(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
8 December 2016 (08.12.2016)

(10) International Publication Number
WO 2016/192569 A2

(51) International Patent Classification: Not classified

(21) International Application Number: PCT/CN2016/083454

(22) International Filing Date: 26 May 2016 (26.05.2016)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
201510290013.1 29 May 2015 (29.05.2015) CN

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

(54) Title: LOW EMISSIVITY GLASS, METHOD FOR MANUFACTURING THE SAME AND VEHICLE WINDOW

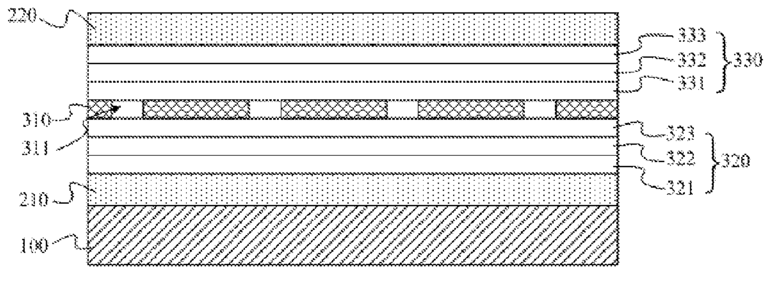

Figure 1

(57) Abstract: A low emissivity glass, a method for manufacturing the low emissivity glass and a vehicle window are provided in the present invention. The low emissivity glass includes: a substrate; and a stacked structure film covering at least a surface of the substrate, the stacked structure film including a metal infrared reflection layer and a plurality of dielectric layers, wherein the metal infrared reflection layer has a plurality of openings. The vehicle window includes an encapsulation, and the low emissivity glass. The method for manufacturing the low emissivity glass includes: providing a substrate; and covering at least a surface of the substrate with a stacked structure film, wherein the stacked structure film comprises a metal infrared reflection layer and a plurality of dielectric layers, wherein covering with the stacked structure film comprises: forming a plurality of openings in the metal infrared reflection layer. The benefits of the present invention lie in that: the plurality of openings is in favor of the wireless signals going through the plurality of openings, thereby reducing the shielding effect of the low emissivity glass on the wireless signals. Therefore, the low emissivity glass in the present invention can not only block the infrared ray, but also increase the transmittance of the wireless signals through the low emissivity glass.

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LOW EMISSIVITY GLASS, METHOD FOR MANUFACTURING THE SAME AND VEHICLE WINDOW

This application claims the benefit of priority to Chinese Patent Application No. 201510290013.1, titled "LOW EMISSIVITY GLASS, METHOD FOR MANUFACTURING THE SAME AND VEHICLE WINDOW", filed with the Chinese State Intellectual Property Office on May 29, 2015, the entire disclosure of which is incorporated herein by reference.

FIELD

The disclosure generally relates to vehicle manufacturing field, and more particularly, to a low emissivity glass, a method for manufacturing the low emissivity glass and a vehicle window.

BACKGROUND

Low emissivity glass has been widely applied to high-end vehicles, residences and office buildings. The low emissivity glass refers to a glass that can reduce the transmittance of radiation light passing through the glass. The low emissivity glass realizes reducing the radiation by forming a material layer on the surface of a glass substrate to block radiation, where the radiation can be absorbed or reflected by the material layer.

SUMMARY

Inventors of the present disclosure realize that the low emissivity glass may block wireless signals to a great extent, which results in it is difficult for the wireless signals to propagate through the glass. Taking the vehicle glass for example, the glass with high blocking capability on the wireless signals may lead to a low signal intensity inside the vehicle, or even no signal surrounding the vehicle, which poses a difficult in using electronic equipments, such as mobile phones, radios etc.

Thus, there is a need for a low emissivity glass, a method for manufacturing the low emissivity glass and a vehicle window, to reduce the blocking effect on the wireless signals entering the vehicle body, thus the intensity of the wireless signals inside the vehicle body rises.

According to an aspect of the present disclosure, a low emissivity glass is provided. The low emissivity glass includes: a substrate; and a stacked structure film covering at least a surface of the substrate, the stacked structure film including a metal infrared reflection layer and a plurality of dielectric layers, wherein the metal infrared reflection layer has a plurality of openings.

A basic idea lies in that, the plurality of openings of the metal infrared reflection layer may increase the transmittance of the wireless signals passing through the low emissivity glass. Specifically, the metal infrared reflection layer is applied to reflect the infrared ray, and thus to reduce the transmittance of the infrared ray passing through the low emissivity glass; As a metallic material, the metal infrared reflection layer may shield the wireless signals, namely, the metal infrared reflection layer may block the wireless signals from passing through the low emissivity glass; the plurality of openings of the metal infrared reflection layer facilitates the wireless signals going through the openings, and thus the shielding effect of the low emissivity glass on the wireless signals is reduced. Therefore, the low emissivity glass in the present disclosure can not only block the infrared ray, but also increase the transmittance of the wireless signals.

According to an aspect of the present disclosure, a vehicle window is provided. The vehicle window includes: an encapsulation, and the aforementioned low emissivity glass.

A basic idea lies in that, the vehicle window includes the aforementioned low emissivity glass. Therefore, the vehicle window can not only reduce the radiation, but also ensure the transmittance of the wireless signal through the low emissivity glass. That is, the intensity of the wireless signals inside the vehicle can be ensured.

According to an aspect of the present disclosure, a method for manufacturing a low emissivity glass is provided. The method for manufacturing the low emissivity glass includes: providing a substrate; and covering at least a surface of the substrate with a stacked structure film, the stacked structure film including a metal infrared reflection layer and a plurality of dielectric layers, where covering with the stacked structure film includes: forming a plurality of openings in the metal infrared reflection layer.

A basic idea lies in that, the transmittance of the wireless signals through the low emissivity glass can be increased by forming the plurality of openings in the metal infrared reflection layer. Specifically, the metal infrared reflection layer is applied to reflect the infrared ray, and further to reduce the transmittance of the infrared ray passing through the low emissivity glass. As a metallic material, the metal infrared reflection layer can shield the wireless signals, namely, the metal infrared reflection layer can block the wireless signals from passing through the low emissivity glass; forming the plurality of openings in the metal infrared reflection layer facilitates the wireless signals going through the plurality of openings, thus the shielding effect of the low emissivity glass on wireless signals is reduced. Therefore, the low emissivity glass in the present disclosure can not only block the infrared ray, but also increase the transmittance of the wireless signals passing through the low emissivity glass.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 and Figure 2 schematically illustrate a low emissivity glass according to a first embodiment of the present disclosure;

Figure 3 and Figure 4 schematically illustrate a low emissivity glass according to a second embodiment of the present disclosure;

Figure 5 and Figure 6 schematically illustrate a low emissivity glass according to a third embodiment of the present disclosure;

Figure 7 schematically illustrates a low emissivity glass according to a forth embodiment of the present disclosure; and

Figure 8 schematically illustrates a flow chart of a method for manufacturing the low emissivity glass according to an embodiment of the present disclosure.

DETAILED DESCRIPTION OF EMBODIMENTS

The above described objectives and features and advantages of the present disclosure will become more apparent and readily understood by describing in detail the exemplary embodiments with reference to the accompanying drawings.

