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(54) **SURFACE LIGHT SOURCE, METHOD FOR MANUFACTURING THE SAME, AND DISPLAY DEVICE USING THE SURFACE LIGHT SOURCE**

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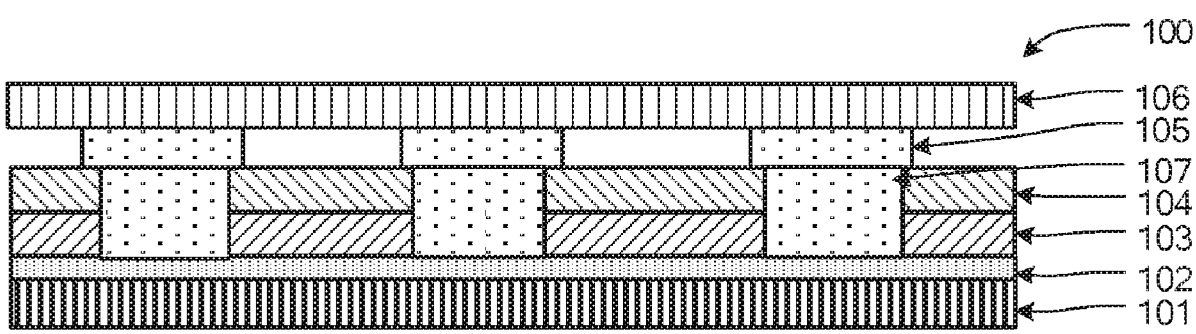
(57) **ABSTRACT**

The present invention provides a surface light source, a method for manufacturing the same, and a display device using the surface light source. The surface light source includes a substrate, a conductor line layer having a plurality of conductor lines to be distributed on one surface of the substrate, a mirror reflecting layer being covered on the conductor line layer, a high temperature resistant layer being covered on the mirror reflecting layer, a plurality of LED chips being arranged on the high temperature resistant layer and being electrically connected to the corresponding conductor lines, and a fluorescent film being covered on the LED chips and the high temperature resistant layer. The present invention can more effectively improve the reflectance and overall luminous efficiency of the surface light source.



