bending area connected to the planar area;

Shin teaches Element 1[a]. Ex-1002 ¶¶80–81.

⁵ Petitioner uses the term “teaches” to include both express teachings and those fairly suggested to a person of ordinary skill in the art. *In re Baird*, 16 F.3d 380, 383 (Fed. Cir. 1994); *In re Keller*, 642 F.2d 413, 425 (C.C.P.A. 1981) (“The test for obviousness is...what the combined teachings of the references would have suggested to those of ordinary skill in the art.” (citations omitted)).

Shin's display device includes a flexible screen body comprising a planar area and bending area connected to the planar area. Shin teaches that "electronic device ED which is flat may include a display surface DS *in a plane which is parallel to a plane* defined by a first direction DR1 and a second direction DR2 which crosses the first direction DR1." Ex-1005 ¶53. Shin also teaches that the ED "may include a display device DD," which "generates an image IM and/or senses an external input" and includes display module DM having display panel DP. Ex-1005 ¶68. As shown in annotated Figure 6 below, similar to the challenged patent, Shin's DP includes "a display area DP-DA [blue] and a non-display area DP-NDA ... adjacent to the display area DP-DA." Ex-1005 ¶¶53–54, 69, 90, Fig. 6. Shin further teaches that the display area "*may be a planar area at which the image IM is displayed,*" and the non-display area "may be a planar area at which the image IM is not displayed." Ex-1005 ¶54. The non-display area "surround[s] the display area ... in a plan view." *Id.* Shin explains that the display area and the non-display area "together may define a front surface of the ... ED," which "may have a total planar area including planar areas of both the" display area and non-display area. *Id.* Shin also teaches that "display panel DP may be bendable at the bending area BA along the bending axis." Ex-1005 ¶¶93, 99 (Fig. 6 illustrates "a cross-sectional view of ... display device DD which is ben[t] or folded at the bending area BA.")).



Shin teaches that “*display panel DP* further *includes a first panel area AA1*, a second panel area AA2 and a *bending area BA* [green] *which are planar areas* distinguished from each other along ... DR2.” Ex-1005 ¶91, Fig. 6. Moreover, Shin teaches that “*first panel area AA1 corresponds to the display surface DS in FIG. 1A*” and “[e]ach of the *bending area BA* and the second panel area AA2 *may be a partial area of the non-display area DP-NDA*” on the DS. Ex-1005 ¶¶91–92. Shin’s bezel pattern BP (red), is “disposed on a top surface of the plastic film PF” and “*overlaps the non-display area NDA.*” Ex-1005 ¶103.

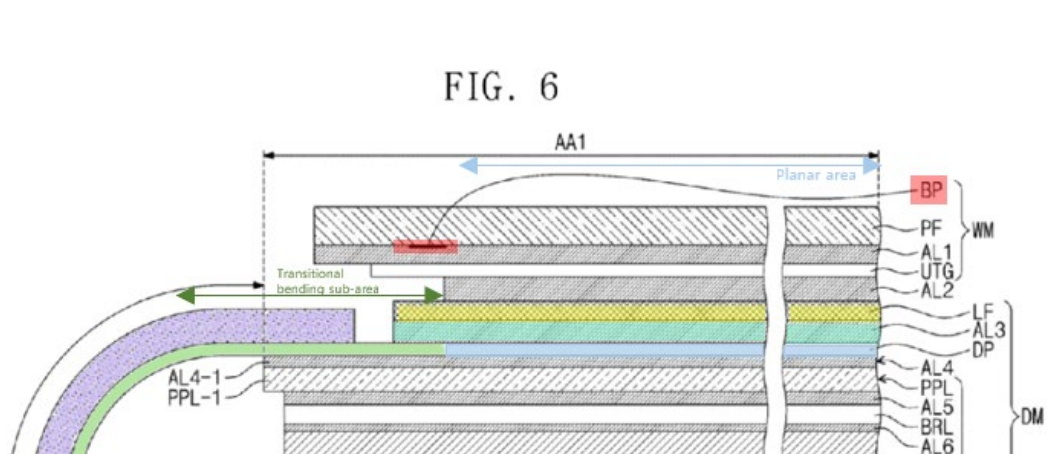
Shin’s display panel DP corresponds to the recited “flexible screen body” because it is bendable. Ex-1005 ¶¶3, 5; Ex-1002 ¶¶82–84; *see also* Ex-1001, 4:33–

34 (“flexible screen body 10 means a highly flexible screen that can be bent and folded”). The portion of first panel AA1 designated by the blue arrow in Figure 6 (extending from the right to bezel portion BP) above corresponds to the recited “planar area” of DP because this is the portion of the display that is both planar and displays the image. Ex-1005 ¶¶92, 103; *see also id.* ¶91 (“first panel area AA1” is a “planar area[]”); *see also* Ex-1001, 4:36–38 (“the planar area AA means an area for displaying, and the bending area means an area that cannot display”). Thus, the “planar area” in the cross-sectional view of Figure 6 extends from the right to BP, but not further left to the remaining length of first panel area AA1, which is the non-display area (NDA). Bending area BA in Figure 6 corresponds to the recited “bending area connected to the planar area” on the non-display side of BP because, for example, Shin teaches that “bending protection layer BPL may be disposed on one portion of the first panel area AA1 and one portion of the second panel area AA2 in addition to the bending area BA,” meaning that they are all connected. Ex-1005 ¶148. Indeed, as shown in annotated Figure 6 above, the transitional bending sub-area designated by the green arrow (extending from the left-most edge of AA1 to BP, as described in more detail below in Section XII.A.2.c) is connected to the “planar area” of AA1 designated by the blue arrow (underneath BP and extending to the right edge), at the point where there is a transition from Shin’s display area to the non-display area. Ex-1005, Fig. 6; Ex-1002 ¶¶84–85.

c. 1[b]: a color filter disposed on the flexible screen body and at least covering the planar area;

Shin teaches Element 1[b]. Ex-1002 ¶¶86.

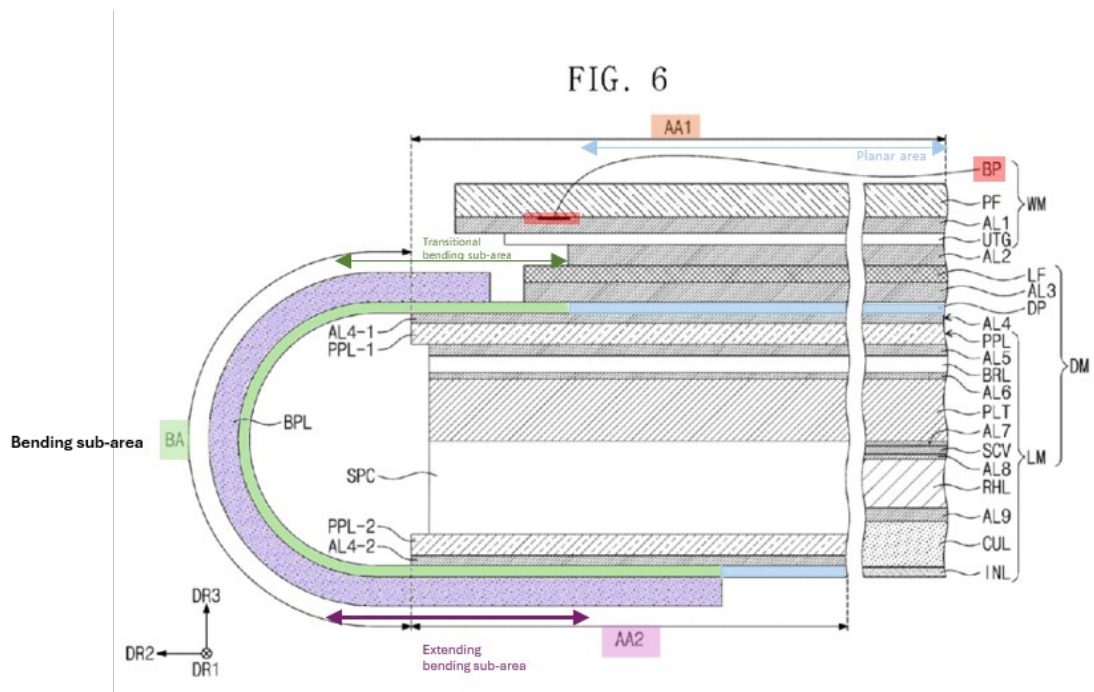
Shin teaches a color filter disposed on the flexible screen body (i.e., DP) and at least covering the planar area (i.e., the section of AA1 described in 1[a], extending from underneath BP to the right). Specifically, Shin teaches that “optical film LF [yellow] is disposed in the first panel area AA1” and “covers at least the display area DP-DA [blue].” Ex-1005 ¶¶115. As shown in annotated and cropped Figure 6 below, optical film LF at least covers this “planar area” of Shin’s first panel AA1, designated by the blue arrow. Ex-1005 ¶¶91–92, 103, Fig. 6. Shin further teaches that “the third adhesive layer AL3 [teal] couples the optical film LF to the display panel DP.” Ex-1005 ¶¶115. Moreover, Shin’s “LF may include color filters in a color filter layer.” Ex-1005 ¶86. Optical film LF thus corresponds to the recited “color filter ... at least covering the planar area” because it covers the entire planar area (DP-DA) and then some. Ex-1002 ¶¶87–88.



- d. **1[c]: a protective layer disposed on the flexible screen body and at least covering a part of the bending area; and**

Shin teaches Element 1[c]. Ex-1002 ¶¶89-92.

Shin teaches a protective layer disposed on the flexible screen body (i.e., DP) and at least covering a part of the bending area (i.e., BA). As shown in annotated Figure 6 below, Shin's bending protection layer BPL (purple) is disposed on the DP and covers at least the bending area BA (green). Ex-1005 ¶148, Fig. 6.



Shin further teaches that “BPL may overlap the bending area BA, the first panel area AA1 and the second panel area AA2.” Ex-1005 ¶148. Specifically, “BPL may be disposed on one portion of the first panel area AA1 and one portion of the second panel area AA2 in addition to the bending area BA.” *Id.* The BPL “protects

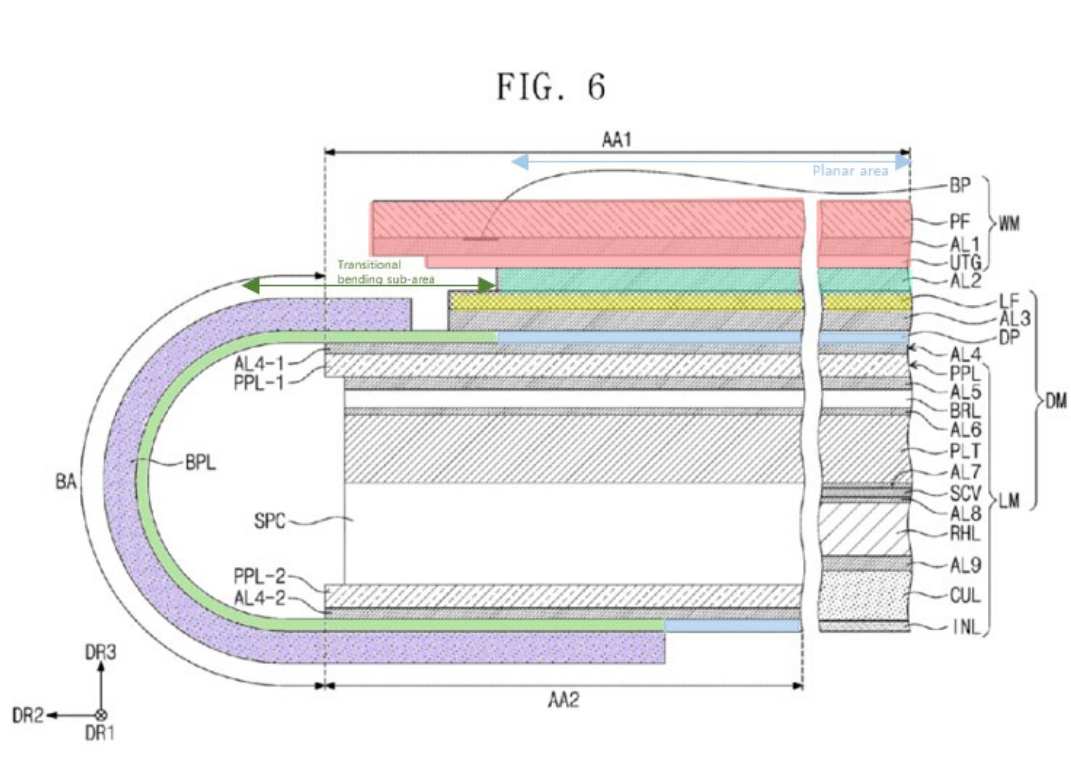
the bending area BA from an external impact” and “controls a neutral plane of” and “a stress of” the BA “so that the neutral plane becomes closer to signal lines disposed in the” BA. Ex-1005 ¶149. Shin’s BPL is thus “a protective layer ... at least covering a part of the bending area” because it covers the bending sub-area BA, as well as the transitional bending areas that extend into Shin’s AA1 and AA2.

e. 1[d]: a coverplate disposed on the color filter and at least covering the planar area;

Shin teaches Element 1[d]. Ex-1002 ¶93.

Shin teaches a coverplate disposed on the color filter (i.e., LF) and at least covering the planar area, blue (i.e., the section of AA1 described in 1[a], extending from underneath BP to the right). Specifically, Shin teaches “a window module WM (e.g., window),” which “defines the front surface of the ... ED.” Ex-1005 ¶67. As shown in annotated Figure 6 below, Shin teaches that “window module WM [red] may include a thin-film glass substrate UTG, a plastic film PF disposed on the ... UTG, a first adhesive layer AL1 coupling the ... UTG and ... PF and a bezel pattern BP.” Ex-1005 ¶102, Fig. 6. Shin further teaches that “second adhesive layer AL2 [teal] couples the optical film LF” (i.e., color filter (yellow)) to window module WM the same way that the recited coverplate is connected to the color filter in the challenged patent. Ex-1005 ¶115; Ex-1001, 2:55–58 (“the coverplate is connected to the color filter by an optical adhesive”). Shin’s window module WM is disposed

on LF via optical adhesive AL2 and it at least covers the “planar area” of AA1 designated by the blue arrow. Ex-1005, Fig. 6; Ex-1002 ¶¶94–95. Shin’s WM thus corresponds to the recited coverplate because it covers the entire planar area (DP-DA) and then some.



- f. 1[e]: wherein in an overlapping area of the protective layer and the coverplate, a distance between the protective layer and the coverplate is greater than or equal to a default value, wherein the default value is greater than 0.**

Shin teaches Element 1[e]. Ex-1002 ¶96.

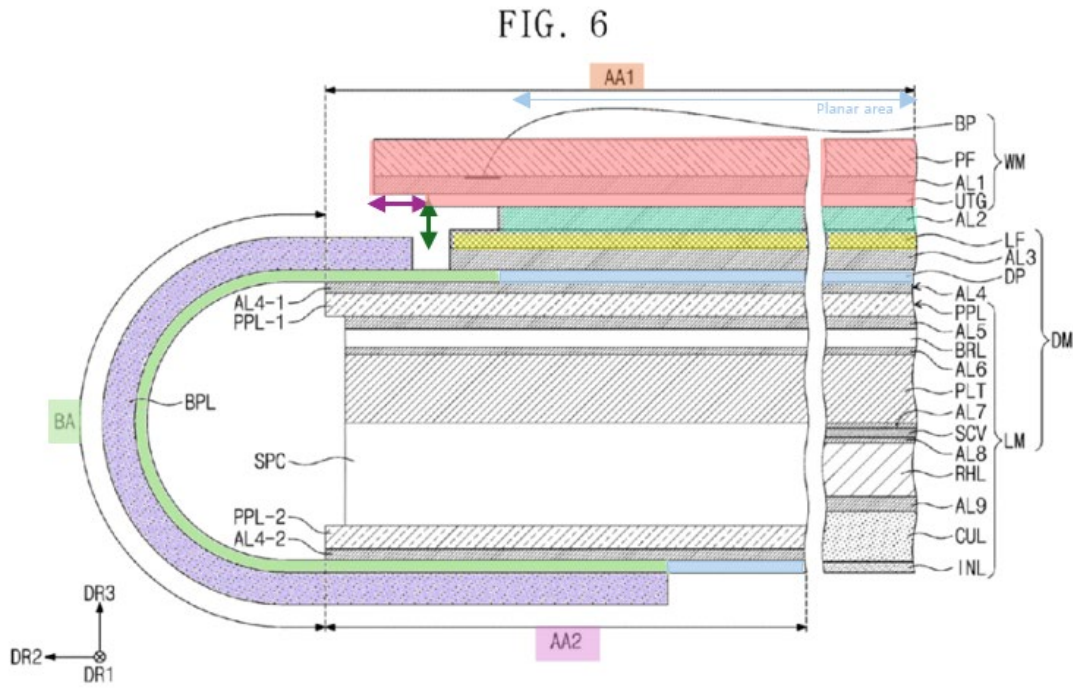
Shin teaches that in an overlapping area of the protective layer (i.e., BPL) and the coverplate (i.e., WM), a distance between the protective layer and the coverplate

is greater than or equal to a default value,⁶ wherein the default value is greater than 0.⁷ As shown in annotated Figure 6 below, the distance (designated by the green arrow) between the BPL (purple) and WM (red) in an overlapping area of the two components (designated by the purple arrow) “is greater than or equal to a default value ... greater than 0” as depicted by the physical gap shown in the figure between BPL and WM. Ex-1005, Fig. 6; Ex-1002 ¶97. Specifically, Shin teaches that “second adhesive layer AL2 [teal] couples the optical film LF” (yellow) to WM. Ex-1005

⁶ The '031 Patent does not define the term “default value” but states that “[i]n an overlapping area of the protective layer 30 and the coverplate of the display device ... a distance between the protective layer 30 and the coverplate 40 is greater than or equal to a default value ... greater than 0 and may be flexibly adjusted according to actual needs Therefore, the *coverplate 40 will not squeeze the protective layer 30, thereby preventing a risk of cracking the display device.*” Ex-1001, 7:1–10. Thus, while it is not clear what the criteria for the “default value” is, a POSITA would have understood that the recited distance greater than 0 between the coverplate and the protective layer must be, at least, large enough to prevent cracking or other damage to the device. Ex-1002 ¶97, n.3.

⁷ The recited “default value” appears to be an unbounded range greater than 0. The prior art teaches such a default value in a reasonable range, as explained herein. Regardless, Samsung reserves the right to argue that the criteria for the “default value” is unclear and/or an unbounded range as recited by the challenged patent is legally improper under section 112. *See, e.g., Cochlear Bone Anchored Sols. AB v. Oticon Med. AB*, 958 F.3d 1348, 1360 (Fed. Cir. 2020) (remanding to the Board, finding that even if a claim is indefinite “such a conclusion would not imply that it is incapable of being compared to prior art to determine if one of its alternatives ... would have been obvious on the grounds asserted”); *MagSil Corp. v. Hitachi Global Storage Techs., Inc.*, 687 F.3d 1377, 1381–84 (Fed. Cir. 2012) (holding claim term’s “open-ended” “at least 10%” term, which did “not have an upper limit,” invalid for lack of enablement because its “broad scope [wa]s “not reasonably supported by the scope of enablement in the specification”).

¶115. Shin further teaches that AL2 “may include a pressure sensitive adhesive or a transparent adhesive such as the optically clear adhesive” and “***have a thickness of about 35 μm to about 65 μm , e.g., about 50 μm .***” Ex-1005 ¶111. Shin thus teaches that a “default value” for the distance in an overlapping area of the BPL and WM components, which encompasses at least the entire thickness of AL2 (as shown in Figure 6) is “***about 50 μm ,***” which is greater than 0. *Id.* Additionally, similar to the ’031 Patent, Shin teaches that this distance may be adjusted as needed to encompass “***a thickness of about 35 μm to about 65 μm .***” Ex-1005 ¶111; *see also id.* ¶113 (explaining how the varied areas of AL1 and AL2 may prevent “a buckling phenomenon or a crack” in UTG and decrease “a probability of foreign substances attached to” AL2); Ex-1002 ¶¶97–99; Ex-1001, 7:1–10. In all cases, the distance is greater than zero, whether it is Shin’s default value of about 50 μm , or anywhere within the allowable range of about 35 μm –65 μm , which prevents failure of Shin’s various layers.



