



(51) International Patent Classification:
G09F 9/30 (2006.01)

(21) International Application Number:
PCT/US2015/039822

(22) International Filing Date:
9 July 2015 (09.07.2015)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant: **HEWLETT-PACKARD DEVELOPMENT COMPANY, L.P.** [US/US]; Hewlett-Packard Development Company, L.P., 11445 Compaq Center Drive West, Houston, Texas 77070 (US).

(72) Inventors: **XU, Gang**; 10092 Amador Oak Ct., Cupertino, California 95014 (US). **HOLDER, Helen A.**; 1501 Page Mill Road, Palo Alto, California 94304 (US).

(74) Agents: **MAISAMI, Ceyda A.** et al.; Hewlett-Packard Company, Intellectual Property Administration, 3404 East Harmony Road, Mail Stop 35, Fort Collins, Colorado 80528 (US).

(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,

BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- as to the identity of the inventor (Rule 4.17(i))
- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))

Published:

- with international search report (Art. 21(3))

(54) Title: FLEXIBLE DISPLAY

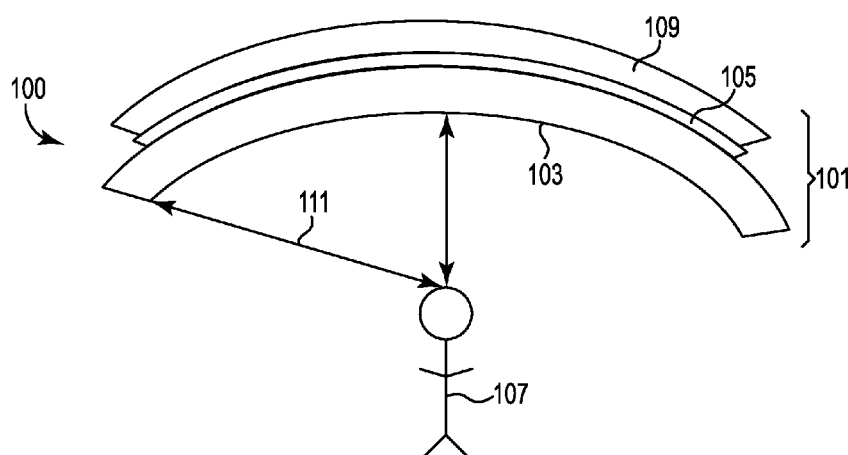


Fig. 1

(57) Abstract: Example implementations relate to flexible displays. For example, a flexible display system may comprise a plurality of display layers, an anti-reflective layer among the plurality of display layers to reduce reflection from an underlying light emitting layer, the anti-reflective layer including a wave plate and a polarizer, and a transistor layer among the plurality of display layers. Further, at least a portion of the plurality of display layers may include properties satisfying particular geometric and force balance constraints to enable the transistor layer to maintain a neutral force in response to compression or tension of the flexible display.



FLEXIBLE DISPLAY

Background

[0001] A flexible display may be convenient to carry, and may embody a relatively large-sized screen, and accordingly, the flexible display may be applied to not only mobile devices, such as cellular phones, portable multimedia players (PMPs), navigation devices, ultra mobile personal computers (UMPCs), e-books, e-newspapers, and the like, but also to other fields, such as TVs, monitors, and the like.

Brief Description of the Drawings

[0002] Figure 1 illustrates an example of a flexible display system according to the present disclosure.

[0003] Figure 2 further illustrates an example of a flexible display system in accordance with the present disclosure.

[0004] Figure 3 further illustrates an example of a flexible display system in accordance with the present disclosure.

[0005] Figure 4 further illustrates an example of a flexible display system in accordance with the present disclosure.

[0006] Figure 5 further illustrates an example of a flexible display system in accordance with the present disclosure.

Detailed Description

[0007] Unlike rigid display devices which maintain a planar state, a flexible display may be folded in various directions and/or rolled. Accordingly, it may be desirable to construct a flexible display that can be manipulated without damaging (e.g., breaking and/or cracking) and/or impacting the performance of the flexible display. In flexible displays that include a thin film transistor (TFT) layer, the TFT layer of the flexible display may be damaged when under pressure. For instance, when the flexible display is bent and/or folded such that the TFT layer is under compression or tension, the TFT layer may break and/or crack.

[0008] In contrast, a flexible display in accordance with the present disclosure may maintain the sensitive layer, the transistor layer, in a neutral force and reduce the risk of damage to the structural integrity of the transistor layer. As used herein, to maintain the transistor layer in a neutral force refers to maintaining the transistor layer in a neutral axis, such that a net zero force (or substantially net zero force) is applied to the transistor layer.