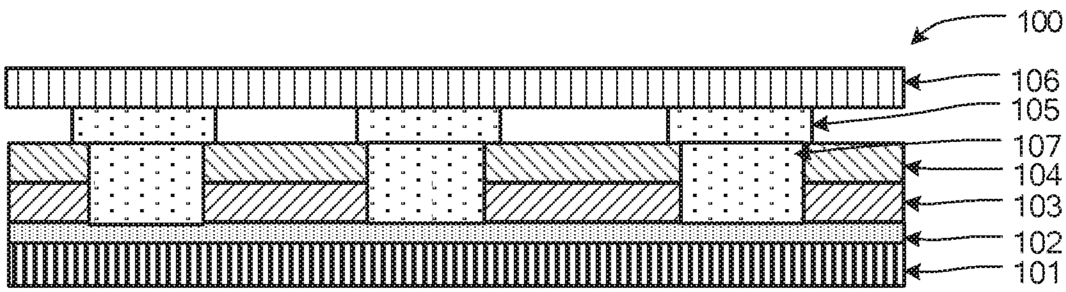


FIG. 1

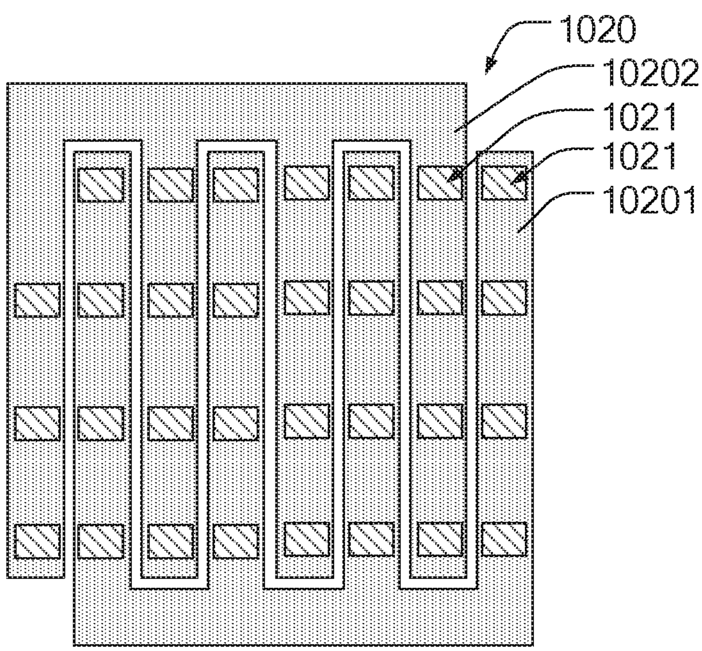


FIG. 2

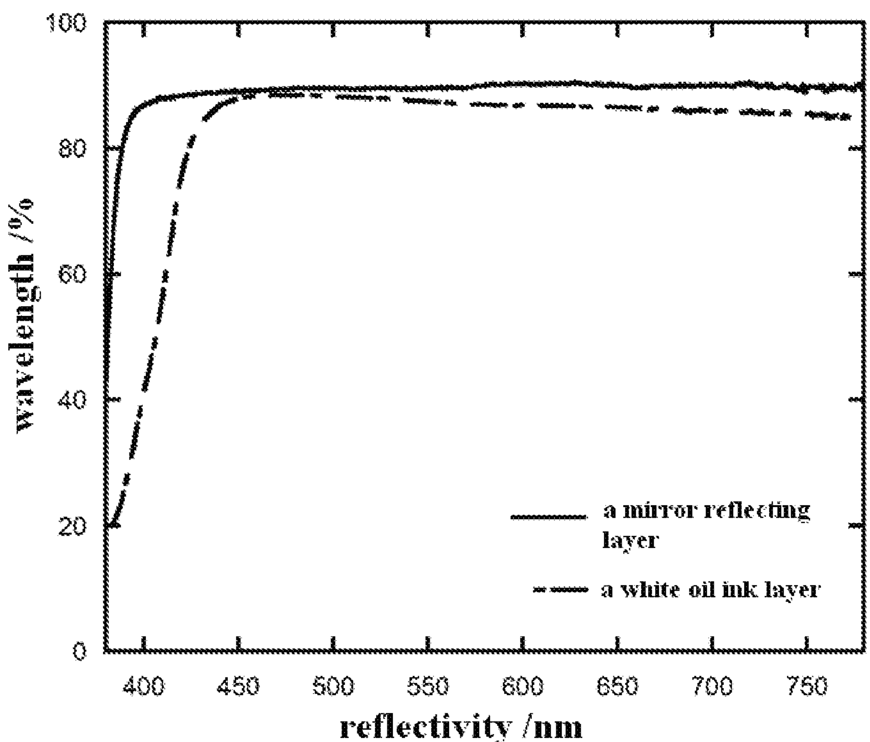

100
80
60
40
20
0
wavelength /%
400
450
500
550
600
650
700
750
reflectivity /nm
a mirror reflecting layer
a white oil ink layer

