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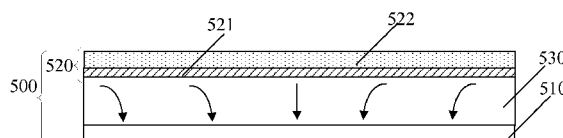


FIG. 5

(57) Abstract: A cover plate and a method for manufacturing the same, a solar glass, and a photovoltaic device are provided. The cover plate (500) is adapted for covering a work device which, in operation, causes an electric field in the cover plate. The cover plate (500) comprises: a transparent substrate (530), having a first surface and a second surface opposite to the first surface, the first surface being adjacent to the work device; and a barrier structure, having at least one of a first barrier layer (510) on the first surface and a second barrier layer (520) on the second surface, configured to prevent performance degradation of the work device caused by leakage current and/or metal ions migration.



COVER PLATE AND METHOD FOR MANUFACTURING THE SAME, SOLAR GLASS, AND PHOTOVOLTAIC DEVICE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority to Chinese patent application No. 201210135182. 4, filed on April 28, 2012, and entitled “a cover plate and a method for manufacturing the same, a solar glass, and a photovoltaic device”, the entire disclosure of which is incorporated herein by reference.

FIELD OF THE DISCLOSURE

[0002] The present invention generally relates to the field of optical materials, and more particularly, to a cover plate and a method for manufacturing the same, a solar glass, and a photovoltaic device.

BACKGROUND

[0003] Glass has features of high transparency, high strength and high gas-impermeability. In addition, glass is chemically inert in natural environment and doesn't react with biological substance. Therefore glass is widely used in construction, automobile, etc. Common glass includes auto glass, flat glass and thermal insulating glass, etc.

[0004] Glass is also used in photovoltaic devices as a cover plate of a solar panel. FIG. 1 schematically illustrates a structure of a conventional photovoltaic device. Referring to FIG. 1, the conventional photovoltaic device includes: a base 11; an adhesive layer 12 located on the base 11 and configured with a plurality of solar cells 13 (for example, crystalline silicon solar cells) therein; and a cover glass 14. The base 11, the adhesive layer 12 and the cover glass 14 constitute a multi-layer structure of a solar panel.

[0005] When the photovoltaic device is in operation, light passes through the cover glass 14 and arrives at the adhesive layer 12. The solar cells 13 configured in the adhesive layer 12 convert the solar energy into electrical energy, so as to realize the

function of the photovoltaic device. After the conversion, there will be a lot of negative charges accumulated at the solar cells 13, and thus the solar cells present a negative potential.

[0006] For safe use, the photovoltaic device further includes a frame 15 which covers edges of the multi-layer structure of the solar panel. The frame 15 is grounded or connected to a low potential power supply. Thus, when a person touches the frame 15, he or she will not get an electric shock.

[0007] When the photovoltaic device is in operation, there exists an electric potential difference between the frame 15 and the solar cells 13, which may lead to leakage current and Potential Induced Degradation (PID) of the photovoltaic device. How to reduce PID has become a hot topic of persons skilled in the art.

[0008] In the 26th European Photovoltaic Solar Energy Conference and Exhibition, 5-8 September 2011, Hamburg, Germany, Simon Koch et al. published an article titled "POLARIZATION EFFECTS AND TESTS FOR CRYSTALLINE SILICON CELLS, reporting that metal ions such as alkali metal ions contained in the cover glass were one of the possible reasons for PID.

[0009] With reference to FIG. 1, the reason how the metal ions contained in the cover glass lead to PID is described in detail. In the photovoltaic device, the cover glass 14 usually employs soda-lime glass which contains a plurality of metal ions, for example, alkali metal ions such as Na^+ , alkaline-earth metal ions such as Ca^{2+} , and other metal ions such as Fe^{3+} . The frame 15 is grounded or connected to a low potential power supply whereas the solar cells 13 present a negative potential, therefore the potential of the frame 15 is higher than that of the solar cells 13 and an electric field exists in the photovoltaic device in the direction from the frame 15 to the solar cells 13 (as shown by the arrows in FIG. 1). In the cover glass 14, the electric field is in the direction from top to bottom.

[0010] Metal ions in the soda-lime glass will move toward the solar cells 13 under the electric field force. The metal ions can arrive at the surface of the solar cells 13 or

enter the solar cells 13, which may lead to PID and result in performance degradation of the photovoltaic device.

SUMMARY

[0011] Embodiments of the present disclosure provide solutions to prevent or reduce performance degradation of a work device such as a photovoltaic device.

[0012] In one aspect, there is provided a cover plate, which is adapted for covering a work device which causes an electric field in the cover plate, including: a transparent substrate, having a first surface and a second surface opposite to the first surface, the first surface being adjacent to the work device; and a barrier structure, having at least one of a first barrier layer on the first surface and a second barrier layer on the second surface, configured to prevent performance degradation of the work device caused by leakage current and/or metal ions migration.

[0013] In one embodiment, the barrier structure comprises only the second barrier layer, and wherein the second barrier layer comprises a first dielectric layer.

[0014] Optionally, the second barrier layer further comprises a second dielectric layer, the first and the second dielectric layers having different dielectric constants.

[0015] Optionally, the first dielectric layer comprises a dense dielectric layer and the second dielectric layer comprises a porous dielectric layer.

[0016] Optionally, the dense dielectric layer and the porous dielectric layer are stacked in sequence on the second surface, the dense dielectric layer being between the porous dielectric layer and the second surface.

[0017] Optionally, the dense dielectric layer and the porous dielectric layer are stacked in sequence on the second surface, the porous dielectric layer being between the dense dielectric layer and the second surface.

[0018] Optionally, second barrier layer comprises a first dense dielectric layer, a porous dielectric layer and a second dense dielectric layer stacked in sequence on the second surface.

[0019] Optionally, the dense dielectric layer and porous dielectric layer comprise silicon dioxide, or a combination of silicon dioxide with one or more selected from aluminum oxide, zirconium oxide, hafnium oxide, tantalum oxide, silicon nitride and titanium dioxide.

[0020] Optionally, the dense dielectric layer comprises dense silicon dioxide with a dielectric constant ranging from 3 to 4.5, and the porous dielectric layer comprises porous silicon dioxide with a dielectric constant ranging from 1.3 to 3.2.

[0021] Optionally, the dense dielectric layer has a thickness ranging from 50 nm to 200 nm, and the porous dielectric layer has a thickness ranging from 50 nm to 200 nm.

[0022] In another embodiment, the barrier structure comprises both the first barrier layer and the second barrier layer which has a first dielectric layer, the first dielectric layer and the first barrier layer having the same material.

[0023] In still another embodiment, the barrier structure comprises only the first barrier layer on the first surface.

[0024] Optionally, the first barrier layer comprises a transparent insulating material.

[0025] Optionally, the first barrier layer comprises silicon dioxide, or a combination of silicon dioxide with one or more selected from aluminum oxide, zirconium oxide, hafnium oxide, tantalum oxide, silicon nitride and titanium dioxide.

[0026] Optionally, the first barrier layer has a thickness ranging from 20 nm to 250 nm.

[0027] Optionally, the first barrier layer has a thickness ranging from 20 nm to 50 nm.

[0028] Optionally, the first barrier layer has a thickness of 20 nm, 30 nm or 40 nm.

[0029] Optionally, the first barrier layer has a thickness ranging from 50 nm to 150

nm.

[0030] Optionally, the first barrier layer has a thickness of 80 nm, 100 nm, 120nm or 150 nm.

[0031] Optionally, the first barrier layer comprises silicon dioxide doped with aluminum oxide and the barrier layer has a thickness of 100 nm.

[0032] In still another embodiment, the cover plate further comprises an anti-reflective layer, located on the second surface of the transparent substrate, configured to reduce incident-light reflection on the second surface.

[0033] Optionally, the anti-reflective layer is of a single-layer structure, or a multi-layer structure comprising multiple anti-reflective films stacked in sequence on the second surface of the transparent substrate.

[0034] In still another embodiment, the transparent substrate comprises glass.

[0035] In another aspect, there is provided a solar glass, comprising a cover plate according to present invention, adapted to be mounted on a plurality of solar cells, wherein the transparent substrate comprises glass and the work device comprises the plurality of solar cells. The barrier structure of the cover plate is configured to prevent performance degradation of the work device caused by leakage current and/or metal ions migration.

[0036] In still another aspect, there is provided a photovoltaic device comprising a base configured with a plurality of solar cells therewithin and a cover plate according to present invention.

