United States Patent Application Publication	20250268093
Kind Code	A1
Publication Date	August 21, 2025
Inventor(s)	SONG; Kelly Sooyeun et al.

DISPLAY DEVICE

Abstract

A display device can include a display panel including a plurality of subpixels, a substrate having a first surface facing the display panel and a second surface facing away from the first surface, a plurality of groove patterns on at least one of the first surface of the substrate or the second surface of the substrate, each of the plurality of groove patterns including a first part having a width equal to or smaller than a reference width and a second part having a width equal to or larger than the reference width, the second part having an outwardly convex shape, and an adhesive member disposed on the substrate to fill the plurality of groove patterns.

Inventors: **SONG; Kelly Sooyeun (Paju-si, KR), PARK; SoJung (Paju-si, KR)**

Applicant: **LG DISPLAY CO., LTD.** (Seoul, KR)

Family ID: **1000008451337**

Assignee: **LG DISPLAY CO., LTD. (Seoul, KR)**

Appl. No.: **19/030313**

Filed: **January 17, 2025**

Foreign Application Priority Data

KR	10-2024-0022266	Feb. 16, 2024

Publication Classification

Int. Cl.: **H10K77/10** (20230101); **G02F1/1333** (20060101); **H10K102/00** (20230101)

U.S. Cl.:

CPC **H10K77/111** (20230201); **G02F1/133305** (20130101); H10K2102/311 (20230201)

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to Korean Patent Application No. 10-2024-0022266 filed in the Republic of Korea, on Feb. 16, 2024, the entirety of which is hereby incorporated by reference into the present application for all purposes as if fully set forth herein.

BACKGROUND

Field

[0002] Embodiments of the present disclosure relate to a display device.

Description of Related Art

[0003] As technology advances, a display device which displays an image, etc. is becoming increasingly lighter and thinner. In addition, in order to be applicable to various applications, the display device should be manufactured so that it can be easily curved or bent when an external force is applied.

[0004] However, stress occurs in a course in which the display device is curved or bent by an external force. Specifically, differences in stress and physical properties occur between various layers which constitute the display device, at a location where the display device is curved or bent or in the bending area of the display device.

[0005] In this way, when differences in stress and physical properties occur between the various layers which constitute the display device, a delamination phenomenon can occur in which various layers constituting the inside of the display device are separated from each other, or distortion can occur in the bending area, resulting in a problem that the performance of the display device degrades.

[0006] Thus, a need exists for a display device having a configuration that can facilitate bending while preventing damage and delamination within the display device.

SUMMARY OF THE DISCLOSURE

[0007] Embodiments of the present disclosure are directed to providing a display device capable of preventing a delamination phenomenon inside the display device.

[0008] Embodiments of the present disclosure are directed to providing a display device capable of preventing distortion in the bending area of the display device.

[0009] According to embodiments of the present disclosure, a display device can include a display panel, a substrate having a first surface which faces one surface of the display panel and a second surface which faces away from the first surface, and including a plurality of groove patterns which are located on at least one of the first surface or the second surface, each of the plurality of groove patterns including a first part which has a width equal to or smaller than a reference width and a second part which has a width equal to or larger than the reference width and which has an outwardly convex shape, and an adhesive member disposed on the substrate to fill the groove patterns.

[0010] According to embodiments of the present disclosure, a display device can include a display panel, a substrate having a first surface which faces one surface of the display panel and a second surface which faces away from the first surface, and including a plurality of groove patterns which are located on at least one of the first surface or the second surface, each of the plurality of groove patterns including a first part which has a surface at least partially flat toward an outside and a second part which has an outwardly convex shape, and an adhesive member disposed on the substrate to fill the groove patterns.

[0011] According to embodiments of the present disclosure, a flexible display device can include: a display panel including a plurality of subpixels, a substrate having a bending area and a non-bending area, an adhesive member disposed between the display panel and the substrate, and a

plurality of groove patterns in the bending area of the substrate, each grove pattern among the plurality of groove patterns including a first part corresponding to a bottom of the grove pattern and a second part corresponding to an opening of the grove pattern, wherein a side of the first part has a first slope, and a side of the second part has a second slope different than the first slope, and wherein portions of the adhesive member extend at least partially into the plurality of groove patterns.

[0012] According to the embodiments of the present disclosure, it is possible to provide a display device capable of preventing a delamination phenomenon inside the display device.

[0013] According to the embodiments of the present disclosure, it is possible to provide a display device capable of preventing distortion in the bending area of the display device.

[0014] According to the embodiments of the present disclosure, by preventing a peeling phenomenon inside the display device and preventing distortion in the bending area of the display device, degradation in the performance of the display device can be prevented and the lifespan of the display device can be increased, whereby it is possible to provide a display device capable of low power consumption.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The above and other objects, features, and advantages of the present disclosure will become more apparent to those of ordinary skill in the art by describing example embodiments thereof in detail with reference to the attached drawings, which are briefly described below.

[0016] FIG. **1** is a view showing an example of the cross-sectional structure of a display device according to an embodiment of the present disclosure.

[0017] FIG. **2** is an enlarged view of a part A of FIG. **1**, showing a structure in which the display device is bent according to an embodiment of the present disclosure.

[0018] FIG. **3**A is a view showing an example of the cross-sectional structure of a comparative example display device and a partially enlarged structure thereof.

[0019] FIG. **3**B is a view showing a structure in which the display device having the cross-sectional structure of FIG. **3**A is bent.

[0020] FIG. **4** is a view illustrating an example of a part of the cross-sectional structure of a display device according to embodiments of the present disclosure.

[0021] FIG. **5** is a view showing an example in which the cross-sectional structure of FIG. **4** is deformed according to an embodiment of the present disclosure.

[0022] FIG. **6** is a view showing a structure in which the display device including the cross-sectional structure of FIG. **4** is bent according to an embodiment of the present disclosure.

[0023] FIGS. **7**A, **7**B and **7**C, and FIGS. **8**A, **8**B, **8**C and **8**D are views showing other examples of the cross-sectional structure of the display device according to the embodiments of the present disclosure.

[0024] FIG. **9**, including parts (a)-(d), is a view showing still other examples of the cross-sectional structure of the display device according to the embodiments of the present disclosure.

[0025] FIG. **10** is a view showing a structure in which the display device including the cross-sectional structure of FIG. **9** is bent according to an embodiment of the present disclosure.

[0026] FIG. **11** is a view illustrating an example of a structure in which the cross-sectional structure illustrated in FIG. **4** is expanded according to an embodiment of the present disclosure.