[0009] Similarly, a flexible display in accordance with the present disclosure may incorporate and/or integrate various portions of the flexible display so as to reduce the thickness of the flexible display. For instance, a touch function may be integrated with a transistor layer to reduce the overall thickness of the flexible display. Additionally and/or alternatively, a touch function may be incorporated in a polarizing layer of the flexible display.

[0010] As used herein, to incorporate or to integrate layers within the flexible display, may refer to directly bonding the layers. For instance, the touch layer may be directly bonded to the polarizing layer. However, examples are not so limited, and to incorporate or to integrate layers may refer to physically combined layers within the flexible display. For instance, the components of the touch layer may be included in the components of the polarizing layer. Put another way, when disparate materials are referred to herein, it is to be understood that such materials may refer to separate, distinct materials that are directly bonded to one another

and/or a single material with a treatment or treatments thereon to achieve particular material properties.

[0011] Figure 1 illustrates an example flexible display system 100 in accordance with the present disclosure. The flexible display system 100 may include a flexible display 101 comprising a plurality of display layers. As used herein, a display layer refers to a layer within a flexible display 101 that includes a material and/or composition of materials for facilitating display of images. Further, as used herein, a flexible display 101 refers to a display that is capable of being folded and/or rolled in a plurality of directions. For instance, a flexible display 101 may refer to a display that is capable of dual sided bending, such that the display may be folded in a first direction and also in a second direction opposite of the first direction. Put another way, the flexible display 101 may be bent, folded, and/or manipulated as illustrated in Figure 1, such that a viewer 107 may view the flexible display from the center of the curvature illustrated. Additionally and/or alternatively, a flexible display 101 may refer to a display that is capable of tri-fold bending, such that the flexible display 101 may be folded in at least two regions. In yet another example, a flexible display 101 may refer to a display that is capable of being rolled, such that the flexible display 101 may be bent and/or manipulated to form a substantially circular shape.

[0012] The flexible display 101 may satisfy particular geometric and force balance constraints. For instance, at least a portion of the plurality of display layers comprising the flexible display 101 may include properties satisfying the particular geometric and force balance constraints. For example, the flexible display 101 may include a top layer 103, a bottom layer 109, and a transistor layer 105. In some examples, the transistor layer 105 may include a TFT. At least a portion of the plurality of display layers (e.g., the top layer 103, the bottom layer 109, and the transistor layer 105) may include properties that satisfy the particular geometric and force balance constraints to enable the transistor layer 105 to maintain a neutral force in response to compression or tension of the flexible display 101.

[0013] The particular geometric and force balance constraints may be described in relation to the relative thickness of each layer, as well as the bending radius of the flexible display 101. Referring to Figure 1, the flexible display 101 may be bent such that the top layer 103 is under compression, whereas the bottom layer 109 may be under tension. An assumption underlying the particular geometric and force balance constraints may be that the flexible display 101 may have a strain at yield of 3.5%. As used herein, a yield point may refer to a point at which an elastic material under increasing stress ceases to behave elastically. Also, as used herein, strain is a change in length due to a force applied. In other words, the flexible display 101 may experience a change in length of 3.5% at a particular yield point, at which point the flexible display 101 may not return to its original length. As referenced herein, the flexible display 101 may be under geometric constraints. The geometric constraints may be defined by the following equations:

$$\begin{aligned} t_c &\leq 0.035 * R \text{ and} \\ t_t &\leq 0.035 * R \\ \text{where } t &\leq 0.07 * R. \end{aligned}$$

As used herein, t_c refers to the thickness of the layer in the flexible display 101 that is under compression (e.g., layer 103 illustrated in Figure 1), and t_t refers to the thickness of the layer in the flexible display 101 that is under tension (e.g., layer 109 illustrated in Figure 1). Furthermore, R refers to the bending radius of the flexible display 101, illustrated as radius 111 in Figure 1. Based on the above equations, when the flexible display 101 is folded, either in a tri-fold example or a dual-sided bending example as discussed previously, the radius 111 of the flexible display 101 may be 5mm or greater. Similarly, when the flexible display 101 is folded, the total thickness of the flexible display 101, defined by the equation $t = t_c + t_t$, may be 0.35mm or less (e.g., $\leq 0.35\text{mm}$). Also based on the above equations, when the flexible display 101 is rolled, as discussed previously, the radius 111 of the flexible display 101 may be 15mm or greater. When the flexible

display 101 is rolled, the total thickness of the flexible display 101, defined by the equation $t = t_c + t_t$, may be 1.05mm or less (e.g., $\leq 1.05\text{mm}$).