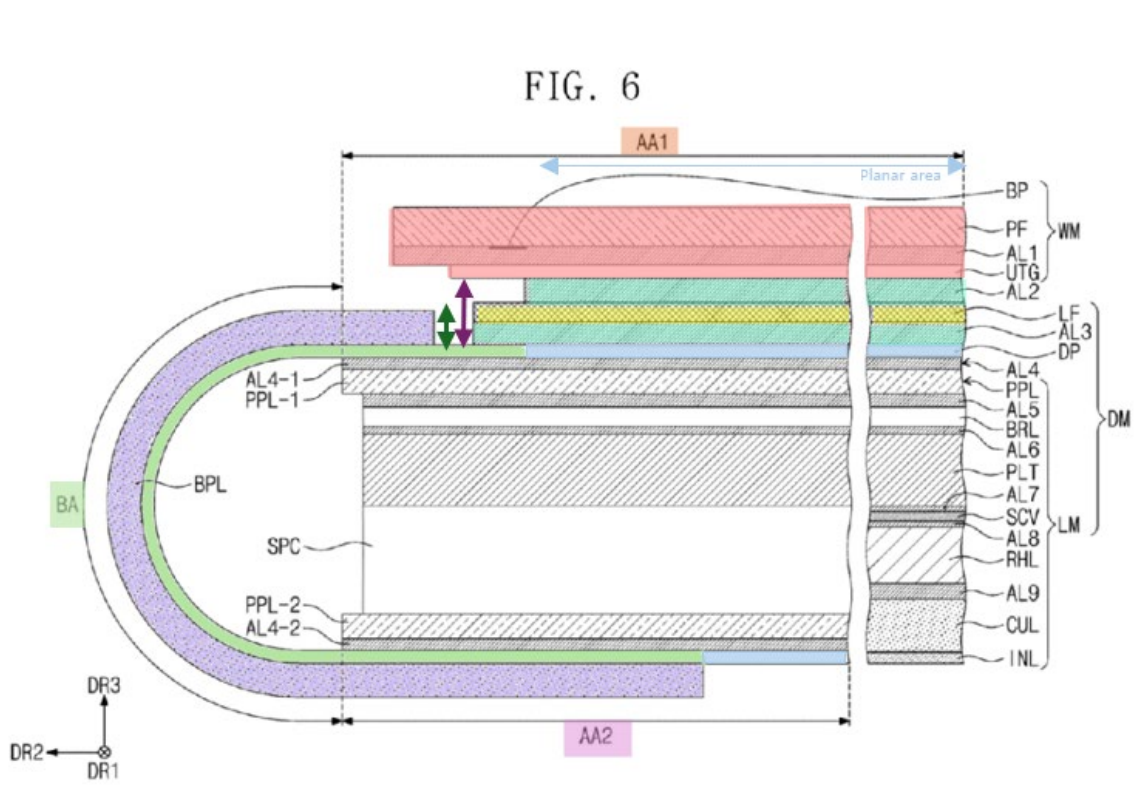
2. Dependent Claims 2–3, 5, 7, 9–15, and 17–19

- a. **Claim 2:** The display device according to claim 1, wherein the protective layer is disposed on a surface of the flexible screen body, and a thickness of the protective layer on the surface of the flexible screen body is less than or equal to a distance between one side of the coverplate adjacent to the flexible screen body and one side of the flexible screen body adjacent to the coverplate.

Shin teaches Claim 2. Ex-1002 ¶100.

Shin teaches that the protective layer (i.e., BPL) is disposed on a surface of the flexible screen body (i.e., DP), and a thickness of the protective layer on the surface of the flexible screen body is less than or equal to a distance between one side of the coverplate (i.e., WM) adjacent to the flexible screen body and one side

of the flexible screen body adjacent to the coverplate. As shown in annotated Figure 6 below, the BPL (i.e., purple) is disposed on a surface of the bending portions of DP (green) and, as indicated by the green and purple arrows, the thickness of the BPL is less than the distance between the WM (red) and the DP. Ex-1005, Fig. 6; Ex-1002 ¶101.



While there is no scale shown in Figure 6, the BPL is depicted as having a thickness that is less than the combined thickness of optical film LF, second adhesive layer AL2, and third adhesive layer AL3, which together separate the DP from the WM. *See, e.g.*, Ex-1005 ¶111 (“second adhesive layer AL2 may have a thickness of about 35 μm to about 65 μm , e.g., about 50 μm ”); Ex-1002 ¶102. Moreover, as

shown in Figure 6, there is a physical gap between the top of BPL (purple) and the bottom of WM (red).

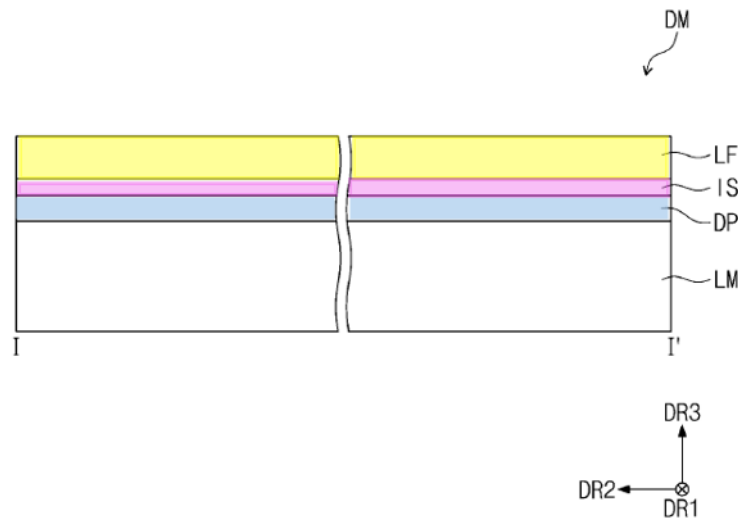
Additionally, the '031 Patent teaches that a POSITA “can set a suitable thickness for the protective layer 30 according to a size and type of the flexible screen body 10, a bending radius of the bending sub-area B2, flexibility and an ability to relieve stresses of the protective layer 30, and is not specifically limited in the embodiment.” Ex-1001, 8:3–10. Like the '031 Patent, Shin teaches that “display device DD which is bent has a curvature and a radius of curvature at the bending area BA,” the BPL “may overlap” with and is “bendable together with the bending area BA,” and the BPL “protects the bending area BA from an external impact” and “controls a neutral plane of” and “a stress of” the BA “so that the neutral plane becomes closer to signal lines disposed in the” BA. Ex-1005 ¶¶147–149. A POSITA would thus have understood that Shin’s BPL would be set at a suitable thickness according to a size and type of the DP, a bending radius of the bending area BA, flexibility and an ability to relieve stresses of the BPL, which would be less than the distance between the WM and the DP because this is consistent with the teachings of both Shin and the '031 Patent. Specifically, the gap shown in Figure 6 ensures that there is adequate physical separation between BPL and WM to prevent damage to them along the bend area of the display. Ex-1002 ¶¶103–104.

- b. **Claim 3: The display device according to claim 1, further comprising a touch control layer disposed between the flexible screen body and the color filter and an insulating layer disposed between the touch control layer and the color filter; wherein the protective layer is disposed on a surface of the insulating layer, and a thickness of the protective layer on the surface of the insulating layer is less than or equal to a distance between one side of the coverplate adjacent to the insulating layer and one side of the insulating layer adjacent to the coverplate.**

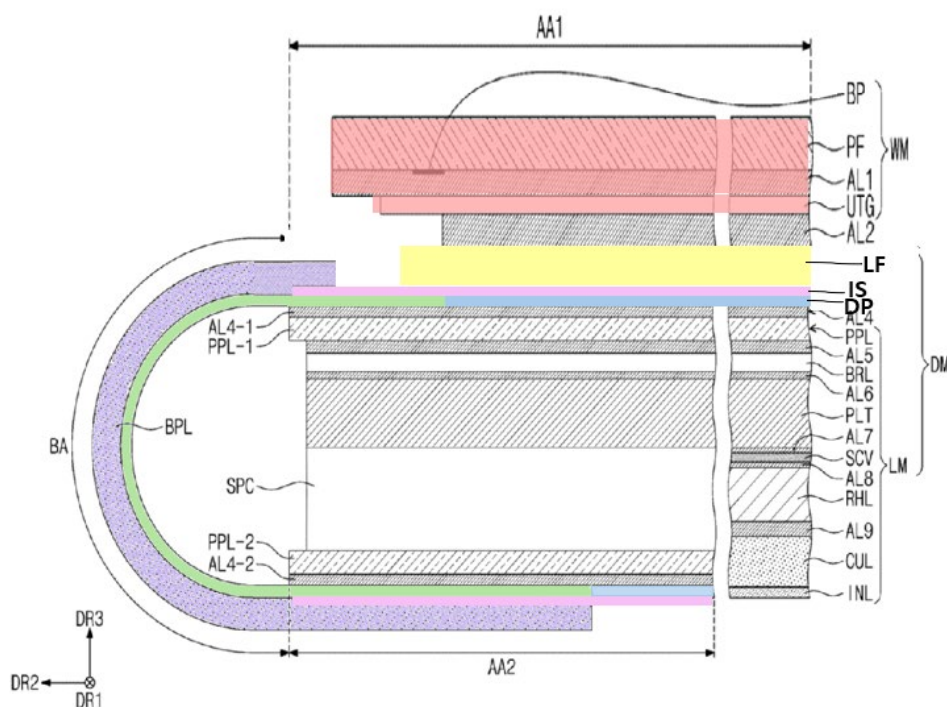
Shin teaches Claim 3. Ex-1002 ¶¶105–106.

As shown in annotated Figure 3 below, Shin teaches a touch control layer (i.e., input sensor IS (pink)) disposed between the flexible screen body (i.e., DP (blue)) and the color filter (i.e., optical film LF (yellow)). Ex-1005, Fig. 3. Specifically, Shin teaches that display module DM includes “display panel DP, an input sensor IS (e.g., input-sensing layer) disposed on the display panel DP,” and “optical film LF disposed on the input sensor IS.” Ex-1005 ¶75. Shin further teaches that “input sensor IS may include a plurality of sensing electrodes (not shown) *for sensing an external input*” and “conductive trace lines (not shown) connected to the plurality of sensing electrodes.” Ex-1005 ¶80.

FIG. 3

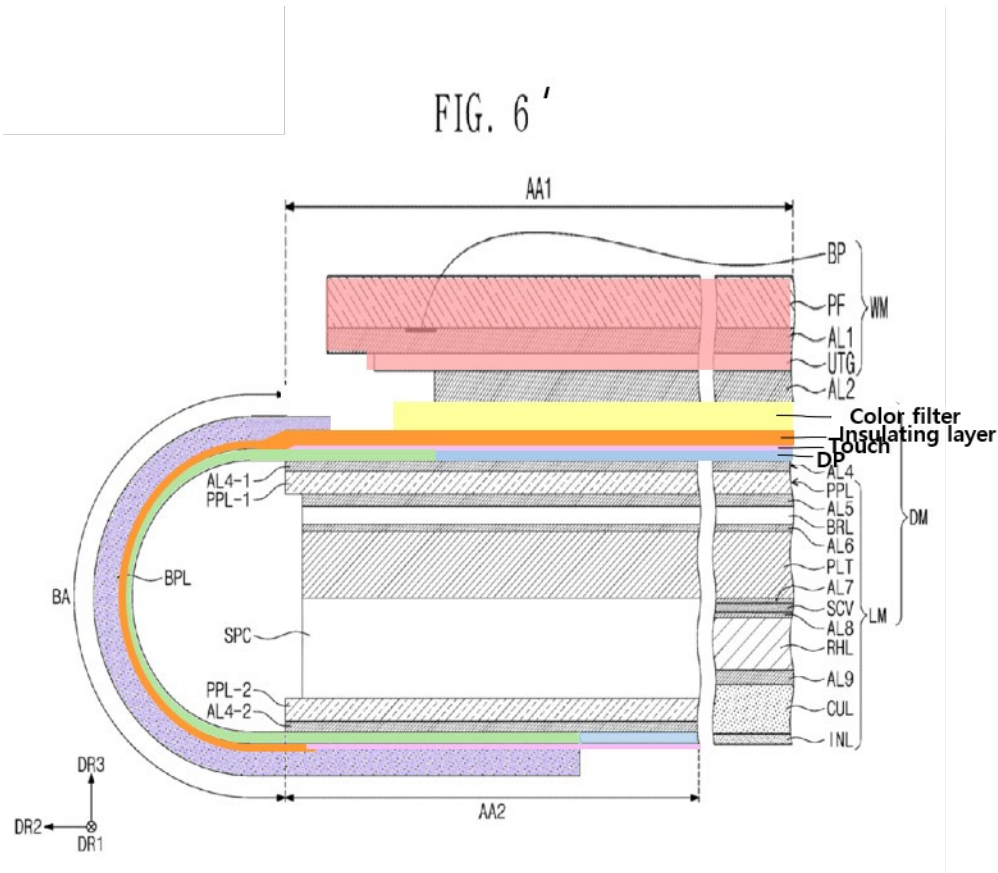


Shin's Figure 6 does not depict input sensor IS but Shin teaches that "input sensor IS may be directly provided or formed on the thin-film encapsulation layer of the display panel DP such as through a continuous process when the display panel DP is provided or manufactured." Ex-1005 ¶81. In that case, "input sensor IS integrated with display panel DP through the continuous process may be defined as an electronic panel." *Id.* In the modified, annotated version of Shin's Figure 6 below, Shin's optical film LF (yellow) is disposed on input sensor IS (pink), as taught by Shin for Figure 3. Ex-1005, Figs. 3, 6'; Ex-1002 ¶107.



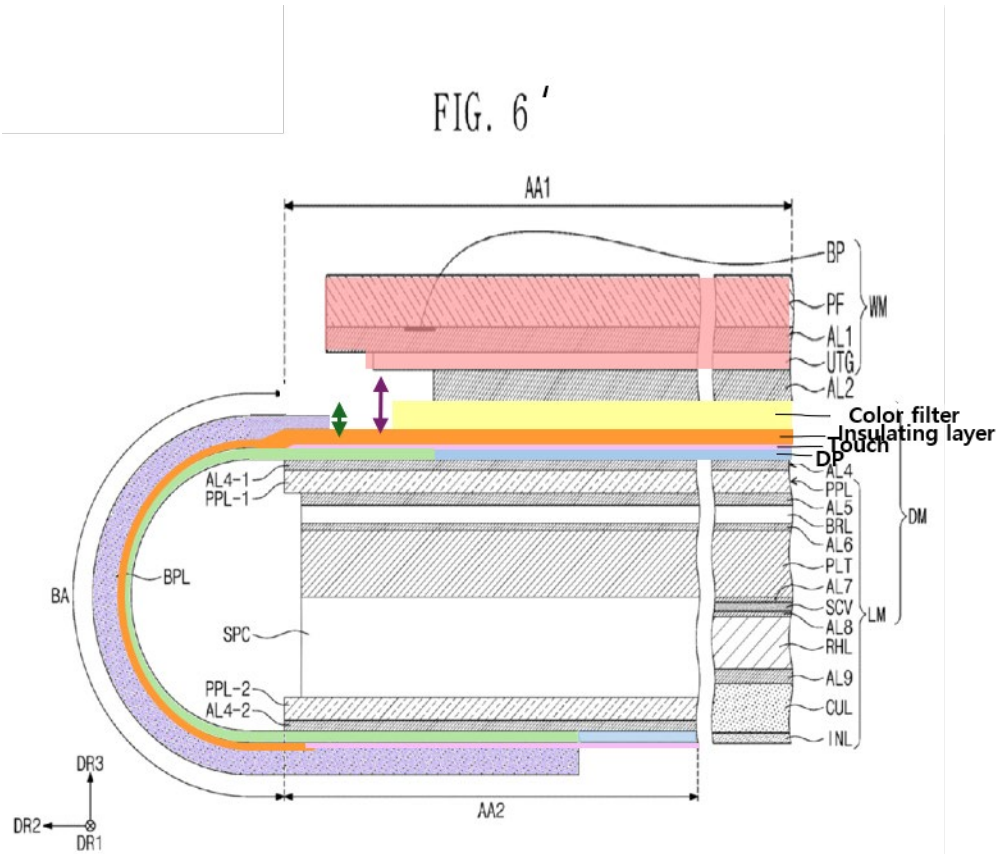
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facing-side of the input sensor IS (pink). Ex-1005, Fig. 6'. A POSITA would thus have implemented Shin's Figure 6 embodiment with the BPL disposed on a surface of the insulating layer (orange) of input sensor IS (pink), which is, in turn, attached to the DP, as shown in Figure 6' below. Ex-1002 ¶108.



Shin teaches that the protective layer (i.e., BPL) is disposed on a surface of the insulating layer for the same reasons. Moreover, as shown in modified, annotated versions of Shin's Figure 6 below and explained in Section XII.A.2.a, the thickness of the BPL (designated by the green arrow) on the surface of the insulating layer (orange) is less than the distance between one side of the coverplate (i.e., WM (red))

adjacent to the insulating layer and one side of the insulating layer adjacent to the coverplate (designated by the purple arrow). Ex-1005 ¶¶111, 147–149, Fig. 6'; Ex-1002 ¶109; *see also* Ex-1001, 8:3–10.



c. Claim 5

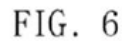
- (1) 5[pre]: The display device according to claim 1, wherein the bending area comprises a transitional bending sub-area, a bending sub-area, and an extending bending sub-area defined in sequence, and the transitional bending sub-area is connected to and flush with the planar area;

Shin teaches Element 5[pre]. Ex-1002 ¶110.

Shin teaches that the bending area comprises a transitional bending sub-area, a bending sub-area, and an extending bending sub-area defined in sequence, and the transitional bending sub-area is connected to and flush with the planar area. Specifically, Shin teaches that the DP “includes a *first panel area AA1*, a *second panel area AA2* and a *bending area BA* which *are planar areas* distinguished from each other *along the second direction DR2*.” Ex-1005 ¶91. Shin further teaches that “[a]long the first direction DR1, each of the bending area BA and the second panel area AA2 may have a dimension such as a length less than a length of the first panel area AA1,” “[a] bending axis may be defined along the first direction DR1,” and “DP may be bendable at the bending area BA along the bending axis.” Ex-1005 ¶93. Shin also teaches that “DD which is bent at the bending area BA disposes the second panel area AA2 below the first panel area AA1” such that first panel area AA1 and second panel area AA2 “may be disposed in different planes or on different reference surfaces from each other” and “bending area BA may be bent convexly in a transverse direction on a cross-section.” Ex-1005 ¶147. Moreover, Shin teaches that “bending area BA may define an end portion of the display device DD which is bent” and “has a curvature and a radius of curvature at the bending area BA.” Ex-1005 ¶147.

As shown in annotated Figure 6 below, the area designated by the green arrow corresponds to the recited “transitional bending sub-area,” the curved area

designated by the black arrow corresponds to the recited “bending sub-area,” and the area designated by the purple arrow corresponds to the recited “extending bending sub-area.” Ex-1005, Fig. 6; Ex-1002 ¶¶111–112. The transitional bending sub-area, bending sub-area, and extending bending sub-area are “defined in sequence” because, as shown in Figure 6, they follow a path in sequence starting from bezel point BP (red) in first panel area AA1 (orange) along the radius of curvature of the BA (green) and ending in a location in second panel area AA2 that mirrors bezel point BP. *See, e.g.*, Ex-1005 ¶91 (DP includes “first panel area AA1,” BA,” and “second panel area AA2 ***in order along the second direction DR2***”). As also shown in Figure 6, the transitional bending sub-area designated by the green arrow is “connected to and flush with the planar area” of first panel area AA1 (extending from BP to the right), designated by the blue arrow. Ex-1002 ¶112.