[0037] In one embodiment, the base comprises a support plate and an adhesive layer located on the support plate, and the plurality of solar cells are located in the adhesive layer.

[0038] Optionally, the first barrier layer is in contact with the adhesive layer and the transparent substrate. The first barrier layer has a same refractive index as the adhesive layer, or the barrier layer has a same refractive index as the transparent substrate, or the barrier layer has a refractive index between those of the adhesive

layer and the transparent substrate.

[0039] Optionally, the first barrier layer has a refractive index ranging from 1.2 to 2.2.

[0040] Optionally, the first barrier layer has a refractive index ranging from 1.3 to 1.8.

[0041] Optionally, the adhesive layer comprises one or more selected from ethylene-vinyl acetate copolymer or polyvinyl butyral.

[0042] In another embodiment, the plurality of solar cells are crystalline silicon solar cells.

[0043] In still another aspect, there is provided a method for manufacturing a cover plate adapted for covering a work device which, in operation, causes an electric field in the cover plate, comprising: providing a transparent substrate having a first surface adjacent to the work device and a second surface opposite to the first surface; and forming a barrier structure on at least one of the first surface and the second surface, configured to prevent performance degradation of the work device caused by leakage current and/or metal ions migration.

BRIEF DESCRIPTION OF THE DRAWINGS

[0044] FIG. 1 schematically illustrates a structure of a conventional photovoltaic device;

[0045] FIG. 2 schematically illustrates a cross-sectional view of a cover plate according to an implementation manner of the present disclosure;

[0046] FIG. 3 schematically illustrates a cross-sectional view of a cover plate according to an embodiment of the present disclosure;

[0047] FIG. 4 shows the surface resistance test results of the second barrier layer in FIG.3;

[0048] FIG. 5 schematically illustrates a cross-sectional view of a cover plate according to another embodiment of the present disclosure;

[0049] FIG. 6 schematically illustrates a cross-sectional view of a cover plate according to still another embodiment of the present disclosure;

[0050] FIG. 7 schematically illustrates a cross-sectional view of a cover plate according to still another embodiment of the present disclosure;

[0051] FIG. 8 schematically illustrates a cross-sectional view of a photovoltaic device according to an embodiment of the present disclosure;

[0052] FIG. 9 shows the leakage current test results of the photovoltaic device in FIG. 8;

[0053] FIG. 10 schematically illustrates a cross-sectional view of a photovoltaic device according to another embodiment of the present disclosure;

[0054] FIG. 11 schematically illustrates a flow chart of a method for manufacturing a cover plate according to an implementation manner of the present disclosure;

[0055] FIG. 12 schematically illustrates a method for manufacturing a cover plate according to an embodiment of the present disclosure;

[0056] FIG. 13 schematically illustrates a method for manufacturing a cover plate according to another embodiment of the present disclosure; and

[0057] FIG. 14 schematically illustrates a method for manufacturing a cover plate according to still another embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE DISCLOSURE

[0058] The disclosure will be described in detail with reference to certain embodiments. It should be understood that the disclosure is presented by way of example only, and those skilled in the art can modify and vary the embodiments without departing from the spirit and scope of the present disclosure, therefore, the disclosure is not limited to the particular embodiments illustrated herein.

[0059] Embodiments are described in conjunction with drawings. It should be understood that the drawings are presented by way of example only, and not intended

to be limiting.

[0060] FIG. 2 schematically illustrates a cross-sectional view of a cover plate according to an implementation manner of the present disclosure.

[0061] In the implementation manner, a cover plate 200 is adapted for covering a work device such as a photovoltaic device, or a module of liquid crystal display (not shown in the drawing). In operation, the work device causes an electric field and the cover plate 200 resides in the electric field. Specifically, the cover plate 200 includes: a transparent substrate 210 and a barrier structure.

[0062] The transparent substrate 210 has a first surface and a second surface opposite to the first surface. In the orientation of FIG.2, the first surface is the lower surface of the transparent substrate 210, and the second surface is the upper surface of the transparent substrate 210. During assembly, a work device (for example, a photovoltaic device or a module of a liquid crystal display) is mounted under the cover plate 210. Therefore, the work device is adjacent to the lower surface, i.e., the first surface of the transparent substrate 210.

[0063] The barrier structure may comprise at least one of a first barrier layer 221 and a second barrier layer 222.

[0064] The first barrier layer 221 is located on the first surface of the transparent substrate 210 to prevent performance degradation of the work device due to leakage current and/or metal ions migration. More specifically, the first barrier layer 221 has at least one of the following features:

[0065] First, the first barrier layer 221 has a suitable thickness and/or chemical potential so as to prevent substance contained in the transparent substrate 210 (for example, alkali metal ions such as Na^+ , alkaline-earth metal ions such as Ca^{2+} , and other metal ions such as Fe^{3+}) from migrating through under the electric field force, and thus preventing substance contained in the transparent substrate 210 from arriving at or entering the work device. Accordingly, performance degradation of the work device caused by metal ions migration can be prevented;

[0066] Second, the first barrier layer 221 increases the surface resistance of the transparent substrate 210, so that leakage current through the transparent substrate 210 is decreased; and

[0067] Third, the first barrier layer 221 increases the surface resistance of the transparent substrate 210, so that migration of the metal ions (Na^+ , Ca^{2+} , and Fe^{3+} , etc.) driven by the electric field can be suppressed. Therefore, the metal ions are less likely to penetrate the transparent substrate 210 or the barrier layer 221 to reach the work device.

[0068] The second barrier layer 222 is located on the second surface of the transparent substrate 210, to prevent performance degradation of the work device due to leakage current and/or metal ions migration. More specifically, the second barrier layer 222 has at least one of the following features:

[0069] First, the second barrier layer 222 increases the surface resistance of the transparent substrate 210, so that leakage current through the transparent substrate 210 is decreased; and

[0070] Second, the second barrier layer 222 increases the surface resistance of the transparent substrate 210, so that migration of the metal ions (Na^+ , Ca^{2+} , and Fe^{3+} , etc.) driven by the electric field can be suppressed. Therefore, the metal ions are less likely to penetrate the transparent substrate 210 or the second barrier layer 222 to reach the work device.

[0071] The barrier structure in FIG. 2 is shown as comprising the first barrier layer 221 and the second barrier layer 222. However it should be noted that FIG.2 is just is used for purposes of illustration and is not to be taken in a limiting sense. The barrier structure may comprise only the first barrier layer 221 or comprise only the second barrier layer 222.

[0072] Hereinafter, the present disclosure will be described in detail in conjunction with exemplary embodiments.

[0073] FIG. 3 schematically illustrates a cover plate according to one embodiment. The cover plate 300 comprises a transparent substrate 330 and a barrier structure 320 on the transparent substrate 310.

[0074] In the embodiment, the transparent substrate 330 is made of glass. In other embodiments, other transparent materials, for example, transparent plastic, are also suitable.

[0075] Referring to FIG. 3, the barrier structure 320 comprises only the second barrier layer on the second surface of the transparent substrate 330 which is comprised of two kinds of dielectric layers. Specifically, the second barrier layer 320 comprises a first dielectric layer 321 and a second dielectric layer 322 stacked in sequence on the second surface of the transparent substrate 330, with the first dielectric layer 321 being between the second dielectric layer 322 and the transparent substrate 330. The first and the second dielectric layers have different dielectric constants.

[0076] More specifically, the first dielectric layer 321 is a dense dielectric layer and the second dielectric layer 322 is a porous dielectric layer. The first dielectric layer 321 and the second dielectric layer 322 may be made of same or different materials. Suitable materials comprise, but not limited to, silicon dioxide, a combination of silicon dioxide with one or more selected from aluminum oxide, zirconium oxide, hafnium oxide, tantalum oxide, silicon nitride and titanium dioxide. In one example, the first dielectric layer 321 is made of dense silicon dioxide with a dielectric constant ranging from 3.0 to 4.5, and the second dielectric layer 322 is made of porous silicon dioxide with a dielectric constant ranging from 1.3 to 3.2.

[0077] Such configured, the second barrier layer 320 provides the transparent substrate 330 with a relatively high surface resistance, and therefore reduces the leakage current through the transparent substrate 330. In addition, because the surface resistance of the transparent substrate 330 is increased, migration of the metal ions (Na^+ , Ca^{2+} , and Fe^{3+} , etc.) driven by the electric field can be suppressed. Therefore, the metal ions are less likely to penetrate the transparent substrate 330 or the second

barrier layer 320 to reach the work device. In summary, by applying the second barrier layer 320, the performance degradation of the work device caused by metal ions migration and/or leakage current is prevented.