[0014] Also referring to Figure 1, the flexible display 101 may be under particular force balance constraints. For instance, the particular force balance constraints may be defined by the following equations:

$$(K_t * t_t)^2 = (K_c)^2 \text{ and}$$

$$(K_t * t_t)^2 = (t_c)^2.$$

The geometric and force balance constraints described above may enable the transistor layer 105 to maintain a neutral force in response to compression or tension of the flexible display. That is, while the top layer 103 may be under compression, and the bottom layer 109 may be under tension, the transistor layer 105 may be under neither compression nor tension.

[0015] While Figure 1 illustrates three layers, examples are not so limited and more or fewer layers may be included in the flexible display 101 than illustrated. Furthermore, each of the layers illustrated may also include a plurality of layers. For instance, the bottom layer 109 may comprise a light emitting layer, whereas the top layer 103 may comprise an anti-reflective layer to reduce reflection from the underlying light emitting layer 109, the top layer 103 including a wave plate and a polarizer, as described further herein.

[0016] As used herein, a compressive modulus of a material refers to a ratio of the compressive stress applied to a material compared to the resulting compression. Similarly, a tensile modulus of a material refers to a ratio of stress along an axis to the strain along that axis. Put another way, the tensile modulus of a material refers to a measure of stiffness of an elastic materials. The tensile modulus may also be referred to as Young's modulus. In some examples, the top layer 103 and the bottom layer 109 may have substantially similar compressive moduli and tensile moduli. For instance, if the top layer 103 comprised an anti-reflective layer, and the bottom layer 109 comprised a light emitting layer, the anti-reflective layer and the light emitting layer may have substantially similar compressive and tensile moduli. In some examples, a thickness and Young's

modulus of each of the plurality of layers satisfy the particular geometric and force balance constraints within a particular tolerance. Notably, while Figure 1 illustrates the transistor layer 105 as being located between the top layer 103 and the bottom layer 109, examples are not so limited and the transistor layer 105 may be in a position within the flexible display 101 other than the middle. Similarly, while the phrases “top layer” and “bottom layer” were used to describe the relative positions of portions of the flexible display 101, such as an anti-reflective layer and a light emitting layer, respectively, such terminology was used merely for illustrative purposes and does not restrict the location of the anti-reflective layer and the light emitting layer. As described herein, particular layers within the flexible display 101 may be located in various positions to enable folding and/or rolling of the flexible display 101 without compromising the integrity of the transistor layer 105.

[0017] Figure 2 further illustrates an example of a flexible display system 200 in accordance with the present disclosure. The flexible display system 200 may be analogous to the flexible display system 100 illustrated in Figure 1.

[0018] As illustrated in Figure 2, the flexible display system 200, including the flexible display 201, may comprise a plurality of display layers. For instance, the flexible display 201 may include an anti-reflective layer 213 among the plurality of display layers. The anti-reflective layer 213 may comprise a material or a plurality of materials to reduce reflection from an underlying light emitting layer 215. For instance, the flexible display 201 may include a polarizer 217 and a wave plate 219. As used herein, a polarizer may refer to an optical filter that passes light of a specific polarization and blocks waves of other polarizations. In some examples, the polarizer 217 may comprise a polyvinyl alcohol (PVA) layer. A wave plate may refer to an optical device that alters the polarization state of a light wave travelling through it. In some examples, the wave plate 219 may comprise a quarter-wave plate which converts linearly polarized light into circularly polarized light and vice versa.

[0019] Also, as illustrated in Figure 2, the flexible display 201 may include a protective layer 221. The protective layer 221 may include a material or a plurality

of materials to protect the flexible display 201 from various forces. For instance, the protective layer 221 may include a hard coating 223 as well as a cover lens 225. The hard coating 223 and/or the cover lens 225 may be comprised of a plurality of materials, such as polymethyl methacrylate (PMMA) and triacetyl cellulose (TAC), among other materials. Additionally, the flexible display 201 may include a moisture barrier layer 227. The moisture barrier layer 227 may protect the underlying light emitting layer 215 and/or underlying TFT layer 205 (e.g., a transistor layer) from damage due to moisture exposure.