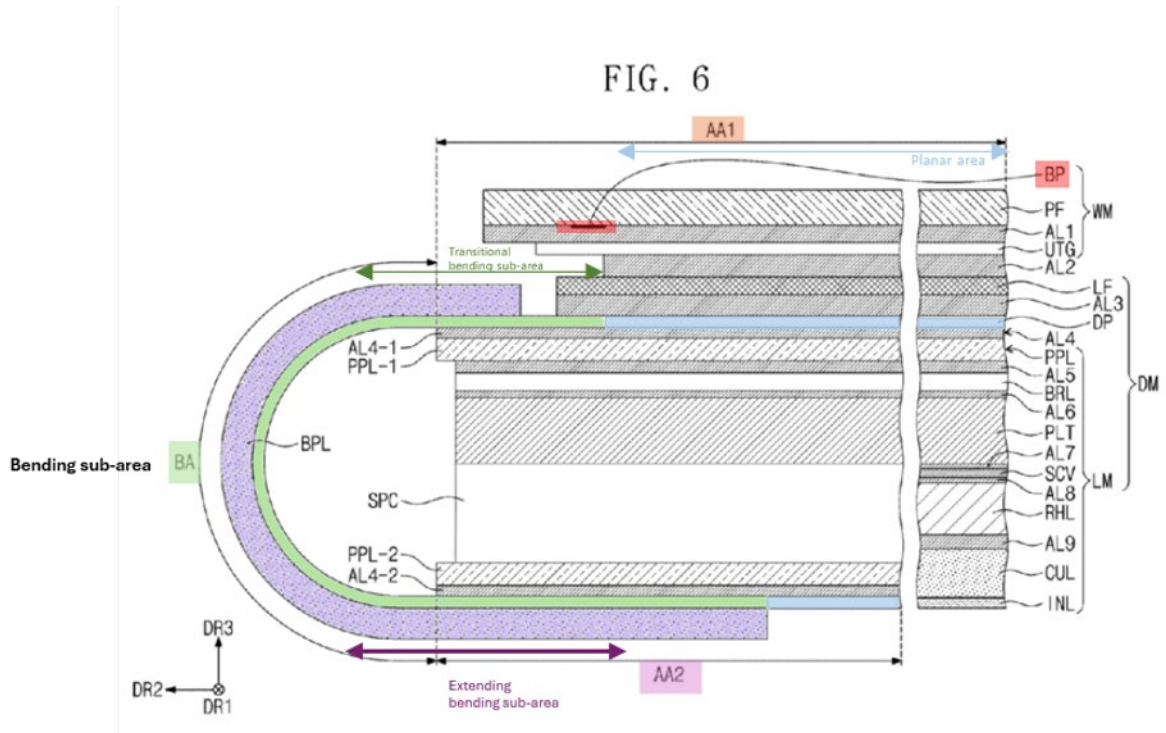


- (2) **5[a]: the protective layer completely covers the bending sub-area and covers at least a part of the transitional bending sub-area; and**

Shin teaches Element 5[a]. Ex-1002 ¶113.

As shown in annotated Figure 6 below, Shin teaches that the protective layer (i.e., BPL (purple)) completely covers the bending sub-area (designated by the black arrow) and covers at least a part of the transitional bending sub-area (designated by the green arrow). Ex-1005, Fig. 6; Ex-1002 ¶114. Specifically, Shin teaches that “BPL is disposed in at least the bending area BA,” “may be bendable together with” bending area BA, and “may overlap” the BA, first panel area AA1, and second panel area AA2. Ex-1005 ¶¶148–149. Shin also teaches that “BPL may be disposed on one

portion of the first panel area AA1 and one portion of the second panel area AA2 in addition to the bending area BA.” Ex-1005 ¶148.

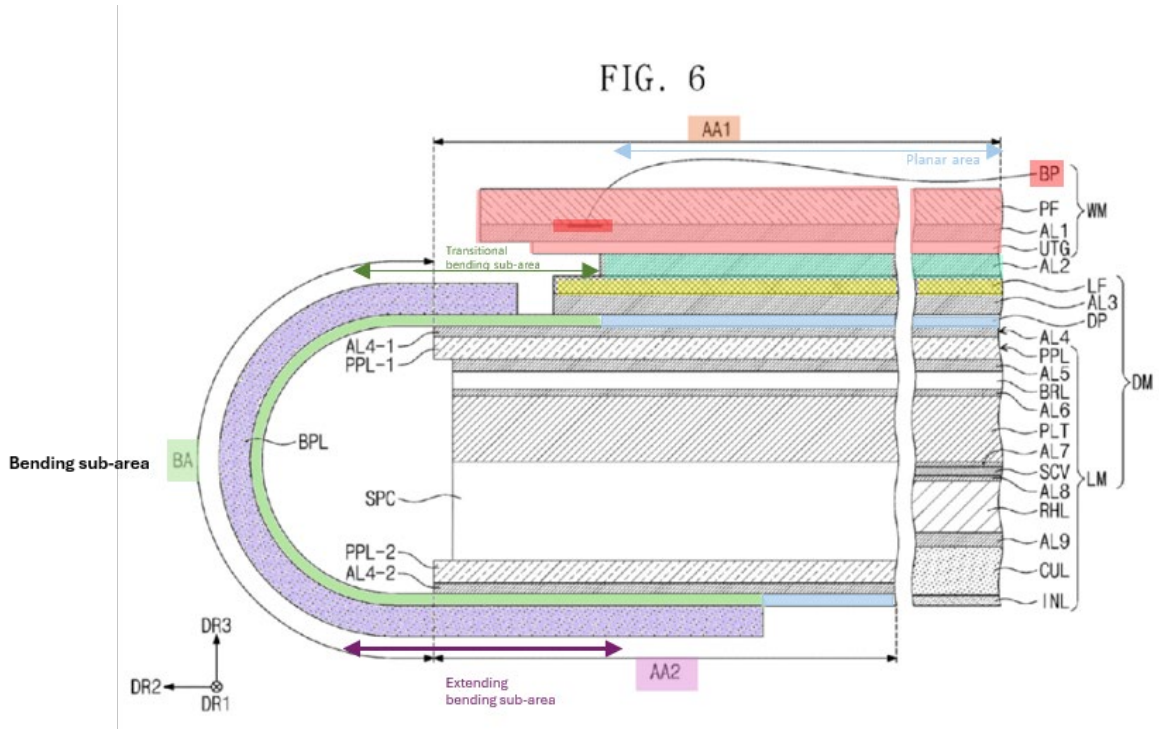


- (3) **5[b]: the coverplate is connected to the color filter by an optical adhesive, and the coverplate completely covers the planar area and covers at least the part of the transitional bending sub-area.**

Shin teaches Element 5[b]. Ex-1002 ¶115.

Shin teaches that the coverplate (i.e., WM) is connected to the color filter (i.e., LF) by an optical adhesive. As shown in annotated Figure 6 below, Shin teaches that “second adhesive layer AL2 [teal] couples the optical film LF [yellow] to the window module WM [red].” Ex-1005 ¶115, Fig. 6. Shin further teaches that AL2 is

“a pressure sensitive adhesive or a transparent adhesive such as the *optically clear adhesive*.” Ex-1005 ¶111.

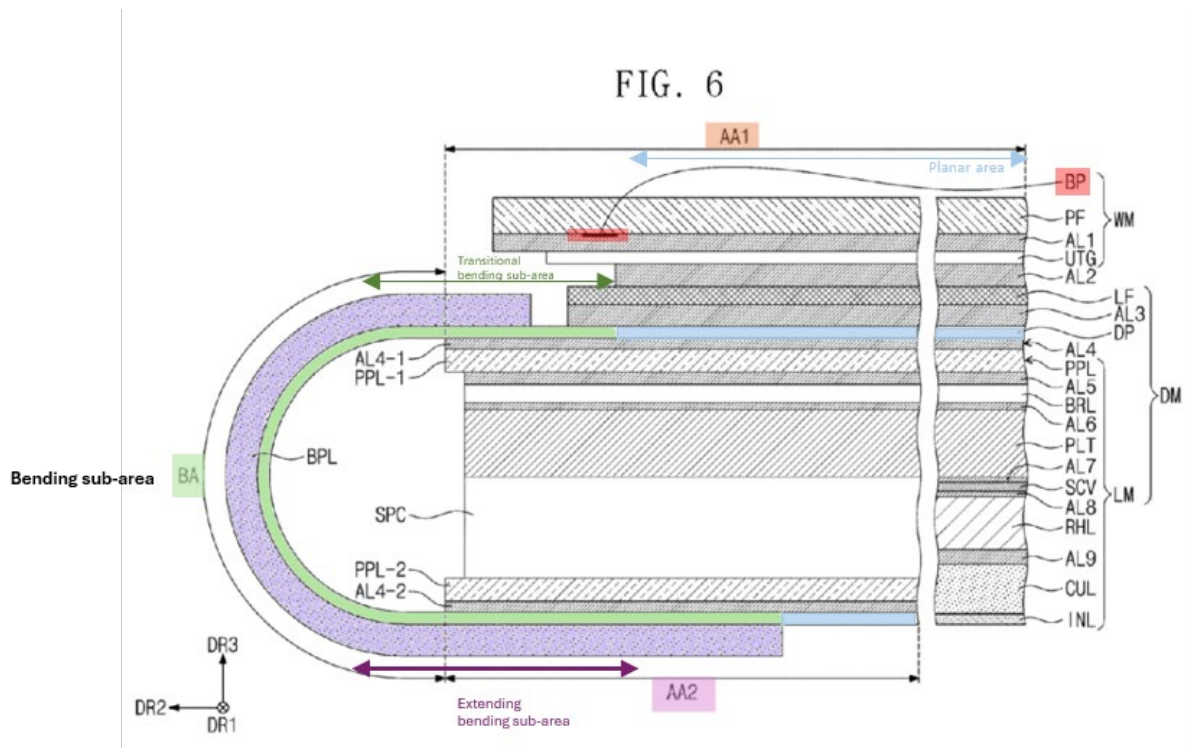


As also shown above, Shin’s coverplate (i.e., WM (red)) completely covers the planar area of first panel area AA1 (the area from BP, extending to the right, designated by the blue arrow) and covers at least the part of the transitional bending sub-area (the area from BP extending to the left, designated by the green arrow). Ex-1005, Fig. 6; Ex-1002 ¶¶116–117.

- d. **Claim 7: The display device according to claim 5, wherein the protective layer further covers at least a part of the extending bending sub-area.**

Shin teaches Claim 7. Ex-1002 ¶118.

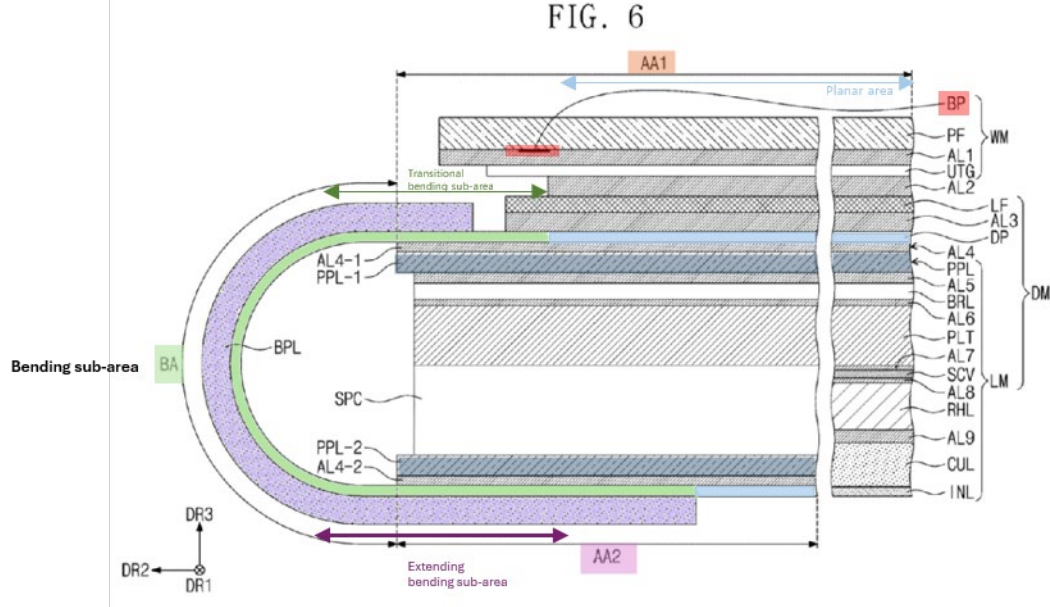
Shin teaches that the protective layer (i.e., BPL) further covers at least a part of the extending bending sub-area. *See* §§XII.A.2.c(1)–XII.A.2.c(2). Specifically, Shin teaches that BPL “may overlap” bending area BA, first panel area AA1, and second panel area AA2. Ex-1005 ¶¶148–149. Shin also teaches that “BPL may be disposed on one portion of the first panel area AA1 and one portion of the second panel area AA2 in addition to the bending area BA.” Ex-1005 ¶148. As shown in annotated Figure 6 below, the protective layer (i.e., BPL (purple)) covers at least a part of the extending bending sub-area of second panel area AA2 (designated by the purple arrow). Ex-1005, Fig. 6; Ex-1002 ¶119.



- e. **Claim 9: The display device according to claim 5, further comprising: a support layer, wherein one side of the support layer supports the planar area and the transitional bending sub-area, and another side of the support layer away from the planar area supports the extending bending sub-area.**

Shin teaches Claim 9. Ex-1002 ¶120.

Shin's display device includes a support layer, wherein one side of the support layer supports the planar area and the transitional bending sub-area, and another side away from the planar area supports the extending bending sub-area. Shin teaches that lower member LM includes "*a support layer supporting the display panel DP.*" Ex-1005 ¶88. Specifically, Shin teaches panel protection layer PPL, which includes "a flexible plastic material," protects "a lower portion of" the DP (i.e., LM), and reduces or effectively prevents "scratches from being generated on a rear surface of ... DP in a process of manufacturing." Ex-1005 ¶116. As shown in annotated Figure 6 below, panel protection layer PPL (navy) includes "first panel protection layer *PPL-1 protecting the first panel area AA1* of the display panel DP" and "second panel protection layer *PPL-2 protecting the second panel area AA2.*" Ex-1005 ¶117, Fig. 6; *see also id.* ¶¶118 ("PPL-2 may be disposed below ... PPL-1 and ... AA1 together with ... AA2"), 119 (fourth adhesive layer AL4 couples "PPL-1 to ... AA1" and "PPL-2 to ... AA2").



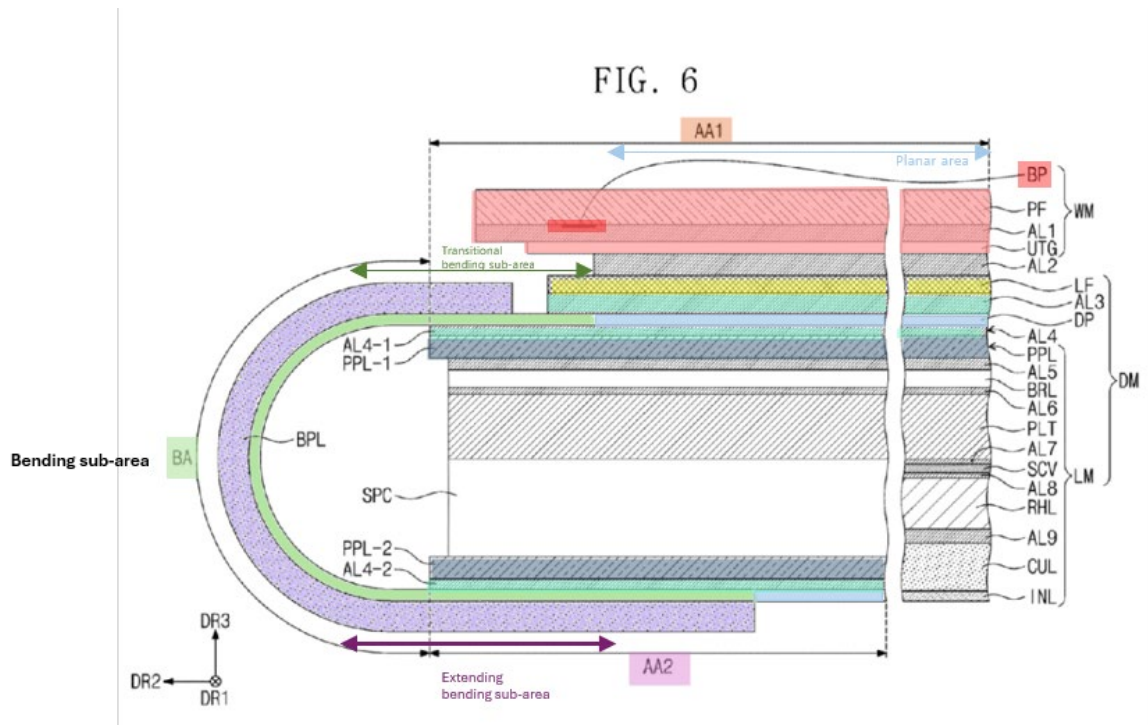
Shin's PPL corresponds to the recited "support layer," PPL-1 corresponds to the recited "side of the support layer [that] supports the planar area [designated by the blue arrow] and the transitional bending sub-area" of AA1 (designated by the green arrow), and PPL-2 corresponds to the recited "side of the support layer away from the planar area [that] supports the extending bending sub-area" of AA2 (designated by the purple arrow). PPL-2 is the side of the support layer "away from" the planar area because it is configured in the same manner as the '031 Patent's corresponding support layer. Ex-1002 ¶¶121–123 (*citing, e.g., Ex-1001, 5:46-55; Ex-1005, Figs. 2, 4*).

- f. **Claim 10: The display device according to claim 9, wherein the support layer comprises a first backplate disposed on one side of the planar area and the transitional bending sub-area away from the coverplate and a second backplate disposed on one side of the extending bending sub-area away from the protective layer.**

Shin teaches Claim 10. Ex-1002 ¶124.

As shown in annotated Figure 6 below, Shin teaches that the support layer (i.e., PPL (navy)) comprises a first backplate (i.e., PPL-1 (navy)) disposed on one side of the planar area (designated by the blue arrow) and the transitional bending sub-area (designated by the green arrow) and a second backplate (i.e., PPL-2 (navy)) disposed on one side of the extending bending sub-area (designated by the purple arrow). Ex-1005, Fig. 6; *see* §XII.A.2.e. The '031 Patent does not define the term “backplate” but states that “first backplate 201 is configured to support and protect the planar area AA and the transitional bending sub-area B1 of the flexible screen body 10, thereby preventing them from being damaged by the external impact” and “second backplate 202 is configured to support and protect the extending bending sub-area B3 of the flexible screen body 10, thereby preventing it from being damaged by the external impact.” Ex-1001, 8:21–28. The '031 Patent also states that “[m]aterials of the first backplate 201 and the second backplate 202 may be polyethylene terephthalate (PET) material.” Ex-1001, 8:28–30. Shin teaches that the “PPL may include a flexible plastic material,” “a colored polyimide film,” or “an

opaque yellow film.” Ex-1005 ¶116. Shin also teaches that the PPL “reduce[s] or effectively prevent[s] scratches from being generated on a rear surface of the display panel DP in a process of manufacturing the display panel DP.” *Id.* A POSITA would thus have understood that PPL-1 and PPL-2 correspond to the recited first backplate and second backplate, respectively, because like the backplates in the ’031 Patent, they are made from a plastic material and protect the DP from being damaged by external impact. Ex-1002 ¶125.



As also shown above, Shin’s first backplate (i.e., PPL-1) is disposed away from the coverplate (i.e., WM (red)) because these components are separated from

one another by at least AL4-1 and AL3 (teal)⁸, and LF (yellow). Ex-1005, Fig. 6. Shin's first backplate is also disposed "away from" the coverplate because it is on the side of the planar area and transitional bending sub-area opposite from the coverplate. Ex-1001, 5:46-55. Shin's second backplate (i.e., PPL-2) is disposed away from the protective layer (i.e., BPL (purple)) because these components are separated from one another by at least AL4-2 (teal). Ex-1002 ¶126. Shin's second backplate is also disposed "away from" the BPL because it is on the side of the extending bending sub-area opposite from the BPL. Ex-1001, 5:46-55.