[0027] FIG. **12** is a view showing a structure in which the display device including the cross-sectional structure of FIG. **11** is bent according to an embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0028] In the following description of examples or embodiments of the present disclosure,

reference will be made to the accompanying drawings in which it is shown by way of illustration specific examples or embodiments that can be implemented, and in which the same reference numerals and signs can be used to designate the same or like components even when they are shown in different accompanying drawings from one another. Further, in the following description of examples or embodiments of the present disclosure, detailed descriptions of well-known functions and components incorporated herein will be omitted when it is determined that the description can make the subject matter in some embodiments of the present disclosure rather unclear. The terms such as “including,” “having,” “containing,” “constituting,” “make up of” and “formed of” used herein are generally intended to allow other components to be added unless the terms are used with the term “only.” As used herein, singular forms are intended to include plural forms unless the context clearly indicates otherwise.

[0029] Terms, such as “first,” “second,” “A,” “B,” “(A)” or “(B)” can be used herein to describe elements of the present disclosure. Each of these terms is not used to define essence, order, sequence, number of elements, etc., but is used merely to distinguish the corresponding element from other elements.

[0030] When it is mentioned that a first element “is connected or coupled to,” “contacts or overlaps,” etc. a second element, it should be interpreted that, not only can the first element “be directly connected or coupled to” or “directly contact or overlap” the second element, but a third element can also be “interposed” between the first and second elements, or the first and second elements can “be connected or coupled to,” “contact or overlap,” etc. each other via a fourth element. Here, the second element can be included in at least one of two or more elements that “are connected or coupled to,” “contact or overlap,” etc. each other.

[0031] When time relative terms, such as “after,” “subsequent to,” “next,” “before” and the like, are used to describe processes or operations of elements or configurations, or flows or steps in operating, processing, manufacturing methods, these terms can be used to describe non-consecutive or non-sequential processes or operations unless the term “directly” or “immediately” is used together.

[0032] In addition, when any dimensions, relative sizes, etc. are mentioned, it should be considered that numerical values for elements or features, or corresponding information (e.g., level, range, etc.) include a tolerance or error range that can be caused by various factors (e.g., process factors, internal or external impact, noise, etc.) even when a relevant description is not specified. Further, the term “can” fully encompasses all the meanings of the term “can.”

[0033] The features of various embodiments of the present disclosure can be partially or entirely coupled to or combined with each other and can be interlocked and operated in technically various ways, and the embodiments can be carried out independently of or in association with each other. Also, the term “can” used herein includes all meanings and definitions of the term “may.”

[0034] Hereinafter, various embodiments of the present disclosure will be described in detail with reference to accompanying drawings.

[0035] FIG. **1** is a view showing an example of the cross-sectional structure of a display device according to an embodiment of the present disclosure.

[0036] Referring to FIG. **1**, a display device **100** can include a display panel **110**, an upper polarizer **120**, a lower polarizer **130**, a plurality of substrates **150**, **170** and **190** and a plurality of adhesive members **140**, **160** and **180**.

[0037] The display panel **110** can display an image. The display panel **110** can be an organic light emitting display panel. However, the present disclosure is not necessarily limited thereto, and the display panel **110** can be a liquid crystal display panel, etc.

[0038] The display panel **110** can include various components for displaying an image. For example, in the situation of an organic light emitting display panel, the display panel **110** can include light emitting elements.

[0039] The display panel **110** can be divided into a bending area BA where bending is performed in

a direction D**3** and a non-bending area NBA where bending is not performed.
[0040] The bending area BA can be defined as an area where the display device **100** including the display panel **110** is curved or bent about a certain axis through an action such as bending or sliding. The axis can be included in the bending area BA and can be an axis parallel to a direction D**2**.
[0041] The bending area BA can exist in the outer area of the display panel **110** or in the center area of the display panel **110** depending on the type of curving or bending, and is not limited to either one. Hereinafter, for the sake of convenience in explanation, it will be described as an example that the bending area BA is disposed in the center area of the display panel **110**, but embodiments are not limited thereto.
[0042] In FIG. **1**, only one bending area BA is shown in the display device **100**. However, the present disclosure is not limited thereto, and a plurality of bending areas BA can exist. The width of the bending area BA can be narrower or wider than the width of the non-bending area NBA.
[0043] The non-bending area NBA as an area except for the bending area BA can mean an area where the display device **100** is not curved or bent.
[0044] A plurality of non-bending areas NBA can exist as shown in FIG. **1**, or only one non-bending area NBA can exist.
[0045] The upper polarizer **120** and the lower polarizer **130** can be disposed on and under, respectively, the display panel **110**.
[0046] Depending on the type of a display panel, a polarizer can play the role of adjusting a direction in which light travels or preventing light from outside a display device from being reflected to deteriorate visibility. For example, in the situation of an organic light emitting display panel, a polarizer can be disposed on or under the display panel **110** depending on the emission type of the display panel **110** to prevent visibility from deteriorating due to external light, and in the situation of a liquid crystal display panel, polarizers can be disposed both on and under the display panel **110** to adjust the path of light.
[0047] In FIG. **1**, a situation where polarizers are disposed both on and under the display panel **110** is shown. However, the present disclosure is not necessarily limited thereto, and depending on the type of the display panel **110**, either one of the upper polarizer **120** and the lower polarizer **130** can be omitted.
[0048] A first adhesive member **140** can be disposed under the lower polarizer **130**. The first adhesive member **140** can play the role of adhering various layers existing inside the display device **100**.
[0049] The first adhesive member **140** can be made of a transparent material, and can be made of a material such as an acrylic-based, silicone-based or urethane-based material.
[0050] The first adhesive member **140** can be an optically clear adhesive (OCA) of a film form or an optically clear resin (OCR) of an amorphous liquid form, but is not necessarily limited to either one. Hereinafter, it will be described as an example that the first adhesive member **140** is an OCA, but embodiments are not limited thereto.
[0051] As shown in FIG. **1**, the first adhesive member **140** can adhere the lower polarizer **130** and a first substrate **150**. For example, first adhesive member **140** can be disposed between the lower polarizer **130** and a first substrate **150**.
[0052] The first substrate **150** can be disposed under the first adhesive member **140**.
[0053] The first substrate **150** can play the role of a support for maintaining the shape of the display device **100**. The first adhesive member **140** and the first substrate **150** can be adhered to each other.
[0054] The first substrate **150** can be made of a material such as polyethylene terephthalate (PET) or polyimide (PI), but is not necessarily limited thereto and can also be made of a metal material.
[0055] A second substrate **170** and a third substrate **190** can be further disposed below the first substrate **150**. A second adhesive member **160** and a third adhesive member **180** can be further disposed between the first substrate **150** and the second substrate **170** and between the second