[0078] The surface resistance test results are shown in FIG.4. The test is performed by accelerated aging techniques. The horizontal axis stands for the accelerated aging time and the vertical axis stands for the surface resistance. Curve 1 is the test result for glass 330 covered with the second barrier layer 320 which is comprised of a dense silicon dioxide layer 321 and a porous silicon dioxide layer 322, and curve 2 is the test result for bare glass 330. From curve 1, the surface resistance is higher than $3\text{G}\Omega$ after accelerated aging for 150 hours, and is stable over the aging time. By comparison, the surface resistance of bare glass is lower than $1\text{G}\Omega$ after accelerated aging for 150 hours, and is unstable over time. As can be seen, glass covered with the second barrier layer 320 has a relatively high and stable surface resistance, and can reduce the leakage current through the second surface.

[0079] It should be noted that, if the first dielectric layer 321 or the second dielectric layer 322 is not thick enough, the effect may be insufficient. However, the increase in thickness will lead to an increase in cost. Preferably, the first dielectric layer 321 or the second dielectric layer 322 has a thickness ranging from 50 nm to 200 nm.

[0080] It should be further noted that the second barrier layer 320 of FIG. 3 is just exemplary and is not to be taken in a limiting sense. In other embodiments, the second barrier layer 320 may take any other suitable form. In one example, the second barrier layer comprises only the first dielectric layer made of dense dielectric material. In another example, the second barrier layer comprises a porous dielectric layer and a dense dielectric layer stacked in sequence on the second surface, with the porous dielectric layer being between the dense dielectric layer and transparent substrate. In still another example, the second barrier layer comprises a first dense dielectric layer, a porous dielectric layer, and a second dielectric layer stacked in sequence on the second surface. It should be appreciated that the material, thickness and stacking

sequence of the dielectric layers may be adjusted according to surface resistance requirements or other requirements.

[0081] FIG. 5 schematically illustrates a cover plate 500 according to another embodiment. It is taken as an example that the cover plate 500 is used in a photovoltaic device which includes solar cells (not shown) and, in operation, causes an electric field as shown by the arrows in FIG.5. It should be noted that the cover plate 500 is also suitable to be applied to other types of work devices which cause an electric field in the cover plate.

[0082] The cover plate 500 comprises a transparent substrate 530, a first barrier layer 510 on a lower surface of the transparent substrate 530, and a second barrier layer 520 on an upper surface of the transparent substrate 530.

[0083] In the embodiment, the transparent substrate 530 is glass. Specifically, the transparent substrate 530 is soda-lime glass which contains a plurality of metal ions, for example, alkali metal ions such as Na^+ , alkaline-earth metal ions such as Ca^{2+} , and other metal ions such as Fe^{3+} . Under the electric field force, the metal ions will move downward toward the lower surface of the transparent substrate 530.

[0084] The first barrier layer 510 is configured to have one or more of the following functions:

[0085] First, the first barrier layer 510 has a suitable thickness and/or chemical potential so as to prevent substance contained in the transparent substrate 530 (for example, alkali metal ions such as Na^+ , alkaline-earth metal ions such as Ca^{2+} , and other metal ions such as Fe^{3+}) from migrating through under the electric field force shown by arrows in FIG. 5, and thus preventing substance contained in the transparent substrate 530 from arriving at or entering the work device. Accordingly, performance degradation of the work device caused by metal ions migration can be prevented;

[0086] Second, the first barrier layer 510 increases the surface resistance of the transparent substrate 530, so that leakage current (and hence power loss) is decreased; and

[0087] Third, the first barrier layer 510 increases the surface resistance of the transparent substrate 530, so that migration of the metal ions (Na^+ , Ca^{2+} , and Fe^{3+} , etc.) driven by the electric field can be suppressed. Therefore, the metal ions are less likely to penetrate the transparent substrate 530 or the first barrier layer 510 to reach the work device.

[0088] In summary, by applying the first barrier layer 510, the performance degradation of the solar cells caused by metal ions migration and/or leakage current is prevented.

[0089] In the embodiment, the first barrier layer 510 includes a transparent insulating material. The first barrier layer 510 is transparent, so that most light can pass through the first barrier layer 510 and arrive at the solar cells. The first barrier layer 510 is insulating, so as not to adversely affect the electrical properties of the solar cells. Preferably, the light transmittance of the barrier layer 510 is greater than or equal to 90%. Suitable materials for the barrier layer 510 may include silicon dioxide, or a combination of silicon dioxide with one or more selected from aluminum oxide, zirconium oxide, hafnium oxide, tantalum oxide, silicon nitride and titanium dioxide.

[0090] In some embodiments, the first barrier layer 510 has a thickness ranging from 20 nm to 250 nm. If the first barrier layer 510 is not thick enough, the blocking effect may be insufficient. However, the increase in thickness of the first barrier layer 510 will lead to an increase in cost. Preferably, the first barrier layer 510 has a thickness ranging from 50 nm to 150 nm. However, when the first barrier layer 510 is formed by methods such as chemical vapor deposition, the thickness ranging from 20 nm to 50 nm is also acceptable. Even within such range, the thickness is still adequate for preventing alkali metal ions, alkaline-earth metal ions, and other metal ions such as Fe^{3+} from escaping, and thus preventing performance degradation of the solar cells.

[0091] It should be noted that, from a large number of experiments, the first barrier layer 510 can block the metal ions efficiently when the first barrier layer 510 has a

thickness of 20nm, 30nm, 40nm, 80nm, 100nm, 120nm, or 150nm. When the thickness of the first barrier layer 510 ranges from 20nm to 30nm, from 30nm to 40nm, from 40nm to 80nm, from 80nm to 100nm, from 100nm to 120nm, or from 120nm to 150nm, the blocking effect of the first barrier layer 510 is also good.

[0092] The second barrier layer 520 is used for preventing the leakage current and/or metal ions migration induced performance degradation of the solar cells. The second barrier layer 520 in this embodiment is similar to the second barrier layer 320 in FIG. 3 and will not be repeated herein.

[0093] In the embodiment, the first barrier layer 510 and the second barrier layer 520 cooperate to provide the barrier function, resulting in reduced performance degradation of the work device.

[0094] It should be noted that the barrier structure in FIG. 5 is just exemplary and is not to be taken in a limiting sense. In one example, the barrier structure may comprise only the first barrier layer 510 on the lower surface of the transparent substrate 530. In another example, the second barrier layer 520 may comprise only a dense dielectric layer. The dense dielectric layer may be consisted of a single film or consisted of multiple films. Suitable materials for the dense dielectric layer comprise, but not limited to, silicon dioxide, or a combination of silicon dioxide with one or more selected from aluminum oxide, zirconium oxide, hafnium oxide, tantalum oxide, silicon nitride and titanium dioxide.

[0095] FIG. 6 schematically illustrates a cover plate 600 according to another embodiment. In the embodiment, the cover plate 600 includes a transparent substrate 610, a first barrier layer 610 on the lower surface of the transparent substrate 610 and an anti-reflective layer 640 on the upper surface of the transparent substrate 610.

[0096] In the embodiment, the transparent substrate 630 and the first barrier layer 610 are similar to those in FIG.5, and will not be repeated herein.

[0097] The anti-reflective layer 640 is configured to reduce the incident light reflection. In the embodiment, the anti-reflective layer 640 has a single-layer

structure.

[0098] Preferably, the anti-reflective layer 640 can also block alkali metal ions, alkaline-earth metal ions, and other metal ions. For example, alkali metal ions, alkaline-earth metal ions and other metal ions in a glass may escape from an upper surface of the glass due to thermal diffusion. In such case the anti-reflective layer 640 can prevent the metal ions from escaping while reducing incident-light reflection.

[0099] Suitable materials for the anti-reflective layer 640 may include, but not limited to, silicon dioxide, or a combination of silicon dioxide with one or more selected from aluminum oxide, zirconium oxide, hafnium oxide, silicon nitride, tantalum oxide and titanium dioxide.

[0100] Preferably, the anti-reflective layer 640 is the same in material as the first barrier layer 610. Therefore, in one aspect, types of materials may be decreased, and so is the cost. In another aspect, the anti-reflective layer 640 and the first barrier layer 610 may be formed on the two surfaces of the transparent substrate 630 in one step, which simplifies the manufacturing process.

[0101] In the embodiment, the barrier structure is the first barrier layer 610 on the lower surface of the transparent substrate 630. However, the barrier structure may take any other suitable form. In another example, the barrier structure further includes a second barrier layer on the upper surface of the transparent substrate 630 (such as the second barrier layer 320 in FIG.3). In such case, the anti-reflective layer 640 may be located on the second barrier layer. In other words, the second barrier layer and the anti-reflective layer may be stacked in sequence on the second surface of the transparent substrate.