FIG. 3

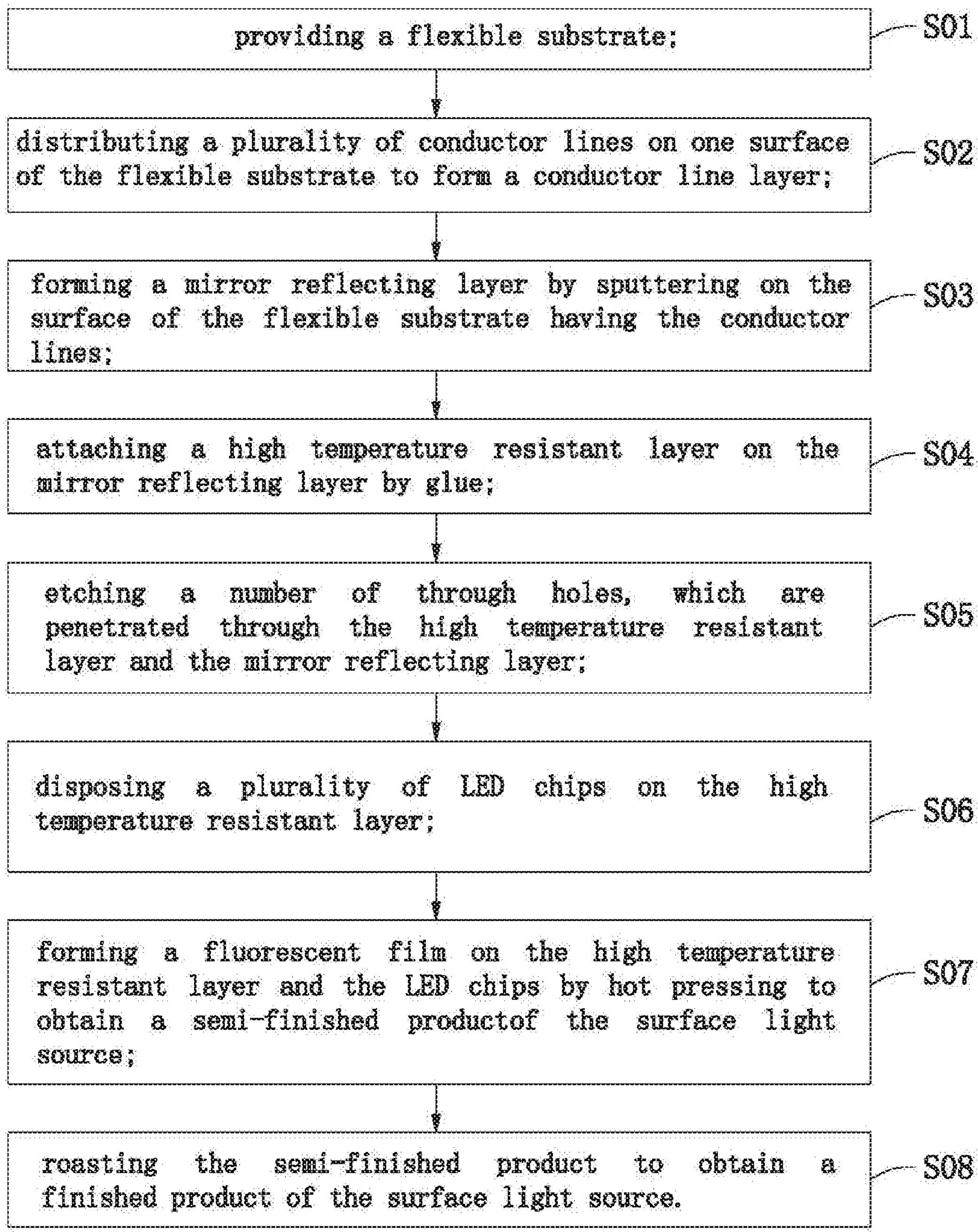

providing a flexible substrate;
S01
distributing a plurality of conductor lines on one surface of the flexible substrate to form a conductor line layer;
S02
forming a mirror reflecting layer by sputtering on the surface of the flexible substrate having the conductor lines;
S03
attaching a high temperature resistant layer on the mirror reflecting layer by glue;
S04
etching a number of through holes, which are penetrated through the high temperature resistant layer and the mirror reflecting layer;
S05
disposing a plurality of LED chips on the high temperature resistant layer;
S06
forming a fluorescent film on the high temperature resistant layer and the LED chips by hot pressing to obtain a semi-finished productof the surface light source;
S07
roasting the semi-finished product to obtain a finished product of the surface light source.
S08

FIG. 4

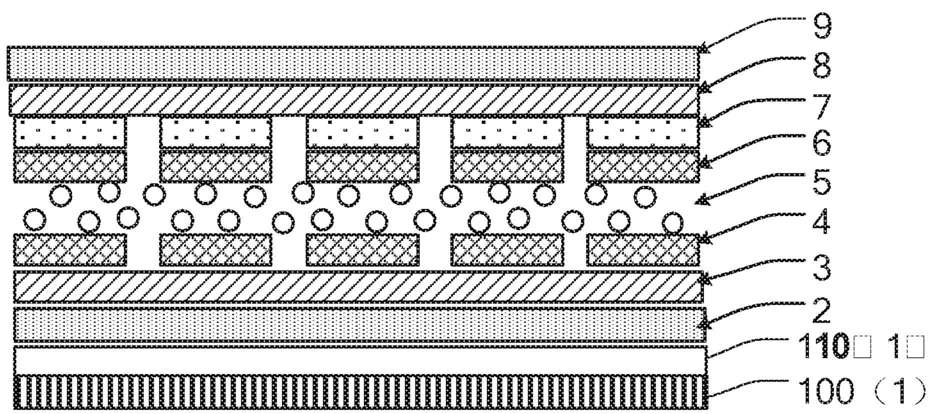


FIG. 5

SURFACE LIGHT SOURCE, METHOD FOR MANUFACTURING THE SAME, AND DISPLAY DEVICE USING THE SURFACE LIGHT SOURCE

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a flexible display device technology field, and more particularly to a surface light source, a method for manufacturing the same, and a display device using the surface light source.

