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(54) **Title**: LAYERED DISPLAY DEVICE AND FABRICATION METHOD THEREOF

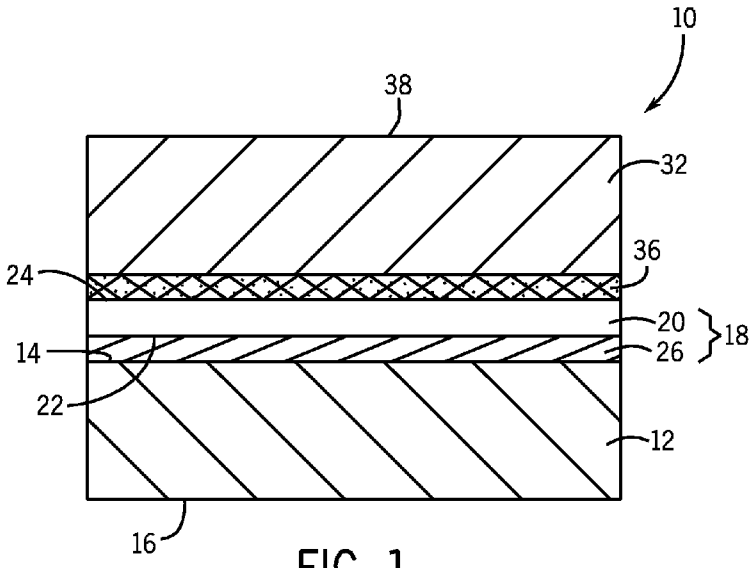

FIG. 1

(57) **Abstract**: A layered display device (10) and a fabrication method thereof are provided. The layered display device (10) comprises a non-flexible first substrate (12) having a surface (14); an optically-clear adhesive layer (26) of a flexible adhesive preform (18) adherently attached to the surface (14) of the non-flexible first substrate (12), the adhesive preform (18) comprising an optically-clear flexible film (20) having first and second sides (22, 24) and the optically-clear adhesive layer (26) situated on the first side (22) of the flexible film (20); and a non-flexible second substrate (32) mounted to the second side (24) of the flexible film (20) by a uniformly thick optically-clear adhesive film (36) therebetween.

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DISPLAY DEVICES AND METHODS OF ASSEMBLY

FIELD OF THE INVENTION

[0001] Embodiments of the invention relate to methods for assembling a laminated, multi-layered display device.

BACKGROUND OF THE INVENTION

[0002] Display devices, such as liquid crystal displays (LCDs) are used in a variety of applications. Typically, a tempered glass or transparent plastic overlayer or an actively functional touch interface or screen is laminated over the surface of the LCD unit.

[0003] Systems that utilize a multi-layered approach, for example, a layer of film plastic, an ITO layer, adhesive layer, glass layer, etc., involve interfaces between layers that can be optically disruptive due to reflection and to the formation of air bubbles during the lamination process. Attachment of a cover panel, touch screen or other overlayer to an LCD unit is typically performed by bonding with an optically clear adhesive (OCA), which is either a liquid adhesive that is cured in place or a double-sided pressure-sensitive adhesive (PSA) tape. For example, current assembly methods apply a die-cut, double-sided OCA tape to an LCD or top plate, and then press together the LCD and top plate. However, such a lamination is difficult to achieve without the inclusion of air bubbles between the adhesive and the substrate, particularly with large sized articles, which result in optical defects that affect the quality of the display. Bonding a rigid substrate or panel to another rigid substrate or panel without allowing air bubbles to form is particularly difficult.

[0004] Consequently, post-processing of the laminated system is required to remove air bubbles from the interface between the two substrates, which is typically an autoclave process that uses a combination of heat and pressure. Other processes use a vacuum lamination in an attempt to eliminate residual bubbles and avoid post-processing steps. However, such processes are time consuming and have a low yield for removing air bubbles from the laminated structure.

[0005] It would be useful to provide a system that overcomes the foregoing problems.

SUMMARY OF THE INVENTION

[0006] The present invention relates to multi-layered display devices and methods of fabricating the devices.

[0007] Compared to other known assembly methods, the methods of the invention provide a better and more reliable yield, a faster assembly process (without batch processing), and can be performed by a Tier 1 or OEM (Original Equipment Manufacturer) rather than by the LCD or touch panel manufacturer.

[0008] In embodiments of the invention, the layered display device is composed of a non-flexible first substrate, an optically clear adhesive layer of a flexible adhesive preform adherently attached to the surface of the non-flexible first substrate, the optically clear adhesive layer situated on an optically clear flexible film, and a non-flexible second substrate mounted to the second side of the flexible film by a uniformly thick optically clear adhesive film therebetween. The layered display device is further characterized in that substantially no air bubbles exist between the optically-clear adhesive layer of the adhesive preform and the surface of the non-flexible first substrate, and that substantially no air bubbles are situated within the uniformly thick optically-clear adhesive film between the second substrate and the flexible film.

[0009] In some embodiments, the layered display device is in an intermediate form in which the optically-clear adhesive film on the second side of the flexible film is in liquid form. In other embodiments, the optically-clear adhesive film on the second side of the flexible film of the layered display device is in a cured, solid form.

[0010] The invention further provides methods for fabricating a layered display device. In embodiments of the invention, the method includes:

a) mounting an optically-clear adhesive layer of a flexible adhesive preform to a surface of a non-flexible first substrate, the adhesive preform comprising an optically-clear flexible film having first and second sides and an outer edge, the optically-clear adhesive layer situated on the first side of the flexible film, and the second side of the flexible film

defined by a central section encircled by a perimeter section adjacent the outer edge of the flexible film;

b) dispensing an optically-clear liquid adhesive onto the central section of the second side of the flexible film;

c) mounting a second substrate onto the liquid adhesive such that said adhesive flows from the central section to the outer edge of the flexible film to form a uniformly thick film of the liquid adhesive having substantially no air bubbles between the flexible film and the second substrate; and

d) curing the liquid adhesive film to form a solid adhesive layer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Embodiments of the invention are described below with reference to the following accompanying drawings, which are for illustrative purposes only. Throughout the following views, the reference numerals will be used in the drawings, and the same reference numerals will be used throughout the several views and in the description to indicate same or like parts. The invention is capable of other embodiments or of being practiced or carried out in various other ways. The drawings illustrate a best mode presently contemplated for carrying out the invention.