substrate **170** and the third substrate **190** to adhere the respective substrates to each other.
[0056] The second substrate **170** and the third substrate **190** can be made of the same material and serve a same type of role as the first substrate **150**. The second adhesive member **160** and the third adhesive member **180** can be made of the same material and serve the same type of role as the first adhesive member **140**.
[0057] In FIG. **1**, the second substrate **170**, the third substrate **190**, the second adhesive member **160** and the third adhesive member **180** are shown. However, the present disclosure is not necessarily limited thereto, and depending on the type of the display device **100**, at least one substrate and adhesive member can be additionally disposed or can be omitted. Also, as the occasion demands, at least one substrate and adhesive member can be additionally disposed on the upper polarizer **120**.
[0058] FIG. **2** is an enlarged view of a part A of FIG. **1**, showing a structure in which the display device is bent.
[0059] Referring to FIG. **2**, the display device **100** can be bent as shown in FIG. **2** in the bending area BA. FIG. **2** shows only a partial structure of the display device **100**, that is, a structure in which the first adhesive member **140** and the first substrate **150** are bent, but this is for the sake of convenience in explanation. The entire display device **100** shown in FIG. **1** can be bent as shown in FIG. **2** in the bending area BA.
[0060] For example, the first substrate **150** of the display device **100** can be bent in the direction D**3** by being slid as shown in FIG. **2**.
[0061] When the first adhesive member **140** is adhered to the first substrate **150**, the first adhesive member **140** can be bent together with the first substrate **150**.
[0062] When the first adhesive member **140** is bent in the direction D**3**, the upper surface of the first adhesive member **140** shrinks more than the lower surface of the first adhesive member **140**, that is, the surface of the first adhesive member **140** which contacts the first substrate **150**. Therefore, as stress due to shrinkage is concentrated on the upper surface of the first adhesive member **140**, and a phenomenon in which the upper surface of the first adhesive member **140** is distorted can occur.
[0063] When the stress due to shrinkage increases, a phenomenon can occur in which the lower surface of the first adhesive member **140** is not properly attached to the first substrate **150** and delaminates from the first substrate **150**. For example, when the display device is bent, one side of the first adhesive member **140** may bunch up and ripple in the bending area BA while the opposite side of first adhesive member **140** may shrink and start to peel away from the first substrate **150**.
[0064] According to one way to solve these problems, a straight pattern **300** (see FIGS. **3**A and **3**B) is formed in the first substrate **150**.
[0065] The straight pattern **300** can mean a pattern in which each side surface of a pattern has a slope of a constant angle (e.g., flat sided grooves in the first substrate **150**).
[0066] FIG. **3**A is a view showing an example of the cross-sectional structure of a comparative example display device and a partially enlarged structure thereof. FIG. **3**B is a view showing a structure in which the display device having the cross-sectional structure of FIG. **3**A is bent.
[0067] The display device shown in FIG. **3**A is the same as the display device **100** shown in FIG. **1** except that the straight pattern **300** is disposed in the first substrate **150**, and thus, repeated description will be omitted.
[0068] Referring to FIG. **3**A, the straight pattern **300** can be disposed on the upper surface of the first substrate **150**. The straight pattern **300** can also be disposed on the lower surface of the first substrate **150** depending on a bending direction.
[0069] The straight pattern **300** can be disposed in the bending area BA.
[0070] When the straight pattern **300** is disposed on the upper surface of the first substrate **150**, the first adhesive member **140** can be disposed to fill the interior of the straight pattern **300**. The first adhesive member **140** can be adhered onto the first substrate **150** through a roll lamination process.

However, the present disclosure is not necessarily limited thereto, and the first adhesive member **140** can be adhered using a molding method, etc.

[0071] Referring to FIG. **3**B, when the first substrate **150** and the first adhesive member **140** included in the display device **100** are bent in the direction D**3** in the bending area BA, the first adhesive member **140** can become separated from the first substrate **150** and begin to peel away.

[0072] For example, when the first substrate **150** is bent in the direction D**3**, as the widths of straight patterns **300** decrease (e.g., when the flat angle sides between to squeeze together in a direction towards each other), a problem can arise in that the first adhesive member **140** which fills the interiors of the straight patterns **300** is pushed out of the straight patterns **300** (e.g., the first adhesive member **140** can get squished out of the grooves and delaminate). In other words, because the side surfaces of the straight pattern **300** have the slope of the constant angle, when the first substrate **150** is bent, the first adhesive member **140** may no longer be trapped in the interiors of the straight patterns **300**, and can be pushed out of the straight patterns **300**. Therefore, a phenomenon in which the first adhesive member **140** delaminates from the first substrate **150** can occur.

[0073] Hereunder, measures capable of solving these problems will be described with reference to a display device according to embodiments of the present disclosure, as detailed below.

[0074] FIG. **4** is a view illustrating an example of a part of the cross-sectional structure of a display device according to embodiments of the present disclosure.

[0075] The first substrate **150** shown in FIG. **4** is the same as the first substrate **150** described above with reference to FIGS. **3**A and **3**B except for that the first substrate **150** includes a first groove pattern **400** instead of the straight pattern **300**, and thus, repeated description will be omitted.

[0076] Referring to FIG. **4**, the first substrate **150** can include at least one first groove pattern **400**. The first groove pattern **400** can be formed on a first surface **150***a* or a second surface **150***b* of the first substrate **150**. The first groove pattern **400** can be in the bending area BA.

[0077] The first surface **150***a* is a surface which faces the lower surface of the display panel **110**, and the second surface **150***b* is a surface which faces away from the display panel **110**. The first surface **150***a* can be closer to the display panel **110** than the second surface **150***b*, but embodiments are not limited thereto.

[0078] When the first substrate **150** is bent in the direction D**3**, the first groove pattern **400** can be on the first surface **150***a*. When the first substrate **150** is bent in a direction opposite to the direction D**3**, the first groove pattern **400** can be on the second surface **150***b*.

[0079] Hereinafter, for the sake of convenience in explanation, it will be described as an example that the first groove pattern **400** is disposed on the first surface **150***a*, but embodiments are not limited thereto.

[0080] The first groove pattern **400** can include a first part **410** which is recessed from the first surface **150***a* and a second part **420** on the first part **410**. For example, the first groove pattern **400** can for a type of “head and shoulders” pattern that extends into the first substrate **150** (e.g., **410** can correspond to the head and **420** can correspond to the shoulders). In other words, a cross section of the first groove pattern **400** can have a bottle neck type of shape. The total depth of the first groove pattern **400** including the first part **410** and the second part **420** can be W**1**. The depth of the first part **410** can be larger than the depth of the second part **420**, but is not limited thereto.

[0081] The first part **410** can include a bottom surface which is recessed from the first surface **150***a* and first sidewalls **410***a* on both side surfaces connected to the bottom surface. The first part **410** can be defined by the bottom surface and the first sidewalls **410***a* on both side surfaces.