2. Description of the Prior Art

[0002] With the development of science and technology, people have more and more frequent contacts with electronic equipment, and the requirements for display devices (or named display panels) thereof are also increasing. A mini LED display device is a powerful competitive product of the OLED display device in the future market. The mini LED display device has many advantages, such as bright, flexible and bendable, high dynamic contrast display technology, narrow frame display technology, abnormal display technology and so on. Thus the mini LED display device has become a hot spot of market research.

[0003] However, at present, there are still some gaps between the mini LED display device and the OLED display device using the conventional backlight in luminous efficiency, mixing uniformity, cost, module thickness and so on. In terms of luminous efficiency, the mini LED display device uses an FPC (Flexible Printed Circuit) or a PCB (Printed Circuit Board) as a substrate of a surface light source of a direct-type backlight module, and a white oil ink layer with high reflectivity is adopted on the substrate surface to reflect the internal reflection of the mini LED display device into a diffusion layer and a brighten film. On the market, because the reflectance of the existing white oil ink layer is difficult to exceed 85%, and the organic materials made into the white oil ink layer have higher absorbance for light, these conditions will result in more loss of the internal luminous efficiency of the surface light source. It can be seen that there is a technical bottleneck to enhance the light efficiency of the surface light source through improving the ink reflectivity.

BRIEF SUMMARY OF THE INVENTION

[0004] The technical problem to be solved in the present invention is to providing a surface light source, a method for manufacturing the same, and display device using the surface light source, wherein the surface light source employs a mirror reflecting layer with a high temperature resistant layer to replace a white oil reflecting layer for effectively improving the reflectivity and the overall luminous efficiency of the surface light source.

[0005] In order to solve the above technical problems, the present invention provides a surface light source, which comprises: a substrate; a conductor line layer, having a plurality of conductor lines distributed on one surface of the substrate; a mirror reflecting layer, being covered on the conductor line layer; a high temperature resistant layer, being covered on the mirror reflecting layer; a plurality of LED chips, being arranged on the high temperature resistant layer and being electrically connected to the corresponding conductor lines; and a fluorescent film, being covered on the LED chips and the high temperature resistant layer.

[0006] In one embodiment of the present invention, a heat resistance temperature of the high temperature resistant layer is 200° C.-500° C., a penetration rate thereof is higher than 90%, and a thickness thereof is 100 μm-150 μm.

[0007] In one embodiment of the present invention, the high temperature resistant layer is made of one of polycarbonate copolymers, polyaryl ether ketone derivatives, polyimide sulfone derivatives, polyimide derivatives and aromatic polyheterocyclic derivatives.

[0008] In one embodiment of the present invention, a thickness of the mirror reflecting layer is 1 μm-5 μm, and a surface roughness of the mirror reflecting layer is 0.1 μm-0.3 μm.

[0009] In one embodiment of the present invention, the surface light source is further etched with a number of through holes, each of which passes through the high temperature resistant layer and the mirror reflecting layer; the conductor line layer are provided with a plurality of weld pads connected to the conductor lines; the through holes are corresponding to the weld pads; and each LED chip has pins, which pass through the corresponding through holes to be welded onto the corresponding weld pads.

[0010] The present invention also provides a method for manufacturing a surface light source, comprising the following steps: providing a flexible substrate; distributing a plurality of conductor lines on one surface of the flexible substrate to form a conductor line layer; forming a mirror reflecting layer by sputtering on the surface of the flexible substrate having the conductor lines; attaching a high temperature resistant layer **104** on the mirror reflecting layer by glue; disposing a plurality of LED chips on the high temperature resistant layer; wherein each LED chip is electrically connected to the corresponding conductor lines of the conductor line layer; and forming a fluorescent film on the high temperature resistant layer and the LED chips by hot pressing.

[0011] In one embodiment of the present invention, before disposing a plurality of LED chips on the high temperature resistant layer, the method further comprising the following steps: etching a number of through holes penetrated through the high temperature resistant layer and the mirror reflecting layer; wherein the conductor line layer are provided with a plurality of weld pads connected to the conductor lines; the through holes are corresponding to the weld pads; in the step of disposing the LED chips on the high temperature resistant layer, each LED chip has pins, which pass through the corresponding through holes to be welded onto the corresponding weld pads by a solder paste process, a crystal solidification process and a reflow soldering process.

[0012] In one embodiment of the present invention, the reflow soldering process is a laser reflow soldering process.