In an conventional technology, some glass may block the wireless signals to a great extent, as a result, the wireless signals transmitting through the glass decrease. Taking the vehicle glass for example, this kind of glass may lead to the wireless signals inside the vehicle becoming weak or even no wireless signals inside the vehicle, which may affect people using electronic equipments inside the vehicle.

In order to solve the technical problems described above, a low emissivity glass, a method for manufacturing the low emissivity glass and a vehicle are provided in the present disclosure.

In the following description of the present disclosure, “the low emissivity glass" refers to a glass that can reduce the transmittance of the radiation through the glass. That is, when the radiation irradiates one side of the low emissivity glass, the low emissivity glass can block a portion of radiation, thereby the radiation intensity on the other side of the low emissivity glass with respect to the radiation source becomes relatively lower. In addition, the "low emissivity" mentioned in the present disclosure refers to the radiation intensity lower than the intensity of the radiation source. For instance, the radiation intensity is lower than -110dbm. However, it is appreciated to those of ordinary skill in the art that, the low emissivity may refer to different extent in different environments or different standards. Therefore, the protection scope should not be limited by the embodiments disclosed herein.

The present disclosure will take the vehicle window glass for example. Firstly referring to Figure 1, Figure 1 schematically illustrates a cross-sectional view of a low emissivity glass according to an embodiment of the present disclosure. The low emissivity glass includes:

A substrate 100, and a stacked structure film covering at least a surface of the substrate 100.

In the present disclosure, the substrate 100 is a glass substrate.

The stacked structure film includes a metal infrared reflection layer 310 and a plurality of dielectric layers; wherein the metal infrared reflection layer 310 is applied to reflect and absorb at least a portion of infrared ray, to reduce the transmittance of the infrared ray through the substrate 100, and thus to reduce the radiation intensity on the other side of the low emissivity glass with respect to the radiation source.

In some embodiments, the metal infrared reflection layer 310 may be a silver layer or a silver alloy layer. The silver layer or the silver alloy layer is well capable of blocking the infrared ray. The metal infrared reflection layer 310 of the silver alloy layer may include Au-Cu alloy, Ag-Ni alloy, Ag-Cr alloy, Ag-Cu-Ni alloy, Ag-Cu-Al alloy or Ag-Cu-Pt alloy.

As is known to those of ordinary skill in the art, besides the metal layer, the stacked structure film of low emissivity further includes a plurality of dielectric layers, for instance, a silicon nitride layer, a nickel-chromium layer, a zinc oxide layer etc, to increase the binding force between the plurality of dielectric layers and the binding force between the plurality of dielectric layers and the substrate, or to serve as a seed layer or a protective layer and so on. In addition, some of the plurality of dielectric layers themselves can block and absorb the ultraviolet ray and other radiations (such as, solar radiation). Therefore, the stacked structure film overall can block a great portion of radiations.

In some embodiments, the plurality of dielectric layers includes a first dielectric layer 320 and a second dielectric layer 330 respectively on the two sides of the metal infrared reflection layer 310, and a multi-layer structure.

Specifically, the first dielectric layer 320 and the second dielectric layer 330 have a same structure, either of which is composed of sequentially stacked layers including a titanium dioxide layer, a zinc chromium layer and a silicon nitride layer, that is, the first dielectric layer 320 includes a dielectric layer 321 of the titanium dioxide layer, a dielectric layer 322 of the zinc chromium layer, and a dielectric layer 323 of the silicon nitride layer; similarly, the second dielectric layer 330 includes a dielectric layer 331 of the titanium dioxide layer, a dielectric layer 332 of the zinc chromium layer, and a dielectric layer 333 of the silicon nitride layer.

The first dielectric layer 320, the metal infrared reflection layer 310 and the second dielectric layer 330 together constitute the stacked structure film.

The metal infrared reflection layer 310 has a plurality of openings 311. The plurality of openings may increase the transmittance of the wireless signals through the low emissivity glass.

As a metallic material, the metal infrared reflection layer may shield the wireless signals. That is, the metal infrared reflection layer 310 may block the wireless signals from going through the low emissivity glass. Accordingly, the plurality of openings formed in the metal infrared reflection layer 310 is beneficial for the wireless signals to pass through the openings, thereby reducing the shielding effect of the low emissivity glass on the wireless signals. Therefore, the low emissivity glass as disclosed in the embodiments can not only block the infrared ray, but also increase the transmittance of wireless signals through the low emissivity glass.

With reference to Figure 2, Figure 2 schematically illustrates a distribution of the plurality of openings 311 in the metal infrared layer 310. In some embodiments, the plurality of openings 311 is evenly distributed in the metal infrared layer 310. The metal infrared layer 310 covers the substrate 100, that is, the plurality of openings 311 is evenly distributed on the substrate 100. The evenly distributed plurality of openings 311 can not only simplify the production and manufacture, but also make the transmittance of the wireless signals through each part of the low emissivity glass tend to the same.

In some embodiments, the plurality of openings 311 is hole-shaped. The hole-shaped openings 311 are independent from each other, which ensures the integrality of the metal infrared reflection layer 310. Further, the hole-shaped openings 311 are not very apparent with respect to the appearance of the whole low emissivity glass, which ensures the aesthetics of the low emissivity glass in the present disclosure.

Specifically, the hole-shaped openings 311 have a circular-shaped cross-section parallel to the substrate 100, which can further simplify the production and manufacture.

In some embodiments, the hole-shaped openings 311 have a diameter ranging from 50 microns to 500 microns. The hole-shaped openings 311 within such a diameter range can allow the wireless signals to pass through, do not influence the performance of the metal infrared reflection layer 310 on lowering the infrared ray radiation , and do not influence the aesthetics of the whole low emissivity glass either.

In some embodiments, the plurality of openings 311 has a rectangular-shaped cross section perpendicular to the substrate 100 (referring to Figure 1). That is, the hole-shaped openings 311 have a diameter remaining the same through the hole, which can further simplify the production and manufacturing process.

In some embodiments, a total area of the plurality of openings 311 in the metal infrared reflection layer 310 accounts for 1 percent to 0.001 percent of a total area of the substrate 100, which helps to achieve a balance between the performance of the metal infrared reflection layer 310 on transmitting signals and reducing the infrared ray radiation, and the aesthetics. That is, the signal intensity inside the vehicle is large enough to support the use of some basic electronic equipments (such as mobile phones and radios), further, the aesthetics of the metal infrared reflection layer 310 and the performance of the metal infrared reflection layer 310 on reducing the radiation of will not be influenced.

The intensity of the wireless signals received inside vehicles by electronic equipments, can be calculated using the following formula:

$$dBm_e = -113.0 - 40.0\ log_{10}(r/R)$$

Wherein, dBm_e represents the power (Units: dB) of the wireless signals received by the equipments, the intensity of the referenced wireless signal is 1 mW; *r* represents the distance between the mobile phone and mobile base station; *R* represents the average distance between the adjacent mobile base station.