[0082] The width in a direction D**1** of the first part **410** can gradually increase in the direction D**3**. In other words, the width of the first part **410** can be smallest at the bottom surface, and can be largest at the boundary between the first part **410** and the second part **420**. However, the present disclosure is not necessarily limited thereto. For example, the first groove pattern **400** can have a tapered shaped as it extends into the first substrate **150**.

[0083] The second part **420** can be located on the first part **410**.
[0084] The second part **420** can include second sidewalls **420***a* on both side surfaces. The second part **420** can be defined by the second sidewalls **420***a* on both side surfaces and a portion where the first surface **150***a* of the first substrate **150** is opened by the first groove pattern **400**. For example, the second part **420** can be a type of hole that is in communication with the first part **410**.
[0085] The second sidewall **420***a* of the second part **420** can have an outwardly convex shape.
[0086] The width in the direction D**1** of the second part **420** can be larger than the width in the direction D**1** of the first part **410**. Namely, the width of the second part **420** can be larger than a width at the boundary between the second part **420** and the first part **410**.
[0087] As the second sidewall **420***a* has the outwardly convex shape, an angle θ formed by a straight line which is tangent to the second sidewall **420***a* and the first surface **150***a* increases as a point where the straight line is tangent to the second sidewall **420***a* is close to the first surface **150***a*.
[0088] As the first groove pattern **400** includes the first part **410** and the second part **420**, even when the first substrate **150** is bent, the first adhesive member **140** can be prevented from delaminating from the first substrate **150**. This advantage is described in more detail below.
[0089] FIG. **5** is a view showing an example in which the cross-sectional structure of FIG. **4** is deformed.
[0090] Referring to FIG. **5**, when the first substrate **150** is bent, the shape of the first groove pattern **400** can change.
[0091] When the first substrate **150** is bent ({circumflex over (**1**)}), the width of the first groove pattern **400** can decrease. As the width of the first groove pattern **400** decreases, each of the distance between the first sidewalls **410***a* and the distance between the second sidewalls **420***a* can decrease (e.g., when the display device is bent, the sides of the groove can move closer to each other).
[0092] When the first substrate **150** is bent and is then straightened through repeated movements (e.g., bent back and forth) ({circumflex over (**2**)}), the width of the first groove pattern **400** can decrease and then return to an original width. In addition, each of the distance between the first sidewalls **410***a* and the distance between the second sidewalls **420***a* can decrease and then return to its original distance. As can be seen in {circumflex over (**2**)}, the shape of the first groove pattern **400** can be freely changed according to repeated movements, and thus, it is possible to prevent the shape of the first substrate **150** from being distorted due to repeated movements.
[0093] As the first substrate **150** is bent in the direction D**3**, the width of the first groove pattern **400** can decrease. At this time, since the first substrate **150** is bent in the direction D**3**, the width of the first groove pattern **400** decreases more at a portion closer to the first surface **150***a* (e.g., at the upper portion of the groove). That is to say, the width of a portion where the second part **420** is connected to the first surface **150***a* can decrease most.
[0094] Accordingly, the width of the portion where the second part **420** is connected to the first surface **150***a* can become smaller than the widths of other portions of the second part **420**. In other words, the width of the second part **420** can be largest in the middle portion thereof.
[0095] FIG. **6** is a view showing a structure in which the display device including the cross-sectional structure of FIG. **4** is bent according to an embodiment of the present disclosure.
[0096] Referring to FIG. **6**, the first adhesive member **140** can be disposed to fill a part of the first groove pattern **400**.
[0097] When the first substrate **150** is bent in the direction D**3**, the first adhesive member **140** can fill the first groove pattern **400** more than before the first substrate **150** is bent. In other words, when the display device is bent, rather than squishing the first adhesive member **140** out of the first groove pattern **400**, the shape and depth of the first groove pattern **400** can provide an expansion space at the bottom of the first groove pattern **400** and the first adhesive member **140** can be squished into the first groove pattern **400** by extending further towards the bottom of the first groove pattern **400**, which can prevent any delamination or undue distortion from occurring.

[0098] As the second part **420** of the first groove pattern **400** has the outwardly convex shape, it is possible to prevent bubbles from being generated when the first adhesive member **140** fills the first groove pattern **400**. In addition, since the second part **420** has a larger surface area, an area in contact with the first adhesive member **140** increases, and thus, the adhesive strength between the first adhesive member **140** and the first substrate **150** can increase.
[0099] Furthermore, since an area by which the first adhesive member **140** fills the first groove pattern **400** is larger than an area by which the first adhesive member **140** fills the straight pattern **300**, the first adhesive member **140** can be absorbed more into the first groove pattern **400** (e.g., the first adhesive member **140** can be squished deeper into the first groove pattern **400**, rather than being squished out of the groove), and a degree by which the upper surface of the first adhesive member **140** shrinks further decreases. Therefore, stress concentrated on the upper surface of the first adhesive member **140** can be reduced more, thereby more effectively solving a problem that the upper surface is distorted, preventing ripples from forming, maintaining image quality, and increasing a lifespan of the display device.
[0100] In addition, when the first substrate **150** is bent in the direction D**3**, as the width of a portion where the second part **420** is connected to the first surface **150***a* becomes smaller than the widths of other portions of the second part **420**, a clamping effect can occur. The clamping effect is an effect that tightens the entrance of a space to prevent an object filled in the space from being discharged. In other words, the shape of the first groove pattern **400** can allow the first groove pattern **400** to grip or pinch the first adhesive member **140** so that the first adhesive member **140** is held in place while the display device is being bent. As the width of the portion where the second part **420** is connected to the first surface **150***a* decreases, the first groove pattern **400** can effectively trap, within the first groove pattern **400**, the first adhesive member **140** introduced into the first groove pattern **400**. Accordingly, even when repeated bending occurs, since the first adhesive member **140** which fills the interior of the first groove pattern **400** can be prevented from being pushed out of the first groove pattern **400**, it is possible to prevent a phenomenon in which the first adhesive member **140** delaminates from or comes off the first substrate **150**.
[0101] The effects described above can be more effective when the first adhesive member **140** has a low storage modulus. Namely, when the first adhesive member **140** has a low storage modulus, because the adhesive member **140** can be better absorbed into the first groove pattern **400**, the above-described effects can be maximized. For example, the storage modulus of the first adhesive member **140** can be equal to or less than 105 Pa. However, the present disclosure is not necessarily limited thereto.
[0102] FIGS. **7**A, **7**B, **7**C and **8**A, **8**B, **8**C and **8**D are views showing other examples of the cross-sectional structure of the display device according to the embodiments of the present disclosure.
[0103] The first groove pattern **400** shown in FIGS. **7**A to **7**C is the same as the first groove pattern **400** shown in FIGS. **4** and **5** except that the shape of the first part **410** or the second part **420** is changed, and thus, repeated description will be omitted.
[0104] Referring to FIG. **7**A, the width of the first part **410** of the first groove pattern **400** can be constant. That is to say, the first sidewall **410***a* of the first part **410** can be perpendicular to the direction D**1**.
[0105] When the first substrate **150** is bent in the direction D**3**, the width of the upper end portion of the first part **410**, that is, the width of a portion where the first part **410** is connected to the second part **420**, can decrease to a greater extent than the width of the bottom surface of the first part **410**.
[0106] Since the widths of the upper end portion and the bottom surface of the first part **410** before the first substrate **150** is bent are the same, the width of the upper end portion of the first part **410** after the first substrate **150** is bent can be smaller than the width of the bottom surface.
[0107] As the width of the upper end portion of the first part **410** becomes smaller than the width of the bottom surface, the first groove pattern **400** can better trap and hold the first adhesive member

