Technical Field

The present disclosure relates to a flexible glass substrate for illumination and a manufacturing method thereof. More particularly, the present disclosure relates to a flexible glass substrate for lighting and a manufacturing method thereof, the flexible glass substrate having a reduced level of brittleness, an improved level of flexibility, and being applicable to a high-temperature process for the manufacturing of an illumination element.

Background Art

The illumination market has experienced a rapid change in product trends, away from fluoresce tube and incandescent bulb towards light emitting diode (LED). Recently, research into electroluminescence (EL) has achieved technical developments in terms of imparting flexibility to allow such illumination to be flexible like paper, in addition to having light and thin profiles. EL is a phenomenon of which the material emits light in response to the passage of an electrical current. It is therefore essential to select a substrate which forms a substantial portion of the thickness of the EL while serving as a base for the deposition of various elements or protecting elements from the external environment.

Disclosure

Technical Problem

Accordingly, the present disclosure has been made in consideration of the above problems occurring in contemporary design of similar technology, and the present disclosure is provided to propose a the present disclosure relates to a flexible glass substrate for lighting and a manufacturing method thereof, the flexible glass substrate having a reduced level of brittleness, an improved level of flexibility, and being applicable to a high-temperature process for the manufacturing of an illumination element.

Contemporary design of similar technology used thin films of transparent polymer as backing and most upper top layer to allow for light transmission. These polymer is permeable by water molecules. This allows the laminated material in between these polymer films to be subjectable to moisture attack. The water reacts with the material and caused degradation of the materials and thus reduce the performance of the system.

Second problems is that these polymer film will deteriorate over time when exposed to ultraviolet from sunlight. Another limitation of polymers film is that only a limited number of materials satisfy all of these three characteristics, such as being lightweight while having a thin profile and flexibility, while having their own particular advantages and disadvantages. Therefore, it is difficult to actually apply such materials to illumination substrates. The use polymer film limit the choice of use materials of that are not compatible with the choice of polymers used.

Technical Solution

According to an aspect of the present disclosure, provided is a flexible hybrid substrate for illumination. The flexible hybrid substrate may include: an ultra-thin glass plate; a first transparent thin film formed on one surface of the ultra-thin glass plate. The transparent thin film being comprised of a transparent conductive material such as nano carbon tube and or graphene. A layer of transparent polymer may be included between the ultra-thin glass and transparent conductive material to improve the adhesion and provide safety as laminator if the ultra-thin glass is tempered. The transparent conductive layer is next cover by electroluminescent material, and follow by a high reflective opaque conductive material film

The thickness of the ultra-thin glass may range from 30 to 100 µm. The first transparent thin film may range from 5 nm to 200 nm for nano carbon tube (CNT); or 20 to 400 nm for graphene; or 20 to 400 nm for mixture of nano carbon tube and graphene.

The electroluminescent material can be phosphor-based for easily manufacturing and handling and thickness range from 5 to 50 µm. The reflective opaque conductive may be made of aluminum and thickness range from 5 to 25 µm. The last layer of proposed

technology is another layer of ultra-thin glass. A layer of transparent polymer may be included between the ultra-thin glass and opaque conductive material to improve the adhesion and provide safety as laminator if the ultra-thin glass is tempered.

According to another aspect of the present disclo-sure, provided is a method of manufacturing a flexible hybrid substrate for illumination. The method may include: a first step of forming a first transparent thin film on one surface of an ultra-thin glass plate, the first transparent thin film comprising a first transparent conductive material; and a second step of forming electroluminescent material over it. The third step is the layering of opaque material over the stack of layers. And the fourth step is to cover the resultant stacked layers by another ultra-thin glass.

The third step may include forming a film of reflective opaque conductive material on top of the stacked layers.

Here, the first, second and third steps may be performed using a wet coating method, such as slot-die coating, slit coating, direct screen printing or physical vapour deposition, or chemical vapour deposition. Here, the three steps can be performed using roll-to-roll process for scale up mass production.

In addition to third may include forming a film of reflective opaque conductive material on a polymer film and laminate the other surface to another ultra-thin glass plate. And the resulting ultra-thin glass plate stack is bonded onto the stacked layers.

Advantageous Effects

According to the present disclosure, the substrate has a hybrid structure including ultra-thin glass plate, the transparent conductive thin film, a layer electroluminescence material, a reflective opaque conductive film and another plate of ultra-glass. Thus, the resulting hybrid structure has a reduced level of brittleness, an improved level of flexibility, and is applicable in a high- temperature process for the manufacturing of an illumination element.

Further, according to the present disclosure, the substrate can further improve the flexibility of illumination elements. The substrate can overlay on contour and undulating surface which was not possible by normal thick glass.

To enable a flexible luminous panel, contemporary design of similar technology used thin films of transport polymer as backing and most upper top layer to allow for light transmission. However, these polymers are permeable by water molecules. This allows the laminated material in between these polymer films to be subjectable to moisture attack. The water reacts with the material and caused degradation of the materials and thus reduce the performance of the system. According to the present disclosure, the hybrid structure using ultra-thin glass will eliminate the problem of the moisture attack to sandwiched materials in between.