[0102] FIG. 7 schematically illustrates a cover plate 700 according to another embodiment. In the embodiment, it is still taken as an example that the cover plate 700 is used in a photovoltaic device.

[0103] In the embodiment, the cover plate 700 includes: a transparent substrate 730, a first barrier layer 710 formed on a lower surface of the transparent substrate 730,

and an anti-reflective layer 740 formed on an upper surface of the transparent substrate 730. The transparent substrate 730 comprises, but not limited to, glass which contains alkali metal.

[0104] The cover plate 700 is different from the cover plate 600 in that the anti-reflective layer 740 has a multi-layer structure which includes multiple anti-reflective films L1, L2, L3.....Ln successively formed on the upper surface of the transparent substrate 730. Other parts of the cover plate 700 are similar to the cover plate 600, which will not be described in detail herein.

[0105] Considering the anti-reflective effect of the anti-reflective films L1, L2, L3.....Ln, each anti-reflective film preferably has a thickness ranging from 40nm to 160nm. The anti-reflective layer 740 has the best performance when each anti-reflective film has a thickness of 50nm, 80nm, 100nm or 120nm. The anti-reflective layer 740 also has good anti-reflective effect and high light transmittance when each anti-reflective film has a thickness ranging from 40nm to 50nm, from 50nm to 80nm, from 80nm to 100nm, from 100nm to 120nm, or from 120nm to 160nm.

[0106] In one embodiment, material of the films L1, L2, L3.....Ln includes silicon dioxide, or a combination of silicon dioxide with one or more selected from aluminum oxide, zirconium oxide, hafnium oxide, tantalum oxide, silicon nitride and titanium dioxide.

[0107] It should be noted that, in the embodiments described above, the cover plates are described as being employed in photovoltaic devices, but the present disclosure is not limited thereto. In other embodiments, the cover plates are also suitable to be used as a cover for other work devices (for example a module of liquid crystal display) which, in operation, cause an electrical field in the cover plate. It should also be noted that, the transparent substrate is described as being made of glass and substance in the transparent substrate is described as metal ions in the above embodiments, but the present disclosure is not limited thereto. In other embodiments,

the transparent substrate may include other materials, such as transparent plastic. According to the embodiments described above, those skilled in the art can modify and vary the embodiments without departing from the spirit and scope of the present disclosure.

[0108] In another aspect, there is provided a solar glass. The solar glass is mounted on a photovoltaic device which may generate an electric field in use, and the solar glass is located in the electric field. Specifically, the solar glass includes the cover plate according to the invention.

[0109] The transparent substrate of cover plate comprises glass which contains metal ions. The configuration of the cover plate is described above and will not be repeated herein. The barrier structure of the cover plate can prevent performance degradation of the solar cells caused by leakage current and/or metal ions migration.

[0110] In another aspect, there is provided a photovoltaic device.

[0111] FIG. 8 schematically illustrates a cross-sectional view of a photovoltaic device 800 according to an embodiment. The photovoltaic device 800 includes: a support plate 840; an adhesive layer 850 located on the support plate 840 and configured with a plurality of solar cells 860 therewithin; and a cover plate located on the adhesive layer 850.

[0112] The cover plate comprises: a transparent substrate 830; a first barrier layer 810 on the lower surface of the transparent substrate 830 and a second barrier layer 820 on the upper surface of the transparent substrate 830. The first barrier layer 810 and the second barrier layer 820 constitute the barrier structure.

[0113] The support plate 840, the adhesive layer 850, the first barrier layer 810, the transparent substrate 830 and the second barrier layer 820 constitute the multi-layer structure of the photovoltaic device. Further, the photovoltaic device includes a frame 870 covering edges of the multi-layer structure of the photovoltaic device.

[0114] The support plate 840 is adapted for supporting and protecting the plurality of solar cells 860.

[0115] The adhesive layer 850 is adapted for fixing the plurality of solar cells 860 and adjoining the plurality of solar cells 860 to other layers.

[0116] It should be noted that, in the embodiment, the support plate 840 and the adhesive layer 850 configured with a plurality of solar cells 860 therewithin constitute the base, however the present disclosure is not be limited thereto. In other embodiments, the base may be a single-layer structure configured with a plurality of solar cells therewithin.

[0117] In the embodiment, in order to increase utilization of light, the adhesive layer 850 may include a transparent adhesive. Specifically, material of the adhesive layer 850 may include one or more selected from, but not limited to, ethylene -vinyl acetate copolymer (EVA) and polyvinyl butyral (PVB).

[0118] The frame 870 is grounded or connected to a low potential power supply, so as to ensure a safe use of the photovoltaic device. In the embodiment, material of the frame 870 includes a conductive material, such as aluminum, or other metallic materials. When the photovoltaic device is in operation, the electric potential difference between the frame 870 and the plurality of solar cells 860 may generate an electric field in the direction of arrows as shown in FIG. 8, and the transparent substrate 830 is located in the electric field.

[0119] The transparent substrate 830 is configured to protect the plurality of solar cells 860, and enable light to arrive at the plurality of solar cells 860. In the embodiment, the transparent substrate 830 may include glass. Specifically, the transparent substrate 830 includes soda-lime glass and the substance contained in the transparent substrate 830 includes a plurality of metal ions, for example, alkali metal ions such as Na^+ , and alkaline-earth metal ions such as Ca^{2+} . The metal ions move toward the plurality of solar cells 860 under the electric field force.

[0120] The first barrier layer 810 is adapted to prevent substance contained in the transparent substrate 830 from entering the plurality of solar cells 860 and/or prevent leakage current through the transparent substrate 830, so as to prevent performance degradation of the plurality of solar cells 860.

[0121] In the embodiment, the first barrier layer 810 is in contact with the transparent substrate 830 and the adhesive layer 850 configured with the plurality of solar cells 860 therein. The barrier layer 810 can prevent alkali metal ions such as Na^+

from escaping out of the lower surface of the transparent substrate 830. As shown in FIG. 8, alkali metal ions such as Na^+ move downwards under the electric field force, are blocked by the barrier layer 810, and stay in the transparent substrate 830. In addition, because the first barrier layer 810 provides the transparent substrate 830 with a relatively high surface resistance, therefore leakage current, and hence power loss, through the transparent substrate 830 is decreased.

[0122] Specifically, the first barrier layer 810 includes a transparent insulating material. Preferably the light transmittance of the first barrier layer 810 is greater than or equal to 90%.

[0123] In the embodiment, the first barrier layer 810 is in contact with the transparent substrate 830 and the adhesive layer 850 configured with the plurality of solar cells 860 therewithin. For purpose of high light transmittance, the refractive index of the barrier layer 810 ranges from 1.2 to 2.2, preferably, from 1.3 to 1.8.

[0124] For example, for a photovoltaic device without a barrier layer, a laminated structure constituted of the transparent substrate 830 (glass) and the adhesive layer 850 (EVA) has a light transmittance of 88.32%. In comparison, a laminated structure constituted of the transparent substrate 830, the adhesive layer 850 and the silicon dioxide barrier layer 810, with a thickness of 100nm and a refractive index of 1.43, has a light transmittance of 88.19%. Therefore, by matching the refractive indexes of the transparent substrate 830, the first barrier layer 810 and the adhesive layer 850, the light transmittance remains almost unchanged by introducing the barrier layer.

[0125] In the embodiment, the first barrier layer 810 includes silicon dioxide, or a combination of silicon dioxide with one or more selected from aluminum oxide, zirconium oxide, hafnium oxide, tantalum oxide, silicon nitride and titanium dioxide. However the present disclosure should not be limited thereto.

[0126] In some embodiments, the first barrier layer 810 has a thickness ranging from 20 nm to 250 nm. If the first barrier layer 810 is not thick enough, blocking effect of the first barrier layer 810 may be insufficient. However, the increase in thickness of the first barrier layer 810 will lead to an increase in cost. Preferably, the first barrier layer 810 has a thickness ranging from 50 nm to 150 nm. However, when the first

barrier layer 810 is formed by methods such as chemical vapor deposition, the thickness ranging from 20 nm to 50 nm is also acceptable. Even within such range, the thickness is still adequate for preventing alkali metal ions, alkaline-earth metal ions, and other metal ions such as Fe^{3+} from escaping, and thus preventing performance degradation of the solar cells.