140 therein. Accordingly, by preventing the first adhesive member **140** from being pushed out of the first groove pattern **400**, it is possible to more effectively prevent a phenomenon in which the first adhesive member **140** delaminates from the first substrate **150**.

[0108] Referring to FIG. **7**B, the bottom surface of the first part **410** of the first groove pattern **400** can have an outwardly convex shape (e.g., a rounded head and shoulders shape). The first sidewall **410***a* of the first part **410** can include a straight portion **410***a***1** and a curved portion **410***a***2** which is connected to the straight portion **410***a***1**.

[0109] The first part **410** of the first groove pattern **400** shown in FIG. **7**B can have a shape in which the bottom surface in the first part **410** of the first groove pattern **400** shown in FIG. **7**A is changed to the curved portion **410***a***2**. In this situation, the length in the direction D**3** of the straight portion **410***a***1** can be the same as the length of the first sidewall **410***a* of the first part **410** shown in FIG. **7**A. However, the present disclosure is not necessarily limited thereto, and the length of the straight portion **410***a***1** can be different from the length of the first sidewall **410***a* of the first part **410** shown in FIG. **7**A.

[0110] As the first groove pattern **400** shown in FIG. **7**B includes the curved portion **410***a***2**, the first part **410** can be recessed further or deeper from the first surface **150***a* of the first substrate **150** than the first part **410** shown in FIG. **7**A.

[0111] When the first part **410** of the first groove pattern **400** includes the curved portion **410***a***2**, an area where the first adhesive member **140** is adhered to the first groove pattern **400** can be wider than when the first part **410** does not include the curved portion **410***a***2**, and thus, the first adhesive member **140** can be absorbed more into the first groove pattern **400** (e.g., a larger expansion area can be provided at the bottom of the first groove pattern **400**). Accordingly, since a degree by which the upper surface of the first adhesive member **140** shrinks further decreases, stress concentrated on the upper surface of the first adhesive member **140** can be further reduced, thereby more effectively solving a problem that the upper surface is distorted.

[0112] In addition, the adhesive strength between the first adhesive member **140** and the first substrate **150** can increase, thereby preventing a phenomenon in which the first adhesive member **140** delaminates from the first substrate **150**.

[0113] Referring to FIG. **7**C, the width of the first part **410** of the first groove pattern **400** can gradually increase toward the upper end of the first part **410**. The slope of the side surface of the first part **410** can be constant, but is not limited thereto.

[0114] The second part **420** of the first groove pattern **400** can have a shape which is recessed at a right angle. The second sidewall **420***a* of the second part **420** can include a first surface **420***a***1** which is perpendicular to the upper surface of the first substrate **150** and a second surface **420***a***2** which is connected to the first surface **420***a***1** and is perpendicular to the first surface **420***a***1**.

[0115] Since the second part **420** of the first groove pattern **400** has the shape which is recessed at a right angle, compared to the situation where the second part **420** of the first groove pattern **400** has a curved sidewall as described above with reference to FIG. **7**A, the first adhesive member **140** can be absorbed more into the second part **420** of the first groove pattern **400**.

[0116] Therefore, when the first substrate **150** is bent, stress concentrated on the upper surface of the first adhesive member **140** can be further reduced, thereby more effectively solving a problem that the upper surface of the first adhesive member **140** is distorted.

[0117] Referring to FIG. **8**A, the first groove pattern **400** can further include a third part **800** (e.g., a type of pointy or tapered head and rounded double shoulders pattern).

[0118] The total depth of the first groove pattern **400** including the first part **410**, the second part **420** and the third part **800** can be W**2**. W**2** can be larger than W**1**.

[0119] The third part **800** can be formed on the second part **420**.

[0120] The third part **800** can include third sidewalls **800***a* on both side surfaces. The third part **800** can be defined by the third sidewalls **800***a* on both side surfaces and the boundary between the second part **420** and the third part **800**.