[0012] FIG. 1 is a diagrammatic cross-sectional, elevational view of an embodiment of a display device according to the invention.

[0013] FIG. 2 is an exploded view of the display device of FIG. 1.

[0014] FIGS. 3-9 illustrate sequential steps of an embodiment of a method according to the invention to fabricate the display device of FIG. 1. FIG. 3 is a diagrammatic, cross-sectional, elevational view of an adhesive preform prior to mounting. FIG. 4 is a diagrammatic, cross-sectional, elevational view of the adhesive preform of FIG. 3 being attached to a first substrate. FIG. 5 is a diagrammatic, cross-sectional, elevational view of the adhesive preform attached to the first substrate, taken along lines 5-5 of FIG. 5A. FIG. 5A is a top plan view of the adhesive preform of FIG. 5, showing the center area and adjacent perimeter section on the surface of the flexible film. FIG. 6 is a diagrammatic

cross-sectional, elevational view of an optically-clear adhesive (OCA) liquid dispensed within the center area of the exposed surface of the flexible film, taken along lines 6-6 of FIG. 6A. FIG. 6A is a top plan view of the OCA liquid situated within the center area of the flexible film. FIG. 7 is a diagrammatic, cross-sectional, elevational view of a second substrate positioned on the OCA liquid. FIG. 8 is a diagrammatic, cross-sectional, elevational view of a subsequent step with the second substrate positioned above the flexible film of the adhesive preform and the OCA liquid flow to form a layer therebetween. FIG. 9 is a diagrammatic, cross-sectional, elevational view of the curing of the OCA liquid layer.

DETAILED DESCRIPTION OF THE INVENTION

[0015] The following description with reference to the drawings provides illustrative examples of systems and methods according to embodiments of the invention. Such description is for illustrative purposes only and not for purposes of limiting the same.

[0016] The invention provides laminated, layered display devices and methods for fabricating the devices. The methods can be used, for example, for bonding a transparent cover plate of a cellular phone or a touch panel to a flat display such as a liquid crystal display device, bonding a front glass panel to an ITO glass or film, among other applications.

[0017] The term "substantially free of air bubbles" means that bubbles including micro-bubbles greater than about 0.02 mm^2 are not present within the cured OCA film formed from an OCA liquid and/or between the adhesive layer of the adhesive preform and attached substrate, e.g., the first substrate (display).

[0018] The use of the terms "top", "bottom", "upper" and "lower" are for convenience and illustrative purposes only, and are not meant to limit the description of the invention inasmuch as the referenced item can be exchanged in position.

[0019] A first embodiment of a layered display device according to the invention, designated generally with the numeral 10, is depicted in a cross-sectional, elevational view in FIG. 1 and an exploded view in FIG. 2. The layered display device 10 can be, for example, a flat panel display device, a cellular phone display device, a display for a portable computing device such as a personal data assistant (PDA), a smartphone, a monitor, a

television display, or other electronic or graphic display, or an interactive display device such as a touch screen display, which can be found on devices such as cellular phones, PDAs, point of sale systems, household appliances, etc. The shape and thickness of the display device 10 can vary, being rectangular in the present embodiment.

[0020] The layered display device 10 includes a non-flexible (rigid), first substrate 12 having opposing first and second surfaces 14, 16. In some embodiments, the non-flexible, first substrate 12 is a flat or curved display comprising, for example, a reflective, transmissive or transreflective liquid crystal display (LCD) panel, a plasma display, a glass sheet with patterned conductors such as traces and electrodes formed by sputtering and metal patterning of indium tin oxide (ITO) and integrated into the glass sheet ("ITO glass"), among other displays. The external face or first surface 14 of the first substrate 12 typically comprises a glass or plastic substrate.

[0021] A flexible adhesive preform 18 is adhesively attached (e.g., laminated) to the first surface 14 of the non-flexible first substrate 12, such that there is substantially no air bubbles therebetween. The adhesive preform 18 is composed of a flexible and optically clear (transparent) polymeric film 20 having opposing first and second sides 22, 24, and a layer 26 of an optically-clear adhesive (OCA) material on the first side 22 of the film 20, which is attached to the first surface 14 of the first substrate 12.

[0022] The adhesive preform 18 can be produced, for example, by laminating an optically-clear pressure-sensitive adhesive (OC PSA) 26 (situated on a carrier 28) to an optically-clear, flexible plastic film 20, for example, using a nip roll laminator, and then die-cutting the sheet to dimensions that correspond to the shape and size of the substrate to which it will be attached, e.g., the first surface 14 of the first substrate 12.

[0023] The flexible, optically clear polymeric film 20 can be formed of a plastic material such as a polyester, for example, polyethylene terephthalate (PET), or polyethylene naphthalate (PEN), polycarbonate (PC), etc., a polyimide (PI), etc. Examples of adhesives usable for the adhesive layer 26 generally include acrylates, silicone, urethanes, and the like. Optically-clear pressure-sensitive adhesive (OC PSA) 26 on a releasable carrier 28 (i.e., a release sheet or liner) is commercially available. Optionally, but preferably, the adhesive

preform 18 includes a release sheet or liner 28 (FIG. 3) as a cover over the adhesive layer 26, which can be readily removed to expose the surface 30 of the adhesive layer 26 for attachment to the first substrate 12.