[0127] It should be noted that, from a large number of experiments, the first barrier layer 810 blocks the metal ions efficiently when the barrier layer 810 has a thickness of 20nm, 30nm, 40nm, 80nm, 100nm, 120nm, or 150nm. When the thickness of the barrier layer 810 ranges from 20nm to 30nm, from 30nm to 40nm, from 40nm to 80nm, from 80nm to 100nm, from 100nm to 120nm, or from 120nm to 150nm, the blocking effect of the barrier layer 810 is also good.

[0128] To better illustrate the effect of restrained PID, experimental results are listed below.

[0129] Table 1 shows the performance of photovoltaic device samples without a barrier, and samples with a barrier layer having different materials or thickness. Hereinafter, the percentage of remaining output power is used to characterize the performance of the samples, which is the ratio of the output power after testing and the output power before testing.

[0130] It should be noted that, testing parameters of the photovoltaic device samples in Table 1 are the same. Specifically, at a temperature of 85 °C and a relative humidity of 85%, a DC voltage of 1000V is applied between the frame and the internal circuit of each photovoltaic device sample to perform an accelerated aging test. And I-V curves are obtained. The output power is calculated based on the I-V curves.

[0131] In addition, material of the barrier layers of the photovoltaic device samples in Table 1 is silicon dioxide doped with other oxide (aluminum oxide, or aluminum oxide together with zirconium oxide), the doping is not greater than 66% mass percentage.

Table 1

Serial number	Material of the barrier layer	Thickness of the barrier layer	Percentage of remaining output power
1	Without a barrier layer	0	41.3%
2	silicon dioxide	20nm	54.1%
3	silicon dioxide	50nm	43.4%
4	silicon dioxide	100nm	59.1%
5	silicon dioxide	150nm	55.6%
6	silicon dioxide	250nm	56.2%
7	silicon dioxide doped with aluminum oxide	20nm	57.5%
8	silicon dioxide doped with aluminum oxide	50nm	51.3%
9	silicon dioxide doped with aluminum oxide	100nm	62.9%
10	silicon dioxide doped with aluminum oxide	150nm	63.7%
11	silicon dioxide doped with aluminum oxide	250nm	63.8%
12	silicon dioxide doped with aluminum oxide and zirconium oxide	20nm	56.1%
13	silicon dioxide doped with aluminum oxide and zirconium oxide	50nm	47.8%
14	silicon dioxide doped with aluminum oxide and zirconium oxide	100nm	60.2%
15	silicon dioxide doped with aluminum oxide and zirconium oxide	150nm	58.9%
16	silicon dioxide doped with aluminum oxide and zirconium oxide	250nm	61.9%

[0132] For the sample of serial number 1, a barrier layer is not provided, and the percentage of remaining output power is 41.3%. However, for the other samples (serial number 2 to 16) having a barrier layer therein, the percentage of remaining output power is greater than 41.3%. Especially, the percentage of remaining output power of some samples is higher than that of the first sample by 20%.

[0133] As shown in Table 1, the photovoltaic device samples with different materials show different results. Specifically, given the barrier layer thickness of 20nm, the percentage of remaining output power of the sample of serial number 7 having a barrier layer of silicon oxide doped with aluminum oxide is 57.5%. And the percentage of sample of serial number 12 having a barrier layer of silicon oxide doped with aluminum oxide and zirconium is 56.1%. Both are greater than that of the sample of serial number 2 having a barrier layer made of only silicon oxide (54.1%). Therefore, the barrier layer which is made of silicon oxide doped with other oxide(s) has a better performance than the barrier layer which is made of only silicon oxide.

[0134] Furthermore, given the same material, barrier layers with different thickness show different results.

[0135] For samples having a barrier layer of silicon oxide (serial number 2 to 6), barrier layer thicknesses of 20nm, 50nm, 100nm, 150nm and 250nm, respectively correspond to remaining output power percentages of 54.1%, 43.4%, 59.1%, 55.6% and 56.2%. In other words, for barrier layers of silicon oxide, the effect does not increase with the thickness. Specifically, when the thickness of the barrier layer increases from 20nm, the percentage of remaining output power decreases at first, and then increases until the thickness of the barrier layer reaches 100nm. Thereafter, the percentage of remaining output power decreases with the increase of thickness of the barrier layer. Therefore, for a barrier layer made of silicon oxide, the best performance can be obtained with a thickness of about 100nm.

[0136] For samples having a barrier layer of silicon oxide doped with aluminum oxide (serial number 7 to 11), the percentage of remaining output power increases gradually when thickness of the barrier layer increases from 20nm to 250nm, so does the performance of the photovoltaic device. However, compared with the barrier layer having a thickness of 100nm, the percentage of remaining output power of the barriers layers with thickness of 150nm and 250nm is increased by less than 1 percent. That is, when thickness of the barrier layer is more than 100nm, effect of the barrier layer does not improve significantly with the increase of thickness of the barrier layer.

Since the increase in thickness of the barrier layer will lead to an increase in cost, the barrier layer with a thickness of 100nm has the optimal price/performance ratio.

[0137] For samples having a barrier layer of silicon oxide doped with aluminum oxide and zirconium oxide (serial number 12 to 16), the percentage of remaining output power decreases at first when thickness of the barrier layers increases from 20nm, then increases gradually with the increase in thickness. When the thickness of the barrier layer reaches 100nm, the percentage of remaining output power is 60.2%. Thereafter, the percentage of remaining output power decreases with the increase in thickness of the barrier layer, and then begins to increase again. Specifically, the percentage of remaining output power of the barrier layer with a thickness of 250nm is about 61.9%, which is increased by less than 2 percent in comparison with that of the barrier layer with a thickness of 100nm. Therefore, taking both the performance and cost into consideration, the barrier layer with a thickness of 100nm has the optimal price/performance ratio.

[0138] Still referring to FIG.8, the second barrier layer 820 is configured to improve the surface resistance of the substrate 830 to reduce the leakage current and/or metal migration through the substrate 830, so as to reduce the performance degradation of the solar cells 860.

[0139] The second barrier layer 820 is comprised of two kinds of dielectric layers. Specifically, the second barrier layer 820 comprises a first dielectric layer 821 and a second dielectric layer 822 stacked in sequence on the upper surface of the transparent substrate 830. The first and the second dielectric layers have different dielectric constants.

[0140] More specifically, the first dielectric layer 821 is a dense dielectric layer and the second dielectric layer 822 is a porous dielectric layer. The first dielectric layer 821 and the second dielectric layer 822 may be made of same or different materials. Suitable materials comprise, but not limited to, silicon dioxide, a combination of silicon dioxide with one or more selected from aluminum oxide, zirconium

oxide, hafnium oxide, tantalum oxide, silicon nitride and titanium dioxide. In one example, the first dielectric layer 821 is made of dense silicon dioxide with a dielectric constant ranging from 3.0 to 4.5, and the second dielectric layer 822 is made of porous silicon dioxide with a dielectric constant ranging from 1.3 to 3. So configured, the second barrier layer 820 has a relatively high surface resistance, and prevent or reduce the leakage current through the second surface.

[0141] In order to realize good barrier, the surface resistance of the second barrier layer 820 is higher than $3G\Omega$.

[0142] It should be noted that, if the first dielectric layer 821 or the second dielectric layer 822 is not thick enough, the effect may be insufficient. However, the increase in thickness will lead to an increase in cost. Preferably, the first dielectric layer 821 or the second dielectric layer 822 has a thickness ranging from 50 nm to 200 nm.

[0143] It should be further noted that the second barrier layer 820 of FIG. 8 is just exemplary and is not to be taken in a limiting sense. In other embodiments, the second barrier layer 820 may take any other suitable form. In one example, the second barrier layer comprises only the first dielectric layer made of dense dielectric material. In another example, the second barrier layer comprises a porous dielectric layer and a dense dielectric layer stacked in sequence on the second surface. In still another example, the second barrier layer comprises a first dense dielectric layer, a porous dielectric layer, and a second dielectric layer stacked in sequence on the second surface. It should be appreciated that the material, thickness and stacking sequence of the dielectric layers can be adjusted according to surface resistance requirements or other requirements.

[0144] In the embodiment, the first barrier layer 810 and the second barrier layer 820 cooperates to provide the barrier function, resulting in reduced performance degradation.

[0145] From the test results, for a photovoltaic device without any barrier structure,

the output power decreases by 71% after the accelerated aging treatment. By comparison, for a photovoltaic device with the first barrier layer 810, the output power is greater than that of the photovoltaic device without any barrier structure by 20%. For a photovoltaic device with the second barrier layer 820, the output power is greater than that of the photovoltaic device without any barrier structure by 60%. A photovoltaic device with both the first barrier layer 810 and the second barrier layer 820 has the best performance.