[0121] The third sidewall **800***a* can have an outwardly convex shape. However, the present disclosure is not necessarily limited thereto.
[0122] The width of the third part **800** can be larger than the widths of the first part **410** and the second part **420**. In other words, the width of the third part **800** can be larger than the width at the boundary between the first part **410** and the second part **420** and the width at the boundary between the second part **420** and the third part **800**.
[0123] As the third sidewall **800***a* has the outwardly convex shape, an angle θ formed by a straight line which is tangent to the third sidewall **800***a* and the first surface **150***a* increases as a point where the straight line is tangent to the third sidewall **800***a* is close to the first surface **150***a*.
[0124] As the first substrate **150** is bent in the direction D**3**, the width of the first groove pattern **400** can decrease.
[0125] At this time, since the first substrate **150** is bent in the direction D**3**, the width of the first groove pattern **400** decreases more at a portion closer to the first surface **150***a*. Namely, the width of a portion where the third part **800** is connected to the first surface **150***a* can decrease most.
[0126] Accordingly, the width of the portion where the third part **800** is connected to the first surface **150***a* can become smaller than the widths of other portions of the third part **800**. That is to say, the width of the third part **800** can be largest in the middle portion thereof.
[0127] As the first groove pattern **400** includes the third part **800**, the depth of the first groove pattern **400** increases, and thus, the first adhesive member **140** can be absorbed more into the first groove pattern **400**. As the first adhesive member **140** is absorbed more into the first groove pattern **400**, the adhesion area between the first adhesive member **140** and the first substrate **150** increases, and thus, the adhesive strength between the first adhesive member **140** and the first substrate **150** can be further increased.
[0128] Moreover, since an area where the first adhesive member **140** fills the first groove pattern **400** increases more, the first adhesive member **140** can be absorbed more into the first groove pattern **400**, and a degree by which the upper surface of the first adhesive member **140** shrinks further decreases. Therefore, stress concentrated on the upper surface of the first adhesive member **140** can be reduced more, thereby more effectively solving a problem that the upper surface is distorted.
[0129] In addition, since the width of a portion of the third part **800** can become larger than the width of the portion where the third part **800** of the first groove pattern **400** is connected to the first surface **150***a*, that is, since the third part **800** has a shape in which the middle portion of the third part **800** protrudes outward more than the upper end portion of the third part **800**, a space that can trap the first adhesive member **140** therein can be added. Accordingly, the first adhesive member **140** which fills the interior of the first groove pattern **400** can be prevented from being pushed out of the first groove pattern **400**, and it is possible to more effectively prevent a phenomenon in which the first adhesive member **140** delaminates from the first substrate **150**.
[0130] Referring to FIG. **8**B, the width of the first part **410** of the first groove pattern **400** can be constant. That is to say, the first sidewall **410***a* of the first part **410** can be perpendicular to the direction D**1** (e.g., a type of flat or rectangular head and rounded double shoulders pattern).
[0131] The first groove pattern **400** shown in FIG. **8**B is the same as the first groove pattern **400** illustrated in FIG. **8**A except that the shape of the first part **410** is changed and the changed shape of the first part **410** is the same as the shape of the first part **410** shown in FIG. **7**A, and thus, repeated description will be omitted.
[0132] As the width of the upper end portion of the first part **410** becomes smaller than the width of the bottom surface, the first groove pattern **400** can better trap the first adhesive member **140** therein. Accordingly, by preventing the first adhesive member **140** from being pushed out of the first groove pattern **400**, it is possible to more effectively prevent a phenomenon in which the first adhesive member **140** delaminates from the first substrate **150**.
[0133] Referring to FIG. **8**C, the bottom surface of the first part **410** of the first groove pattern **400**

can have an outwardly convex shape. The first sidewall **410***a* of the first part **410** can include a straight portion **410***a***1** and a curved portion **410***a***2** which is connected to the straight portion **410***a***1** (e.g., a type of rounded head and rounded double shoulders pattern).

[0134] The first groove pattern **400** shown in FIG. **8**C is the same as the first groove pattern **400** illustrated in FIG. **8**A except that the shape of the first part **410** is changed and the changed shape of the first part **410** is the same as the shape of the first part **410** shown in FIG. **7**B, and thus, repeated description will be omitted.

[0135] When the first part **410** of the first groove pattern **400** includes the curved portion **410***a***2**, an area where the first adhesive member **140** is adhered to the first groove pattern **400** can be wider than when the first part **410** does not include the curved portion **410***a***2**, and thus, the first adhesive member **140** can be absorbed more into the first groove pattern **400**. Accordingly, since a degree by which the upper surface of the first adhesive member **140** shrinks further decreases, stress concentrated on the upper surface of the first adhesive member **140** can be further reduced, thereby more effectively solving a problem that the upper surface is distorted.

[0136] In addition, the adhesive strength between the first adhesive member **140** and the first substrate **150** can increase, thereby preventing a phenomenon in which the first adhesive member **140** delaminates from the first substrate **150**.

[0137] Referring to FIG. **8**D, the width of the first part **410** of the first groove pattern **400** can gradually increase toward the upper end of the first part **410** (e.g., a type of pointy or triangular head and rectangular double shoulders pattern). The slope of the side surface of the first part **410** can be constant, but is not limited thereto.

[0138] As described above with reference to FIG. **7**C, the second part **420** of the first groove pattern **400** can have a shape which is recessed at a right angle.

[0139] The third part **800** of the first groove pattern **400** can have a shape which is recessed at a right angle. In other words, the third part **800** can have the same shape as the second part **420**.

[0140] The third sidewall **800***a* of the third part **800** can include a first surface **800***a***1** which is perpendicular to the upper surface of the first substrate **150** and a second surface **800***a***2** which is connected to the first surface **800***a***1** and is perpendicular to the first surface **800***a***1**.

[0141] Since the second part **420** and the third part **800** of the first groove pattern **400** have the shapes which are recessed at a right angle, compared to the situation where the second part **420** and the third part **800** of the first groove pattern **400** have curved sidewalls as described above with reference to FIGS. **8**A to **8**C, the first adhesive member **140** can be absorbed more into the second part **420** and the third part **800** of the first groove pattern **400**.

[0142] Therefore, when the first substrate **150** is bent, stress concentrated on the upper surface of the first adhesive member **140** can be further reduced, thereby more effectively solving a problem that the upper surface of the first adhesive member **140** is distorted.

[0143] FIG. **9** is a view showing still other examples of the cross-sectional structure of the display device according to the embodiments of the present disclosure.

[0144] The first groove pattern **400** shown in FIGS. **9** is the same as the first groove pattern **400** shown in FIGS. **4** and **7**A except a structure in which the first part **410** passes through the first substrate **150**, and thus, repeated description will be omitted. For example, the first groove pattern **400** can penetrate all the way through opposite sides of the first substrate **150**.

[0145] Referring to FIG. **9**, including parts (a)-(d), the first part **410** of the first groove pattern **400** can pass through the first substrate **150**.

[0146] As shown in part (a) and part (b) of FIG. **9**, the first groove pattern **400** can pass through the first substrate **150** as the depth of the first part **410** increases. As shown in part (c) and part (d) of FIG. **9**, the first groove pattern **400** can pass through the first substrate **150** as the depths of both the first part **410** and the second part **420** increase (e.g., a cross section of the first groove pattern **400** can have a bottle neck type of shape).

[0147] When the depth of the first part **410** increases as shown in part (a) and part (b) of FIG. **9**, the

first adhesive member **140** can be absorbed more from the upper surface **150***a* of the first substrate **150**. Therefore, an area where the first adhesive member **140** and the first groove pattern **400** are adhered to each other can increase.

[0148] When the depths of both the first part **410** and the second part **420** increase as shown in part (c) and part (d) of FIG. **9**, compared to part (a) and part (b) of FIG. **9**, the area of the second sidewall **420***a* of the second part **420** becomes larger, and an area where the first adhesive member **140** and the first substrate **150** can be adhered to each other can further increase.

[0149] FIG. **10** is a view showing a structure in which the display device including the cross-sectional structure of FIG. **9** is bent.

[0150] Referring to FIG. **10**, the first adhesive member **140** can be disposed on the first substrate **150**.

[0151] When the first substrate **150** is bent in the direction D**3** as described above, since the first groove pattern **400** has a passing-through structure, the first adhesive member **140** can be absorbed deeper into the first groove pattern **400**. Accordingly, the adhesion area between the first substrate **150** and the first adhesive member **140** can increase.