[0024] In the illustrated embodiment, a non-flexible (rigid) second substrate 32 is bonded by an inner surface 34 to the second side 24 of the flexible film 20 by a cured, uniformly thick, optically-clear adhesive (OCA) film 36 to form the laminated, layered display device 10. In embodiments, the OCA film 36 is substantially free of air bubbles. The OCA film 36 is formed from an optically-clear adhesive (OCA) liquid 36a, which hardens to form a solid film 36. Examples of OCA liquids include acrylates, urethanes, epoxies, and the like. In preferred embodiments, the OCA film 36 is formed from a curable liquid adhesive (36a), for example, a UV curable adhesive liquid. The curable adhesive liquid 36a typically remains in a liquid phase prior to curing. In embodiments, the OCA film 36 is in a cured, solid form after curing. The thickness of the OCA film 36 can vary. In some embodiments, the film 36 can be about 0.01-0.5 mm thick, and in other embodiments about 0.05-0.1 mm thick.

[0025] In embodiments of the invention, the layered display device 10 comprises a first substrate 12 composed of a display, and a second substrate 32 comprising an optically clear (transparent) top plate or cover or a capacitive touch panel.

[0026] In other embodiments, the first substrate 12 of the layered display device 10 comprises an optically clear top plate or cover or a capacitive touch panel, and the second substrate 32 comprises a display.

[0027] An optically-clear top plate or cover, can be fabricated, for example, from glass or a transparent plastic material such as an polyacrylate resin, polycarbonate, polyethylene terephthalate (PET), poly(methyl methacrylate) (PMMA), and the like. A capacitive touch panel (or plate or screen) can be installed, for example, to operate an LCD panel. The thickness of a top plate/cover or touch panel can vary depending, for example, on device requirements, device size, etc., generally ranging between about 50 μm and about 500 μm in thickness. In some embodiments, the outer surface (e.g., 16 or 38) of a top plate can be

covered with an additional film coating or laminate (not shown), such as a low reflective film, scratch-resistant hard coat film, anti-glare film, and/or anti-reflective film, among others.

[0028] Preferably, the individual layers optically match to enhance the optical characteristics of the display system and minimize or substantially eliminate any disruption in the image display. The adhesive preform 18 and the adhesive film 36 should not disturb the reflective index and transparency of the second substrate 32 (e.g., top plate, touch panel, etc.) or viewing of the underlying display. The layers (e.g., 18, 36) overlying a display are preferably composed of index-matched materials such that the refractive indices are substantially similar.

[0029] FIGS. 3-8 illustrate an embodiment of a method for fabricating the layered display device 10 depicted in FIGS. 1-2. The methods can be used, for example, to bond a display to a top panel or touch panel, or a front panel to an ITO glass layer, or other layered structure, without allowing air bubbles to form during the assembly process.

[0030] FIG. 3 depicts a flexible, adhesive preform 18 before lamination, showing the removal of a carrier or release sheet 28 (where used) from the surface 30 of the adhesive layer 26.

[0031] As shown in FIG. 4, the exposed surface 30 of the adhesive layer 26 is brought into contact with the exposed surface 14 of the first substrate 12. Air bubbles (micro-bubbles) can form at the interface between the adhesive layer 26 and the surface 14 of the first substrate 12 when bonding them together. To avoid the generation of bubbles during bonding, a full surface lamination of the first substrate 12 and the adhesive preform 18 can be performed by rolling the adhesive preform 18 onto the exposed surface 14 of the first substrate 12 as shown in FIG. 4, for example, from one edge 40a to the other edge 40b of the first substrate. This provides an adhesive attachment of the flexible adhesive preform 18 to the non-flexible first substrate 12 such that there are substantially no air bubbles therebetween. Lamination pressure with rollers is typically applied onto the adhesive preform 18 to assist and/or enhance bonding to the first substrate 12, for example, at about 1-4 bars (about 20-60 psi), optionally with low heat, for example, at about 23-60°C, or in some embodiments, at about 50-60°C.

[0032] The adhesive preform 18 mounted on the first substrate 12 is illustrated in FIG. 5. As depicted in FIG. 5-5A, the second side 24 of the flexible film 20 can be generally divided into a center area 42 surrounded or encircled by a perimeter section 44 situated adjacent to and along the outer edge 46 of the flexible film 20.

[0033] Referring now to FIG. 6, in a next step, an optically-clear adhesive (OCA) liquid 36a is dispensed in the form of a center drop or line 42 onto the center section of the second side 24 of the flexible film 20 of the adhesive preform 18 for bonding a second substrate 32 to the first substrate 12. The OCA liquid 36a is preferably matched to the index of refraction of the underlying adhesive preform 18 and the second substrate 32. The liquid adhesive can be a heat, radiation or room temperature curable adhesive or, in preferred embodiments, an ultra-violet (UV) curable adhesive material. The amount of OCA liquid 36a dispensed onto the flexible film can be calculated based upon the desired thickness of the cured OCA layer and the surface area of the flexible film 20 and/or the first substrate 12. In some embodiments, the OCA liquid 36a can be dispensed in a line onto the flexible film 20, preferably in a straight or slightly bent line.

[0034] Then, as depicted in FIG. 7, the inner surface 34 of the second substrate 32, e.g., a top plate, is positioned to face the uncured OCA liquid 36a on the flexible film 20.

[0035] The second substrate 32 is then lowered (arrows ↓↓) onto the OCA liquid 36a but suspended or positioned at a distance above the flexible film 20 to form a flow channel 48 therebetween, the distance being determined by the desired thickness of the OCA layer 36. The exposed outer surface 24 of the flexible film 20 and inner surface 34 of the second substrate 32 are composed of a material that can become wetted by the OCA liquid 36a. The OCA liquid 36a will wet out over the surfaces of the flexible film 20 and the second substrate 32 and flow (arrows ← →) from the center area 42 to the outer edge 46 of the flexible film 20 by capillary action and/or by pressure applied to the second substrate 32, without the formation of air bubbles within the OCA liquid layer 36a. Entrapped air bubbles within the OCA liquid 36a layer are avoided by the flow of liquid outward from the center 42 to the edges 46, which displaces the air bubbles. A suitable viscosity of the OCA liquid 18 is about 50 to 10000 cps (ASTM D789, D4878). The resulting layer of the OCA liquid 36a is a

uniformly thick layer that contains substantially no air bubbles, which in some embodiments is about 0.01-0.5 mm thick.