[0013] In one embodiment of the present invention, in the step of forming the fluorescent film on the high temperature resistant layer and the LED chips by hot pressing, a hot-pressing temperature is 130° C.-150° C., and a hot-pressing time is 10 min-15 min; after forming the fluorescent film on the high temperature resistant layer and the LED chips by hot pressing, a semi-finished product of the surface light source is obtained, and then the semi-finished product is roasted for 2 min-10 min at 130° C.-150° C. and becomes a finished product of the surface light source.

[0014] The present invention further provides a display device comprising a surface light source.

[0015] The surface light source and the display device using the surface light source of the present invention employ the mirror reflecting layer with the high temperature resistant layer to replace a white oil reflecting layer on the market. The reflectivity of the mirror reflecting layer with the high temperature resistant layer reaches over 90%, which is higher than the reflectivity of the best white oil reflecting layer on the market now 85%. The reflection spectrum of the mirror reflecting layer with the high temperature resistant layer is higher in the blue band, and the blue light has higher luminous efficiency and excitation energy, so this will more effectively improve the reflectance and overall luminous efficiency of the surface light source. Moreover, in the method for manufacturing the surface light source, the laser reflow soldering process is adopted to effectively avoid the shrinkage of the substrate and each film. The high temperature resistant layer and the mirror reflecting layer with high temperature resistance are not affected by the high temperature process during hot-pressing coating. Further, the mirror reflecting layer with the high temperature resistant layer is not affected by the high temperature process when hot pressing. The method for manufacturing the surface light source is more simple and reasonable, and is conducive to control, thus further improving the overall quality of the surface light source.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] For more clearly understanding above content of the present invention, the following text will briefly introduce the accompanying drawings used in the preferred embodiment of the present invention. It is obvious that the accompanying drawings in the following description are only some embodiments of the present invention. For the technical personnel of the field, other drawings can also be obtained from these drawings without paying creative work.

[0017] The present invention is further explained in conjunction with the accompanying drawings and embodiments.

[0018] FIG. **1** is a layered structure schematic view of a surface light source of one embodiment of the invention;

[0019] FIG. **2** is a distribution diagram of a conductor line layer of FIG. **1** and mainly shows the distribution of conductor lines and the positions of weld pads;

[0020] FIG. **3** is a reflectivity comparison diagram of a mirror reflecting layer with a high temperature resistant layer in one embodiment of the invention and a white oil reflecting layer;

[0021] FIG. **4** is a flow chart of a method for manufacturing the surface light source of one embodiment of the invention; and

[0022] FIG. **5** is a layered structure schematic view of a display device of one embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0023] The following text will describe embodiments of the present invention in detailed. The embodiments are shown in the accompanying drawings, in which the same or similar signs represent the same or similar elements or elements with the same or similar functions from beginning to end. The following embodiments described with reference to the accompanying drawings are illustrative and are intended only to explain the present invention and are not understood as limitations to the invention.

[0024] The following description of every embodiment with reference to the accompanying drawings is used to exemplify a specific embodiment, which may be carried out in the present invention. Directional terms mentioned in the present invention, such as "up", "down", "front", "back", "left", "right", "top", "bottom" etc., are only used with reference to the orientation of the accompanying drawings. Therefore, the used directional terms are intended to illustrate, but not to limit, the present invention.

[0025] Referring to FIG. **1**, in one embodiment, a surface light source **100** of the present invention includes a substrate **101**, a conductor line layer **102**, a mirror reflecting layer **103**, a high temperature resistant layer **104**, a plurality of LED chips **105**, and a fluorescent film **106**.

[0026] The substrate **101** may be an FPC substrate or a PCB substrate. In the embodiment, the substrate **101** is the FPC substrate, which can be named a flexible substrate.

[0027] The conductor line layer **102** has a plurality of conductor lines **1020** (seen in FIG. **2**). The conductor lines **1020** are distributed on an upper surface of the substrate **101** to form the conductor line layer **102**. The conductor lines **1020** can be made of copper conductors, which are attached to the upper surface of the flexible substrate **101** to form a basic structure of the surface light source **100**.

[0028] Referring to FIG. **2**, according to the design requirements of the process, each LED chip **105** has pins, including a P-pole pin and an N-pole pin. The conductor lines **1020** include a P-pole conductor line **10201** and an N-pole conductor line **10202**, both of which are provided with a plurality of weld pads **1021**.