[0152] Hence, as described above, it is possible to more effectively prevent a problem that the upper surface of the first adhesive member **140** is distorted.

[0153] In addition, it is possible to more effectively prevent a phenomenon in which the first adhesive member **140** delaminates from the first substrate **150**.

[0154] Referring to FIG. **10**, the second adhesive member **160** can be further disposed under the first substrate **150**.

[0155] When the first substrate **150** is bent in the direction D**3**, since the first groove pattern **400** has the passing-through structure, the second adhesive member **160** can be partially absorbed into the first groove pattern **400**. For example, during bending, the first adhesive member **140** and the second adhesive member **160** can squish into the first groove pattern **400** from opposite sides.

[0156] One part of the second adhesive member **160** which is absorbed into the first groove pattern **400** can adhere to the first substrate **150**, and the other part can adhere to the first adhesive member **140**.

[0157] Namely, since the first groove pattern **400** has the passing-through structure, the first adhesive member **140** can adhere not only to the first substrate **150** but also to the second adhesive member **160**, so that when bending occurs, the first adhesive member **140** can be better trapped in the first groove pattern **400**. Therefore, it is possible to better prevent a phenomenon in which the first adhesive member **140** delaminates from the first substrate **150**.

[0158] FIG. **11** is a view illustrating an example of a structure in which the cross-sectional structure illustrated in FIG. **4** is expanded, according to an embodiment of the present disclosure.

[0159] The cross-sectional structure of the display device **100** shown in FIG. **11** is the same as the cross-sectional structure shown in FIG. **4** except for that at least one second groove pattern **1000** is disposed in the non-bending area NBA, and thus, repeated description will be omitted.

[0160] Referring to FIG. **11**, at least one second groove pattern **1000** can be disposed in the non-bending area NBA.

[0161] The second groove pattern **1000** can be the same pattern as the first groove pattern **400**. That is to say, the second groove pattern **1000** can include a first part **1010** and a second part **1020** on the first part **1010**.

[0162] The first part **1010** of the second groove pattern **1000** can have the same pattern as the first part **410** of the first groove pattern **400**. The second part **1020** of the second groove pattern **1000** can have the same pattern as the second part **420** of the first groove pattern **400**. However, the present disclosure is not limited thereto, and at least one of the respective parts of the second groove pattern **1000** can be different from at least one of the respective parts of the first groove pattern **400**.

[0163] Second groove patterns **1000** can be disposed at a lower density than first groove patterns

400. In other words, the number of second groove patterns **1000** per unit area disposed in the non-bending area NBA can be smaller than the number of first groove patterns **400** per unit area disposed in the bending area BA.

[0164] FIG. **12** is a view showing a structure in which the display device including the cross-sectional structure of FIG. **11** is bent, according to an embodiment of the present disclosure.

[0165] Referring to FIG. **12**, when the display device **100** is bent in the bending area BA, some bending can also occur at the boundary between the bending area BA and the non-bending area NBA and in the non-bending area NBA near the boundary.

[0166] When bending occurs at the boundary between the bending area BA and the non-bending area NBA and in the non-bending area near the boundary, as stress is concentrated on the boundary between the bending area BA and the non-bending area NBA and the non-bending area near the boundary, a phenomenon can occur in which the upper surface of the first adhesive member **140** is distorted, and as shown in FIG. **12**, a phenomenon can occur in which the first adhesive member **140** delaminates from the first substrate **150**. In this way, stress that may occur at the boundary between the bending area BA and the non-bending area NBA, during bending, can be alleviated.

[0167] When the second groove pattern **1000** is disposed in the non-bending area NBA, the first adhesive member **140** which is disposed at the boundary between the bending area BA and the non-bending area NBA and in the non-bending area NEA near the boundary can be absorbed into the second groove pattern **1000**. Therefore, it is possible to prevent a phenomenon in which the upper surface of the first adhesive member **140** is distorted in the non-bending area NBA, and since the adhesion area between the first adhesive member **140** and the first substrate **150** is widened, it is possible to prevent a phenomenon in which the first adhesive member **140** delaminates from the first substrate **150** in the non-bending area NBA.

[0168] In addition, as described above with respect to the first groove pattern **400** with reference to FIG. **5**, since the shape of the second groove pattern **1000** can be freely changed according to repeated movements, it is possible to prevent the shape of the first substrate **150** from being distorted due to repeated movements in the non-bending area NBA.

[0169] Brief description of the embodiments of the present disclosure described above is as follows.

[0170] According to embodiments of the present disclosure, a display device can include a display panel, a substrate having a first surface which faces one surface of the display panel and a second surface which faces away from the first surface, and including a plurality of groove patterns which are located on at least one of the first surface or the second surface, each of the plurality of groove patterns including a first part which has a width equal to or smaller than a reference width and a second part which has a width equal to or larger than the reference width and which has an outwardly convex shape, and an adhesive member disposed on the substrate to fill the groove patterns.

[0171] In the display device according to the embodiments of the present disclosure, the first surface can be closer to the display panel than the second surface, the plurality of groove patterns can be disposed on the first surface, and the second part can be connected to the first surface.

[0172] In the display device according to the embodiments of the present disclosure, an angle formed by a straight line tangent to a sidewall of the second part and the first surface can increase as a location where the straight line is tangent to the sidewall of the second part is close to the first surface.

[0173] In the display device according to the embodiments of the present disclosure, at least one width of widths of the second part can be larger than a width of a portion where the second part is connected to the first surface.

[0174] In the display device according to the embodiments of the present disclosure, the substrate can include a bending area which is bent about an axis and a non-bending area, the plurality of groove patterns can include a plurality of first groove patterns which are disposed in the bending

area and a plurality of second groove patterns which are disposed in the non-bending area, and the plurality of second groove patterns can be disposed at a lower density than the plurality of first groove patterns.

[0175] In the display device according to the embodiments of the present disclosure, a width of a portion where the first groove pattern is connected to the first surface can be smaller than a width of a portion where the second groove pattern is connected to the first surface.

[0176] In the display device according to the embodiments of the present disclosure, at least two widths of each of the plurality of first groove patterns can be different from each other.

[0177] In the display device according to the embodiments of the present disclosure, each of the plurality of groove patterns can be formed to pass through the substrate.

[0178] In the display device according to the embodiments of the present disclosure, a storage modulus of the adhesive member can be equal to or less than 105 Pa.

[0179] According to embodiments of the present disclosure, a display device can include a display panel; a substrate having a first surface which faces one surface of the display panel and a second surface which faces away from the first surface, and including a plurality of groove patterns which are located on at least one of the first surface or the second surface, each of the plurality of groove patterns including a first part which has a surface at least partially flat toward an outside and a second part which has an outwardly convex shape; and an adhesive member disposed on the substrate to fill the groove patterns.