Generally, the transmission power of the mobile base station ranges from 20 W to 40 W, assuming the transmission power is 40 W. The mobile base station is usually constructed in a way of arranging three base stations in a circular region with a diameter ranging from 1.5 km to 3 km. In such a construction way of the mobile base station, the lowest power density in the region covered by the wireless signals is $0.01 uW/cm^2$; and the mobile phone can be normally used when the power is larger than 130 dBme. Furthermore, assuming there are four persons inside the vehicle, based on the aforementioned formula, the total area of the plurality of openings 311 accounts for 1 percent to 0.001 percent of the total area of the substrate 100 by dividing the power by power density.

What need to be mentioned is that, from the above computing process, the different conditions, for instance, the changes of the person number inside the vehicle, the changes of the required power of the electronic equipments being used, or the changes of the transmission power of the mobile base station etc., will all induce the changes of the computed results. Therefore, the aforementioned percentage range of the total area of the plurality openings 311 accounting for the total area of the substrate 100 is only an example of the present embodiment. The protection scope should not be limited by the embodiments disclosed herein.

In some embodiments, the low emissivity glass further includes a first base layer 210 between the stacked structure film and the substrate 100, and a second base layer 220 on a surface of the stacked structure film. The first base layer 210 and the second base layer 220, as a support for the stacked structure film in the production and manufacture process, can also protect the stacked structure film.

The first base layer 210 and the second base layer 220 may be made of PET. However, the protection scope should not be limited by the embodiments disclosed herein.

Furthermore, referring to Figure 3 and Figure 4, a low emissivity glass is provided according to a second embodiment of the present disclosure. Figure 3 schematically illustrates a cross-sectional view of the low emissivity glass. Figure 4 schematically illustrates a distribution of a plurality of openings 311a in a metal infrared layer 310a.

In some embodiments, a stacked structure film is formed between a first base layer 210a and a second base layer 220a, and the first base layer 210a is disposed on a substrate 100a; The stacked structure film includes a metal infrared reflect layer 310a and a multilayer of dielectric layers 321a, 322a and 323a sequentially on the first base layer 210a. A difference between the present embodiment and the previous embodiment lies in that: the dielectric layers 321a, 322a, and 323a are all disposed between the metal infrared reflection layer 310a and the first base layer 210a, and sequentially stacked on the first base layer 210a, the second base layer 220a lies on the metal infrared reflection layer 310a. That is, compared with the previous embodiment, there are no dielectric layers formed between the metal infrared reflection layer 310a and the second base layer 220a, which will not influence the implementation of the present disclosure.

Another difference between the present embodiment and the previous embodiment lies in that: the plurality of dielectric layers includes a zinc tin oxide layer or a zinc aluminum oxide layer, which is beneficial to form the plurality of openings 311a in the metal infrared reflection layer 310a by laser. Specifically, a thermal absorptivity and a thermal conductivity of the zinc tin oxide layer or the zinc aluminum oxide layer are relatively lower than a thermal absorptivity and a thermal conductivity of the silicon nitride in the previous embodiment, which can gather the heat produced by laser to the metal infrared reflection layer 310a, namely, the metal infrared reflection layer 310a can absorb heat, and then vaporize to form the plurality of openings 311a.

Further, in some embodiments, the zinc tin oxide layer or the zinc aluminum oxide layer is disposed adjacent to the metal infrared reflection layer 310a. That is, the dielectric layer 323a adjacent to the metal infrared reflection layer 310a is the zinc tin oxide layer or the zinc aluminum oxide layer, which facilitates the metal infrared reflection layer 310a absorbing heat and then vaporizing.

Another difference between the present embodiment and the previous embodiment lies in that: the plurality of openings 311a has a trapezoid-shaped (trumpet-shaped) cross section perpendicular to the substrate 100a. Specifically, one side of the plurality of openings 311a close to the substrate 100a has a smaller diameter, while the other side of the plurality of openings 311a far away from the substrate 100a has a relatively larger diameter. The plurality of openings 311a with this structure further facilitate for wireless signals transmitting.

Another difference between the present embodiment and the previous embodiment lies in that: the hole-shaped openings 311a have a polygonal-shaped cross section parallel to the substrate 100a. Specifically, the cross section is rectangular-shaped. Namely, the hole-shaped openings 311a are a plurality of square-shaped holes. In addition, according to other embodiments of the present disclosure, the plurality of openings 311a may also have a pentagonal-shaped cross section, a hexagonal-shaped cross section or any other polygonal-shaped cross section parallel to the substrate 100a. The protection scope of the present disclosure should not be limited to the specific shape of the hole-shaped openings 311a.

Another difference between the present embodiment and the previous embodiment lies in that: a distribution density of the plurality of openings 311a in a peripheral area of the metal infrared reflection layer 310a is higher than a distribution density of the plurality of openings 311a in a central area of the metal infrared reflection layer 310a. Thus, not only the performance of the metal infrared reflection layer 310a on reflecting the infrared ray of can be ensured, but also the appearance of the low emissivity glass is improved, since no openings 311a are formed in the central area of the low emissivity glass. In addition, the plurality of openings 311a in the peripheral area of the metal infrared reflection layer 310a can increase the transmittance of wireless signals through the metal infrared reflection layer 310a, thus increase the transmittance of wireless signals through the low emissivity glass.

Furthermore, referring to Figure 5 and Figure 6, a low emissivity glass according to a third embodiment of the present disclosure is provided. Figure 5 schematically illustrates a cross-sectional view of the low emissivity glass. Figure 6 schematically illustrates a distribution of a plurality of openings 311b in a metal infrared layer 310b.

A difference between the present embodiment and the second embodiment lies in that: a stacked structure film is disposed directly on a surface of the substrate 100b. That is, the first base layer 210b and the second base layer 220b in the second embodiment are not formed in the present embodiment, which will not influence the implementation of the present disclosure.

Another difference between the present embodiment and the previous embodiment lies in that: the plurality of openings 311b in the metal infrared reflection layer 310b is slit-shaped. The slit-shaped openings 311b can allow the wireless signals to pass through as well.

Specifically, the slit-shaped openings 311b extend toward a first direction or a second direction in the metal infrared reflection layer 310b, and the slit-shaped openings 311b are parallel to each other, which can reduce or even avoid the diffraction of the wireless signals, thereby keeping the stability of the wireless signals.

In some embodiments, the slit-shaped openings 311b have a length ranging from 0.15 meters to 0.3 meters; the slit-shaped openings 311b have a width ranging from 50 microns to 500 microns. Since the typical wireless signals have a frequency ranging roughly from 900 MHz to 1800 MHz, and the aforementioned plurality of openings 311b has a size range close to the characteristic wavelength of the wireless signals, thereby facilitating the wireless signals going through the plurality of openings 311b.

In addition, referring to Figure 7, a low emissivity glass is provided according to a forth embodiment of the present disclosure. Figure 7 schematically illustrates a distribution of a plurality of openings in a metal infrared layer 310c.

The difference between the present embodiment and the previous embodiment lies in that: the slit-shaped openings include a plurality of first openings 311c extending along a first direction, and a plurality of second openings 312c extending along a second direction different from the first direction. Specifically, the first direction is perpendicular to the second direction. That is, the plurality of first openings 311c and the plurality of second openings 312c form a criss-cross structure. Since the wireless signals have polarity, the criss-cross structure facilitates the wireless signals going through.