[0036] In some embodiments, the non-flexible first substrate 12, the adhesive preform 18 (flexible substrate 20, optically clear adhesive 26) and the optically-clear adhesive (OCA) liquid 36a form an intermediate structure for the layered display device 10.

[0037] Referring now to FIG. 9, the layer of the OCA liquid 36a is then cured to form a solid adhesive layer 36 (as shown in FIG. 1). In embodiments of the method, the OCA liquid 36a can be cured at room temperature or by the application of heat. In preferred embodiments, a UV curable OCA liquid is used, which can be exposed to UV radiation (e.g., wavelength of about 100-400 nm) transmitted (arrows ↓↓) through the optically-clear (transparent) second substrate 32. In preferred embodiments, the characteristics of the cured OCA layer 36 include a refractive index of about 1.41 to about 1.51.

[0038] Although specific embodiments have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that any arrangement which is calculated to achieve the same purpose may be substituted for the specific embodiments shown. This application is intended to cover any adaptations or variations that operate according to the principles of the invention as described. Therefore, it is intended that this invention be limited only by the claims and the equivalents thereof. The disclosures of patents, references and publications cited in the application are incorporated by reference herein.

WHAT IS CLAIMED:

1. A layered display device, characterized in that, the layered display device comprises:

a non-flexible first substrate having a surface;

an optically-clear adhesive layer of a flexible adhesive preform adherently attached to the surface of the non-flexible first substrate, the adhesive preform comprising an optically-clear flexible film having first and second sides and the optically-clear adhesive layer situated on the first side of the flexible film; and

a non-flexible second substrate mounted to the second side of the flexible film by a uniformly thick optically-clear adhesive film therebetween.

2. The layered display device of Claim 1, characterized in that, no air bubbles exist between the optically-clear adhesive layer of the adhesive preform and the surface of the non-flexible first substrate.

3. The layered display device of Claims 1 or 2, characterized in that, no air bubbles are situated within the uniformly thick optically-clear adhesive film.

4. The layered display device of Claim 3, characterized in that, the uniformly thick optically-clear adhesive film is about 0.01-0.5 mm thick.

5. The layered display device of Claim 1, characterized in that, the optically-clear adhesive film on the second side of the flexible film is in liquid form.

6. The layered display device of Claim 1, characterized in that, the optically-clear adhesive film on the second side of the flexible film is in a cured, solid form.

7. The layered display device of Claim 1, characterized in that,

a) the non-flexible first substrate comprises a display and the second substrate is an optically-clear plate or capacitive touch panel; or

b) the non-flexible first substrate is an optically-clear plate or capacitive touch panel and the second substrate comprises a display.

8. The layered display device of Claim 7, characterized in that, the display is selected from the group consisting of a liquid crystal display (LCD) and a plasma display.

9. The layered display device of Claim 7, characterized in that, the optically-clear top plate is selected from the group consisting of a touch plate, a glass plate, a plastic plate, and a glass substrate with indium tin oxide (ITO) coating.

10. An intermediate for a layered display device, characterized in that the intermediate for the layered display device comprises:

a non-flexible first substrate having a surface;

an optically-clear adhesive layer of a flexible adhesive preform attached to the surface of the non-flexible first substrate, the adhesive preform comprising an optically-clear flexible film having first and second sides and an outer edge, the optically-clear adhesive layer situated on the first side of the flexible film, and the second side of the flexible film defined by a central section encircled by a perimeter section adjacent the outer edge of the flexible film; and

an optically-clear liquid adhesive contained within the central section of the second side of the flexible film.

11. A method for fabricating a layered display device, comprising:

a) mounting an optically-clear adhesive layer of a flexible adhesive preform to a surface of a non-flexible first substrate, the adhesive preform comprising an optically-clear flexible film having first and second sides and an outer edge, the optically-clear adhesive layer situated on the first side of the flexible film, and the second side of the flexible film defined by a central section encircled by a perimeter section adjacent the outer edge of the flexible film;

b) dispensing an optically-clear liquid adhesive onto the central section of the second side of the flexible film;

c) mounting a non-flexible second substrate onto the liquid adhesive such that said adhesive flows from the central section to the outer edge of the flexible film to form a

uniformly thick film of the liquid adhesive having substantially no air bubbles between the flexible film and the second substrate; and

d) curing the liquid adhesive film to form a solid adhesive layer.

12. The method of Claim 11, wherein the non-flexible first substrate comprises a display and the second substrate comprises an optically-clear top plate.

13. The method of Claim 11, wherein the non-flexible first substrate comprises an optically-clear plate and the second substrate comprises a display.

14. The method of Claims 12 or 13, wherein the display is selected from the group consisting of a liquid crystal display (LCD) and a plasma display.

15. The method of Claims 12 or 13, wherein the optically-clear top plate is selected from the group consisting of a touch plate, a glass plate, a plastic plate, and a glass substrate with indium tin oxide (ITO) electrodes [ITO glass].

16. The method of Claim 11, wherein the non-flexible display comprises an LCD display and the optically-clear top plate comprises a touch panel.

17. The method of Claim 11, wherein the adhesive preform comprises an optically-clear pressure-sensitive adhesive layer on the flexible film.

18. The method of Claim 11, wherein the adhesive preform is die-cut.

19. The method of Claim 11, wherein the optically-clear adhesive layer of the adhesive preform is a pressure-sensitive adhesive.

20. The method of Claim 11, wherein step a) comprises applying pressure to the flexible adhesive preform to adhere the adhesive layer to the surface of the non-flexible first substrate.