[0029] The mirror reflecting layer **103** is covered on the conductor line layer **102**. In the embodiment, the mirror reflecting layer **103** covers the basic structure of the surface light source **100**. Namely, the mirror reflecting layer **103** covers an entire surface of the copper conductors. A thickness of the mirror reflecting layer **103** is 1 μm-5 μm, preferably 3 μm. A surface roughness of the mirror reflecting layer **103** is 0.1 μm-0.3 μm, and its average surface roughness is generally 0.2 μm. The surface roughness of the mirror reflecting layer **103** can increase the diffuse reflection of light to a certain extent, so that the light can disperse evenly.

[0030] The high temperature resistant layer **104** is covered on the mirror reflecting layer **103**. In the embodiment, because the high temperature resistant layer **104** is added on the mirror reflecting layer **103**, it can protect the mirror reflecting layer **103** from being damaged when the fluorescent film **106** is subsequently hot-pressed. According to the design requirements of the performance, the high temperature resistant layer **104** is made of one of polycarbonate copolymers, polyaryl ether ketone derivatives, polyimide sulfone derivatives, polyimide derivatives and aromatic polyheterocyclic derivatives. Wherein, a heat resistance temperature of the high temperature resistant layer **104** is 200° C.-500° C., its penetration rate is higher than 90%, and its thickness is 100 μm-150 μm, preferably 120 μm-130 μm.

[0031] Referring to FIG. **3**, FIG. **3** is a reflectivity comparison diagram of the mirror reflecting layer with the high temperature resistant layer of the embodiment and a white oil reflecting layer. It can be seen from the reflectivity comparison diagram of FIG. **3** that a reflectivity of the mirror reflecting layer **103** with the high temperature resistant layer **104** is over 90%, which is higher than the reflectivity of the best white oil reflecting layer on the market now 85%. A reflectivity of the mirror reflecting layer **103** with the high temperature resistant layer **104** is higher in a blue band, and a blue light has higher luminous efficiency and excitation energy, so this will more effectively improve the luminous efficiency.

[0032] Please refer to FIG. **1**, the LED chips **105** are arranged on the high temperature resistant layer **104** and are electrically connected to the conductor lines **1020** (seen in FIG. **2**). The length and width of each LED chip **105** are 100 μm-500 μm.

[0033] In die bonding, the surface light source **100** is further etched with a number of through holes **107**, each of which passes through the high temperature resistant layer **104** and the mirror reflecting layer **103**. The through holes **107** are corresponding to the weld pads **1021**. The pins of each LED chip pass through the corresponding through holes **107** to be welded onto the corresponding weld pads **1021**.

[0034] The fluorescent film **106** is covered on the LED chips **105** and the high temperature resistant layer **104**.

[0035] Referring to FIG. **4**, in order to fully realize the surface light source **100** of the above embodiment, the present invention further provides a method for manufacturing the surface light source **100**, including steps S**01**-S**08**.

[0036] The structures and the reference numerals involved below can refer to FIG. **1** and FIG. **2**.

[0037] A step S**01** is providing a substrate **101**, which may be an FPC substrate or a PCB substrate.

[0038] A step S**02** is distributing a plurality of conductor lines **1020** on an upper surface of the substrate **101** to form a conductor line layer **102**. The conductor lines **1020** can be made of copper conductors, which are attached to the upper surface of the substrate **101** to form a basic structure of the surface light source **100**.

[0039] A step S**03** is forming a mirror reflecting layer **103** by sputtering on the upper surface of the substrate **101** having the conductor lines **1020**. The mirror reflecting layer **103** covers the basic structure of the surface light source **100** and an entire surface of the copper conductors. A thickness of the mirror reflecting layer **103** is 1 μm-5 μm, preferably 3 μm. A surface roughness of the mirror reflecting layer **103** is 0.1 μm-0.3 μm, and its average surface roughness is generally 0.2 μm.

[0040] A step S**04** is attaching a high temperature resistant layer **104** on the mirror reflecting layer **103**. Wherein, a heat resistance temperature of the high temperature resistant layer **104** is 200° C.-500° C., its penetration rate is higher than 90%, and its thickness is 100 μm-150 μm, preferably 120 μm-130 μm. Specifically, the high temperature resistant layer **104** is glued on the mirror reflecting layer **103** by glue, so the high temperature resistant layer **104** can be closely bonded with the mirror reflecting layer **103**.