[0146] FIG.9 shows the leakage current test results of photovoltaic devices. The horizontal axis stands for the accelerated aging time, and the vertical axis stands for the leakage current. Curve 3 is the test result for a photovoltaic device with a second barrier layer comprised of a dense silicon dioxide layer and a porous silicon dioxide layer, curve 4 is the test result for a photovoltaic device with a second barrier layer comprised of a dense silicon dioxide layer, and curve 5 is the test result for a photovoltaic device without any barrier structure. From the results, the leakage current of curve 3 is the lowest (lower than 1 μA) and stable over time, the leakage current of curve 4 is in the range of 2.5-6 μA and increases over time, and the leakage current of curve 5 is the highest and increases over time. As can be seen, the second barrier layer comprising a dense silicon dioxide layer and a porous silicon dioxide layer has the best performance.

[0147] FIG. 10 schematically illustrates a cross-sectional view of a photovoltaic device according to another embodiment. The photovoltaic device is different from that in FIG. 8 in that, the barrier structure only comprises a first barrier layer 810 on the lower surface of the transparent substrate 830, and the photovoltaic device further comprises an anti-reflective layer 880 on the upper surface of the transparent substrate 830.

[0148] The anti-reflective layer 880 is adapted for reducing incident-light reflection on the transparent substrate 830. In the embodiment, the anti-reflective layer 880 has a multi-layer structure which includes anti-reflective films L1, L2, L3.....Ln successively located on the transparent substrate 830. However the present disclosure

is not limited thereto.

[0149] In the embodiment, the barrier structure is the first barrier layer 810 on the lower surface of the transparent substrate 830. However, the barrier structure may take any other suitable form. In another example, the barrier structure further includes a second barrier layer on the upper surface of the transparent substrate 830 (such as the second barrier layer in FIG.3). In such case, the anti-reflective layer 880 may be located on the second barrier layer. In other words, the second barrier layer and the anti-reflective layer are stacked in sequence on the second surface of the transparent substrate.

[0150] In another aspect, there is provided a method for manufacturing a cover plate. FIG. 11 schematically illustrates a flow chart of a method for manufacturing a cover plate according to an implementation manner of the present disclosure. The method includes:

[0151] Step S1: providing a transparent substrate having a first surface adjacent to a work device and a second surface opposite to the first surface; and

[0152] Step S2: forming a barrier layer on at least one of the first surface and the second surface of the transparent substrate to prevent performance degradation of the work device caused by leakage current and/or metal ions migration.

[0153] Hereinafter, the method for manufacturing a cover plate will be described in detail in combination with exemplary embodiments and accompanied drawings.

[0154] FIG. 12 schematically illustrates an exemplary method for manufacturing the cover plate 500 (see FIG. 5) according to an embodiment of the present disclosure. In the embodiment, the barrier structure of the cover plate comprises a first barrier layer 510 on the first surface and a second barrier layer 520 on the second surface, the second barrier layer 520 being comprised of a dense dielectric layer 521 and a porous dielectric layer 522.

[0155] In step S1, a transparent substrate 530 is provided. In the embodiment, the

transparent substrate 530 is glass, and metal ions contained in the transparent substrate 500 include alkali metal ions, alkaline-earth metal ions, and other metal ions. The transparent substrate 530 has an upper surface and a lower surface opposite to the upper surface. The lower surface is adjacent to a work device such as a solar cell, a module of liquid crystal display, etc.

[0156] In step S2, a dense silicon dioxide layer 521 is formed on the second surface by at least one of physical vapor deposition, magnetron sputtering, chemical vapor deposition, sol-gel coating, roll to roll coating, spin coating, roller coating, spraying, slit coating and dip coating. Afterwards a drying at a first temperature ranging from 100 °C to 300 °C is carried out. And then a first barrier layer 510 of silicon dioxide is formed on the first surface by at least one of physical vapor deposition, magnetron sputtering, chemical vapor deposition, sol-gel coating, roll to roll coating, spin coating, roller coating, spraying, slit coating and dip coating, followed by a drying at the first temperature ranging from 100 °C to 300 °C. Finally, a porous silicon dioxide layer 522 is formed on the dense silicon dioxide layer 521 by at least one of physical vapor deposition, magnetron sputtering, chemical vapor deposition, sol-gel coating, roll to roll coating, spin coating, roller coating, spraying, slit coating and dip coating, followed by a drying at a second temperature ranging from 300 °C to 700 °C.

[0157] It should be noted that the layers 510, 521 and 522 may be made of any other suitable materials, for example, a combination of silicon dioxide with one or more selected from aluminum oxide, zirconium oxide, hafnium oxide, tantalum oxide, silicon nitride and titanium dioxide.

[0158] The method for forming a cover plate may further includes heating the glass to make it tempered after forming the layers 510, 521 and 522. In such case, the drying at the second temperature from 300 °C to 700 °C may be done during heating the glass.

[0159] FIG. 13 schematically illustrates another exemplary method for

manufacturing the cover plate 500 according to an embodiment of the present disclosure. In the embodiment, the dense dielectric layer 521 is the same in material as the first barrier layer 510.

[0160] After providing the transparent substrate 530, the first barrier layer 510 and the dense dielectric layer 521 are formed simultaneously on the surfaces of the transparent substrate 530.

[0161] In one example, the first barrier layer 510 and the dense dielectric layer 521 are both made of silicon dioxide, and are formed simultaneously by dip coating.

[0162] Afterwards, a drying at a first temperature ranging from 100 °C to 300 °C is performed.

[0163] And then the porous silicon dioxide layer 522 is formed on the dense silicon dioxide layer 521.

[0164] Finally a drying at a second temperature ranging from 300 °C to 700 °C is performed.

[0165] The method for forming a cover plate may further includes heating the glass to make it tempered after forming the layers 510, 521 and 522. In such case, the drying at the second temperature from 300 °C to 700 °C may be done during heating the glass.

[0166] FIG. 14 schematically illustrates an exemplary method for manufacturing a cover plate 700 according to an embodiment of the present disclosure. In the embodiment, the barrier structure only comprises a first barrier layer 710 on the first surface of the transparent substrate, and the cover plate 700 further comprises an anti-reflective layer 740 of a multiple-layer structure on the second surface of the transparent substrate.

[0167] The method for forming the anti-reflective layer 740 on the second surface of the transparent substrate 730 may include: successively forming anti-reflective films L1, L2, L3.....Ln on the second surface of the transparent substrate 730. The

anti-reflective films L1, L2, L3.....Ln constitute the multi-layer structure.

[0168] In other examples, the anti-reflective layer 740 may have a single-layer structure.

[0169] Although the present disclosure has been disclosed above with reference to preferred embodiments thereof, it should be understood that the disclosure is presented by way of example only, and not intended to be limiting. Those skilled in the art can modify and vary the embodiments without departing from the spirit and scope of the present disclosure.

CLAIMS

What is claimed is:

1. A cover plate, adapted for covering a work device which, in operation, causes an electric field in the cover plate, comprising:
 - a transparent substrate, having a first surface and a second surface opposite to the first surface, the first surface being adjacent to the work device; and
 - a barrier structure, having at least one of a first barrier layer on the first surface and a second barrier layer on the second surface, configured to prevent performance degradation of the work device caused by leakage current and/or metal ions migration.
2. The cover plate of claim 1, wherein the barrier structure comprises the second barrier layer, and wherein the second barrier layer comprises a first dielectric layer.
3. The cover plate of claim 2, wherein the second barrier layer further comprises a second dielectric layer, the first and the second dielectric layers having different dielectric constants.
4. The cover plate of claim 3, wherein the first dielectric layer comprises a dense dielectric layer and the second dielectric layer comprises a porous dielectric layer.
5. The cover plate of claim 4, wherein the dense dielectric layer and the porous dielectric layer are stacked in sequence on the second surface, the dense dielectric layer being between the porous dielectric layer and the second surface.
6. The cover plate of claim 5, wherein the surface resistance of the second barrier layer is greater than 1 Gohm.
7. The cover plate of claim 4, wherein the dense dielectric layer and the porous dielectric layer are stacked in sequence on the second surface, the porous dielectric layer being between the dense dielectric layer and the second surface.
8. The cover plate of claim 4, wherein second barrier layer comprises a first dense dielectric layer, a porous dielectric layer and a second dense dielectric layer stacked in sequence on the second surface.