Furthermore, a low emissivity glass is provided according to a fifth embodiment of the present disclosure. The difference between the present embodiment and the previous embodiment lies in that: the low emissivity glass is an architectural glass, namely, the substrate is an architectural glass. That is, the low emissivity glass provided in the present disclosure can not only block the infrared ray from entering rooms, but also increase the transmittance of wireless signals through the low emissivity glass, which enable indoor people to use the electronic equipments, such as mobile phones and radios etc.

Furthermore, a vehicle window is also provided according to an embodiment of the present disclosure. The vehicle window includes an encapsulation, and the aforementioned low emissivity glass. Since the vehicle window includes the low emissivity glass, the vehicle window can reduce radiation, and can also ensure the transmittance of wireless signals through the low emissivity glass, namely, can ensure the wireless signals intensity inside the vehicle.

Furthermore, a method for manufacturing the low emissivity glass is also provided in the present disclosure. Referring to Figure 1 and Figure 8, Figure 8 schematically illustrates a flow chart of the method for manufacturing the low emissivity glass according to an embodiment of the present disclosure.

The present embodiment takes a vehicle window glass applied to vehicles for example. However, what need to be mentioned is that, the present disclosure is not limited to the vehicle fields, and the low emissivity glass can also be an architectural glass.

The method for manufacturing the low emissivity glass includes:

Step S1, providing a substrate 100;

In some embodiments, the substrate 100 is a glass substrate. However, as mentioned above, the low emissivity glass can also be an architectural glass. That is, the substrate 100 is the architectural glass. The low emissivity glass provided in the present disclosure can not only block the infrared ray from entering rooms, but also increase the transmittance of wireless signals through the low emissivity glass, and thus can enable indoor people to use the electric equipments, such as mobile phones and radios etc. The protection scope should not be limited by the embodiments disclosed herein.

Step S2, covering at least a surface of the substrate 100 with a stacked structure film, wherein the stacked structure film includes a metal infrared reflection layer 310 and a plurality of dielectric layers, wherein covering with the stacked structure film includes forming a plurality of openings 311 in the metal infrared reflection layer 310.

The metal infrared reflection layer 310 included in the stacked structure film is applied to reflect and absorb at least a portion of infrared ray, to reduce the transmittance of the infrared ray through the substrate 100, and thus to reduce the radiation intensity on the other side of the low emissivity glass with respect to the radiation source.

In some embodiments, the metal infrared reflection layer 310 can be made from silver or silver alloy. Silver or silver alloy has a good performance on blocking the infrared ray. The metal infrared reflection layer 310 made of the silver alloy layer includes Au-Cu alloy, Ag-Ni alloy, Ag-Cr alloy, Ag-Cu-Ni alloy, Ag-Cu-Al alloy or Ag-Cu-Pt alloy.

As is known to those of ordinary skill in the art, besides the metal layer, the stacked structure film of low emissivity further includes a plurality of dielectric layers, for instance, a silicon nitride layer, a nickel-chromium layer, a zinc oxide layer etc, to increase the binding force between the plurality of dielectric layers and the binding force between the plurality of dielectric layers and the substrate, or to serve as a seed layer or a protective layer and so on. In addition, some of the plurality of dielectric layers themselves can block and absorb the ultraviolet ray and other radiations (such as, solar radiation). Therefore, the stacked structure film overall can block a great portion of radiations.

The transmittance of the wireless signals through the low emissivity glass can be increased by forming the plurality of openings 311 in the metal infrared reflection layer 310. Specifically, the metal infrared reflection layer 310 is applied to reflect the infrared ray, and further to reduce the transmittance of the infrared ray through the low emissivity glass disclosed in the present invention. As a metallic material, the metal infrared reflection layer 310 may shield the wireless signals. Namely, the metal infrared reflection layer 310 may block the wireless signals from going through the low emissivity glass. Accordingly, the plurality of openings 311 formed in the metal infrared reflection layer 310 facilitates the wireless signal going through the openings 311, thereby reducing the shielding effect of the low emissivity glass on the wireless signals. Therefore, the low emissivity glass as disclosed in the embodiments can not only block the infrared ray, but also increase the transmittance of wireless signals through the low emissivity glass.

In some embodiments, covering with the stacked structure film includes: the plurality of openings 311 is formed in the metal infrared reflection layer 310 after the formation of the dielectric layers; it can simplify the process sequence by forming the plurality of openings 311 after the formation of the dielectric layers.

Specifically, after providing the substrate 100, the method further includes:

Providing a first base layer 210 and a second base layer 220; as a support for the stacked structure film in the production and manufacture process, the first base layer 210 and the second base layer 220 can also be applied to protect the stacked structure film.

In some embodiments, a material of the first base layer 210 and the second base layer 220 is PET. However, the material of the first base layer 210 and the second base layer 220 in the present disclosure should not be limited by the embodiments disclosed herein.

Covering the surface of the substrate with the stacked structure film includes:

Forming the stacked structure film on a surface of the first base layer 210;

Specifically, in some embodiments, forming the stacked structure film includes:

Forming a first dielectric layer 320 with a multi-layer structure on a surface of the first base layer 210 sequentially. The first dielectric layer 320 includes a dielectric layer 321 of a titanium dioxide layer, a dielectric layer 322 of a zinc chromium layer and a dielectric layer 323 of a silicon nitride layer.

Thereafter, forming the metal infrared reflection layer 310 on the first dielectric layer 320;

After forming the metal infrared reflection layer 310, forming a second dielectric layer 330 with the same structure as the first dielectric layer 320 on the metal infrared reflection layer 310. The second dielectric layer 330 includes a dielectric layer 331 of a titanium dioxide layer, a dielectric layer 332 of a zinc chromium layer and a dielectric layer 333 of a silicon nitride layer sequentially formed on the metal infrared reflection layer 310.

The first dielectric layer 320, the metal infrared reflection layer 310 and the second dielectric layer 330 together constitute the stacked structure film.

In some embodiments, the stacked structure film is formed by deposition. For instance, the metal infrared reflection layer 310 can be formed by a sputtering deposition method, and the first dielectric layer 320 and the second dielectric layer 330 can be formed by a chemical vapor deposition method.

Thereafter, covering a surface of the stacked structure film with the second base layer 220;

Then, adhering and fixing the first base layer 210 to a surface of the substrate 100, so as to cover the surface of the substrate 100 with the stacked structure film. If two surfaces of the substrate 100 are needed to be covered with the stacked structure film, attaching two pieces of the first base layer 210 with the stacked structure film to the two surfaces of the substrate 100 respectively.

Thereafter, forming the plurality of openings 311 in the metal infrared reflection layer 310.

In some embodiments, forming the plurality of openings 311 in the metal infrared reflection layer 310 includes etching the metal infrared reflection layer 310 by laser ablation or mask-based etching. Specifically, the dielectric layer has a low absorption on the energy produced by laser, and the energy of the laser will be focused on the metal infrared reflection layer 310, thereby enabling the portion of the metal infrared reflection layer 310 irradiated by laser to absorb heat and explode, then the irradiated portion of the silver layer (or silver alloy layer) vaporize to form the plurality of openings 311.