[0041] A step S**05** is etching a number of through holes **107**, which are penetrated through the high temperature resistant layer **104** and the mirror reflecting layer **103**. The conductor line layer **102** has a plurality of weld pads **1021** connected to the conductor lines **1020**. In the embodiment, each LED chip **105** has pins, including a P-pole pin and an N-pole pin. The conductor lines **1020** are divided into a P-pole conductor line and an N-pole conductor line, both of which are provided with the weld pads **1021**. The through holes **107** are corresponding to the weld pads **1021**. When etching is completed, the weld pads **1021** can be exposed in the through holes **107**. This will facilitate subsequent operations.

[0042] A step S**06** is disposing a plurality of LED chips **105** on the high temperature resistant layer **104**. Each LED chip **105** is electrically connected to the corresponding conductor lines of the conductor line layer **102**. Specifically, the pins of the LED chips **105** pass through the corresponding through holes **107** to be welded onto the corresponding weld pads **1021** by a solder paste process, a crystal solidification process and a reflow soldering process. For example, solder pastes can be coated on the weld pads **1021** by the solder paste process, and then the LED chips **105** can be fixed by the solidification process and the reflow soldering process. The reflow soldering process is a laser reflow soldering process. In the embodiment, each LED chip **105** is welded by the laser reflow soldering process. The laser reflow soldering process is different from a conventional hot gas reflow soldering process. When the conventional hot gas reflow soldering process is carried out, the welding area is large. But when the laser reflow soldering process is used, laser beams can be concentrated in the weld pads **1021**, and form a local heating zone on the weld pads **1021** in a relatively short time, thus avoiding the expansion and contraction of the substrate or each layer caused by the conventional hot gas reflow soldering process.

[0043] A step S**07** is forming a fluorescent film **106** on the high temperature resistant layer **104** and the LED chips **105** by hot pressing. A hot-pressing temperature is 130° C.-150° C., a hot-pressing time is 10 min-15 min (10 to 15 minutes). Wherein, the hot-pressing temperature is 130° C.-150° C., but a heat resistance temperature of the high temperature resistant layer **104** is 200° C.-500° C., so the hot-pressing temperature is much lower than the heat resistance temperature of the high temperature resistant layer **104**, thereby effectively protecting the mirror reflecting layer **103** from the influence of the hot-pressing temperature. In the embodiment, the fluorescent film **106** is hot pressed on the high temperature resistant layer **104** and the LED chips **105**, so a semi-finished product of the surface light source **100** is obtained.

[0044] A step S**08** is putting the semi-finished product of the surface light source **100** into an oven and roasting for 2 min-10 min at 130° C.-150° C. to solidify the fluorescent film **106** and obtain a finished product of the surface light source **100**.

[0045] The following text will take a mini LED display device as an example to introduce the structure of the display device of the present invention.

[0046] Referring to FIG. **5**, in one embodiment, the mini LED display device includes a backlight device **1**, a first polarizer **2**, a first glass substrate **3**, a first electrode layer **4**, a liquid crystal molecular layer **5**, a second electrode layer **6**, a color filter **7**, a second glass substrate **8** and a second polarizer **9**. Wherein the first polarizer **2** and the second polarizer **9** are opposite to each other, and located on the backlight device **1**. The first glass substrate **3** and the second glass substrate **8** are opposite to each other, and located between the first polarizer **2** and the second polarizer **9**. The first electrode layer **4** and the second electrode layer **6** are disposed between the first glass substrate **3** and the second glass substrate **8**. The liquid crystal molecular layer **5** is disposed between the first electrode layer **4** and the second electrode layer **6**. And the color filter **7** is disposed between the second glass substrate **8** and the second electrode layer **6**. The light emitted by the backlight device **1** passes through the first polarizer **2**, the first glass substrate **3**, the liquid crystal molecular layer **5**, the color filter **7**, the second glass substrate **8** and the second polarizer **9** in sequence.

[0047] The backlight device **1** includes the surface light source **100** and at least one optical film **110**. The optical film **110** may be a diffusion sheet, a prism sheet, an intensifying film or a combination, disposed on the surface light source **100**.

[0048] Since the focus of the present invention is on the surface light source **100** in the backlight device **1** of the mini LED display device, other components of the mini LED display device will not be described in detail.

[0049] Of course, the backlight device **1** of the embodiment can also be applied to other kinds of display devices. The mini LED display device listed in the embodiment is merely an explanation of the invention, but not a limitation thereof.