[0180] In the display device according to the embodiments of the present disclosure, the first surface can be closer to the display panel than the second surface, the plurality of groove patterns can be disposed on the first surface, and the second part can be connected to the first surface.

[0181] In the display device according to the embodiments of the present disclosure, an angle formed by a straight line tangent to a sidewall of the second part and the first surface can increase as a location where the straight line is tangent to the sidewall of the second part is close to the first surface.

[0182] In the display device according to the embodiments of the present disclosure, at least one width of widths of the second part can be larger than a width of a portion where the second part is connected to the first surface.

[0183] In the display device according to the embodiments of the present disclosure, the substrate can include a bending area which is bent about an axis and a non-bending area, the plurality of groove patterns can include a plurality of first groove patterns which are disposed in the bending area and a plurality of second groove patterns which are disposed in the non-bending area, and the plurality of second groove patterns can be disposed at a lower density than the plurality of first groove patterns.

[0184] In the display device according to the embodiments of the present disclosure, each of the plurality of groove patterns can be formed to pass through the substrate.

[0185] According to embodiments of the present disclosure, a display device can include a display panel, a substrate having a first surface which faces one surface of the display panel and a second surface which faces away from the first surface, and including a plurality of groove patterns which are located on at least one of the first surface or the second surface, each of the plurality of groove patterns including at least partially a part which has an outwardly convex shape, and an adhesive member disposed on the substrate to fill the groove patterns.

[0186] In the display device according to the embodiments of the present disclosure, the first surface can be closer to the display panel than the second surface, the plurality of groove patterns can be disposed on the first surface, and the part which has the convex shape can be connected to the first surface.

[0187] The above description has been presented to enable any person skilled in the art to make and use the technical idea of the present disclosure, and has been provided in the context of a particular application and its requirements. Various modifications, additions and substitutions to the

described embodiments will be readily apparent to those skilled in the art, and the general principles defined herein can be applied to other embodiments and applications without departing from the spirit and scope of the present disclosure. The above description and the accompanying drawings provide an example of the technical idea of the present disclosure for illustrative purposes only. That is, the disclosed embodiments are intended to illustrate the scope of the technical idea of the present disclosure.

Claims

1. A display device comprising: a display panel including a plurality of subpixels; a substrate having a first surface facing the display panel and a second surface facing away from the first surface; a plurality of groove patterns on at least one of the first surface of the substrate or the second surface of the substrate, each of the plurality of groove patterns including a first part having a width equal to or smaller than a reference width and a second part having a width equal to or larger than the reference width, the second part having an outwardly convex shape; and an adhesive member disposed on the substrate to fill the plurality of groove patterns.
2. The display device of claim 1, wherein the first surface of the substrate is closer to the display panel than the second surface of the substrate, the plurality of groove patterns are on the first surface of the substrate, and the second part is connected to or adjacent to the first surface of the substrate.
3. The display device of claim 1, wherein an angle formed by a straight line tangent to a sidewall of the second part and the first surface increases as a location where the straight line is tangent to the sidewall of the second part is close to the first surface.
4. The display device of claim 1, wherein at least one width of widths of the second part is larger than a width of a portion where the second part is connected to the first surface.
5. The display device of claim 1, wherein the substrate includes a bending area configured to bend about an axis and a non-bending area, wherein the plurality of groove patterns include a plurality of first groove patterns in the bending area and a plurality of second groove patterns in the non-bending area, and wherein the plurality of second groove patterns are disposed at a lower density than the plurality of first groove patterns.
6. The display device of claim 5, wherein a width of a portion where the first groove pattern is connected to the first surface is smaller than a width of a portion where the second groove pattern is connected to the first surface.
7. The display device of claim 5, wherein at least two widths of each of the plurality of first groove patterns are different from each other.
8. The display device of claim 1, wherein each of the plurality of groove patterns is a hole that penetrates through the substrate.
9. The display device of claim 1, wherein a storage modulus of the adhesive member is equal to or less than 105 Pa.
10. A display device comprising: a display panel including a plurality of subpixels; a substrate having a first surface facing the display panel and a second surface facing away from the first surface; a plurality of groove patterns on at least one of the first surface of the substrate or the second surface of the substrate, each of the plurality of groove patterns including a first part having a surface that is at least partially flat and a second part having an outwardly convex shape; and an adhesive member disposed on the substrate, the adhesive member filling at least a portion of the plurality of groove patterns.
11. The display device of claim 10, wherein the first surface of the substrate is closer to the display panel than the second surface of the substrate, the plurality of groove patterns are disposed on the first surface of the substrate, and the second part is connected to the first surface of the substrate.
12. The display device of claim 10, wherein an angle formed by a straight line tangent to a sidewall

of the second part and the first surface increases as a location where the straight line is tangent to the sidewall of the second part is close to the first surface.

13. The display device of claim 10, wherein at least one width of widths of the second part is larger than a width of a portion where the second part is connected to the first surface.

14. The display device of claim 10, wherein the substrate includes a bending area configured to bend about an axis and a non-bending area, wherein the plurality of groove patterns include a plurality of first groove patterns in the bending area and a plurality of second groove patterns in the non-bending area, and wherein the plurality of second groove patterns are disposed at a lower density than the plurality of first groove patterns.

15. The display device of claim 10, wherein each of the plurality of groove patterns is a hole that penetrates through the substrate.

16. A flexible display device comprising: a display panel including a plurality of subpixels; a substrate having a bending area and a non-bending area; an adhesive member disposed between the display panel and the substrate; and a plurality of groove patterns in the bending area of the substrate, each grove pattern among the plurality of groove patterns including a first part corresponding to a bottom of the grove pattern and a second part corresponding to an opening of the grove pattern, wherein a side of the first part has a first slope, and a side of the second part has a second slope different than the first slope, and wherein portions of the adhesive member extend at least partially into the plurality of groove patterns.

17. The flexible display device of claim 16, wherein the portions of the adhesive member are configured to extend deeper into the plurality of groove patterns when the flexible display device is in a bent state than when the flexible display device is in a non-bent state.

18. The flexible display device of claim 16, wherein a cross section of each of the plurality of groove patterns has a bottle neck shape or a head and shoulders shape.

19. The flexible display device of claim 16, wherein each of the plurality of groove patterns is configured to more tightly grip or squeeze one the portions of the adhesive member when the flexible display device is in a bent state than when the flexible display device is in a non-bent state.

20. The flexible display device of claim 16, wherein the plurality of groove patterns include a first plurality of groove patterns disposed in the bending area of the substrate and a second plurality of groove patterns disposed in the non-bending area of the substrate, and wherein the first plurality of groove patterns are spaced closer together than the second plurality of groove patterns.