21. The method of Claim 20, wherein the pressure is at about 1-4 bars (20-60 psi).

22. The method of Claim 11, wherein step a) comprises rolling the flexible adhesive preform onto the surface of the non-flexible first substrate.

23. The method of Claim 20, wherein step a) comprises applying heat while mounting the flexible adhesive preform to adhere the adhesive layer to the surface of the non-flexible first substrate.

24. The method of Claim 23, wherein heat at about 23-60°C is applied.

25. The method of Claim 11, wherein the optically-clear liquid adhesive is a UV-curable liquid adhesive.

26. The method of Claim 11, wherein step c) comprises suspending the second substrate above the flexible film to form a capillary flow channel therebetween such that the liquid adhesive flows from the central section to the outer edge of the flexible film by capillary action between the second substrate and the flexible film.

27. The method of Claim 11, wherein the liquid adhesive film of step c) is about 0.01-0.5 mm thick.

28. The method of Claims 12 or 13, wherein step d) comprises exposing the liquid adhesive film to UV radiation through the optically-clear plate to cure the liquid adhesive film.

29. The method of Claim 28, wherein the liquid adhesive film is exposed to a wave length of about 100-400 nm.

30. The method of Claim 11, wherein step d) comprises applying heat to cure the liquid adhesive film.

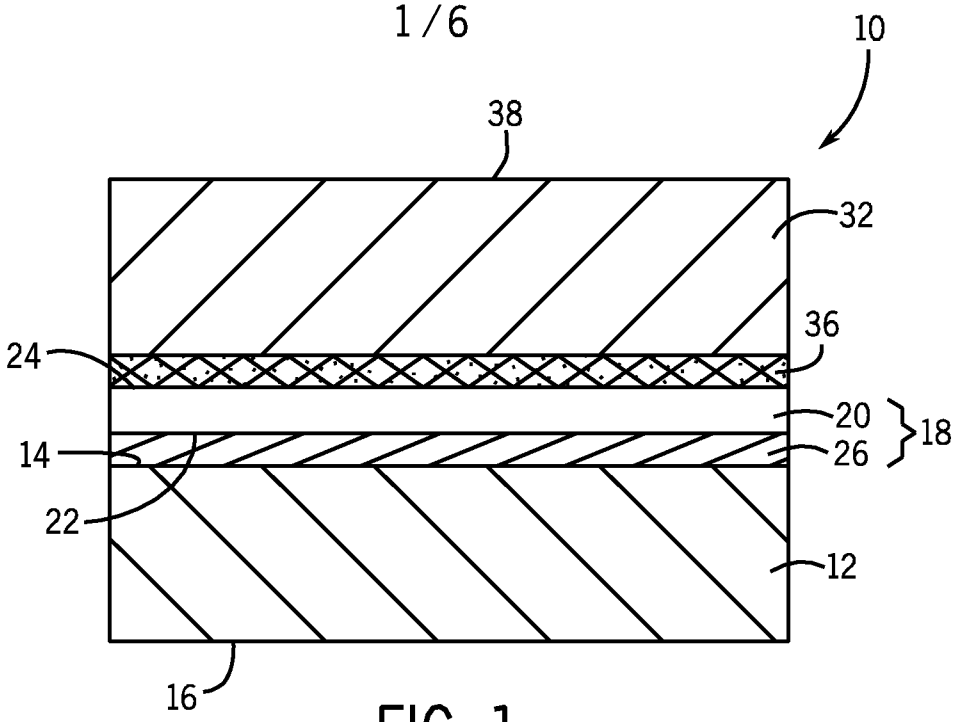
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FIG. 1

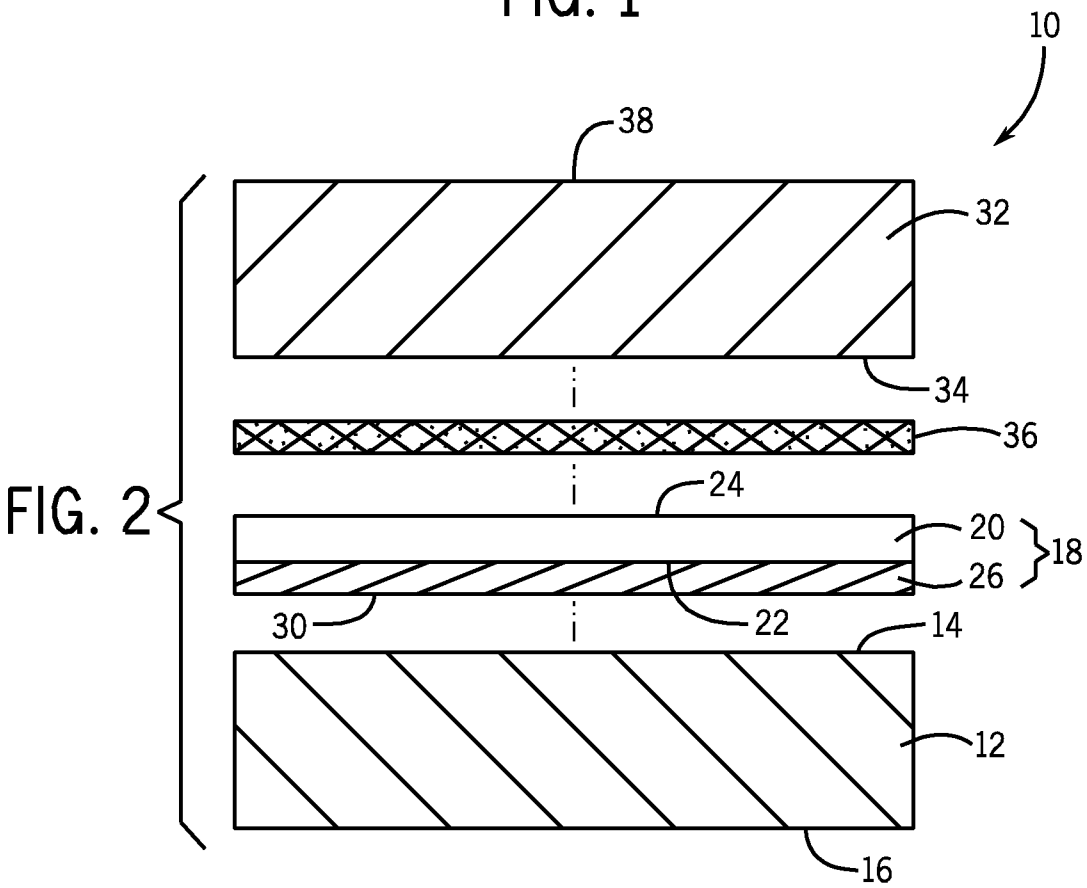
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FIG. 2