Second benefit of the ultra-thin glass is that it will not deteriorate over time when exposed to ultraviolet from sunlight. The use of ultra-thin glass opens new opportunity to use materials that were not possible before due to compatibility issues with the choice of polymers used. Another limitation of polymers film is that only a limited number of materials satisfy all of these three characteristics, such as being lightweight while having a thin profile and flexibility, while having their own particular advantages and disadvantages. Therefore, it is difficult to actually apply such materials to illumination substrates. The use of ultra-thin glass opens new opportunity to use materials that were not possible before due to compatibility issues with the choice of polymers used. For example, the current transparent conductive layers of indium tin oxide (ITO) can be replaced by nano carbon tubes or graphene. Another example is the back conductive layer is currently composited of expensive silver paste. This back layer can now be substituted with relatively lower cost aluminum material.

According to the present disclosure, the hybrid structure module can be assembled with other hybrid structure module both in x- and y-direction. This allow the hybrid structure to be deployed easily over a large area.

Description of Drawings

FIG. 1 is a schematic planar view illustrating a flexible hybrid of illumination according to an exemplary embodiment.

FIG. 2 is a schematic section and cross-sectional view illustrating a flexible hybrid of illumination according to an exemplary embodiment how individual module can join into a larger area.

FIG.3 is a schematic illustrating the different layers of material be stacked i a flexible hybrid of illumination according to an exemplary embodiment

FIG. 4 is a schematic illustrating the different layers of material be stacked in with lamination film in a flexible hybrid of illumination according to another exemplary embodiment

Mode for Invention

Hereinafter, reference will be made in detail to a flexible hybrid substrate for illumination and a manufacturing method thereof according to the present disclosure, exemplary embodiments of which are illustrated in the accompanying drawings.

In the following description, detailed descriptions of known functions and components will be omitted in the case that the subject matter of the present disclosure is rendered unclear by the inclusion thereof.

As illustrated in FIG. 1, a flexible hybrid substrate 100 for illumination according to an exemplary embodiment. The flexible hybrid substrate 100 for illumination can join in both x- and y – direction to form a large area by the use of the feature of a tab 110 and slot 120. The tab 110 function like plug, while slot 120 function like a socket.

As illustrated in FIG. 2, a cross section details 200 of the flexible hybrid substrate 100 for illumination according to an exemplary embodiment. The details cross section of the feature of upper slot 210, upper tab 220, lower tab 230 and lower slot 240 are illustrated.

The different layers of the material of the flexible hybrid substrate are illustrated in cross section details 200. The substrate includes an ultra-thin glass plate 250, a transparent conductive thin film 260, a layer of electroluminescent material 270, a layer of reflective opaque conductive layer 280, and finally another ultra-thin glass plate 290.

As illustrated in FIG. 2 , the upper slot 210 of a flexible hybrid substrate 130 is shown on the left and the upper tab 220 of another flexible hybrid substrate 140 shown on the right. When the upper tab 220 is insert into the upper slot 210, they connect the transparent conductive films of both flexible hybrid substrates 130 and 140 together electrically. When the lower tab 230 is insert into the lower slot 240, they connect the reflective opaque conductive films of both flexible hybrid substrates 130 and 140 together electrically.

Since the ultra-thin glass plate 250 and 290 are applied to a flexible illumination, the ultra-thin glass plate itself must be flexible. In this regard, the ultra-thin glass plate 250 is formed at a thickness ranging from 30 μm to 100 μm.

When the ultra-thin glass plate 250 and 290 are formed to have a micrometer-scale thickness, the ultra-thin profile of the glass plate allows for flexibility and satisfies thinness and lightness requirements that flat panel illumination devices basically need.

In addition, the ultra-thin glass plates 250 and 290 have improved high-temperature stability as compared to a plastic material that is conventionally used as a substrate material in order to provide flexibility, so the ultra-thin glass plate can be reliably used in high temperature processing for the growth or formation of an element during the manufacturing of an

illumination device. That is, when the hybrid substrate 100 including the ultra-thin glass plates 250 and 290 according to the present embodiment is applied to a flat panel illumination device, the hybrid substrate 100 is advantageous for high temperature processing. The ultra-thin glass plates 250 and 290 may be formed from silicate glass, silica glass, borosilicate glass, non-alkali glass, or the like.

The first conductive transparent thin film 260 is formed on the beneath surface (when viewed in the direction of the drawing) of the ultra-thin glass plate 250. In the present embodiment, the thickness of the first transparent thin film may range from 5 nm to 200 nm when formed from nano carbon tube. The conductive transparent thin film 260 may range from 20 to 400 nm thick when formed by graphene. The film 260 may be ranged from 20 to 400 nm thick when a mixture of nano carbon tube and graphene is used to form the film 260. In additional, conductive transparent thin film 260 may be formed from PEDOT-PSS, a conductive polymer.