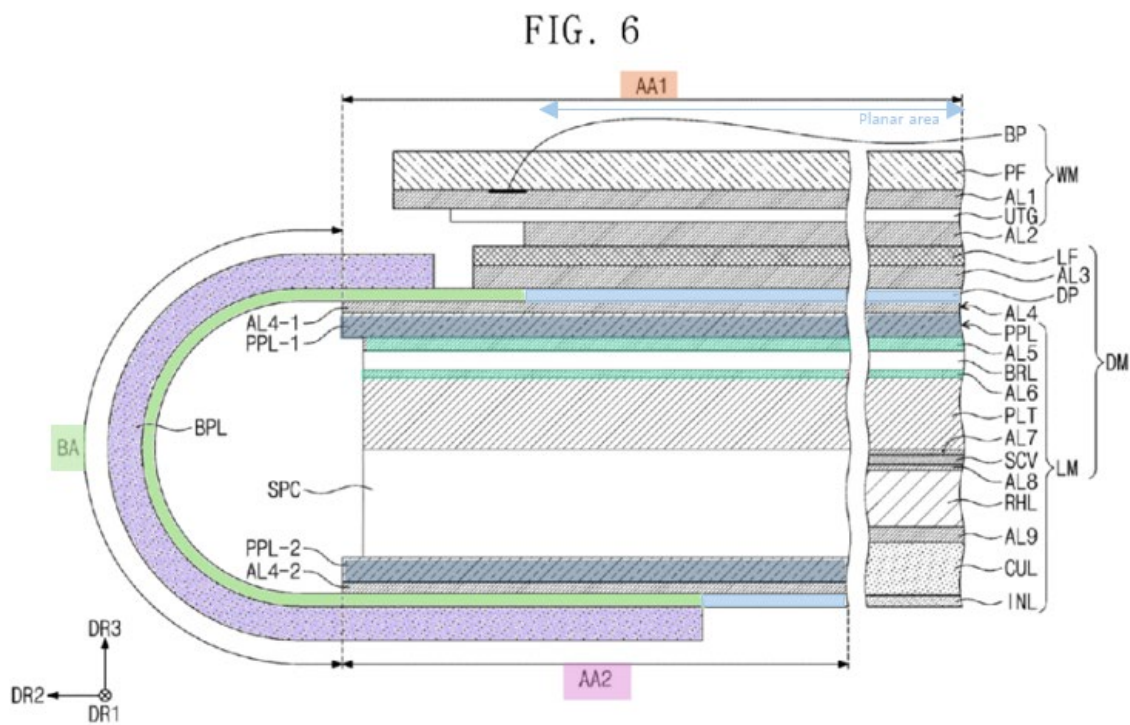
g. Claim 11: The display device according to claim 10, wherein a foam is disposed between the first backplate and the second backplate.

Shin teaches Claim 11. Ex-1002 ¶127.

Shin teaches that a foam is disposed between the first backplate and the second backplate. As shown in annotated Figure 6 below, Shin teaches adhesive layers (AL5 and/or AL6) (teal), which are disposed between the first backplate (i.e., PPL-1) and second backplate (i.e., PPL-2) (navy). Ex-1005, Fig. 6, ¶¶126 ("AL6 may be disposed between the barrier layer BRL and the support layer PLT"), 132 ("AL5 may be disposed between the panel protection layer PPL and the barrier layer BRL

⁸ The '031 Patent figures do not explicitly depict a glue or an adhesive layer but the specification discloses its use (Ex-1001, 8:18–20), similar to Shin's AL4-1 and AL4-2 layers. Ex-1002 ¶126 n.5.

to couple ... BRL to ... PPL.”). A POSITA would have known that the adhesive layers may comprise a foam-type adhesive or polyolefin foam. Ex-1002 ¶¶128–129 (*citing, e.g.*, Ex-1038, 15:57–16:3; Ex-1006, 16:15–20); *see also* Ex-1005 ¶142 (Shin teaching that other layers such as cushion layer CUL “may include a foam sheet having an elastic force”).

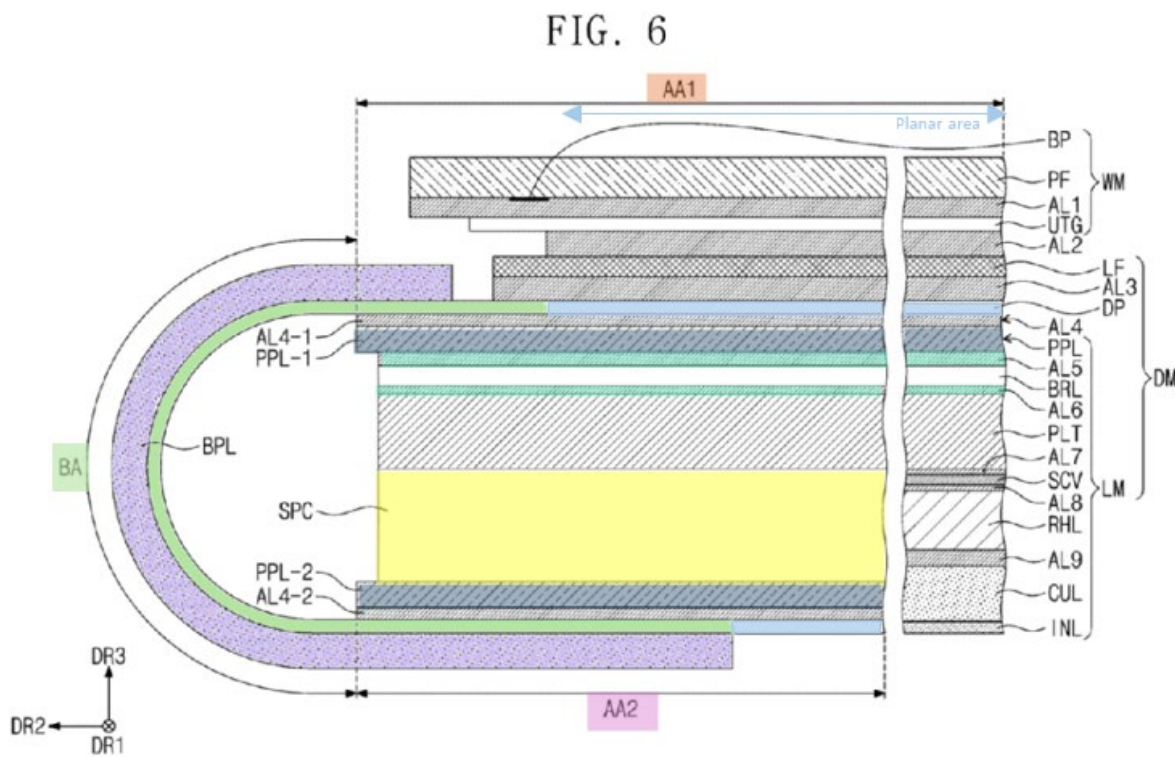


- h. Claim 12: The display device according to claim 11, wherein a stiffener plate is disposed between the foam and the second backplate.**

Shin teaches Claim 12. Ex-1002 ¶130.

Shin teaches that a stiffener plate is disposed between the foam and the second backplate. As shown in annotated Figure 6 below, Shin teaches a spacer SPC

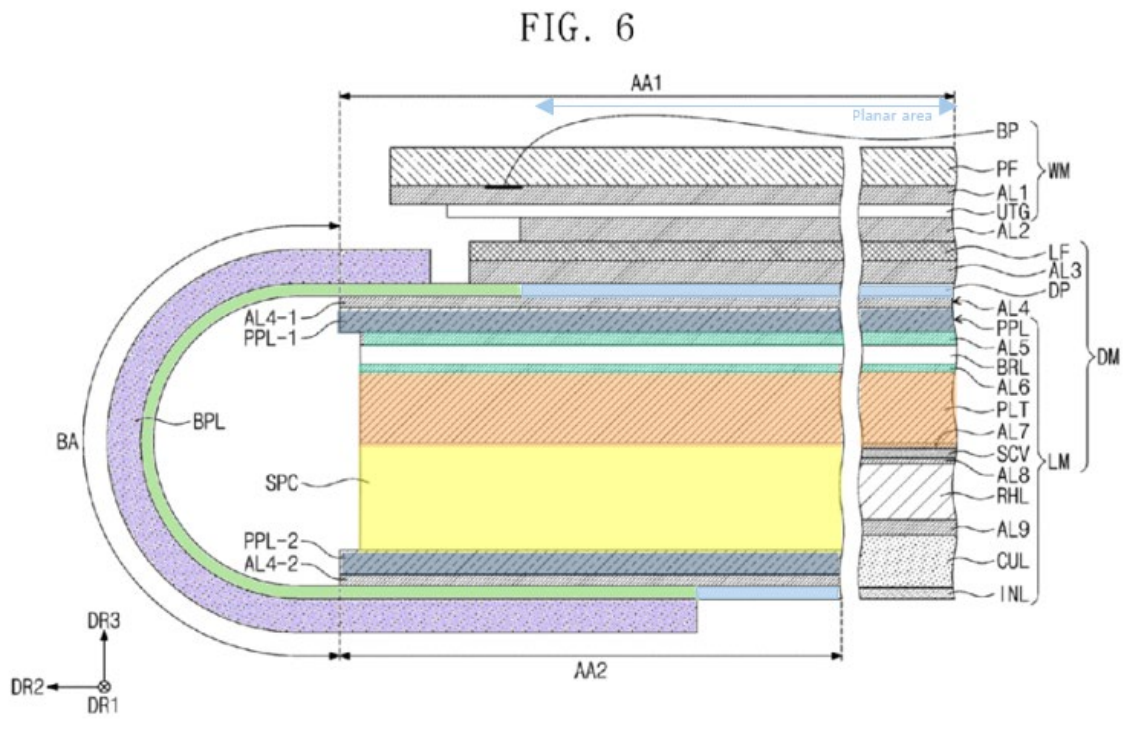
(yellow), which is disposed between the foam (i.e., AL5 and/or AL6 (teal)) and second backplate (i.e., PPL2 (navy)). Ex-1005, Fig. 6. The '031 Patent does not define the term “stiffener plate” but states that it may be “a graphite layer.” Ex-1001, 9:20–27. A POSITA would have understood that Shin’s spacer SPC corresponds to the recited “stiffener plate” because Shin’s “SPC may have a multi-layered structure” comprising a “baser layer ... disposed between two adhesive layers,” which includes “graphite.” Ex-1005 ¶150; Ex-1002 ¶131.



- i. **Claim 13: The display device according to claim 12, wherein a heat dissipation layer is disposed between the foam and the stiffener plate.**

Shin teaches Claim 13. Ex-1002 ¶132.

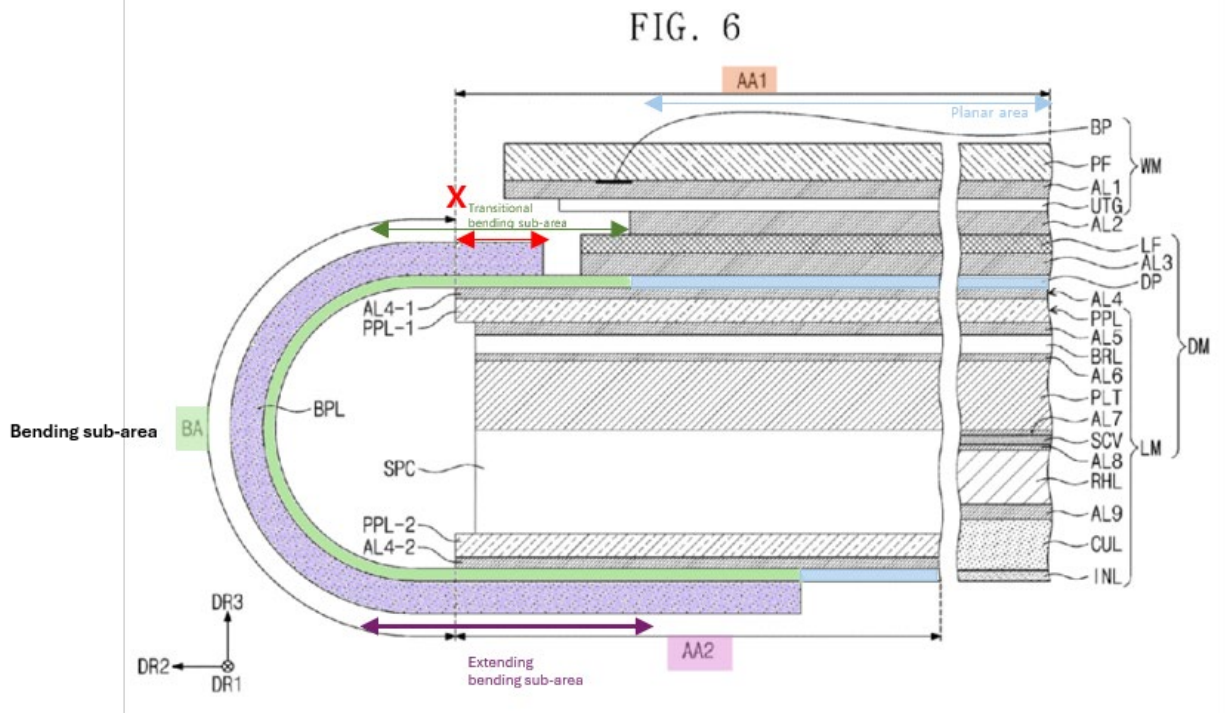
Shin teaches that a heat dissipation layer is disposed between the foam and stiffener plate. As shown in annotated Figure 6 below, Shin teaches a support layer PLT (orange) disposed between the foam (i.e., AL5 and/or AL6 (teal)) and the stiffener plate (i.e., SPC (yellow)). Ex-1005, Fig. 6. Shin's PLT corresponds to the recited "heat dissipation layer" because Shin teaches that "PLT may improve a heat dissipation performance of the display device." Ex-1005 ¶123; Ex-1002 ¶133.



- j. **Claim 14: The display device according to claim 5, wherein a distance between one side end of the protective layer adjacent to the planar area and an initial bending position of the flexible screen body is greater than a first default value, wherein the first default value is greater than or equal to 0, and the initial bending position is a jointed position of the bending sub-area and the transitional bending sub-area.**

Shin teaches Claim 14. Ex-1002 ¶134.

As shown in annotated Figure 6 below, Shin teaches that a distance between one side end of the protective layer (i.e., BPL (purple)) adjacent to the planar area (designated by the blue arrow, extending from BP to the right) and an initial bending position of the flexible screen body (i.e., DP-NDA, green) (designated by the red arrow) is greater than a first default value, which is greater than or equal to 0. Ex-1005, Fig. 6. Moreover, as shown in Figure 6, the initial bending position (designated by the red X) is a jointed (i.e. bendable) position of the bending sub-area (designated by the black arrow) and the transitional bending sub-area (designated by the green arrow). *Id.*; Ex-1002 ¶135.

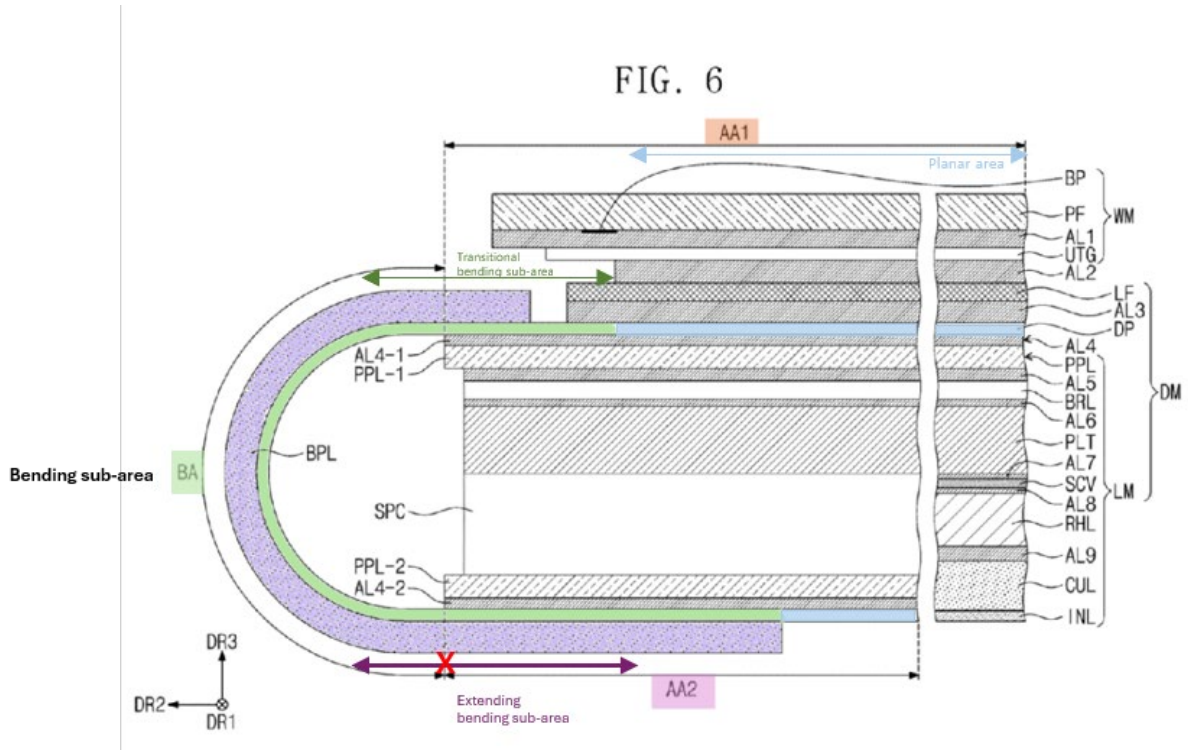


- k. **Claim 15:** The display device according to claim 14, wherein a distance between one side end of the protective layer adjacent to the extending bending sub-area and a terminal bending position of the flexible screen body is greater than a second default value, wherein the second default value is greater than or equal to 0.

Shin teaches Claim 15. Ex-1002 ¶136.

As shown in annotated Figure 6 below, Shin teaches that a distance between one side end of the protective layer (i.e., BPL (purple)) adjacent to the extending bending sub-area (designated by the purple arrow) and a terminal bending position of the flexible screen body (i.e., DP-NDA, green) is greater than a second default value, which is greater than or equal to 0. Ex-1005, Fig. 6. As also shown in Figure 6, Shin's terminal bending position (designated by the red X) is a jointed (i.e.

bendable) position of bending area BA (designated by the black arrow) and extending bending sub-area. *Id.*; Ex-1002 ¶137.



- I. **Claim 17: The display device according to claim 5, wherein the optical adhesive is an optically clear adhesive (OCA).**

Shin teaches Claim 17. Ex-1002 ¶¶138–139.

Shin teaches that the optical adhesive (i.e., AL2) is an optically clear adhesive (OCA). *See* §XII.A.2.c. Specifically, “AL2 couples the optical film LF to the window module WM.” Ex-1005 ¶115. Shin further teaches that AL2 is “a pressure sensitive adhesive or a transparent adhesive such as the *optically clear adhesive*.” Ex-1005 ¶111.

- m. Claim 18: The display device according to claim 13, wherein a material of the heat dissipation layer is a metal material or graphite, and the metal material comprises one or more combinations of copper foil, aluminum foil, or stainless steel foil.**

Shin teaches Claim 18. Ex-1002 ¶140.

Shin teaches that a material of the heat dissipation layer (i.e., PLT) is a metal material comprising one or more combinations of copper foil, aluminum foil, or stainless steel foil. Specifically, Shin teaches that “PLT may include a metal material such as stainless steel” or “various metal materials.” Ex-1005 ¶123. It would have been obvious to a POSITA that the “various metal materials” would include “one or more combinations of copper foil, aluminum foil, or stainless steel foil” because, for example, Shin teaches that its other heat dissipation layer RHL “may include metal or metal alloy, e.g., copper, copper alloy, or graphite.” Ex-1005 ¶137; Ex-1002 ¶141.