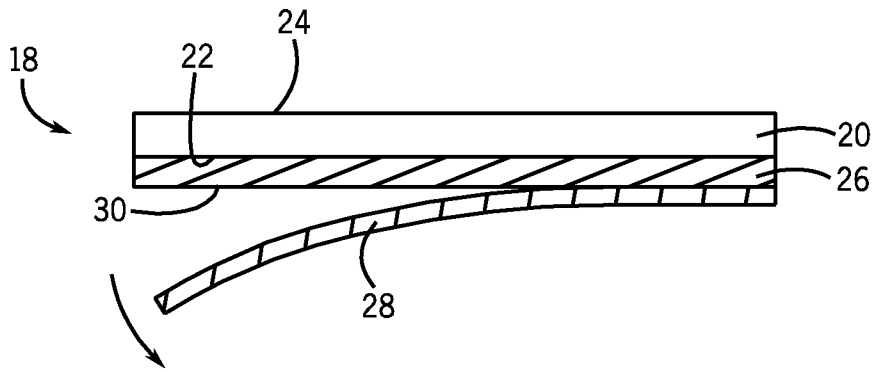

FIG. 3

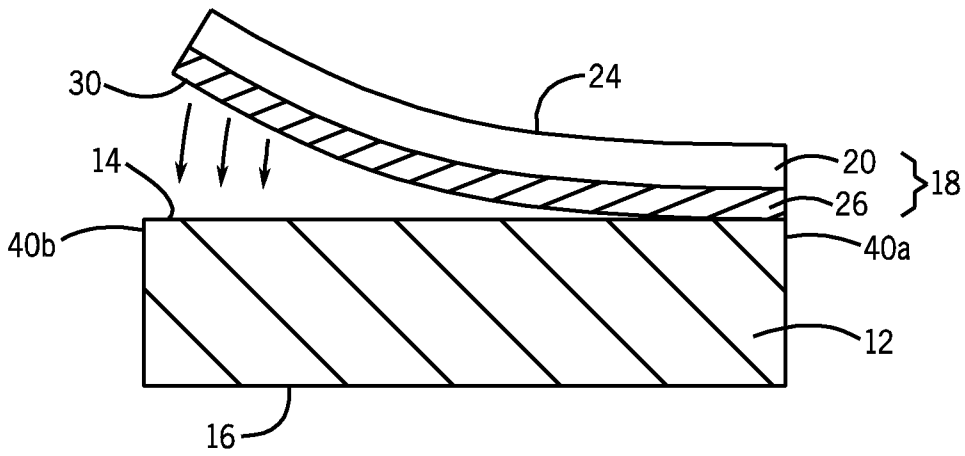

FIG. 4

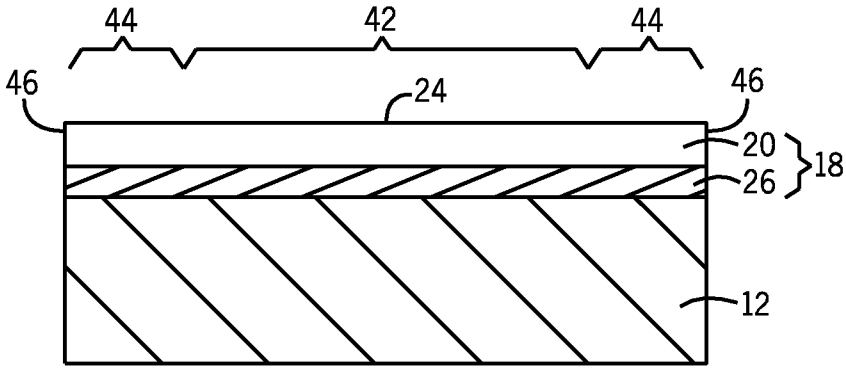

FIG. 5

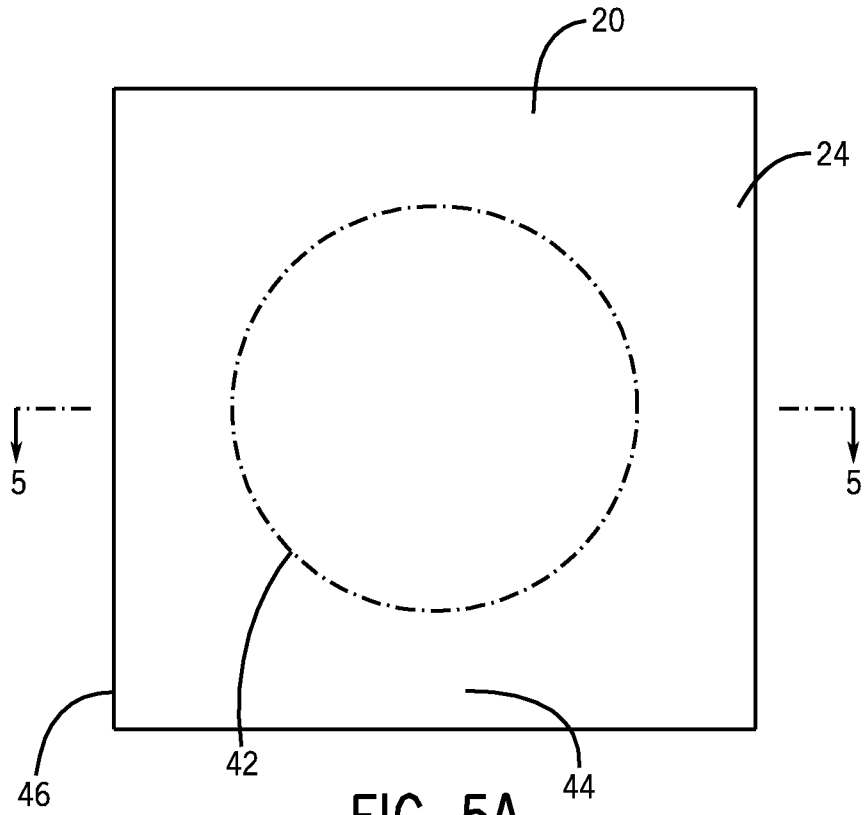

FIG. 5A

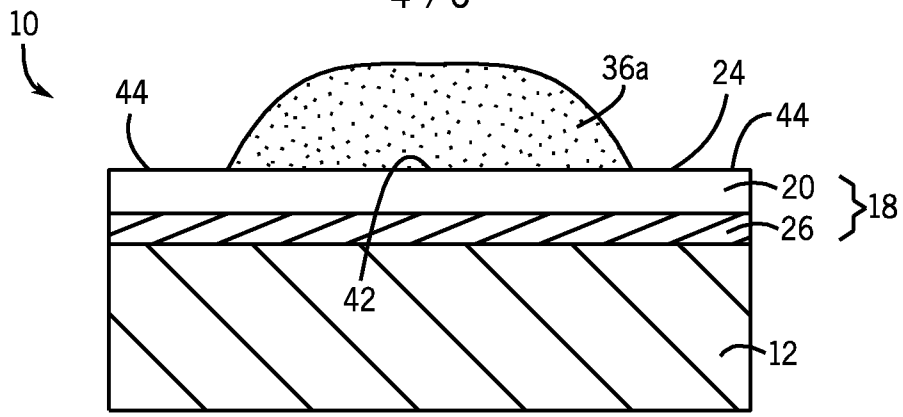

FIG. 6

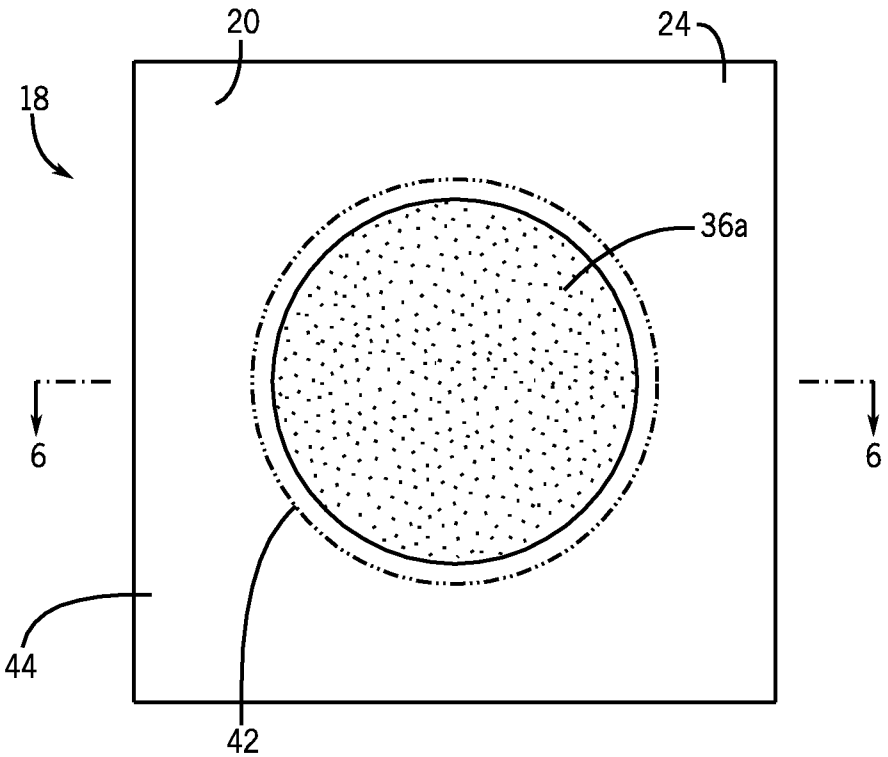

FIG. 6A

FIG. 7

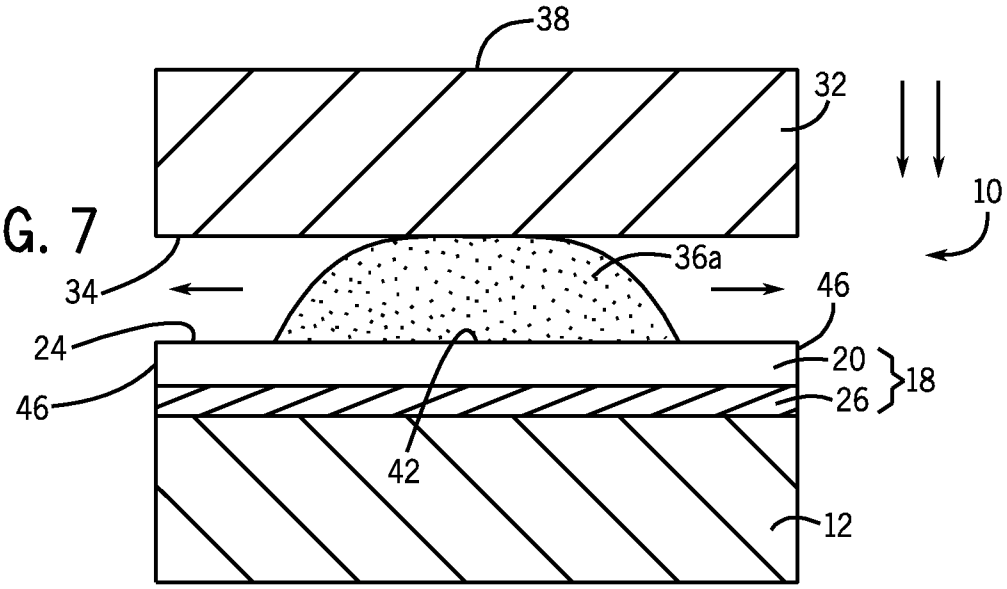
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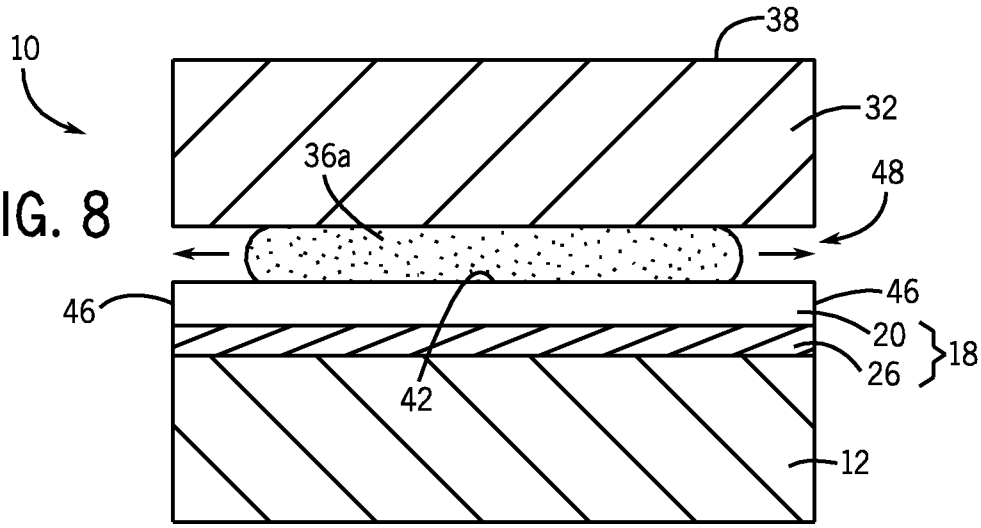
FIG. 8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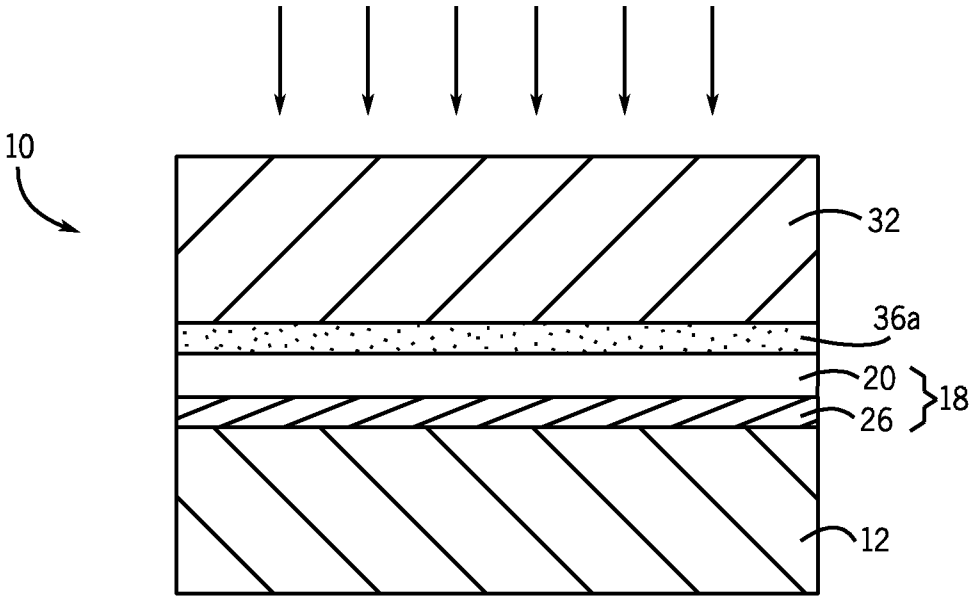

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2011/077826

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

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)

IPC: G02F, B32B

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