[0050] The above description is only a preferred embodiment of the invention and is not intended to limit the invention. Any modification, equivalent substitution and improvement made within the spirit and principles of the invention shall be included in the scope of protection of the invention.

REFERENCE NUMERALS

[0051] **1** backlight device
[0052] **100** surface light source
[0053] **110** optical film
[0054] **101** flexible substrate
[0055] **102** conductor line layer
[0056] **103** mirror reflecting layer
[0057] **104** high temperature resistant layer
[0058] **105** LED chip
[0059] **106** fluorescent film
[0060] **107** through hole
[0061] **1020** conductor line
[0062] **1021** weld pad
[0063] **10201** P-pole conductor line
[0064] **10202** N-pole conductor line
[0065] **2** first polarizer
[0066] **3** first glass substrate
[0067] **4** first electrode layer
[0068] **5** liquid crystal molecular layer
[0069] **6** second electrode layer
[0070] **7** color filter
[0071] **8** second glass substrate
[0072] **9** second polarizer

What is claimed is:

1. A surface light source, which comprises:
a substrate;
a conductor line layer, having a plurality of conductor lines distributed on one surface of the substrate;
a mirror reflecting layer, being covered on the conductor line layer;
a high temperature resistant layer, being covered on the mirror reflecting layer;
a plurality of LED chips, being arranged on the high temperature resistant layer and being electrically connected to the corresponding conductor lines; and
a fluorescent film, being covered on the LED chips and the high temperature resistant layer.

2. The surface light source as claimed in claim **1**, wherein a heat resistance temperature of the high temperature resistant layer is 200° C.-500° C., a penetration rate thereof is higher than 90%, and a thickness thereof is 100 μm-150 μm.

3. The surface light source as claimed in claim **1**, wherein the high temperature resistant layer is made of one of polycarbonate copolymers, polyaryl ether ketone derivatives, polyimide sulfone derivatives, polyimide derivatives and aromatic polyheterocyclic derivatives.

4. The surface light source as claimed in claim **1**, wherein a thickness of the mirror reflecting layer is 1 μm-5 μm, and a surface roughness of the mirror reflecting layer is 0.1 μm-0.3 μm.

5. The surface light source as claimed in claim **1**, wherein the surface light source is further etched with a number of through holes, each of which passes through the high temperature resistant layer and the mirror reflecting layer; the conductor line layer are provided with a plurality of weld pads connected to the conductor lines; the through holes are corresponding to the weld pads; and each LED chip has pins, which pass through the corresponding through holes to be welded onto the corresponding weld pads.

6. A method for manufacturing a surface light source as claimed in claim **1**, comprising the following steps:
providing a flexible substrate;
distributing a plurality of conductor lines on one surface of the flexible substrate to form a conductor line layer;
forming a mirror reflecting layer by sputtering on the surface of the flexible substrate having the conductor lines;
attaching a high temperature resistant layer **104** on the mirror reflecting layer by glue;
disposing a plurality of LED chips on the high temperature resistant layer;
wherein each LED chip is electrically connected to the corresponding conductor lines of the conductor line layer; and
forming a fluorescent film on the high temperature resistant layer and the LED chips by hot pressing.

7. The method for manufacturing the surface light source as claimed in claim **6**, wherein before disposing a plurality of LED chips on the high temperature resistant layer, the method further comprising the following steps:
etching a number of through holes penetrated through the high temperature resistant layer and the mirror reflecting layer; wherein the conductor line layer are provided with a plurality of weld pads connected to the conductor lines; the through holes are corresponding to the weld pads;
in the step of disposing the LED chips on the high temperature resistant layer, each LED chip has pins, which pass through the corresponding through holes to be welded onto the corresponding weld pads by a solder paste process, a crystal solidification process and a reflow soldering process.

8. The method for manufacturing the surface light source as claimed in claim **7**, wherein the reflow soldering process is a laser reflow soldering process.

9. The method for manufacturing the surface light source as claimed in claim **6**, wherein in the step of forming the fluorescent film on the high temperature resistant layer and the LED chips by hot pressing, a hot-pressing temperature is 130° C.-150° C., and a hot-pressing time is 10 min-15 min;

after forming the fluorescent film on the high temperature resistant layer and the LED chips by hot pressing, a semi-finished product of the surface light source is obtained, and then the semi-finished product is roasted for 2 min-10 min at 130° C.-150° C. and becomes a finished product of the surface light source.

10. A display device, comprising a surface light source as claimed in claim **1**.

* * * * *