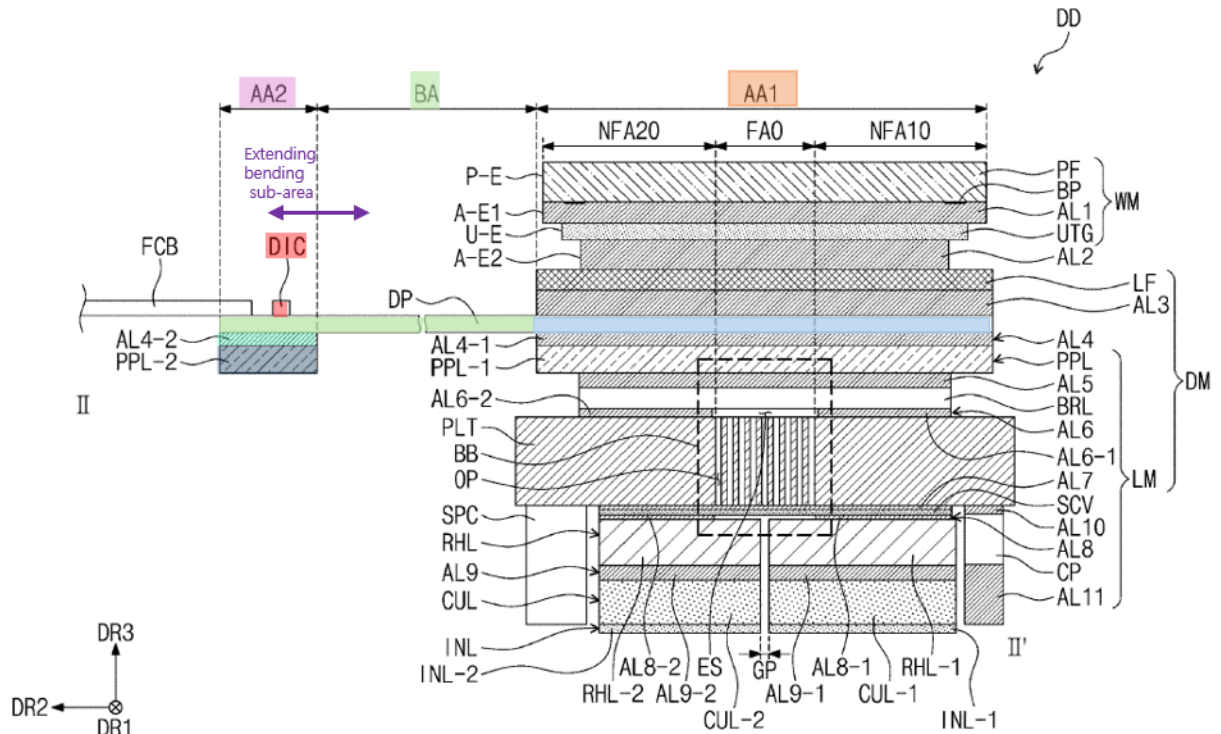
- n. Claim 19: The display device according to claim 9, further comprising a driving unit disposed on one surface of the extending bending sub-area away from the support layer.**

Shin teaches Claim 19. Ex-1002 ¶¶142–143.

As shown in annotated Figure 5 below, Shin teaches a driving unit (i.e., DIC (red)) disposed on one surface of the extending bending sub-area (designated by the purple arrow, over the bending portion of DP, green (DP-NDA)) away from the support layer (i.e., PPL-2 (navy)). Specifically, Shin teaches that “DM may include

a driving chip DIC disposed in the non-display area DP-NDA” and “flexible circuit film FCB coupled to” the DP at the DP-NDA. Ex-1005 ¶69, Fig. 5.

FIG. 5



Shin’s driving chip DIC corresponds to the recited “driving unit” because Shin teaches that “[a]n electrical signal may be provided to the” DP through the DIC and/or FCB and “DIC may include a driving element for driving a pixel PX of the display panel DP, e.g., a data driving circuit.” Ex-1005 ¶¶69–70. As shown in Figure 5 above, Shin’s DIC is disposed on one surface of the extending bending sub-area in AA2 “away from” the PPL because there is an AL4-2 layer (teal) between the DIC and PPL-2. Ex-1002 ¶144; *see also, e.g.*, Ex-1005 ¶95 (“[D]ata lines DL1 to DLn may each extend ... through ... BA and be electrically connected to *the driving*

chip DIC at the second panel area AA2.”). Shin’s DIC is also disposed “away from” the PPL because it is on the side of the extending bending sub-area opposite from the PPL. Ex-1001, 5:46-55.

B. Ground 2: Claims 1–3, 5, 7–15, and 17–19 Are Obvious over Shin in View of Luo

1. A POSITA would have been motivated to combine Shin’s teachings with Luo’s teachings and would have had a reasonable expectation of success.

A POSITA would have been motivated to combine the teachings of Shin and Luo and had a reasonable expectation of success in doing so because each relates to a flexible, bendable display device including multiple defined layers and components. Ex-1005, Abstract, Fig. 6; Ex-1006, Abstract, Figs. 4A–4B; Ex-1002 ¶145.

Shin teaches a “foldable display device.” Ex-1005 ¶2. Shin further teaches that its display device comprises bending protection layer BPL, which is disposed on display panel DP and “may overlap” bending area BA, first panel area AA1, and second panel area AA2. Ex-1005 ¶148. Additionally, Shin teaches “window module WM (e.g., window),” which is coupled to optical film LF by second adhesive layer AL2 and “provides or defines the front surface of the electronic device ED.” Ex-1005 ¶¶67, 102, 115. Shin also teaches that AL2 may “have a thickness of about 35 μm to about 65 μm , e.g., about 50 μm .” Ex-1005 ¶111. Shin thus teaches a “default value” for the distance in an overlapping area of the BPL and WM components,

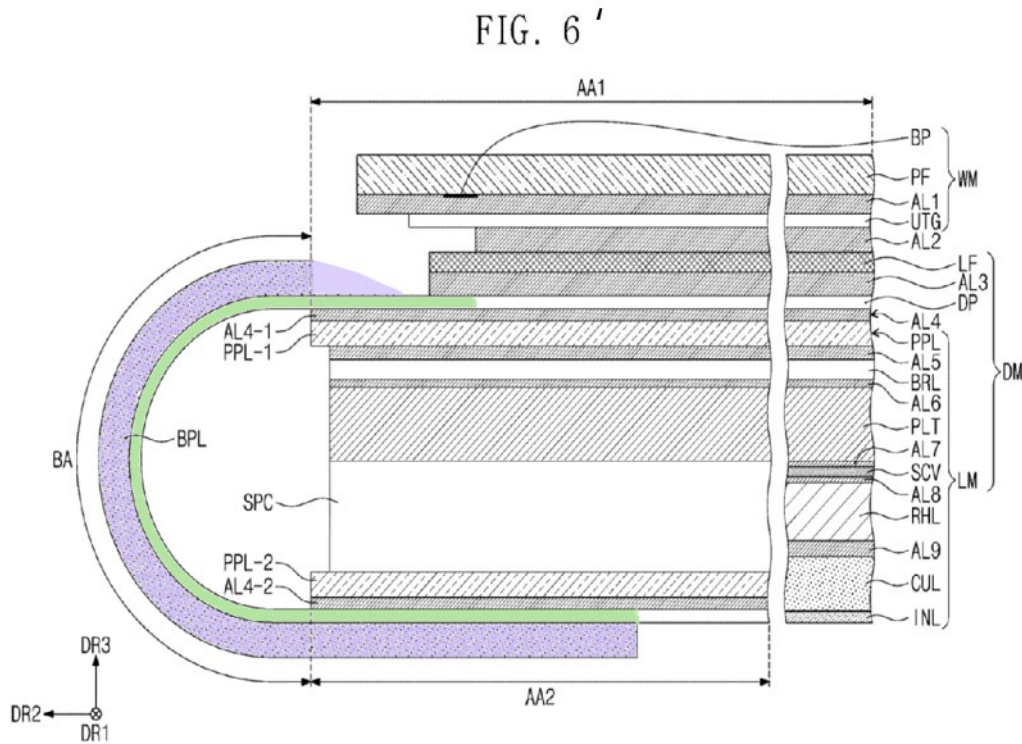
which encompasses at least the entire thickness of AL2 of “about 50 μm ,” which is greater than 0. *Id.*; Ex-1002 ¶146. Shin also teaches that this distance may be adjusted as needed to encompass “a thickness of about 35 μm to about 65 μm .” Ex-1005 ¶111.

Luo teaches a display apparatus having a structure to eliminate interference “by defining critical parameters including at least one of the first shortest distance Ds1, the second shortest distance Ds2, the third shortest distance Ds3, or the fourth shortest distance Ds4.” Ex-1006 ¶77. Luo teaches that “fourth shortest distance Ds4 between the orthographic projection of the edge Eoca ... on the plane ... of the display portion DP and the orthographic projection of the edge Ecf of the cover window CF adjacent to ... the plane ... of the display portion DP is equal to or greater than a second value.” Ex-1006 ¶68. Luo further teaches that “the second value is equal to a bonding tolerance of the optically clear adhesive layer OCA,” which may be “in a range of 100 μm to 200 μm , e.g., 100 μm to 125 μm , 125 μm to 150 μm , 150 μm to 175 μm , or 175 μm to 200 μm ” such that, for example, “fourth shortest distance Ds4 is equal to or greater than 150 μm .” Ex-1006 ¶69. Luo also teaches that “not only the interference between the cover window CF and the coating layer MCL can be eliminated, but also other defects such as cover window depression, bending portion cracking, and light leakage, can be effectively prevented or entirely eliminated.” Ex-1006 ¶77. Luo specifically defines vertical factors such

as heights h_1 and h_2 by adjusting parameters like D_{s1} , D_{s3} , point Ept, or tapering, which consequently ensures a vertical gap. Ex-1006 ¶¶64, 68. Moreover, Luo explicitly recognizes that the absence of a vertical gap (like first interference region, Ri1) leads to defects and interference (i.e., cracking). Ex-1006 ¶¶76–79, Fig. 6. Consequently, Luo proposes solutions by controlling various parameters to prevent such issues. In other words, Luo provides teachings regarding the recognition of similar problems as Shin arising in similar processes. Luo thus teaches a “default value” for the distance in the overlapping area of the MCL and WM components “equal to or greater than $150\text{ }\mu\text{m}$,” which is greater than 0. Ex-1006 ¶69; Ex-1002 ¶147. Additionally, Luo teaches that this distance may be adjusted as needed to encompass “a range of $100\text{ }\mu\text{m}$ to $200\text{ }\mu\text{m}$.” Ex-1006 ¶69. Moreover, Luo teaches that the purpose of the default value is to avoid, among other things, cracking during bending. Ex-1006 ¶77; Ex-1001, 7:1–10.

A POSITA would have understood that the presence of similar elements and recognized issues in the prior art implies the existence of comparable processes. Ex-1002 ¶148. Specifically, product manufacturing includes steps such as protective layer coating, manufacturing a Shin LF or polarizer, and window attachment performed after the Panel Process (BP). A POSITA would have understood that cracking issues frequently arise during these steps, and would have implemented precise parameter control to address such known issues. *Id.*

To the extent that a POSITA was interested in additional implementation details for the “default value” taught by Shin, such as the purpose for this value, a POSITA would have looked to Luo, which teaches the existence of multiple “critical parameters” or “shortest distances” having the function of avoiding cracking during bending. Ex-1006 ¶77. Shin already explains, for example, that the varied dimensional areas of AL1 and AL2 may prevent “a buckling phenomenon or a crack” in the UTG and decrease “a probability of foreign substances attached to” AL2. Ex-1005 ¶113. Moreover, a POSITA would have understood that Luo’s MCL (Ex-1006 ¶80) corresponds to and performs identical functions as Shin’s BPL (Ex-1005 ¶149). The Shin-Luo combination is shown in the modified, annotated version of Shin’s Figure 6 below. Ex-1005, Fig. 6’. It would have been obvious to a POSITA that setting a minimum thickness value of AL2 between the BPL and WM would avoid “bending portion cracking,” as taught by Luo. Ex-1002 ¶¶149–151.



A POSITA would have had a reasonable expectation of success in combining the teachings of Shin and Luo. Both describe flexible, bendable display devices including similar layers and components. Ex-1005, Abstract, Fig. 6; Ex-1006, Abstract, Figs. 4A–4B. A POSITA would thus have understood that these references disclose interrelated teachings based on well-understood technologies that would have been amenable to various well-understood and predictable combinations. Ex-1002 ¶152.

2. Independent Claim 1

a. 1[pre]: A display device, comprising:

Shin in view of Luo (“Shin-Luo”) teaches Element 1[pre]. *See* §XII.A.1.a. Ex-1002 ¶153.

b. 1[a]: a flexible screen body comprising a planar area and a bending area connected to the planar area;

Shin-Luo teaches Element 1[a]. *See* §XII.A.1.b. Ex-1002 ¶154.

c. 1[b]: a color filter disposed on the flexible screen body and at least covering the planar area;

Shin-Luo teaches Element 1[b]. *See* §XII.A.1.c. Ex-1002 ¶155.

d. 1[c]: a protective layer disposed on the flexible screen body and at least covering a part of the bending area; and

Shin-Luo teaches Element 1[c]. *See* §XII.A.1.d. Ex-1002 ¶156.

e. 1[d]: a coverplate disposed on the color filter and at least covering the planar area;

Shin-Luo teaches Element 1[d]. *See* §XII.A.1.e. Ex-1002 ¶157.

f. 1[e]: wherein in an overlapping area of the protective layer and the coverplate, a distance between the protective layer and the coverplate is greater than or equal to a default value, wherein the default value is greater than 0.

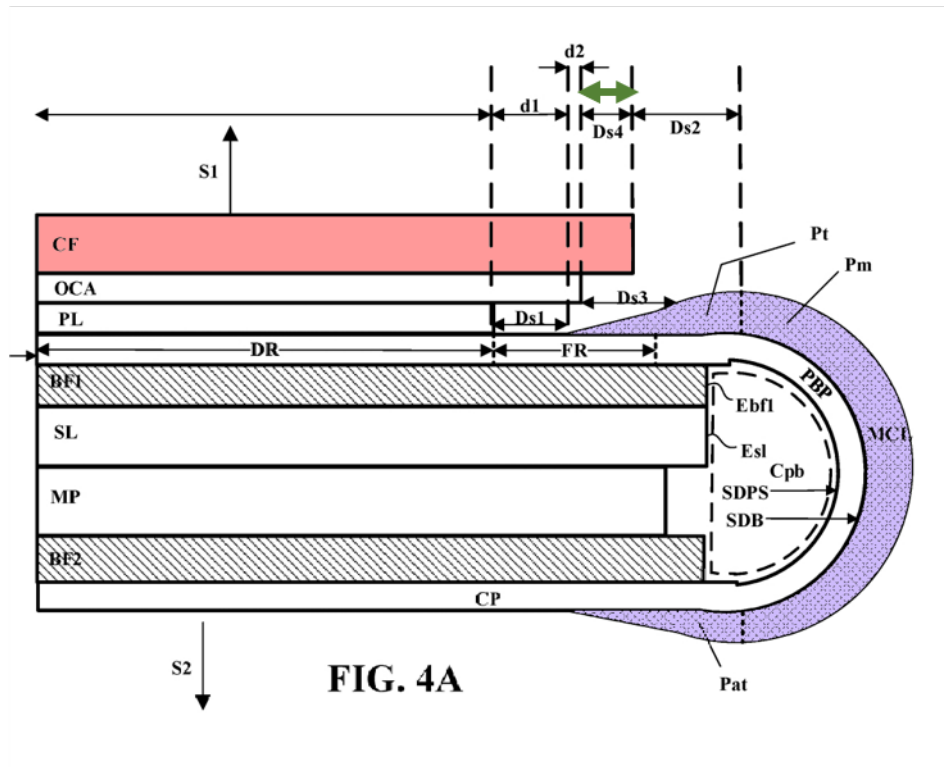
Shin-Luo teaches Element 1[e]. Ex-1002 ¶¶158–159.

Shin teaches Element 1[e]. *See* §XII.A.1.f. To the extent a POSITA was interested in additional implementation details for the “default value” limitation of

1[e], a POSITA would have looked to Luo. Luo teaches the existence of multiple “critical parameters” or “shortest distances” that have the function of avoiding cracking during bending.

As shown in Figure 4A below, Luo teaches eliminating interference “by defining critical parameters including at least ... the *fourth shortest distance Ds4 [designated by the green arrow]*.” Ex-1006 ¶77. Luo teaches that “FIG. 4A is a cross-sectional view around a bending portion of a display apparatus,” which “includes a display portion DP; a polarizer PL on a first side S1 of ... DP; *a cover window CF [red]* on the first side S1 of ... DP, and on a side of the polarizer PL away from the display portion DP; a connecting portion CP; a bending portion PBP connecting the display portion DP and the connecting portion CP.” Ex-1006 ¶58. Luo further teaches that “bending portion PBP is bent so that the connecting portion CP is facing a second side S2 of ... DP, forming a bending cavity Cpb that is surrounded by” PBP and “the second side S2 is opposite to the first side S1.” Ex-1006 ¶58, Fig. 4A. And that “the display apparatus further includes *a coating layer MCL [purple]* covering a back side SDB of the bending portion PBP opposite to a side SDPS directly surrounding the bending cavity Cpb.” Ex-1006 ¶59. Luo’s coating layer MCL corresponds to the recited “protective layer” and cover window CF corresponds to the recited “coverplate.” Ex-1002 ¶160. Luo’s fourth shortest

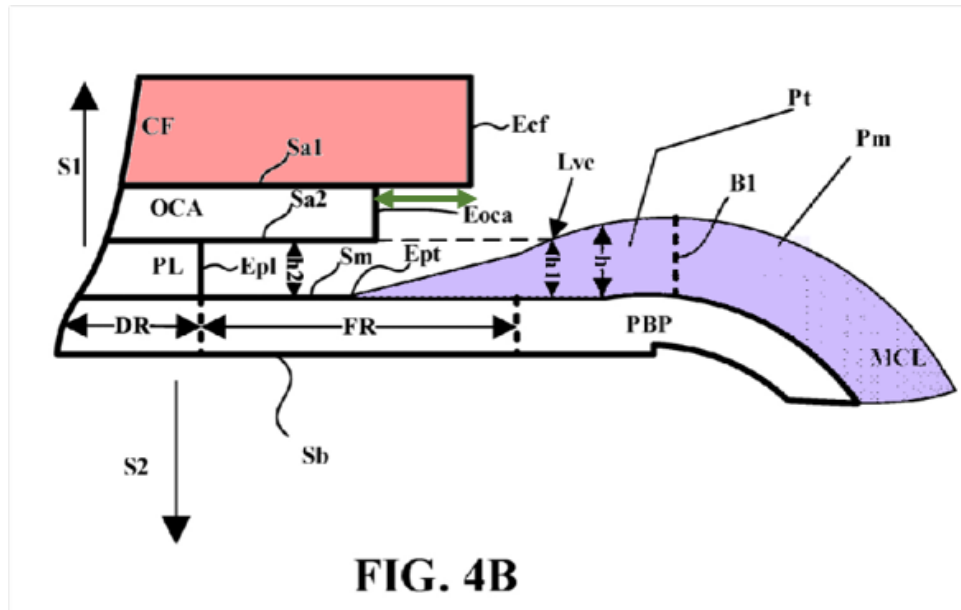
distance $Ds4$ corresponds to the recited “overlapping area of the protective layer and the coverplate.” *Id.*



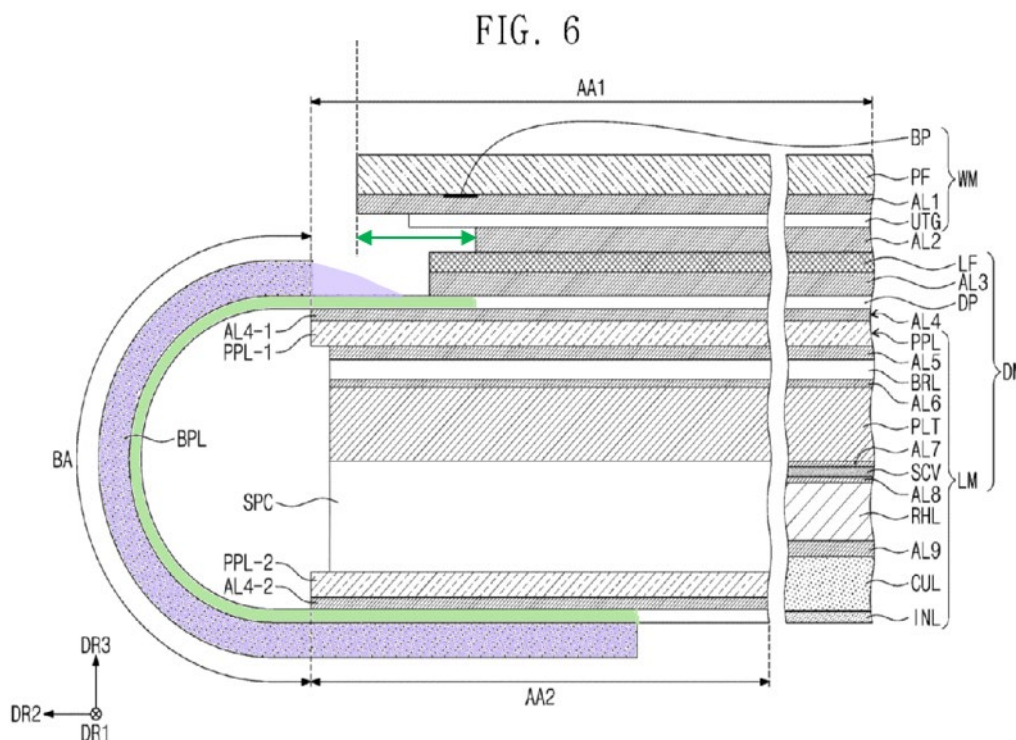
Luo further teaches, as shown in Figure 4B below, that “*a fourth shortest distance $Ds4$ [designated by the green arrow] between the orthographic projection of the edge Eoca ... on the plane ... of the display portion DP and the orthographic projection of the edge Ecf of the cover window CF adjacent to the tapered portion Pt on the plane ... of the display portion DP is equal to or greater than a second value.*” Ex-1006 ¶68. Additionally, Luo teaches that “*the second value is equal to a bonding tolerance of the optically clear adhesive layer OCA,*” which may be “in a range of 100 μm to 200 μm , e.g., 100 μm to 125 μm , 125 μm to 150 μm , 150 μm to

175 μm , or 175 μm to 200 μm ” such that, for example, “the fourth shortest distance Ds4 is *equal to or greater than 150 μm .*” Ex-1006 ¶69 (“bonding tolerance refers to a tolerance for an error or a range of error in bonding two parts of the display apparatus, for example, in bonding the optically clear adhesive layer OCA, e.g., to the cover window CF or to the polarizer PL”). Luo also teaches that “*not only the interference between the cover window CF and the coating layer MCL can be eliminated, but also other defects such as cover window depression, bending portion cracking, and light leakage, can be effectively prevented or entirely eliminated.*” Ex-1006 ¶77. Luo thus teaches that a “default value” for the distance in the overlapping area of the MCL and WM components is “*equal to or greater than 150 μm ,*” which is greater than 0. Ex-1006 ¶69. Additionally, similar to the ’031 Patent, Luo teaches that this distance may be adjusted as needed to encompass “a range of 100 μm to 200 μm , e.g., 100 μm to 125 μm , 125 μm to 150 μm , 150 μm to 175 μm , or 175 μm to 200 μm .” Ex-1006 ¶69; Ex-1001, 7:1–10 (the default value “may be flexibly adjusted according to actual needs”). Moreover, like the ’031 Patent, Luo teaches that the purpose of the default value is to avoid, among other things, cracking during bending. Ex-1006 ¶77; Ex-1001, 7:1–10. For example, a POSITA would have understood that Luo adjusts specific parameters to ensure the protective layer’s upper surface does not contact the bottom surfaces of the CF or

OCA, thereby clearly teaching Element 1[e]. Ex-1002 ¶¶161–162 (citing Ex-1006 ¶¶76–79, Fig. 6).