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

CNABS, CNTXT, VEN: air bubble? layer+ stack+ stick+ adher+ adhesive flexible optical?? clear transparent preform

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US2009183819A1 (MATSUHIRA, Tsutomu et al.) 23 Jul. 2009 (23.07.2009) paragraphs 28-36, 42-48 in description, Figs. 1A-1E, 4A-4E	1-30
Y	CN101175635A (NISSHA PRINTING) 07 May 2008 (07.05.2008) paragraphs 26 and 51 in description, Fig. 3	1-30
A	CN102164745A (3M INNOVATIVE PROPERTIES CO.) 24 Aug. 2011 (24.08.2011) the whole document	1-30
A	WO2010018651A1 (KYODO GIKEN CHEM CO. LTD.) 18 Feb. 2010 (18.02.2010) the whole document	1-30
A	JP2010197929A (EPSON IMAGING DEVICES CORP.) 09 Sep. 2010 (09.09.2010) the whole document	1-30
A	US2008230177A1 (WHITE ELECTRONIC DESIGNS CORP.) 25 Sep. 2008 (25.09.2008) the whole document	1-30

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

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"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	Date of mailing of the international search report
09 Mar. 2012(09.03.2012)	**05 Apr. 2012 (05.04.2012)**
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer LI,Qingqing Telephone No. (86-10)62084144

Form PCT/ISA /210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2011/077826

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
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		JP2010522354A	01.07.2010

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2011/077826

A. CLASSIFICATION OF SUBJECT MATTER

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

G02F1/1333 (2006.01) i

B32B7/00 (2006.01) n