9. The cover plate of claim 4, wherein the dense dielectric layer and porous dielectric layer comprise silicon dioxide, or a combination of silicon dioxide with one or more selected from aluminum oxide, zirconium oxide, hafnium oxide, tantalum oxide, silicon nitride and titanium dioxide.
10. The cover plate of claim 4, wherein the dense dielectric layer comprises dense silicon dioxide with a dielectric constant ranging from 3 to 4.5, and the porous dielectric layer comprises porous silicon dioxide with a dielectric constant ranging from 1.3 to 3.2.
11. The cover plate of claim 4, wherein the dense dielectric layer has a thickness ranging from 50 nm to 200 nm, and the porous dielectric layer has a thickness ranging from 50 nm to 200 nm.
12. The cover plate of any of claims 2 to 11, wherein the barrier structure further comprises the first barrier layer, the first dielectric layer and the first barrier layer having the same material.
13. The cover plate of claim 1, wherein the barrier structure comprises the first barrier layer on the first surface.
14. The cover plate of claim 13, wherein the first barrier layer comprises a transparent insulating material.
15. The cover plate of claim 13, wherein the first barrier layer comprises silicon dioxide, or a combination of silicon dioxide with one or more selected from aluminum oxide, zirconium oxide, hafnium oxide, tantalum oxide, silicon nitride and titanium dioxide.
16. The cover plate of claim 13, wherein the first barrier layer has a thickness ranging from 20 nm to 250 nm.
17. The cover plate of claim 16, wherein the first barrier layer has a thickness ranging from 20 nm to 50 nm.
18. The cover plate of claim 17, wherein the first barrier layer has a thickness of 20 nm, 30 nm or 40 nm.
19. The cover plate of claim 16, wherein the first barrier layer has a thickness ranging from 50 nm to 150 nm.

20. The cover plate of claim 19, wherein the first barrier layer has a thickness of 80 nm, 100 nm, 120nm or 150 nm.
21. The cover plate of claim 13, wherein the first barrier layer comprises silicon dioxide doped with aluminum oxide and the barrier layer has a thickness of 100 nm.
22. The cover plate of claim 1, further comprising an anti-reflective layer, located on the second surface of the transparent substrate, configured to reduce incident-light reflection on the second surface.
23. The cover plate of claim 22, wherein the anti-reflective layer is of a single-layer structure, or a multi-layer structure comprising multiple anti-reflective films stacked in sequence on the second surface of the transparent substrate.
24. The cover plate of claim 22, wherein the barrier structure is the first barrier layer on the first surface.
25. The cover plate of claim 24, wherein the anti-reflective layer and the first barrier layer have the same material.
26. The cover plate of claim 22, wherein the anti-reflective layer comprises silicon dioxide, or a combination of silicon dioxide with one or more selected from aluminum oxide, zirconium oxide, hafnium oxide, tantalum oxide, silicon nitride and titanium dioxide.
27. The cover plate of claim 1, wherein the transparent substrate comprises glass.
28. The cover plate of claim 27, wherein the substance contained in the transparent substrate comprises metal ions.
29. A solar glass, comprising a cover plate according to any of claims 1 to 28, adapted to be mounted on a plurality of solar cells, wherein the transparent substrate comprises glass and the work device comprises the plurality of solar cells.
30. The solar glass of claim 29, wherein the glass comprises soda-lime glass.
31. A photovoltaic device, comprising:
 - a base, configured with a plurality of solar cells therewithin; and
 - a cover plate according to any of claims 1 to 28, wherein the work device comprises the plurality of solar cells.

32. The photovoltaic device of claim 31, wherein the base comprises a support plate and an adhesive layer located on the support plate, and the plurality of solar cells are located in the adhesive layer.
33. The photovoltaic device of claim 32, wherein the barrier structure comprises the first barrier layer on the first surface, the first barrier layer being in contact with the adhesive layer and the transparent substrate, and wherein the first barrier layer has a same refractive index as the adhesive layer, or the barrier layer has a same refractive index as the transparent substrate, or the barrier layer has a refractive index between those of the adhesive layer and the transparent substrate.
34. The photovoltaic device of claim 33, wherein the first barrier layer has a refractive index ranging from 1.2 to 2.2.
35. The photovoltaic device of claim 34, wherein the first barrier layer has a refractive index ranging from 1.3 to 1.8.
36. The photovoltaic device of claim 33, wherein the adhesive layer comprises one or more selected from ethylene -vinyl acetate copolymer or polyvinyl butyral.
37. The photovoltaic device of claim 31, wherein the plurality of solar cells are crystalline silicon solar cells.
38. A method for manufacturing a cover plate adapted for covering a work device which, in operation, causes an electric field in the cover plate, comprising:
- providing a transparent substrate having a first surface adjacent to the work device and a second surface opposite to the first surface; and
 - forming a barrier structure on at least one of the first surface and the second surface, configured to prevent performance degradation of the work device caused by leakage current and/or metal ions migration.
39. The method of claim 38, wherein the barrier structure comprises a first barrier layer on the first surface, the first barrier layer comprising silicon dioxide, or a combination of silicon dioxide with one or more selected from aluminum oxide, zirconium oxide, hafnium oxide, tantalum oxide, silicon nitride and titanium dioxide, and
- wherein the step of forming comprises forming the first barrier layer on the

first substrate by at least one of physical vapor deposition, magnetron sputtering, chemical vapor deposition, sol-gel coating, roll to roll coating, spin coating, roller coating, spraying, slit coating and dip coating.

40. The method of claim 39, further comprising drying the first barrier layer after forming the first barrier layer.

41. The method of claim 40, wherein drying the first barrier layer comprises drying at a temperature ranging from 100 °C to 300 °C.

42. The method of claim 38, further comprising forming an anti-reflective layer, on the second surface of the transparent substrate, configured to reduce incident-light reflection on the second surface.

43. The method of claim 39, wherein the barrier structure further comprises a second barrier layer on the second surface, the second barrier layer comprising a first dielectric layer.

44. The method of claim 43, wherein the first dielectric layer comprises a dense dielectric layer, the dense dielectric layer and the first barrier layer comprising silicon dioxide, and

wherein the step of forming comprises forming silicon dioxide layers on the first and the second surfaces of the transparent substrate by dip coating.

45. The method of claim 44, wherein the second barrier layer further comprises a second dielectric layer, the second dielectric layer comprising porous silicon dioxide, and

wherein the step of forming further comprises forming a porous silicon dioxide layer on the second surface of the transparent substrate by at least one of physical vapor deposition, magnetron sputtering, chemical vapor deposition, sol-gel coating, roll to roll coating, spin coating, roller coating, spraying, slit coating and dip coating.

46. The method of claim 45, further comprising drying the first barrier layer and the dense dielectric layer at a first temperature ranging from 100 °C to 300 °C.

47. The method of claim 46, further comprising drying the second dielectric layer at a second temperature ranging from 300 °C to 700 °C.

48. The method of any of claims 38-47, wherein the transparent substrate comprises glass, and the method further comprises heating the glass to form tempered glass after forming the barrier structure.
49. The method of claim 48, when referring to claim 47, wherein the step of drying at the second temperature is performed during heating the glass.