Specifically, since a material of the metal infrared reflection layer 310 in the present embodiment is silver or silver alloy, a laser with a wave length of 1064 nm can be used. it is easy for the laser with this wave length to be absorbed by silver or silver alloy, which facilitates forming the plurality of openings 311 in the metal infrared reflection layer 310.

In some embodiments, the plurality of openings 311 is hole-shaped. The hole-shaped openings 311 are independent from each other, which helps to ensure the integrality of the metal infrared reflection layer 310. Meanwhile, the hole-shaped openings 311 are less apparent with respect to the appearance of the whole low emissivity glass, which is beneficial to ensures the aesthetics of the low emissivity glass in the present invention.

Specifically, the hole-shaped openings 311 have a circular-shaped cross section parallel to the substrate 100. This shape is further in favor of simplifying the production and manufacture.

In some embodiments, the hole-shaped openings 311 have a diameter ranging from 50 microns to 500 microns. The hole-shaped openings 311 within such a diameter range can allow the wireless signals to pass through, do not influence the performance of the metal infrared reflection layer 310 on lowering the infrared ray radiation , and do not influence the aesthetics of the whole low emissivity glass either.

In some embodiments, the plurality of openings 311 has a rectangular-shaped cross section perpendicular to the substrate 100 (referring to Figure 1). That is, the hole-shaped openings 311 have a diameter remaining the same through the hole, which can further simplify the production and manufacturing process.

In some embodiments, a total area of the plurality of openings 311 in the metal infrared reflection layer 310 accounts for 1 percent to 0.001 percent of a total area of the substrate 100, which helps to achieve a balance between the performance of the metal infrared reflection layer 310 on transmitting signals and reducing the infrared ray radiation, and the aesthetics. That is, a signal intensity inside the vehicle is large enough to support the use of some basic electronic equipments (such as mobile phones and radios), further, the aesthetics of the metal infrared reflection layer 310 and the performance of the metal infrared reflection layer 310 on reducing the radiation of will not be influenced.

The intensity of the wireless signals received inside vehicles by electronic equipments, can be calculated using the following formula:

$$dBm_e = -113.0 - 40.0\ log_{10}(r/R)$$

Wherein, dBm_e represents the power (Units: dB) of the wireless signals received by the equipments, the intensity of the referenced wireless signal is 1 mW; r represents the distance between the mobile phone and mobile base station; R represents the average distance between the adjacent mobile base station.

Generally, the mobile base station has a transmission power ranging from 20 W to 40 W, assuming the transmission power is 40 W. The mobile base station is usually constructed in a way of arranging three base stations in a circular region with a diameter ranging from 1.5 km to 3 km. In such a construction way of the mobile base station, the lowest power density in the region covered by the wireless signals is 0.01 uW/cm^2; and the mobile phone can be normally used when the power is larger than 130 dBme. Furthermore, assuming there are four persons inside the vehicle, based on the aforementioned formula, the total area of the plurality of openings 311 accounts for 1 percent to 0.001 percent of the total area of the substrate 100 by dividing the power by power density.

What need to be mentioned is that, from the above computing process, the different conditions, for instance, the changes of the person number inside the vehicle, the changes of the required power of the electronic equipments being used, or the changes of the transmission power of the mobile base station etc., will all induce the changes of the computed results. Therefore, the aforementioned percentage range of the total area of the plurality openings 311 accounting for the total area of the substrate 100 is only an example of the present embodiment. The protection scope should not be limited by the embodiments disclosed herein.

In some embodiments, the plurality of openings 311 is evenly distributed in the metal infrared layer 310 (referring to Figure 2). Since the substrate 100 is covered with the metal infrared reflection layer 310, that is, the plurality of openings 311 is evenly distributed on the surface of the substrate 100. The evenly distributed plurality of openings 311 can not only simplify the production and manufacture, but also make the transmittance of the wireless signals through each part of the low emissivity glass tend to the same.

In addition, although the plurality of openings 311 is formed after the first base layer 210 being adhered and fixed to a surface of the substrate 100, according to other embodiments of the present disclosure, the plurality of openings 311 can also be formed after forming the second base layer 220 on the surface of the stacked structure film, and before adhering and fixing the first base layer 210 to a surface of the substrate 100.

Furthermore, a method for manufacturing the low emissivity glass is provided according to a second embodiment of the present disclosure. Referring to Figure 3 and Figure 4, a difference between the present embodiment and the previous embodiment lies in that: a plurality of dielectric layers 321a, 322a, and 323a are all disposed between a metal infrared reflection layer 310a and a first base layer 210a, and sequentially stacked on the first base layer 210a, a second base layer 220a is disposed on the metal infrared reflection layer 310a. That is, compared with the previous embodiment, there are no dielectric layers formed between the metal infrared reflection layer 310a and the second base layer 220a, which does not influence the implementation of the present disclosure.

Meanwhile, the plurality of dielectric layers is comprised of a zinc tin oxide layer or a zinc aluminum oxide layer, which facilitates forming a plurality of openings 311a in the metal infrared reflection layer 310a by laser. Specifically, a thermal absorptivity and a thermal conductivity of the zinc tin oxide layer or the zinc aluminum oxide layer are relatively lower than a thermal absorptivity and a thermal conductivity of the silicon nitride in the previous embodiment, which is beneficial to gather the heat produced by laser to the metal infrared reflection layer 310a, namely, the metal infrared reflection layer 310a can absorb heat, and then vaporize to form the plurality of openings 311a.

Further, in some embodiments, the zinc tin oxide layer or the zinc aluminum oxide layer is disposed adjacent to the metal infrared reflection layer 310a. That is, the dielectric layer 323a adjacent to the metal infrared reflection layer 310a is the zinc tin oxide layer or the zinc aluminum oxide layer, which further facilitates the metal infrared reflection layer 310a absorbing heat and then vaporizing.

Another difference between the present embodiment and the previous embodiment lies in that: the plurality of openings 311a is formed after the formation of the stacked structure film and before the formation of the second base layer 220a, which achieves the benefits that, the layers penetrated by laser irradiation is less (lacking of the second base layer 220a), thus a more precise control on the operation of forming the openings 311a by laser may be realized, and the laser energy required can also be decreased.

Another difference between the present embodiment and the previous embodiment lies in that: the plurality of openings 311a has a trapezoid-shaped (trumpet-shaped) cross section perpendicular to the substrate 100a. Specifically, one side of the plurality of openings 311a close to the substrate 100a has a smaller diameter, while the other side of the plurality of openings 311a far away from the substrate 100a has a relatively larger diameter. The plurality of openings 311a with this structure are further beneficial to receive wireless signals due to the trumpet shape.

Another difference between the present embodiment and the previous embodiment lies in that: referring to Figure 3, the hole-shaped openings 311a have a polygonal-shaped cross section parallel to the substrate 100a. Specifically, the cross section is rectangular-shaped, which will not influence the implementation of the present disclosure. In addition, according to other embodiments of the present disclosure, the plurality of openings 311a can also have a pentagonal-shaped cross section, a hexagonal-shaped cross section or any other polygonal-shaped cross section parallel to the substrate 100a. The present disclosure imposes no limitation on the specific shape of the hole-shaped openings 311a.