[0020] Figure 2 illustrates a moisture barrier layer 227 proximal to a transistor layer (e.g., TFT layer 205) relative to a protective layer 221. Similarly, Figure 2 illustrates the moisture barrier layer 227 proximal to the transistor layer (e.g., TFT layer 205) relative to the anti-reflective layer 213. However, examples are not so limited. For instance, the location of the anti-reflective layer 213 and the moisture barrier layer 227 may be reversed, such that the anti-reflective layer 213 is proximal to the transistor layer (e.g., TFT layer 205) relative to the moisture barrier layer 227. The flexible display 201 may include a substrate layer 229 to form a base for the flexible display 201. The substrate layer 229 may comprise polyimide (PI), among other substrate materials. When the flexible display 201 includes a moisture barrier layer 227, as illustrated in Figure 2, the flexible display 201 may have a thickness ranging from 0.10 mm to 0.25 mm.

[0021] Figure 3 further illustrates an example of a flexible display system 300 in accordance with the present disclosure. The flexible display system 300 may be analogous to the flexible display system 100 illustrated in Figure 1.

[0022] As illustrated in Figure 3, the flexible display 301 may include a capacitive touch layer 331 to form a capacitance in response to a tactile stimulation on the flexible display 301. The capacitive touch layer 331 may be comprised of a plurality of materials, such as carbon nanobuds (CNB), silver nanoparticles (Nano-Ag), copper nanoparticles (Nano-Cu), metal mesh, and/or indium tin oxide (ITO). Also, as illustrated in Figure 3, the flexible display 301 may include the TFT layer 305 and light emitting layer 315 beneath the capacitive touch layer 331. As used

herein, the light emitting layer 315 may refer to a layer including light emitting particles, such as organic light emitting diodes (OLEDs).

[0023] In some examples, the capacitive touch layer 331 may be integrated in the underlying TFT layer 305, as discussed further in relation to Figure 4. Additionally and/or alternatively, the capacitive touch layer 331 may be integrated in the protective layer 321 and/or the anti-reflective layer 313. For instance, the capacitive touch layer 331 may be attached on the anti-reflective layer 313 by deposition and patterning, transfer, or thin film processes such that the capacitive touch layer 331 is directly bonded to the anti-reflective layer 313.

[0024] The flexible display system 300 may also include a flexible printed circuit (FPC) 333 coupled to the capacitive touch layer 331. The FPC 333 may connect the capacitive touch layer 331 to a computing system for directing the capacitive touch layer 331. Where the flexible display 301 includes a capacitive touch layer 331, as illustrated in Figure 3, the flexible display 301 may have a thickness ranging from 0.10mm to 0.25mm.

[0025] Figure 4 further illustrates an example of a flexible display system 400 in accordance with the present disclosure. The flexible display system 400 may be analogous to the flexible display system 100 illustrated in Figure 1.

[0026] As discussed in relation to Figure 3, a capacitive touch layer may be integrated in the transistor layer (e.g., in-cell). For instance, referring to Figure 4, the flexible display 401 may include a transistor layer 405 which integrates a capacitive touch function. Additionally and/or alternatively, a touch function may be integrated in the flexible display system 400 using a combination of a common electrode layer and the transistor layer 405. The flexible display 401 may include a common electrode 435 disposed on the light emitting layer 415 (e.g., such as an OLED layer). In such examples, the capacitive touch layer may comprise the common electrode 435 and the transistor layer 405.

[0027] In some examples, the flexible display system 400 may include an outer touch function layer 437. As illustrated in Figure 4, the outer touch function layer 437 may be proximal to the transistor layer 405 relative to the common

electrode 435. In such examples, the capacitive touch layer may comprise the common electrode 435 and the outer touch function layer 437. Put another way, the common electrode 435 and the outer touch function layer 437 may collectively perform the functions of the capacitive touch layer 331 described in relation to Figure 3.

[0028] In yet another example, the flexible display system 400 may include the outer touch function layer 437 without a common electrode 435, where the outer touch function layer 437 comprises materials such as CNB, Nano-Ag, Nano-Cu, metal mesh, or ITO. As illustrated in Figure 4, the outer touch function layer 437 may be distal to the transistor layer 405. That is, the outer touch layer function layer 437 may be on a surface of the flexible display 401. That is, the outer touch function layer 437 may perform the functions of the capacitive touch layer 331 discussed in relation to Figure 3. Also, as discussed in relation to Figure 3, a FPC 433 may connect the outer touch function layer 437 to a computing system for directing the outer touch function layer 437. Additionally, the outer touch function layer 437 may be attached on the flexible display 401, such as on the moisture barrier layer 427, by various methods including deposition and patterning, transfer, or thin film processes, such that the outer touch function layer 437 may be directly bonded to the moisture barrier layer 427.

[0029] In examples where the touch function is integrated into the TFT layer 405, the touch function is performed by a combination of the common electrode layer and the TFT layer 405, or the common electrode layer and the outer touch function layer 437, the thickness of the flexible display 401 may be greatly reduced. For example, the thickness of such displays may range from 10 to 50 micrometers (um).