In the Shin-Luo combination, Luo’s “fourth shortest distance Ds4 [designated by the green arrow],” which is “equal to or greater than a second value,” i.e., the recited “default value” is designated by the green arrow in Shin’s annotated Figure 6 below. A POSITA would have been motivated to combine Shin with Luo and had a reasonable expectation in doing so. *See* §XII.B.1. Ex-1002 ¶¶163–164.



3. Dependent Claims 2–3, 5, 7–15, and 17–19

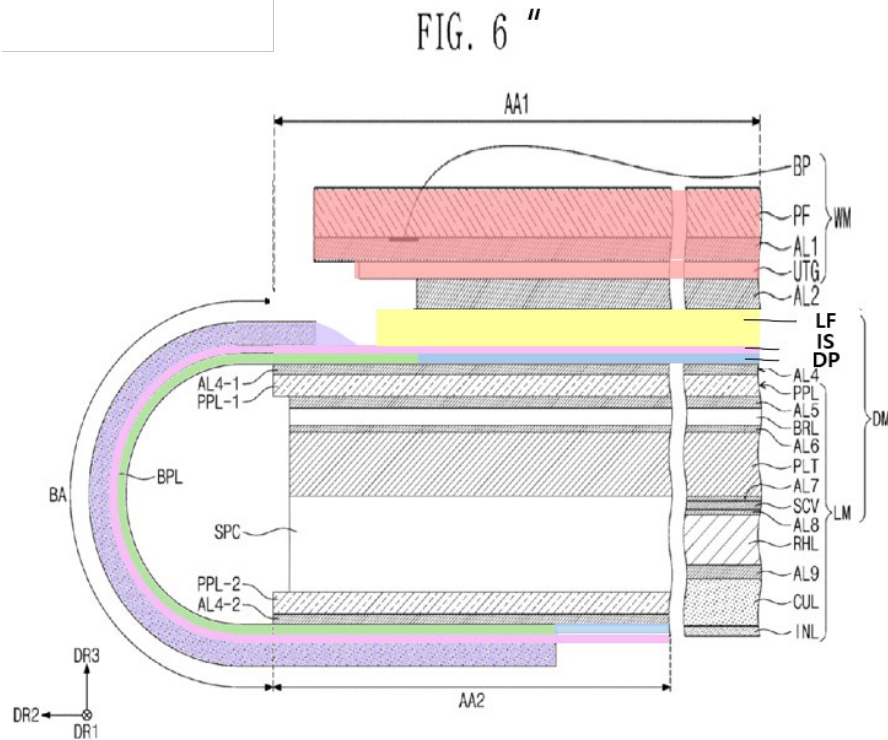
a. Claim 2

Shin-Luo teaches Claim 2. *See* §XII.A.2.a. Ex-1002 ¶165.

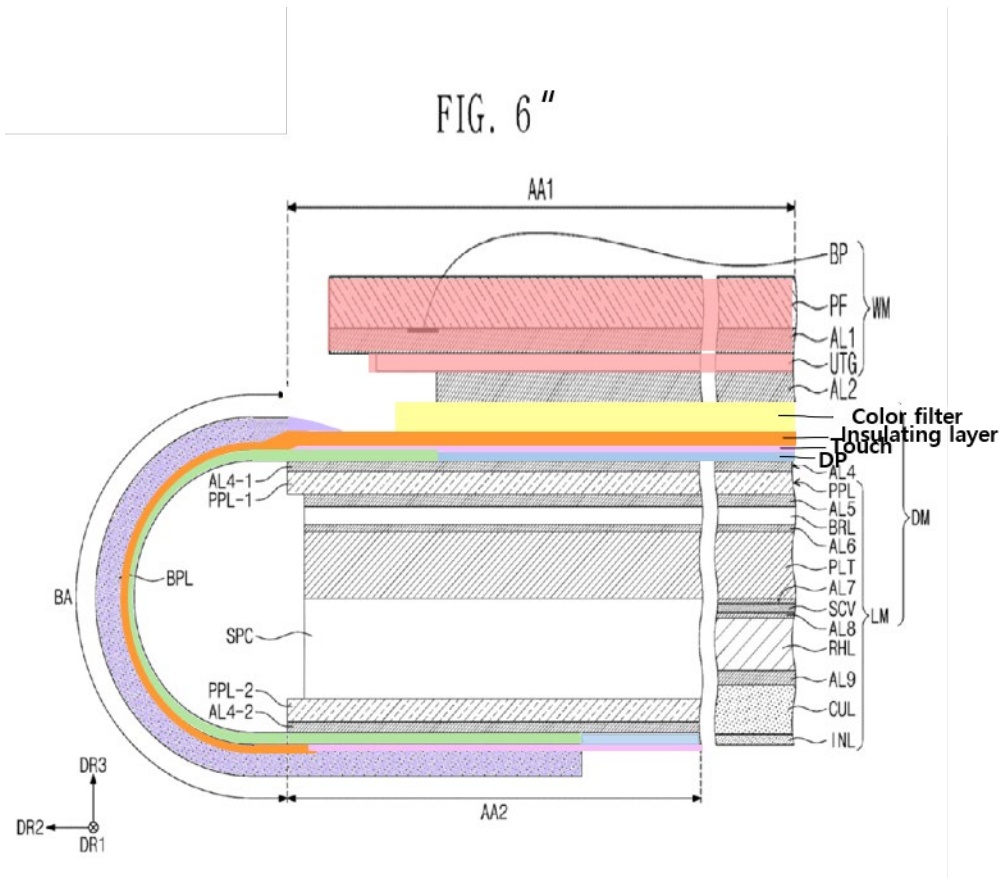
b. Claim 3

Shin-Luo teaches Claim 3. *See* §XII.A.2.b. Ex-1002 ¶¶166–167.

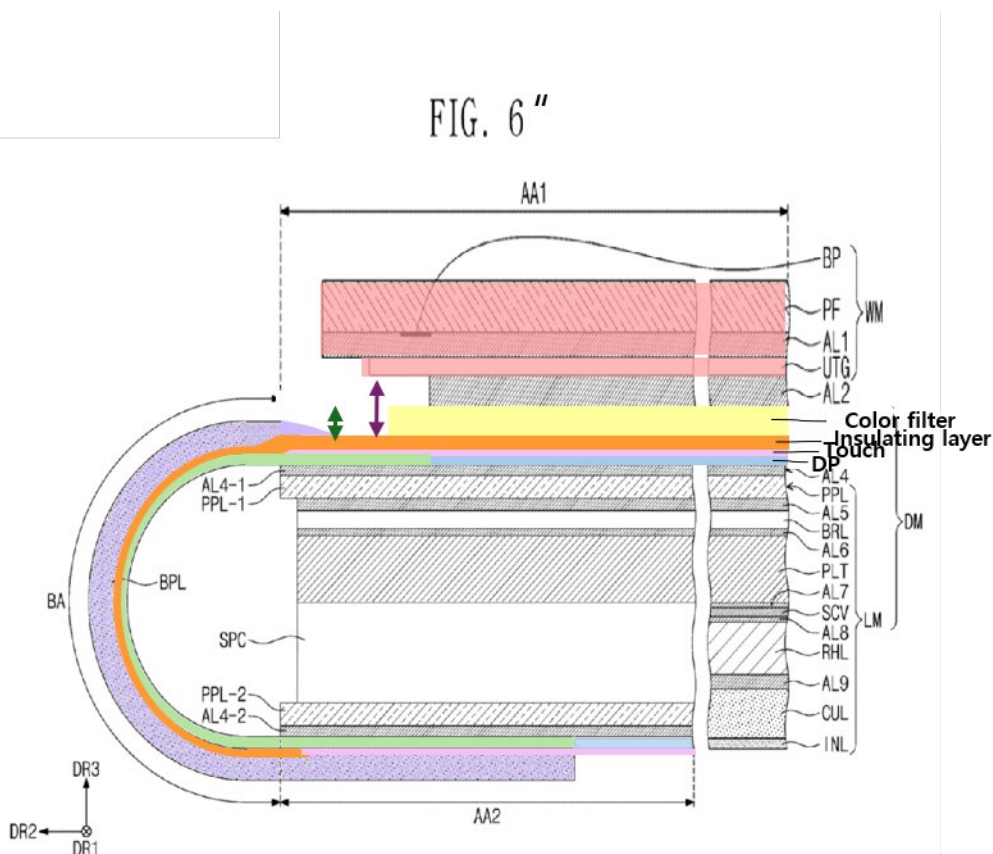
In the modified, annotated version of Shin’s Figure 6 below, Shin’s optical film LF (yellow) is disposed on input sensor IS (pink), as taught by Shin for Figure 3, with Luo’s teachings described above. Ex-1005, Fig. 6’.



In the Shin-Luo combination, a POSITA would have implemented Shin's Figure 6 embodiment with the BPL disposed on a surface of the insulating layer (orange) of input sensor IS (pink), which is, in turn, attached to the DP, as shown in Figure 6'' below. Ex-1002 ¶168.



As shown in modified, annotated versions of Shin's Figure 6 below, the thickness of the BPL (designated by the green arrow) on the surface of the insulating layer (orange) is less than the distance between one side of the coverplate (i.e., WM (red)) adjacent to the insulating layer and one side of the insulating layer adjacent to the coverplate (designated by the purple arrow). Ex-1005, Fig. 6''; Ex-1002 ¶169.



c. Claim 5

Shin-Luo teaches Claim 5. *See* §§XII.A.2.c(1)–XII.A.2.c(3). Ex-1002 ¶¶170–172.

d. Claim 7

Shin-Luo teaches Claim 7. *See* §XII.A.2.d. Ex-1002 ¶173.

e. Claim 8

Shin-Luo teaches Claim 8. Ex-1002 ¶174.

Luo teaches that the protective layer (i.e., MCL) is a UV glue. Specifically, Luo teaches that “[v]arious appropriate materials and various appropriate fabricating methods may be used to make the coating layer” such as “a UV curable adhesive

material” including, for example, those containing “a free radical generating photoinitiator and a compound having multiple unsaturated groups (e.g., acrylate, methacrylate or vinyl groups), such as an oligomer having multiple unsaturated groups and, optionally, a monomer having multiple unsaturated groups,” “type I or type II photoinitiators, such as benzoin ether, 1-hydroxy-cyclohexylphenyl-ketone or benzophenone, among others,” “epoxy acrylates (e.g., bisphenol-A-epoxy acrylate), aliphatic urethane acrylates (e.g., IPDI-based aliphatic urethane acrylates), aromatic urethane acrylates, polyether acrylates, polyester acrylates, aminated acrylates, and acrylic acrylates,” and/or “a cationic photoinitiator and an epoxide compound.” Ex-1006 ¶116. Luo’s UV curable adhesive material that is used for the coating layer corresponds to the recited “UV glue.” Ex-1002 ¶175.

In addition to the reasons described in Section XII.B.1, a POSITA would have been motivated to implement Shin’s BPL as a UV glue, as taught by Luo, because UV curable adhesive materials like glues are typically chosen to protect layers in electronic devices during bending due to their flexibility, temperature performance, and ability to keep layers bonded to each other during dynamic bending. Ex-1002 ¶176.

f. Claim 9

Shin-Luo teaches Claim 9. *See* §XII.A.2.e. Ex-1002 ¶177.

g. Claim 10

Shin-Luo teaches Claim 10. *See* §XII.A.2.f. Ex-1002 ¶178.

h. Claim 11

Shin-Luo teaches Claim 11. *See* §XII.A.2.g. Ex-1002 ¶179.

i. Claim 12

Shin-Luo teaches Claim 12. *See* §XII.A.2.h. Ex-1002 ¶180.

j. Claim 13

Shin-Luo teaches Claim 13. *See* §XII.A.2.i. Ex-1002 ¶181.

k. Claim 14

Shin-Luo teaches Claim 14. *See* §XII.A.2.j. Ex-1002 ¶182.

l. Claim 15

Shin-Luo teaches Claim 15. *See* §XII.A.2.k. Ex-1002 ¶183.

m. Claim 17

Shin-Luo teaches Claim 17. *See* §XII.A.2.l. Ex-1002 ¶184.

n. Claim 18

Shin-Luo teaches Claim 18. *See* §XII.A.2.m. Ex-1002 ¶185.

o. Claim 19

Shin-Luo teaches Claim 19. *See* §XII.A.2.n. Ex-1002 ¶186.

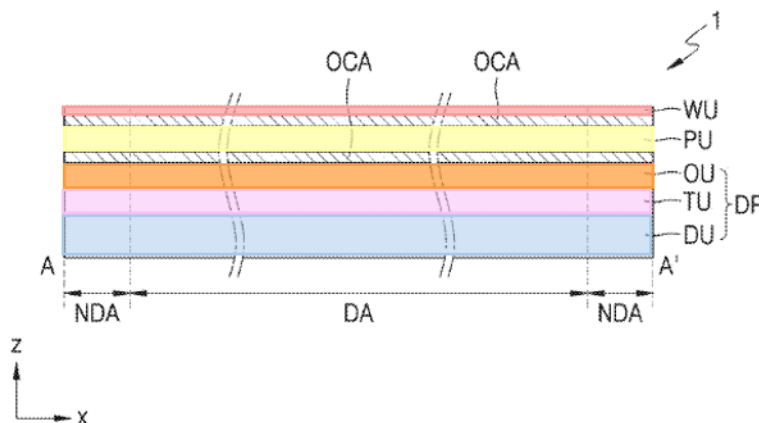
C. Grounds 3–4: Claim 3 Is Obvious over Shin in View of Lee’538 or Shin-Luo in View of Lee’538

1. Dependent Claim 3

Shin in view of Lee’538 (“Shin-Lee’538”) (Ground 3) or Shin-Luo in view of Lee’538 (“Shin-Luo-Lee’538”) (Ground 4) teaches Claim 3. Ex-1002 ¶¶187–188.

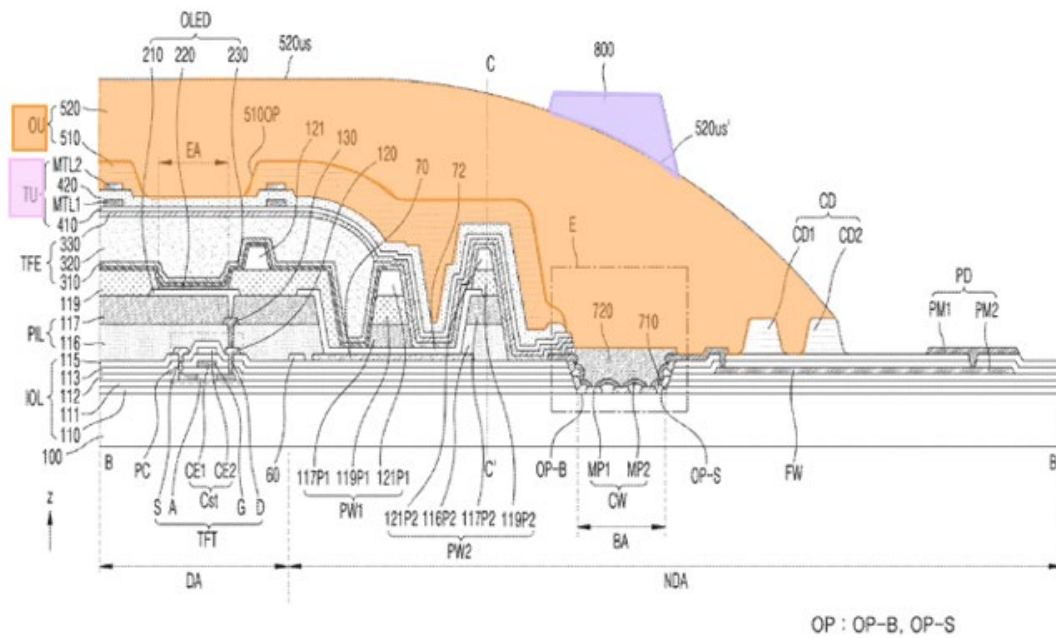
To the extent PO argues that Shin or Shin-Luo does not teach the particular layer configuration recited by Claim 3, the configuration is also taught by Lee’538. Lee’538 teaches display apparatus 1, which includes “display layer DU,” “touch sensing layer TU,” “optical functional layer OU,” “polarization layer PU,” and a window layer WU.” Ex-1007, 6:33–36. As shown in annotated Figure 2A below, Lee’538’s touch control layer (i.e., TU (pink)) is disposed between the flexible screen body (i.e., DU (blue)) and the optical functional layer (i.e., OU (orange)). Ex-1007, Fig. 2A. Moreover, Lee’538’s polarization layer PU (yellow) is disposed between the OU and WU (i.e., the coverplate) layers. *Id.*

FIG. 2A



Lee'538 further teaches an insulating layer disposed between the touch control layer and color filter and a protective layer disposed on a surface of the insulating layer. Specifically, as shown in annotated Figure 6 below, Lee'538 teaches that “optical functional layer OU may be disposed on the touch sensing layer TU” and includes “***first layer 510 [orange] ... and the second layer 520 [orange] arranged on the first layer 510.***” Ex-1007, 15:39–44, Fig. 6. Lee'538 also teaches that “***first layer 510 may include an insulating material*** having a first refractive index.” Ex-1007, 15:43–59. Moreover, Lee'538 teaches that second layer 520 “may include ***an organic insulating material***” (Ex-1007, 8:53–54) and “may ***extend over the peripheral area NDA while covering the bending area BA.***” Ex-1007, 11:40–41. Lee'538 further teaches stress reduction layer 800 (purple), which is “disposed on the second layer 520 of the optical functional layer OU,” “arranged to correspond to the bending area BA,” and includes “an organic insulating material.” Ex-1007, 19:18–22. First layer 510 and second layer 520 together correspond to the recited “insulating layer” and stress reduction layer 800 corresponds to the recited “protective layer disposed on a surface of the insulating layer.” Ex-1002 ¶189.