Another difference between the present embodiment and the previous embodiment lies in that: a distribution density of the plurality of openings 311a in a peripheral area of the metal infrared reflection layer 310a is higher than a distribution density of the plurality of openings in a central area of the metal infrared reflection layer 310a. Thus, not only the performance of the metal infrared reflection layer 310a on reflecting the infrared ray is ensured to the greatest extent, but also the appearance of the low emissivity glass is improved, since no openings 311a are formed in the central area of the low emissivity glass. In addition, the plurality of openings 311a in the peripheral area of the metal infrared reflection layer 310a can increase the transmittance of wireless signals through the metal infrared reflection layer 310a, thus increase the transmittance of wireless signals through the low emissivity glass.

Furthermore, a method for manufacturing the low emissivity glass is provided according to a third embodiment of the present disclosure. Referring to Figure 5 and Figure 6, a difference between the present embodiment and the previous embodiment lies in that: covering a surface of a substrate with a stacked structure film includes: covering the substrate 100b directly with the stacked structure film, which is beneficial to simplify the production process.

Another difference between the present embodiment and the previous embodiment lies in that: a plurality of openings 311b in a metal infrared reflection layer is formed after the formation of a metal infrared reflection layer 310b and before the formation of a plurality of dielectric layers, which can achieve the objective of the present disclosure as well.

Another difference between the present embodiment and the previous embodiment lies in that: the plurality of openings 311b in the metal infrared reflection layer 310b is slit-shaped. The slit-shaped openings 311b allow the wireless signals to pass through as well. Specifically, the slit-shaped openings 311b extend along a first direction or a second direction in the metal infrared reflection layer 310b, and the slit-shaped openings 311b are parallel to each other, which helps to avoid the diffraction of the wireless signals, and to keep the intensity of the wireless signals.

In some embodiments, the slit-shaped openings 311b have a length ranging from 0.15 meters to 0.3 meters, and the slit-shaped openings 311b have a width ranging from 50 microns to 500 microns. Since the typical wireless signals have a frequency ranging roughly from 900 MHz to 1800 MHz, and the aforementioned plurality of openings 311b have a size range close to the characteristic wavelength of the wireless signals, thereby facilitating the wireless signals going through the plurality of openings 311b.

What need to be further mentioned is that, the slit-shaped openings 311b are not limited to extending along a first direction, or extending along a second direction. Referring to Figure 7, according to other embodiments of the present disclosure, the slit-shaped openings 311b include a plurality of first openings 311c extending along a first direction, and a plurality of second openings 312c extending along a second direction different from the first direction. Specifically, the first direction is perpendicular to the second direction. That is, the plurality of first openings 311c and the plurality of second openings 312c form a criss-cross structure. Since the wireless signals have polarity, the criss-cross structure facilitates the wireless signals going through.

What need to be further mentioned is that, the method for manufacturing the low emissivity glass can form the aforementioned low emissivity glass, but is not limited to forming the aforementioned low emissivity glass.

The disclosure is disclosed, but not limited, by preferred embodiments as above. Based on the disclosure of the present invention, those skilled in the art can make any variation and modification without departing from the scope of the disclosure. Therefore, any simple modification, variation and polishing based on the embodiments described herein is within the scope of the present disclosure. The protection scope should refer to the claims of the present disclosure.

CLAIMS

1. A low emissivity glass, comprising:

a substrate; and

a stacked structure film covering at least a surface of the substrate, the stacked structure film comprising a metal infrared reflection layer and a plurality of dielectric layers,

wherein the metal infrared reflection layer has a plurality of openings.

2. The low emissivity glass according to claim 1, characterized in that, the plurality of openings is evenly distributed in the metal infrared reflection layer, or a distribution density of the plurality of openings in a peripheral area is higher than a distribution density of the plurality of openings in a central area.

3. The low emissivity glass according to claim 1, characterized in that, the plurality of openings is hole-shaped or slit-shaped.

4. The low emissivity glass according to claim 3, characterized in that, the plurality of openings has a rectangular-shaped or trapezoid-shaped cross section perpendicular to the substrate.

5. The low emissivity glass according to claim 3, characterized in that, the hole-shaped openings have a circular-shaped or polygonal-shaped cross section parallel to the substrate.

6. The low emissivity glass according to claim 3, characterized in that, the hole-shaped openings have a diameter ranging from 50 microns to 500 microns.

7. The low emissivity glass according to claim 3, characterized in that, the slit-shaped openings have a length ranging from 0.15 meters to 0.3 meters.

8. The low emissivity glass according to claim 3, characterized in

that, the slit-shaped openings have a width ranging from 50 microns to 500 microns.

9. The low emissivity glass according to claim 3, characterized in that, the slit-shaped openings comprise a plurality of first openings extending along a first direction and/or a plurality of second openings extending along a second direction different from the first direction.

10. The low emissivity glass according to claim 1, characterized in that, a total area of the plurality of openings in the metal infrared reflection layer accounts for 1 percent to 0.001 percent of a total area of the substrate.

11. The low emissivity glass according to claim 1, characterized in that, the metal infrared reflection layer is a silver layer or a silver alloy layer.

12. The low emissivity glass according to claim 11, characterized in that, the metal infrared reflection layer comprises Au-Cu alloy, Ag-Ni alloy, Ag-Cr alloy, Ag-Cu-Ni alloy, Ag-Cu-Al alloy or Ag-Cu-Pt alloy.

13. The low emissivity glass according to claim 1, characterized in that, the plurality of dielectric layers comprises a zinc tin oxide layer or a zinc aluminum oxide layer.

14. The low emissivity glass according to claim 13, characterized in that, the zinc tin oxide layer or the zinc aluminum oxide layer is disposed adjacent to the metal infrared reflection layer.

15. The low emissivity glass according to claim 1, characterized in that, the low emissivity glass further comprises a first base layer between the stacked structure film and the substrate, and a second base layer on a surface of the stacked structure film.

16. The low emissivity glass according to claim 15, characterized in that, a material of the first base layer and the second base layer is PET.

17. The low emissivity glass according to claim 1, characterized in

that, the stacked structure film is disposed directly on the surface of the substrate.

18. The low emissivity glass according to claim 1, characterized in that, the substrate is a vehicle window glass or an architectural glass.

19. A vehicle window, characterized in that, comprising:

an encapsulation, and

the low emissivity glass according to any one of claims 1 to 17.

20. A method for manufacturing a low emissivity glass, comprising:

providing a substrate; and

covering at least a surface of the substrate with a stacked structure film, wherein the stacked structure film comprises a metal infrared reflection layer and a plurality of dielectric layers,

wherein covering with the stacked structure film comprises:

forming a plurality of openings in the metal infrared reflection layer.

21. The method for manufacturing the low emissivity glass according to claim 20, characterized in that, covering with the stacked structure film comprises:

forming the plurality of openings in the metal infrared reflection layer after the formation of the metal infrared reflection layer, and before the formation of the plurality of dielectric layers;

or, forming the plurality of openings in the metal infrared reflection layer after the formation of the plurality of dielectric layers.