[0030] Figure 5 further illustrates an example of a flexible display system 500 in accordance with the present disclosure. The flexible display system 500 may be analogous to the flexible display system 100 illustrated in Figure 1. As discussed herein, the flexible display 501 may include a substrate layer 529 to provide mechanical support for the flexible display 501. Also, as discussed herein,

the flexible display 501 may include a protective layer 521. For instance, the protective layer 521 may include a hard coating and/or a cover lens. Also, the flexible display 501 may include a transistor layer 505, such as a TFT layer. As with other examples provided herein, the flexible display 501 in accordance with the present disclosure may maintain the sensitive layer, the transistor layer 505, in a neutral force and reduce the risk of damage to the structural integrity of the transistor layer 505.

[0031] In some examples, the flexible display 501 may include a touch function that is integrated into the substrate layer 529. For instance, referring to Figure 5, the flexible display 501 may include a protective layer 521 disposed on a first surface 502 of the substrate layer 529 and a capacitive touch layer (not illustrated in Figure 5) on a second surface 504 of the substrate layer 529. While the protective layer 521 is described as being disposed on the first surface 502, it is noted that as described, the protective layer is not in direct contact with the first surface 502. Rather, the protective layer 521 is in direct contact with the transistor layer 505, which is in direct contact with the first surface 502. In such a manner, the touch function may be integrated on the back of the substrate layer 529, or at the front or back surfaces of the substrate layer 529. In some examples, the touch function may be integrated on the back of the substrate layer 529 using a solution such as Wacom Electro-Magnetic Resonance (EMR) solution.

[0032] In the foregoing detailed description of the present disclosure, reference is made to the accompanying drawings that form a part hereof, and in which is shown by way of illustration how examples of the disclosure may be practiced. These examples are described in sufficient detail to enable those of ordinary skill in the art to practice the examples of this disclosure, and it is to be understood that other examples may be utilized and that process, electrical, and/or structural changes may be made without departing from the scope of the present disclosure.

[0033] The figures herein follow a numbering convention in which the first digit corresponds to the drawing figure number and the remaining digits identify an

element or component in the drawing. Elements shown in the various figures herein can be added, exchanged, and/or eliminated so as to provide a number of additional examples of the present disclosure. In addition, the proportion and the relative scale of the elements provided in the figures are intended to illustrate the examples of the present disclosure, and should not be taken in a limiting sense. Further, as used herein, "a number of" an element and/or feature can refer to one or more of such elements and/or features.

What is claimed:

1. A system comprising:
 - a flexible display comprising a plurality of display layers;
 - an anti-reflective layer among the plurality of display layers to reduce reflection from an underlying light emitting layer, the anti-reflective layer including a wave plate and a polarizer; and
 - a transistor layer among the plurality of display layers, wherein at least a portion of the plurality of display layers includes properties satisfying particular geometric and force balance constraints to enable the transistor layer to maintain a neutral force in response to compression or tension of the flexible display.
2. The system of claim 1, wherein a top layer among the plurality of display layers and a bottom layer among the plurality of display layers have substantially similar compressive moduli and tensile moduli.
3. The system of claim 1, wherein a thickness and Young's modulus of each of the plurality of layers satisfy the particular geometric and force balance constraints within a particular tolerance.
4. The system of claim 1, wherein a total thickness of the flexible display is less than 0.25 millimeters.
5. The system of claim 1, further comprising:
 - a protective layer among the plurality of display layers; and
 - a moisture barrier layer among the plurality of display layers;wherein the moisture barrier layer is nearer to the transistor layer relative to the protective layer.

6. The system of claim 5, wherein the protective layer includes at least one of polymethyl methacrylate (PMMA) and polyvinyl alcohol (PVA).
7. The system of claim 1, further comprising a capacitive touch layer among the plurality of display layers to form a capacitance in response to a tactile stimulation on the flexible display.
8. A system comprising:
 - a flexible display comprising a plurality of display layers, the flexible display capable of at least one of dual sided or triple fold bending;
 - a transistor layer among the plurality of display layers, wherein at least a portion of the plurality of display layers includes properties satisfying particular geometric and force balance constraints to enable the transistor layer to maintain a neutral force in response to compression or tension of the flexible display; and
 - a capacitive touch layer among the plurality of display layers to form a capacitance in response to a tactile stimulation on the flexible display.
9. The system of claim 8, wherein the capacitive touch layer is integrated with the transistor layer.
10. The system of claim 8, wherein the capacitive touch layer includes a common electrode layer and the transistor layer.
11. The system of claim 10, further comprising:
 - an outer touch layer among the plurality of display layers, the outer touch layer proximal to the transistor layer; and
 - a common electrode layer;
 - wherein the capacitive touch layer comprises the common electrode layer and the outer touch layer.