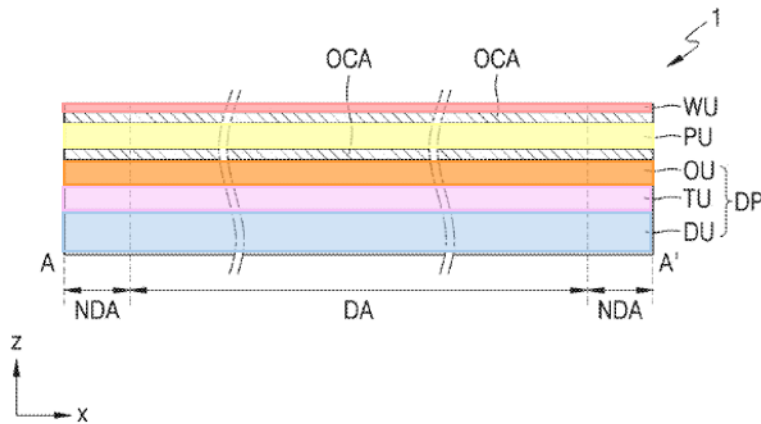
FIG. 6



Lee’538 further teaches that a thickness of the protective layer (i.e., 800) on the surface of the insulating layer (i.e., 510, 520) is less than or equal to a distance between one side of the coverplate (i.e., window layer WU in Fig. 2A) adjacent to the insulating layer and one side of the insulating layer adjacent to the coverplate. While Lee’538 teaches that the thicknesses of layers are “arbitrarily illustrated” (Ex-1007, 5:20–24), a POSITA would have understood that because at least the polarization layer PU (yellow) is disposed between the insulating layers (i.e., 510, 520) of the OU (orange) and the coverplate (i.e., WU (red)), which, like all physical structures, must have some thickness (*see* Fig. 2A), the thickness of the protective layer (800) on the surface of the insulating layer (510, 520) would have a thickness

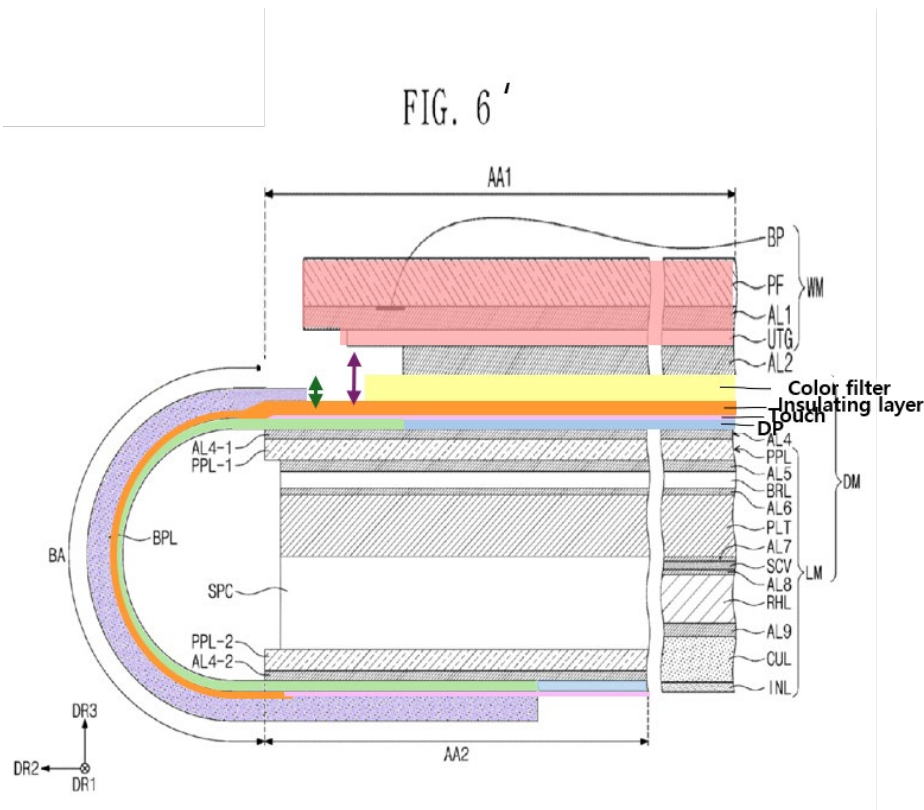
less than the distance between the WU and the insulating layer (510, 520). Ex-1002 ¶190.

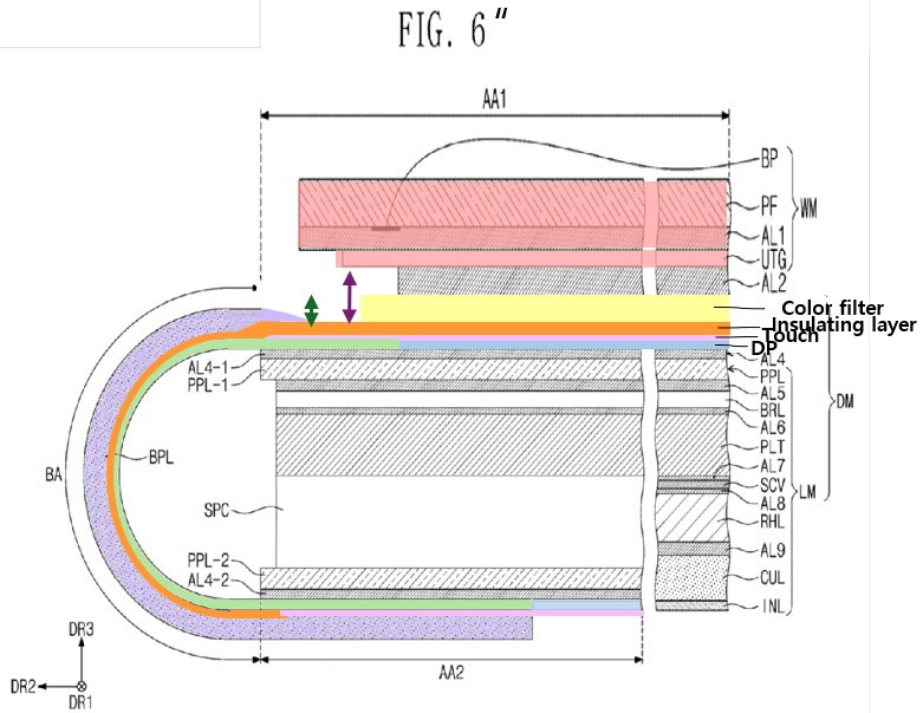
FIG. 2A



Lee'538 thus teaches the specific positional relationships between the touch layer, insulation layer, and protective layer in the bending area. Lee'538's optical functional layer (orange) corresponds to Shin's insulating layer; Lee'538's polarization layer PU (yellow) corresponds to Shin's color filter LF; Lee'538's stress reduction layer (purple) corresponds to Shin's BPL and Luo's MCL; and Lee'538's touch sensing layer TU (pink) corresponds to Shin's input sensor IS. *See* §§XII.A.2.b and XII.B.3.b. Shin, Luo, and Lee'538 all share the common objective of preventing cracks and facilitating bending. They similarly teach forming a protective layer on the display panel surface and bonding a polarizer or LF to a cover plate or window. Lee'538 provides specific teachings on how the back plane in the panel should be configured before and after the bending area BA. In the Shin-Lee'538 (Ground 3) or

Shin-Luo-Lee'538 (Ground 4) combination, as shown in modified, annotated versions of Shin's Figure 6 below, Shin's BPL is disposed on a surface of the insulating layer and a thickness of the BPL is less than or equal to a distance between one side of the coverplate (i.e., WM) adjacent to the insulating layer and one side of the insulating layer adjacent to the WM, as taught by Lee'538. Ex-1002 ¶191.





A POSITA would have been motivated to combine the teachings of Shin and Lee'538 (Ground 3) or Shin-Luo and Lee'538 (Ground 4) and had a reasonable expectation of success in doing so because all three relate to flexible, bendable display devices including multiple defined layers and similar components. *See* §XII.B.1; Ex-1007, Abstract, Figs. 2A, 6. Moreover, Shin, Luo, and Lee'538 have similar vertical structures, which implies that they employ similar processes. A POSITA would thus have understood that these references disclose interrelated teachings based on well-understood technologies that would have been amenable to various well-understood and predictable combinations. Ex-1002 ¶192.

D. Grounds 5–6: Claims 4–6 Are Obvious over Shin in View of Lee’703 or Shin-Luo in View of Lee’703

- 1. A POSITA would have been motivated to combine Shin’s teachings with Lee’703’s teachings or Shin-Luo’s teachings with Lee’703’s teachings and would have had a reasonable expectation of success.**

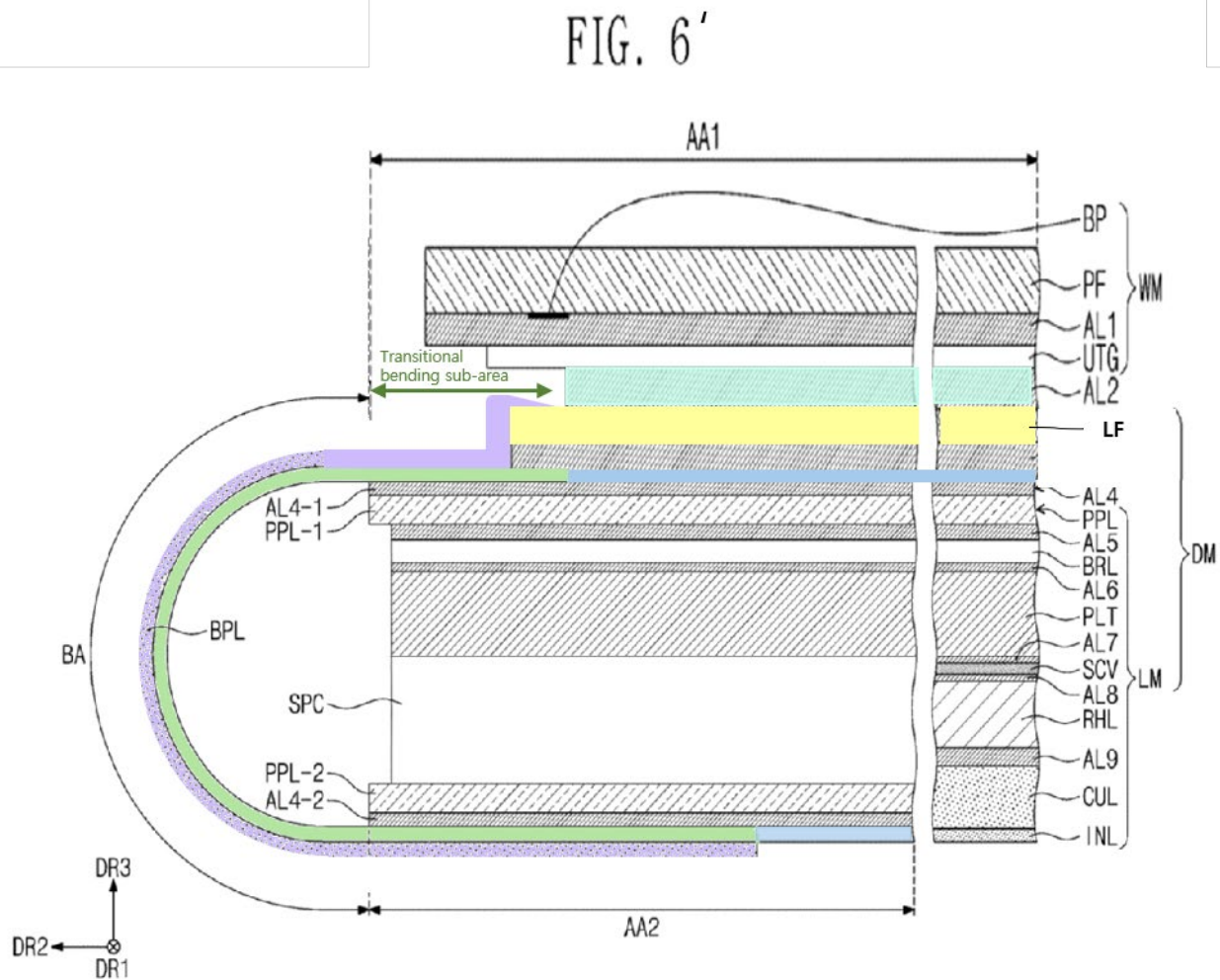
A POSITA would have been motivated to combine the teachings of Shin and Lee’703 (Ground 5) or Shin-Luo and Lee’703 (Ground 6) and had a reasonable expectation of success in doing so because all three relate to flexible, bendable display devices including multiple defined layers and similar components. *See* §XII.B.1; Ex-1009, Abstract, Fig. 12; Ex-1002 ¶193.

Shin teaches that its protective layer (i.e., BPL) is adjacent to instead of disposed on the surface of its color filter (i.e., LF) (*see, e.g.*, Ex-1005, Fig. 6). However, a POSITA would have understood that the placement of the protective layer vis-à-vis the color filter is a design choice and it would have been obvious to dispose the protective layer on the surface of the color filter. Ex-1002 ¶194. Additionally, Shin teaches that the coverplate (i.e., WM) is connected to the color filter (i.e., LF) by an optical adhesive (i.e., AL2) and that the BPL covers the transitional bending sub-area. While Shin does not expressly describe the thickness of the BPL vis-à-vis the AL2 layer, a POSITA would have understood that an obvious design choice would have been to make the thickness of the AL2 greater than a maximum thickness of the BPL in the transitional bending sub-area.

Lee'703 teaches "a polarizer and an organic light-emitting display device equipped therewith." Ex-1009, Abstract. Specifically, Lee'703 teaches that "polarizer (100) is disposed beneath the planar surface portion (420) of the cover glass (400)" and "comprises a first adhesive layer (120), a polarizing layer (130)," and a second adhesive layer (140)." Ex-1009 ¶108. Lee'703 further teaches that display panel (500) includes coating layer (560), which "may be disposed on a portion of the upper surface of the polarizing layer (130)." Ex-1009 ¶¶110, 117. Lee'703 also teaches that coating layer (560) "is composed of an insulating material," "intended to prevent moisture penetration and wiring cracks," and "disposed so as to cover at least the bent region." Ex-1009 ¶116. Moreover, Lee'703 teaches a first adhesive layer (120) between the polarizer layer (130) and the coverplate (400) and that the thickness of first adhesive layer (120) is greater than a maximum thickness of coating layer (560) on the transitional bending sub-area. Ex-1009 ¶108, Fig. 12.

Lee'703 coating layer 560 corresponds to Shin's BPL; Lee'703's polarizer 130 corresponds to Shin's color filter LF; and Lee'703's coverplate 400 corresponds to Shin's coverplate WM. Ex-1002 ¶¶195-196. While Lee'703's protective layer is disposed on a surface of a polarizer instead of a color filter, in the Shin-Lee'703 or Shin-Luo-Lee'703 combination, the protective layer (purple) would be disposed on the surface of Shin's color filter (yellow) as shown in modified, annotated Figure 6'

below. Ex-1005, Fig. 6'. A POSITA would have been motivated to arrange Shin's components in this manner because, for example, it would prevent cracks, as taught by Lee'703, which is also a goal of Shin's invention. *See, e.g.*, Ex-1005 ¶¶109, 113. A POSITA would have also been motivated to implement Lee'703's teachings that the thickness of the BPL is less than or equal to a distance between one side of the WM (red) adjacent to the LF and one side of the LF adjacent to the WM and the thickness of the AL2 (teal) is greater than a maximum thickness of the BPL on the transitional bending sub-area, in Shin's display device. Ex-1002 ¶196. As shown in Figure 6' below, in the Shin-Lee'703 (Ground 5) or Shin-Luo-Lee'703 (Ground 6) combination, Shin's BPL is disposed on a surface of the LF, and a thickness of the BPL is less than or equal to a distance between one side of the WM adjacent to the LF and one side of the LF adjacent to the WM, as taught by Lee'703. Moreover, the thickness of AL2 is greater than a maximum thickness of BPL on the transitional bending sub-area, as taught by Lee'703. Ex-1002 ¶¶197–199.



A POSITA would have had a reasonable expectation of success in combining the teachings of Shin and Lee'703 (Ground 5) and Shin-Luo and Lee'703 (Ground 6). All three describe flexible, bendable display devices including similar layers and components. *See* §XII.B.1; Ex-1009, Abstract, Fig. 12. A POSITA would thus have understood that these references disclose interrelated teachings based on well-

understood technologies that would have been amenable to various well-understood and predictable combinations. Ex-1002 ¶200.

2. Dependent Claims 4–6

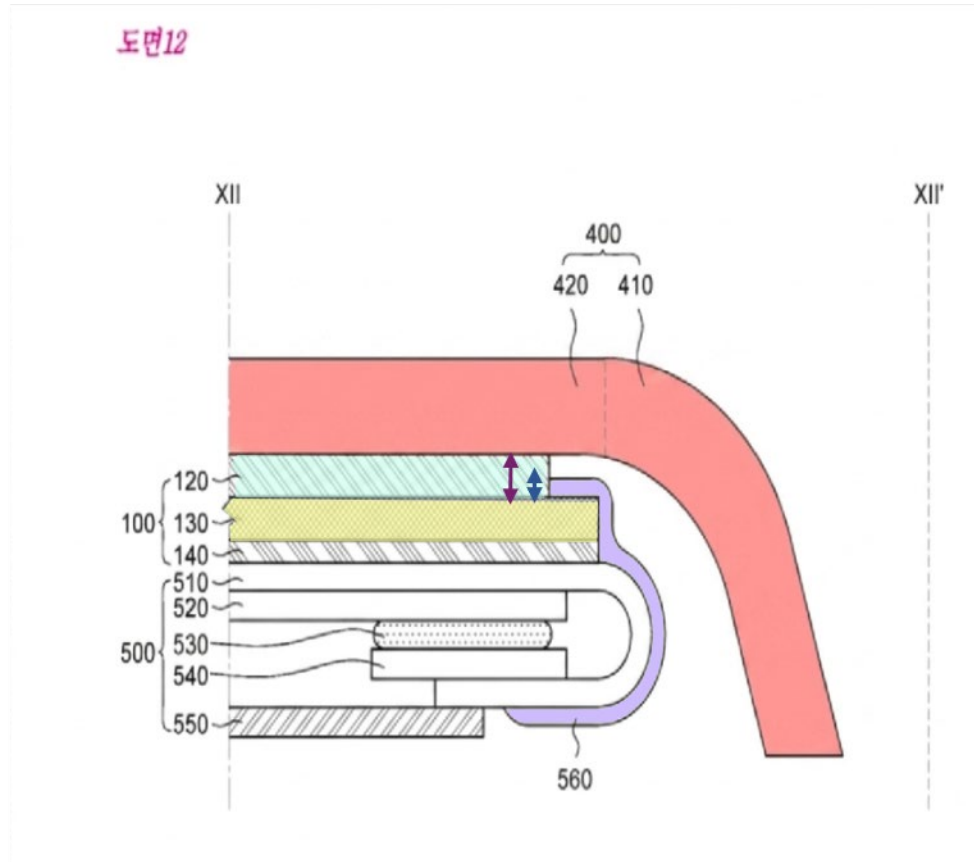
- a. **Claim 4: The display device according to claim 2, wherein the protective layer is further disposed on a surface of the color filter, and a thickness of the protective layer on the surface of the color filter is less than or equal to a distance between one side of the coverplate adjacent to the color filter and one side of the color filter adjacent to the coverplate.**

Shin in view of Lee’703 (“Shin-Lee’703”) (Ground 5) or Shin-Luo in view of Lee’703 (“Shin-Luo-Lee’703”) (Ground 6) teaches Claim 4. Ex-1002 ¶¶201–202.