22. The method for manufacturing the low emissivity glass according to claim 21, characterized in that, forming the plurality of openings in the metal infrared reflection layer comprises:

etching the metal infrared reflection layer by laser ablation or mask-based etching, to form the plurality of openings.

23. The method for manufacturing the low emissivity glass

according to claim 22, characterized in that, etching by laser ablation to form the plurality of openings comprises: setting a wave length of the laser to be 1064nm.

24. The method for manufacturing the low emissivity glass according to claim 20, characterized in that, the substrate is covered with the stacked structure film by deposition.

25. The method for manufacturing the low emissivity glass according to claim 20, characterized in that, covering with the stacked structure film comprises: covering the surface of the substrate directly with the stacked structure film.

26. The method for manufacturing the low emissivity glass according to claim 20, characterized in that, the metal infrared reflection layer is formed with silver or silver alloy.

27. The method for manufacturing the low emissivity glass according to claim 20, characterized in that, the plurality of dielectric layers is formed with zinc tin oxide or zinc aluminum oxide.

28. The method for manufacturing the low emissivity glass according to claim 27, characterized in that, the dielectric layer formed with zinc tin oxide or zinc aluminum oxide is adjacent to the metal infrared reflection layer.

29. The method for manufacturing the low emissivity glass according to claim 20, characterized in that, after providing the substrate and before covering with the stacked structure film, the method further comprises:

providing a first base layer and a second base layer;

wherein covering with the stacked structure film comprises:

forming the stacked structure film on a surface of the first base layer;

covering a surface of the stacked structure film with the second base layer; and adhering and fixing the first base layer to a surface of the substrate, to cover the surface of the substrate with the stacked structure film.

30. The method for manufacturing the low emissivity glass according to claim 29, characterized in that, the plurality of openings is formed after forming the stacked structure film on the surface of the first base layer and before covering the surface of the stacked structure film with the second base layer; or, the plurality of openings is formed after covering the surface of the stacked structure film with the second base layer.