12. The system of claim 8, further comprising:
a polarizing layer among the plurality of display layers, wherein the capacitive touch layer is incorporated in the polarizing layer.
13. A system comprising:
a flexible display comprising a plurality of display layers, the flexibly display capable of at least one of dual sided or triple fold bending;
an anti-reflective layer among the plurality of display layers to reduce reflection from an underlying light emitting layer, the anti-reflective layer including a wave plate and a polarizer;
a transistor layer among the plurality of display layers, wherein at least a portion of the plurality of display layers includes properties satisfying particular geometric and force balance constraints to enable the transistor layer to maintain a neutral force in response to compression or tension of the flexible display; and
a capacitive touch layer among the plurality of display layers to form a capacitance in response to a tactile stimulation.
14. The system of claim 13, further comprising:
a protective layer among the plurality of display layers; and
a substrate layer among the plurality of display layers to provide mechanical support for the flexible display;
wherein the protective layer is disposed on a first surface of the substrate layer and the capacitive touch layer is disposed on a second surface of the substrate layer opposite the first surface.
15. The system of claim 14, further comprising a moisture barrier layer among the plurality of display layers to prevent passage of fluids, wherein the moisture barrier layer is nearer to the transistor layer relative to the protective layer.

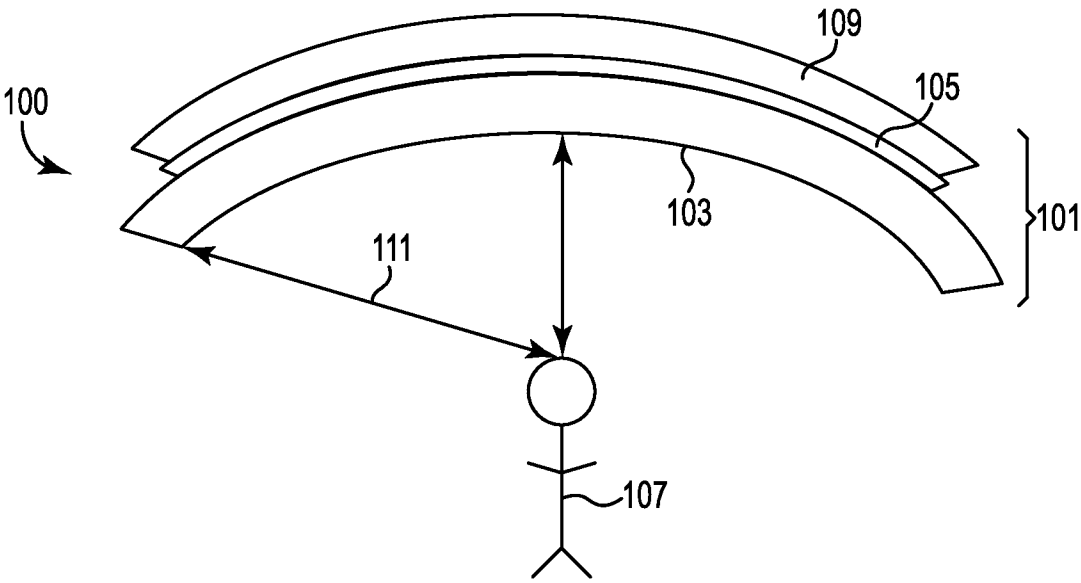
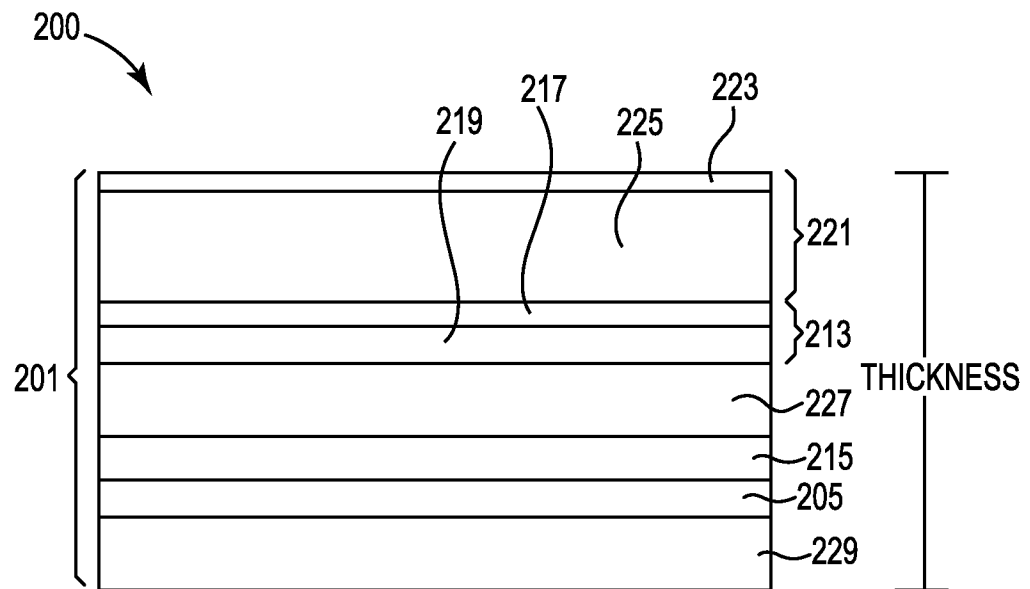
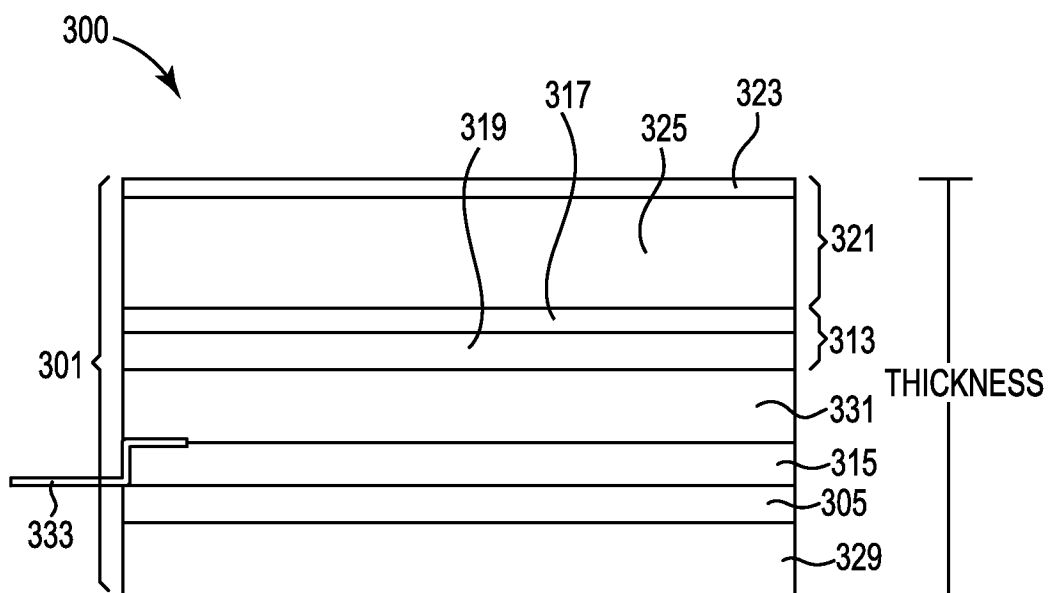