Shin illustrates the protective layer (i.e., BPL) as adjacent to instead of disposed on the surface of the color filter (i.e., LF). *See, e.g.*, Ex-1005, Fig. 6. However, a POSITA would have understood that the placement of the protective layer vis-à-vis the color filter is a design choice and it would have been obvious to dispose the protective layer on the color filter’s surface. A similar arrangement is taught by Lee’703.

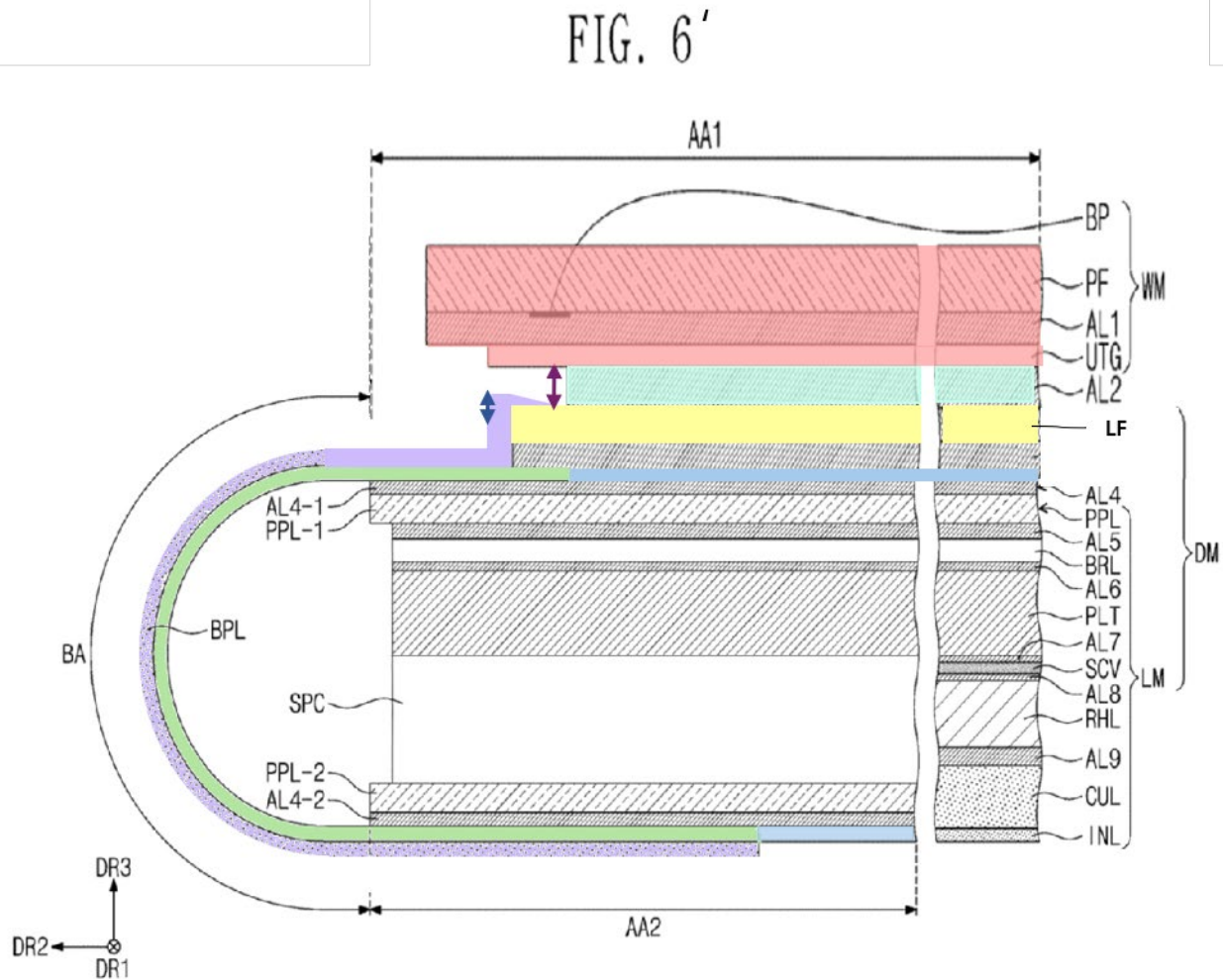
As shown in annotated Figure 12 below, Lee’703 teaches that polarizer (100) and the display panel (500) “are disposed inside the *cover glass (400) [red]*.” Ex-1009 ¶106, Fig. 12. Specifically, Lee’703 teaches that “polarizer (100) is disposed beneath the planar surface portion (420) of the cover glass (400)” and “comprises a first adhesive layer (120) [teal], a polarizing layer (130) [yellow],” and second

adhesive layer (140). Ex-1009 ¶108. Lee’703 further teaches that “display panel (500) includes a substrate (510) with a bent portion, a first back plate (520), a foam tape (530), a second back plate (540), a driving unit (550), and **a coating layer (560) [purple]**.” Ex-1009 ¶110. Moreover, Lee’703 teaches that “coating layer (560) may be disposed on a portion of the upper surface of the polarizing layer (130).” Ex-1009 ¶117. Lee’703 also teaches that coating layer (560) “is composed of an insulating material,” “intended to prevent moisture penetration and wiring cracks,” and “may ... cover at least the bent region.” Ex-1009 ¶116. Lee’703’s cover glass (400) corresponds to the recited “coverplate” and coating layer (560) corresponds to the recited “protective layer.” While Lee’703’s protective layer is disposed on a surface of a polarizer instead of a color filter, in the Shin-Lee’703 or Shin-Luo-Lee’703 combination, the protective layer would be disposed on the surface of Shin’s color filter. A POSITA would have been motivated to arrange Shin’s components in this manner because, for example, it would prevent cracks, as taught by Lee’703, which is also a goal of Shin’s invention. *See, e.g.*, Ex-1005 ¶¶109, 113. Indeed, this was a well-known arrangement of such components by the time of the invention. Ex-1002 ¶203 (*citing, e.g.*, Ex-1010 ¶130 (teaching bending protection layer 600 disposed on the surface of color filter 520), Fig. 3)).



Lee'703 further teaches that a thickness of the coating layer (i.e., 560) on the surface of the polarizer (i.e., 130) is less than or equal to a distance between one side of the coverplate (i.e., 400) adjacent to the polarizer and one side of the polarizer adjacent to the coverplate because, as shown in Figure 12, the thickness of coating layer (560) on polarizer layer (130) (designated by the blue arrow) is less than the distance between polarizer layer (130) and the cover glass (400) (designated by the purple arrow). Indeed, Lee'703 teaches that the purpose for this distance “to prevent the coating layer (560) from overflowing.” Ex-1009 ¶117; Ex-1002 ¶¶204–205.

As shown in modified, annotated version of Shin's Figure 6 below, in the Shin-Lee'703 or Shin-Luo-Lee'703 combination, Shin's protective layer (i.e., BPL) is further disposed on a surface of the color filter (i.e., LF), and a thickness of the BPL on the surface of the LF is less than or equal to a distance between one side of the coverplate (i.e., WM) adjacent to the LF and one side of the LF adjacent to the WM, as taught by Lee'703. Ex-1005, Fig. 6'. While Lee'703's teachings relate to a polarizer, a POSITA would have been motivated to arrange Shin's components (including Shin's color filter) in this manner because, for example, it would prevent the BPL from overflowing, as taught by Lee'703. Ex-1002 ¶¶206–207.



b. Claim 5

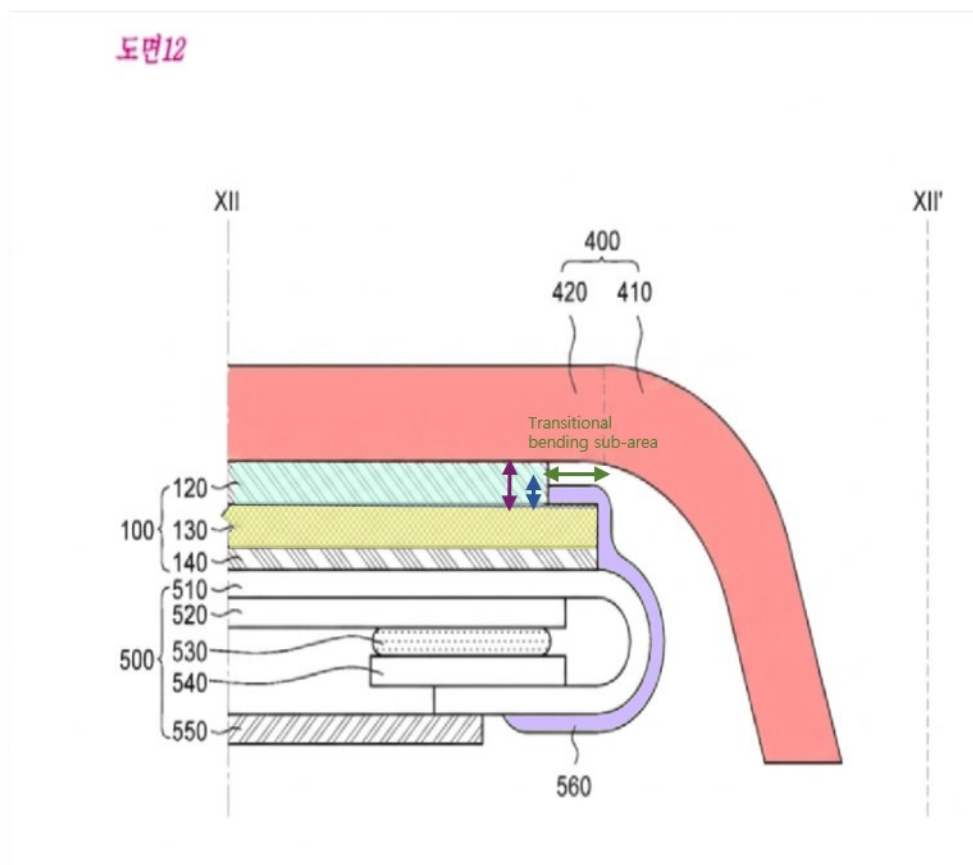
Shin-Lee'703 or Shin-Luo-Lee'703 teaches Claim 5. See §§XII.A.2.c(1)–XII.A.2.c(3). Ex-1002 ¶¶208–210.

c. Claim 6: The display device according to claim 5, wherein a thickness of the optical adhesive is greater than a maximum thickness of the protective layer on the transitional bending sub-area.

Shin-Lee'703 or Shin-Luo-Lee'703 teaches Claim 6. Ex-1002 ¶211.

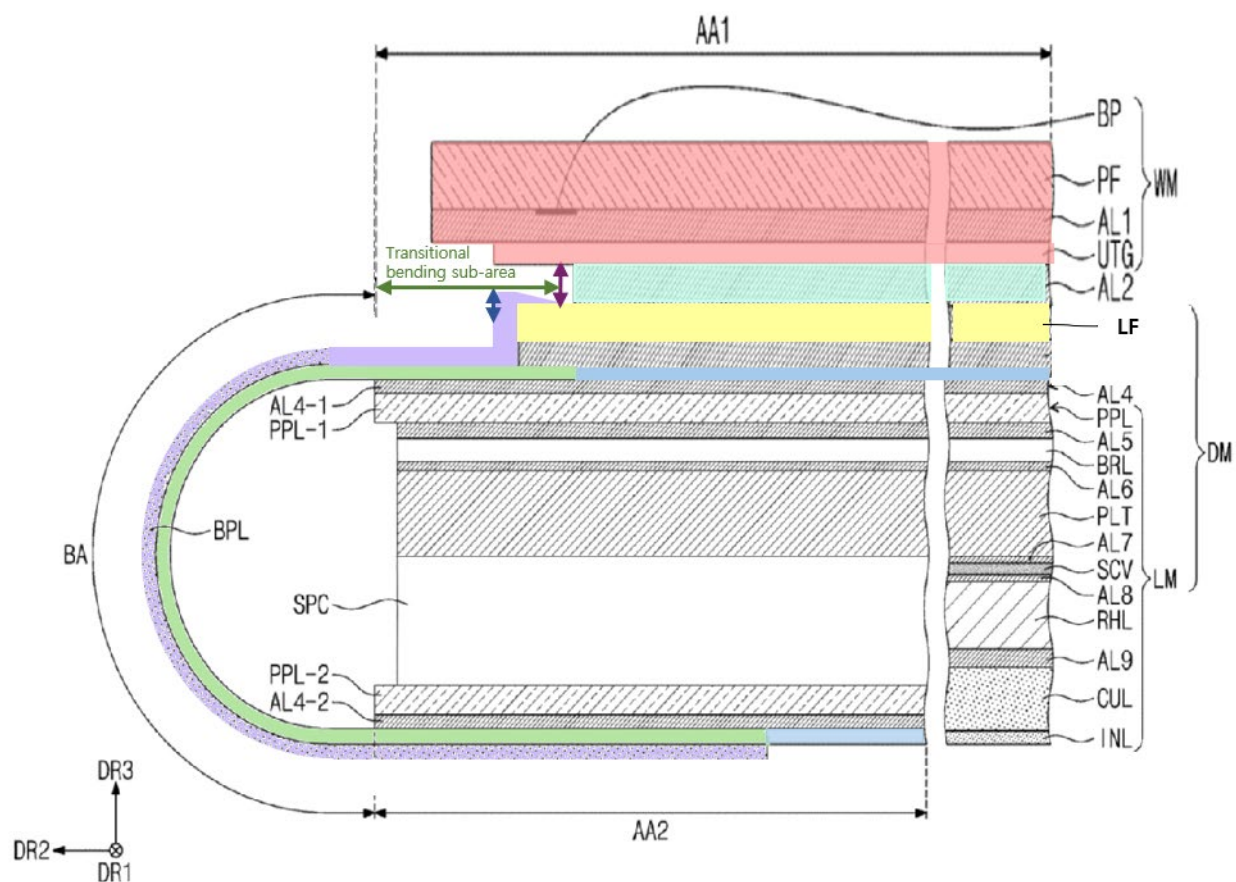
Shin teaches that the coverplate (i.e., WM) is connected to the color filter (i.e., LF) by an optical adhesive (i.e., AL2) and that the protective layer (i.e., BPL) covers the transitional bending sub-area. *See* §XII.A.2.c. Shin does not expressly describe the thickness of the protective layer (i.e., BPL) vis-à-vis the AL2 layer but a POSITA would have understood that an obvious design choice would have been to make the thickness of the AL2 greater than a maximum thickness of the BPL in the transitional bending sub-area, as taught by Lee’703. Ex-1002 ¶212.

As shown in annotated Figure 12 below, Lee’703 teaches a first adhesive layer (120) (teal) between the polarizer layer (130) (yellow) and the coverplate (400) (red). Ex-1009 ¶108, Fig. 12; *see also id.* ¶109 (“first adhesive layer (120) of the polarizer (100) may be bonded to the lower surface of ... cover glass (400)” and “secure[s] the cover glass (400) and the polarizer (100) together”). Additionally, Lee’703 teaches that the thickness of first adhesive layer (120) (designated by the purple arrow) is greater than a maximum thickness of coating layer (560) (designated by the blue arrow) on the transitional bending sub-area (designated by the green arrow). Ex-1002 ¶213.



As shown in modified, annotated version of Shin's Figure 6 below, in the Shin-Lee'703 or Shin-Luo-Lee'703 combination, the thickness of Shin's optical adhesive (i.e., AL2) is greater than a maximum thickness of Shin's protective layer (i.e., BPL) on the transitional bending sub-area, as taught by Lee'703. Ex-1005, Fig. 6'; Ex-1002 ¶214.

FIG. 6'



E. Grounds 7–8: Claim 16 Is Obvious over Shin in View of Park or Shin-Luo in View of Park

- 1. Dependent Claim 16: The display device according to claim 1, wherein the planar area comprises a plurality of red sub-pixel units, green sub-pixel units, and blue sub-pixel units, the color filter comprises a plurality of color resists and a black matrix disposed among the color resists, and the color resists comprise red color resists, green color resists, and blue color resists; and wherein the red color resists are disposed corresponding to the red sub-pixel units, the green color resists are disposed corresponding to the green sub-pixel units, and the blue color resists are disposed corresponding to the blue sub-pixel units.**

Shin in view of Park (“Shin-Park”) (Ground 7) or Shin-Luo in view of Park (“Shin-Luo-Park”) (Ground 8) teaches Claim 16. Ex-1002 ¶215.

Shin teaches that the planar area where the color filter resides comprises a plurality of color filters and a black matrix. Specifically, Shin teaches “optical film LF may include color filters in a color filter layer,” which “may have an arrangement ... determined in consideration of emitted colors of the pixels PX in the display panel DP.” Ex-1005 ¶86. Shin also teaches that “LF may further include a black matrix.” *Id.* Shin leaves the implementation details regarding the specific sub-pixel units that may be included with the color filter to a POSITA. It would have been obvious that red, green, and blue color sub-pixel units and their corresponding color resists would be included because these are the most common color arrays used in color filters. Ex-1002 ¶216. These are also taught by Park.

Park teaches a plurality of red sub-pixel units, green sub-pixel units, and blue sub-pixel units. Specifically, Park teaches that “display area DA includes pixels P,” each of which “may be connected to a signal line, such as a scan line SL extending in the first direction or a data line DL extending in the second direction.” Ex-1010 ¶57. Park also teaches that “pixels P may include electronic elements, such as a thin film transistor (“TFT”) and a storage capacitor, electrically connected to the signal line and the power line and an organic light-emitting device (“OLED”) connected to the electronic elements.” Ex-1010 ¶58. Park further teaches that “pixels P may emit, for example, a red light, a green light, a blue light or a white light through the OLED” and “pixels P may each be a sub-pixel that emit light of one of a red color, a green color, and a blue color as described above, or a sub-pixel that emit light of any one of a red color, a green color, a blue color, and a white color.” *Id.*

Moreover, Park teaches a color filter comprising a plurality of color resists and a black matrix. Specifically, Park teaches a top film, which may be a color filter. Ex-1010 ¶92. Park further teaches that “the color filter may clarify emission color and reduce the reflection of external light due to the inclusion of a matrix of a color corresponding to the color of each pixel and a black matrix.” Ex-1010 ¶93. A POSITA would have understood that Park’s apparatus includes color resists corresponding to the sub-pixel units because it was known that the color matrix and color resists are applied in sequence and work together to form the complete color

filter structure. Ex-1002 ¶¶217–218. Additionally, it was known that the color matrix resist (i.e., black matrix) and the color resists are essential parts of the color filter. Thus, a POSITA would have understood that Park includes the recited “color resists” comprising “red color resists, green color resists, and blue color resists; and wherein the red color resists are disposed corresponding to the red sub-pixel units, the green color resists are disposed corresponding to the green sub-pixel units, and the blue color resists are disposed corresponding to the blue sub-pixel units.” Ex-1002 ¶218.

A POSITA would have been motivated to combine the teachings of Shin and Park (Ground 7) or Shin-Luo and Park (Ground 8) and had a reasonable expectation of success in doing so because all three relate to flexible, bendable display devices including multiple defined layers and similar components. *See* §XII.B.1; Ex-1010, Abstract. A POSITA would thus have understood that these references disclose interrelated teachings based on well-understood technologies that would have been amenable to various well-understood and predictable combinations. In the Shin-Park or Shin-Luo-Park combination, Shin’s color filter comprising a plurality of color filters and a black matrix further comprises a plurality of red sub-pixel units, green sub-pixel units, and blue sub-pixel units and a plurality of color resists comprising red color resists, green color resists, and blue color resists, which are disposed corresponding to the red sub-pixel units, the green sub-pixel units, and the blue sub-pixel units, respectively, as taught by Park. Ex-1002 ¶219.

XIII. CONCLUSION

Petitioner requests institution of IPR for Claims 1–19 of the '031 Patent based on each of the grounds in this Petition.

Respectfully submitted,

/s/ Benjamin Haber
Benjamin M. Haber (Reg. No. 67,129)

CERTIFICATE OF WORD COUNT

Pursuant to 37 C.F.R. § 42.24(d), Petitioner certifies that this petition includes 13,980 words, as measured by Microsoft Word, exclusive of the table of contents, mandatory notices under § 42.8, certificates of service, word count, and exhibits.

CERTIFICATE OF SERVICE (37 C.F.R. § 42.6(e)(1))

The undersigned hereby certifies that the above document was served on September 17, 2026, by filing this document through the Patent Trial and Appeal Board P-TACTS System, as well as delivering a copy via express mail upon the following attorneys of record for the Patent Owner:

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