However, such an application of the flexible hybrid substrate 100 to a flat panel illumination device is merely an illustrative example, so the flexible hybrid substrate can be used as a sensor substrate for a touch panel through a certain process, as in the following embodiment. That is, according to the present embodiment, the flexible hybrid substrate 100 for illumination has the first transparent thin film 260 formed from a transparent conductive thin film in order to be compatible when used as a substrate other than a cover substrate for a flat panel illumination device.

The next layer is electroluminescent material 270. In the present embodiment, electroluminescent material 270 may be formed by phosphor-based film for easily manufacturing and handling and its thickness may range from 5 to 50 μm.

The layer beneath is a layer of reflective opaque conductive 280. In the present embodiment, the reflective opaque conductive 280 may be made of aluminum and thickness range from 5 to 25 μm.

The three layers of transparent conductive film 260, electroluminescent material 270, and reflective opaque material 280 can formed using a wet coating method, such as slot-die coating, slit coating, direct screen printing or physical vapour deposition, or chemical vapour deposition. Here, a roll-to-roll process may be performed to formed these layers when scaled up for mass production.

The last layer of proposed technology is another layer of ultra-thin glass 290.

As illustrated in FIG. 3, a schematic illustration of the exploded view 300 of the flexible hybrid substrate 100 for illumination according to an exemplary embodiment.

The exploded view 300 shows how each different layers of the substrate is stacked on top of each other and their respective to each other. In the exploded view 300, relative positions of each layer to one other, ultra-thin glass 250 and 290, the transparent conductive film 260, electroluminescent material 270, and reflective opaque conductive 280 are displayed.

As illustrated in FIG. 4, a schematic illustration of the exploded view 400 of the flexible hybrid substrate 100 for illumination according to another exemplary embodiment, with the addition of transparent lamination thin film 410 and 420.

The transparent lamination thin film 410 and 420 serves as a shock- absorbing material to prevent the ultra-thin glass plate 250 and 290 from breaking. These lamination film 410 and 420 can serve as lamination to hold the broken glass intact in the event the glass plate 250 and 290 is shattered. Therefore, the transparent lamination thin film 410 and 420 are formed to have a micrometer-scale thickness in order to be sufficiently thick, unlike the other transparent conductive film 260 having a nanometer-scale thickness. The extra transparent lamination thin film 410 and 420 , may be ranged from 1 to 100 μm, is added to stack of layers.

Claims

1. A flexible hybrid substrate for illumination comprising of a protruding tab and a opening slot on each side, such that the mentioned substrates can be join together physically and still connected electrically as such the resulting large area comprising of multiple mentioned substrates can be illuminated with only a single set of power supply circuit.

2. A flexible hybrid substrate for illumination comprising: an ultra-thin glass plate; a transparent conductive thin film formed on one surface; a layer of electroluminescent material forms onto the transparent conductive thin film; a film of reflective opaque material lay over the electroluminescent material; and enclosed by another ultra-thin glass plate on the other side of the mentioned substrate, such that the mentioned substrates is protected by ultra-thin glass plates on both surfaces and that mentioned substrate is flexible and able to illuminate.

3. The flexible hybrid substrate of claim 1, wherein the transparent conductive film comprises a nano carbon tubes or graphene or mixture of both.

4. The flexible hybrid substrate of claim 1, wherein the transparent conductive film comprises of PEDOT-PSS.

5. The flexible hybrid substrate of claim 3, wherein a thickness of the transparent thin film ranges from 5 nm to 200 nm for nano carbon tube (CNT); or 20 to 400 nm for graphene; or 20 to 400 nm for mixture of nano carbon tube and graphene.

6. The flexible hybrid substrate of claim 1, wherein a thickness of the ultra-thin glass plate ranges from 30 µm to 100 µm and may be laminated with another film of transparent polymer film for protection against shattering.

7. A method of manufacturing a flexible hybrid substrate for illumination, the method comprising:
   a first step of forming a transparent conductive material thin film on one surface of an ultra-thin glass plate; and
   a second step of forming a layer of electroluminescent material forms onto the transparent conductive thin film; and
   a third step of layering a film of reflective opaque material over the electroluminescent material; and
   a fourth step of enclosing a layer of ultra-thin glass plate over the reflective opaque material film.

8. The method of claim 7, wherein the first, second and third steps may be performed using a wet coating method, such as slot-die coating, slit coating; or direct screen

printing; or physical vapour deposition or chemical vapour deposition; or in a roll-to-roll process.

9. Another method of manufacturing a flexible hybrid substrate for illumination, the method comprising:
   a first step of over laying a film of reflective opaque material on one surface of an ultra-thin glass plate; and
   a second step of forming a layer of electroluminescent material over the reflective opaque material; and
   a third step of building a transparent conductive thin film conductive material onto the electroluminescent material; and
   a fourth step of enclosing a layer of ultra thin glass plate over the transparent conductive thin film conductive film.

10. The method of claim 9, wherein the first, second and third steps may be performed using a wet coating method, such as slot-die coating, slit coating; or direct screen printing; or physical vapour deposition or chemical vapour deposition; or in a roll-to-roll process.