Fig. 1

2/3

**Fig. 2****Fig. 3**

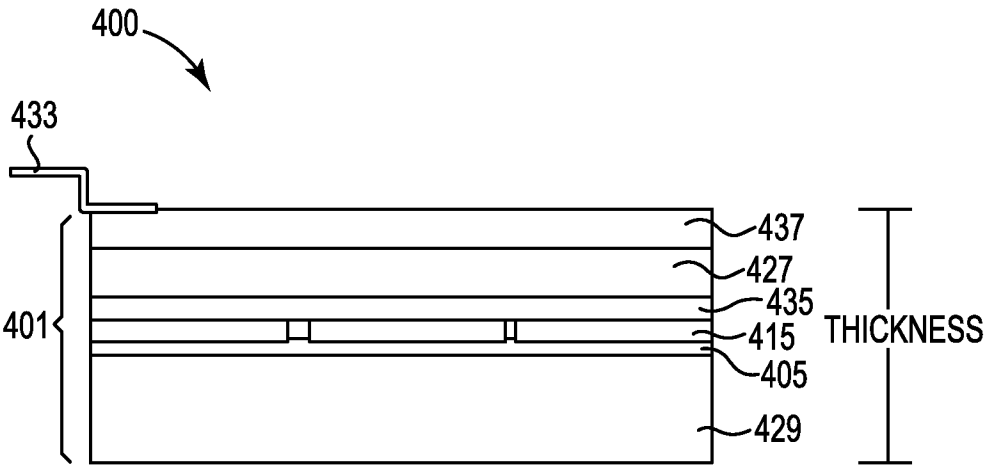


Fig. 4

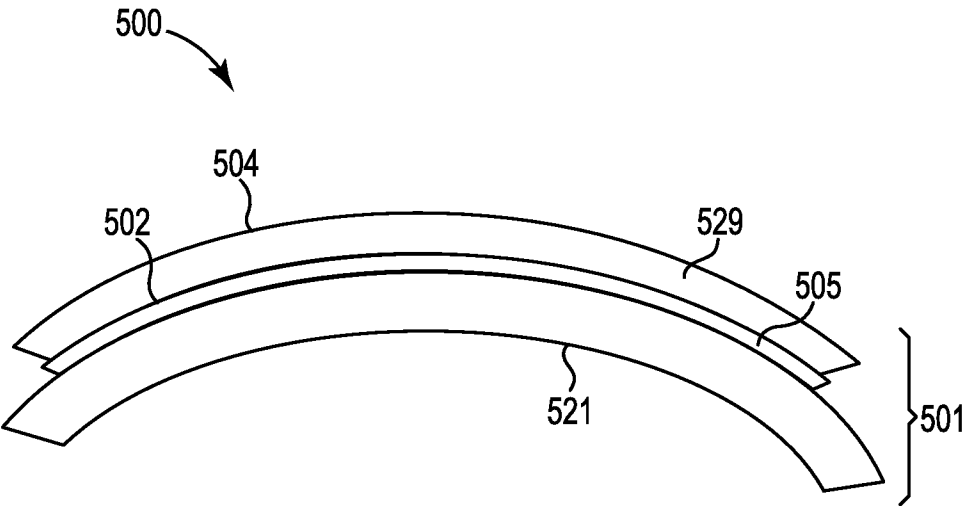


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/039822**A. CLASSIFICATION OF SUBJECT MATTER****G09F 9/30(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G09F 9/30; H01L 27/32; H01L 51/00; G02B 5/20; H01L 33/08; G06F 3/045; G02F 1/1335; H01L 27/12

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: flexible display, anti-reflective layer, transistor layer, compression, tension, moisture, capacitive touch layer, integrate

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2013-0135244 A1 (STEPHEN BRIAN LYNCH et al.) 30 May 2013 See paragraphs [0017], [0025], [0026], [0028]-[0030]; claims 3, 12; and figure 6.	8
Y		1-7, 9-15
Y	US 2015-0042913 A1 (SAMSUNG DISPLAY CO., LTD.) 12 February 2015 See paragraphs [0012], [0028]; and figure 5.	1-7, 13-15
Y	US 2013-0044282 A1 (MASATO KUWABARA et al.) 21 February 2013 See paragraphs [0051], [0085]; and figure 5.	5, 6, 9-12, 15
A	US 2014-0145150 A1 (APPLE INC.) 29 May 2014 See paragraph [0035]; claim 12; and figure 12.	1-15
A	US 2014-0061651 A1 (YANG-HUI CHANG et al.) 06 March 2014 See paragraphs [0006], [0023]; and figure 6.	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

27 March 2016 (27.03.2016)

Date of mailing of the international search report

30 March 2016 (30.03.2016)

Name and mailing address of the ISA/KR

International Application Division

Korean Intellectual Property Office

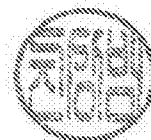
189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea

Facsimile No. +82-42-481-8578

Authorized officer

CHIN, Sang Bum

Telephone No. +82-42-481-8398



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2015/039822

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2013-0135244 A1	30/05/2013	US 2015-103050 A1 US 8922523 B2	16/04/2015 30/12/2014
US 2015-0042913 A1	12/02/2015	EP 2849239 A1 KR 10-2015-0018680 A	18/03/2015 24/02/2015
US 2013-0044282 A1	21/02/2013	CN 103048825 A CN 202838829 U TW 201310090 A US 8525405 B2 WO 2013-028321 A1	17/04/2013 27/03/2013 01/03/2013 03/09/2013 28/02/2013
US 2014-0145150 A1	29/05/2014	CN 104813475 A CN 203659866 U EP 2909864 A1 KR 10-2015-0074175 A TW 201421719 A US 9070648 B2 WO 2014-084972 A1	29/07/2015 18/06/2014 26/08/2015 01/07/2015 01/06/2014 30/06/2015 05/06/2014
US 2014-0061651 A1	06/03/2014	TW 201409144 A	01/03/2014