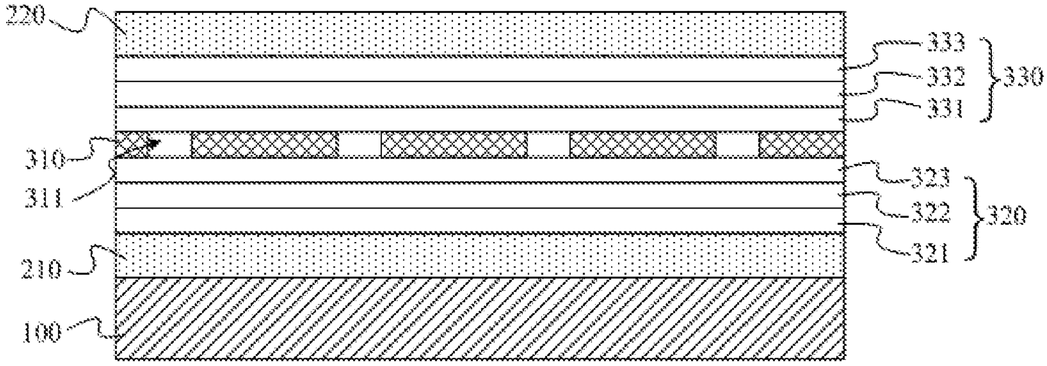

Figure 1

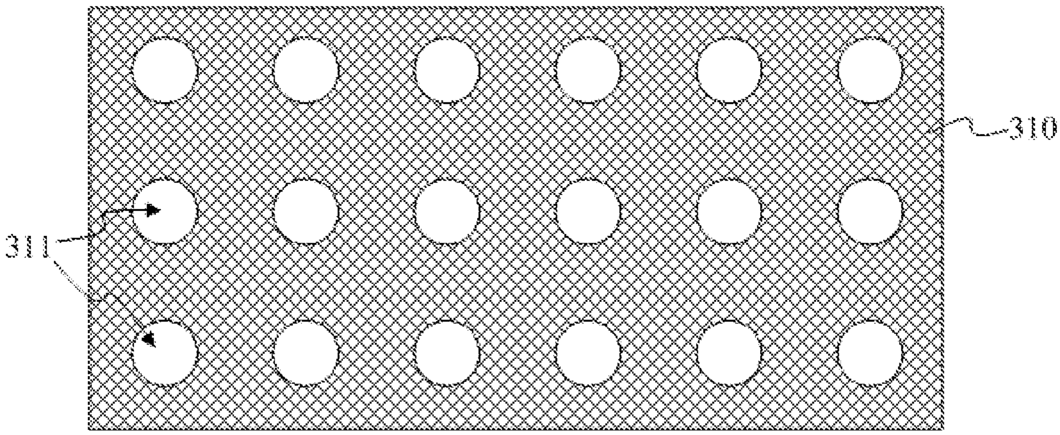

Figure 2

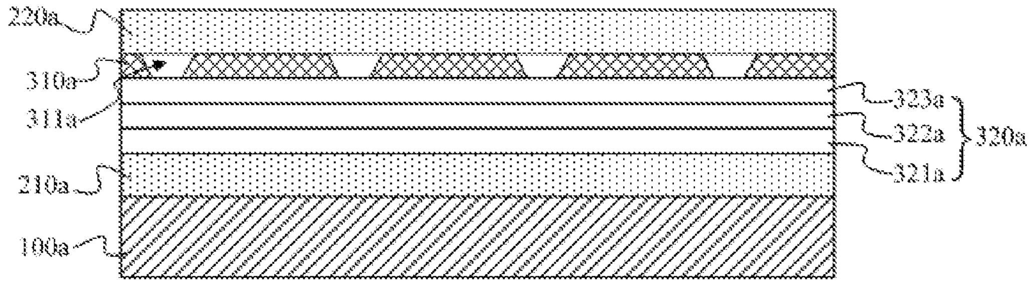

Figure 3

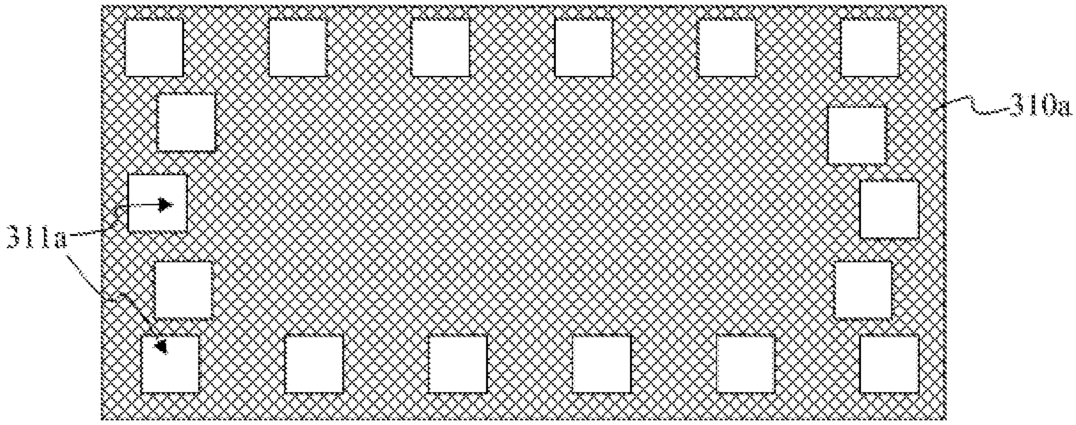

Figure 4

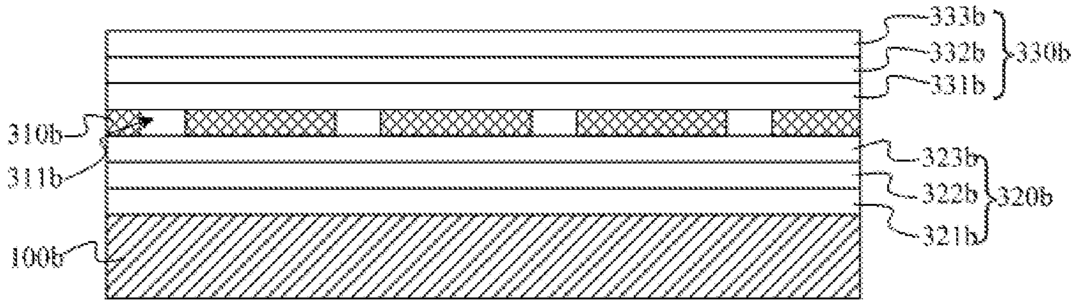

Figure 5

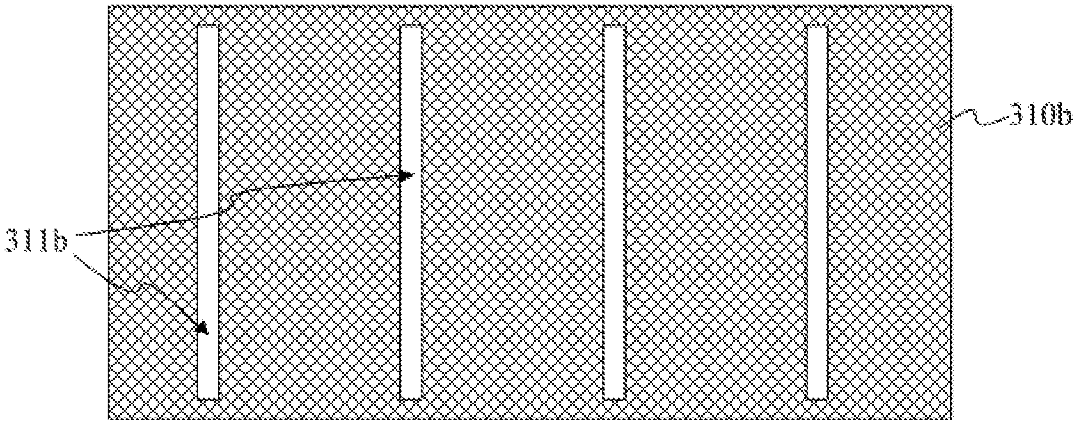

Figure 6

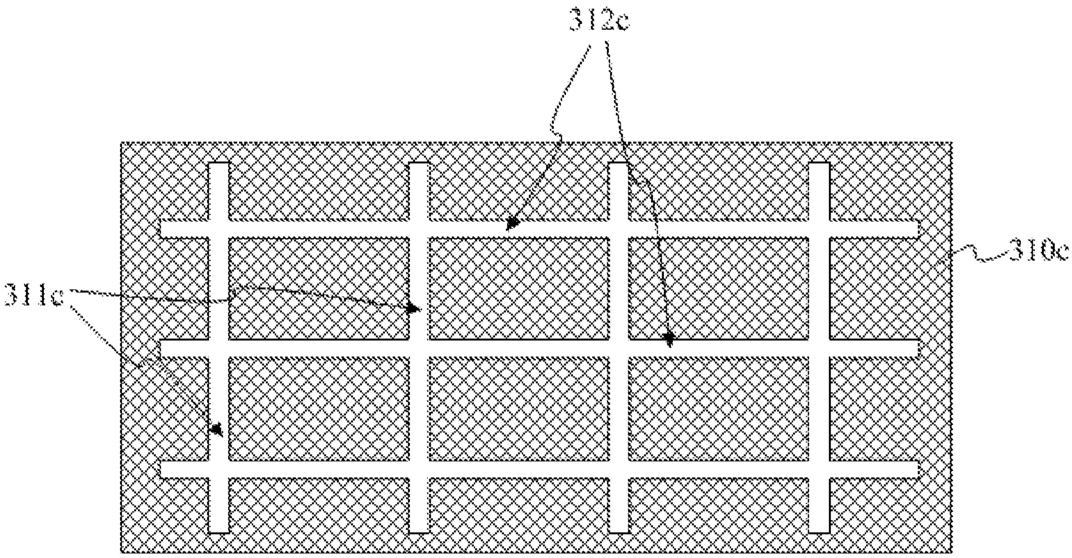

Figure 7

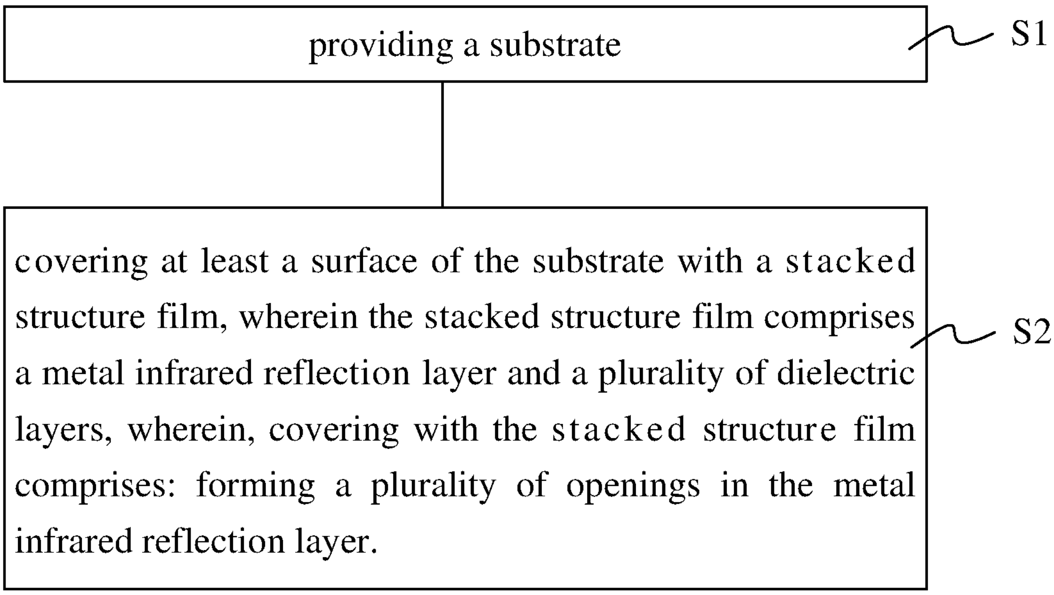

Figure 8