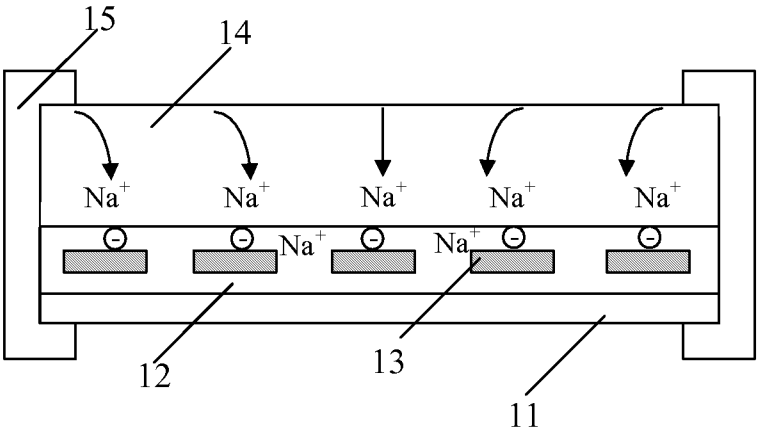


FIG. 1

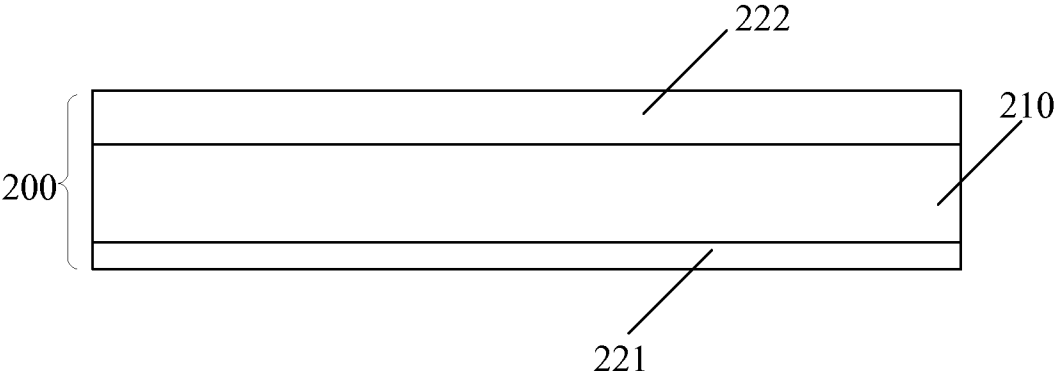


FIG. 2

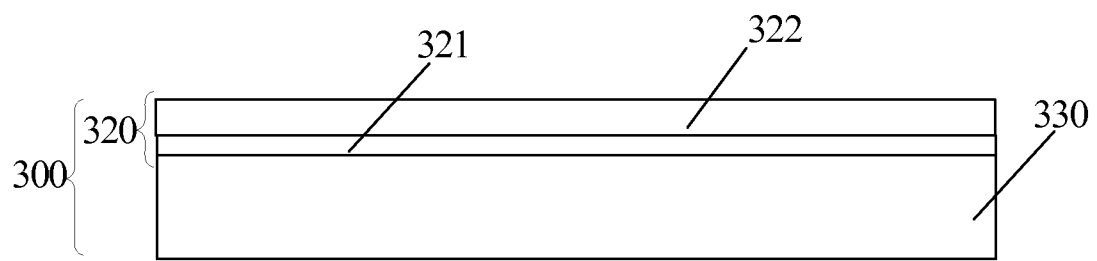


FIG. 3

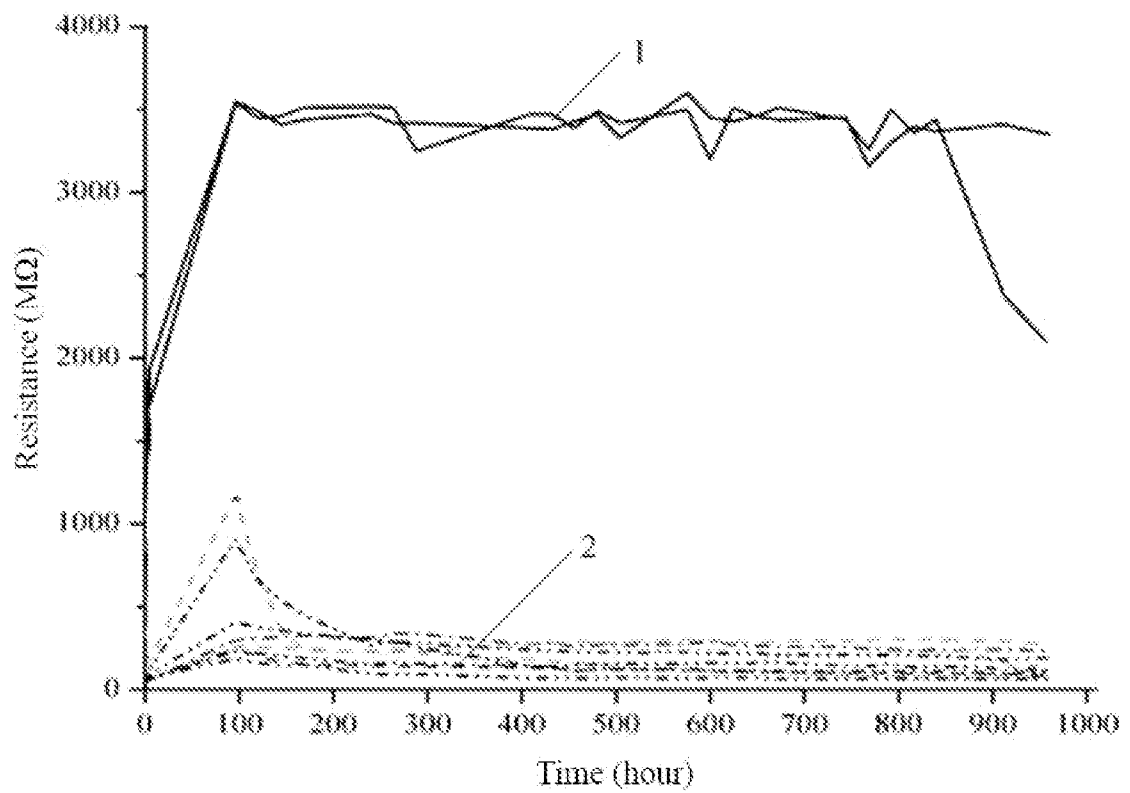


FIG. 4

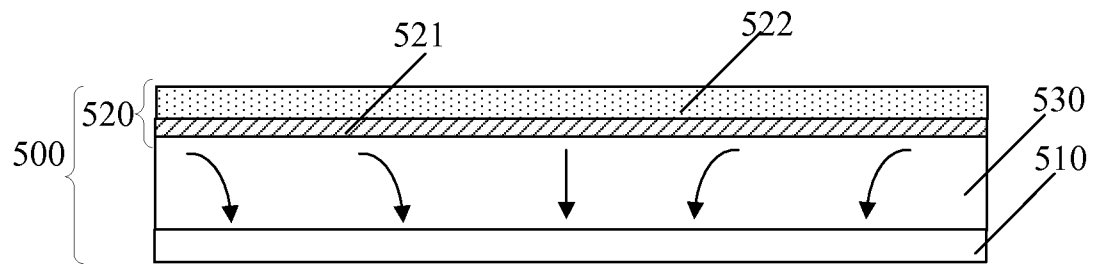


FIG. 5

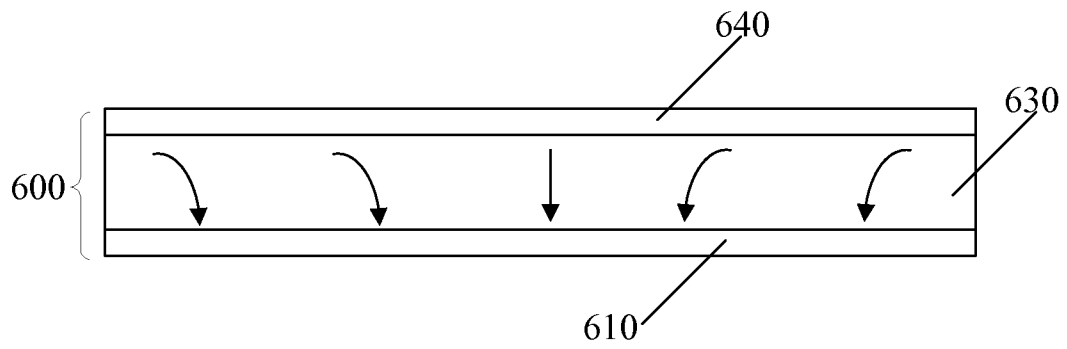


FIG. 6

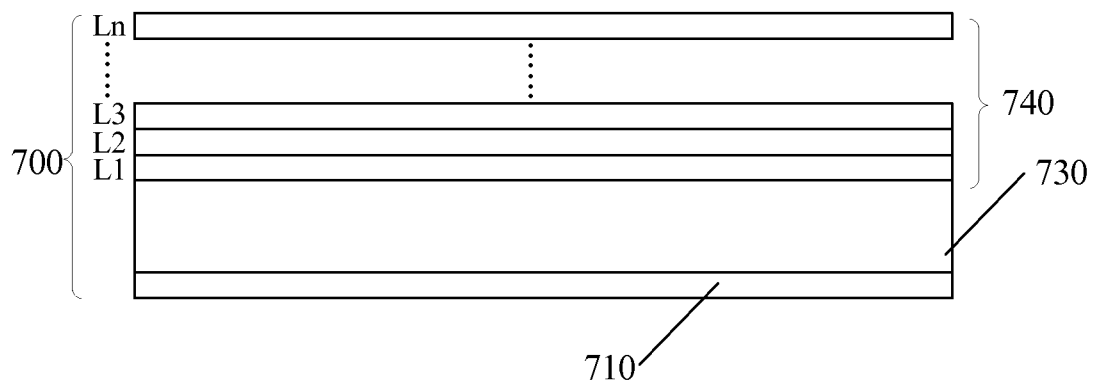


FIG. 7

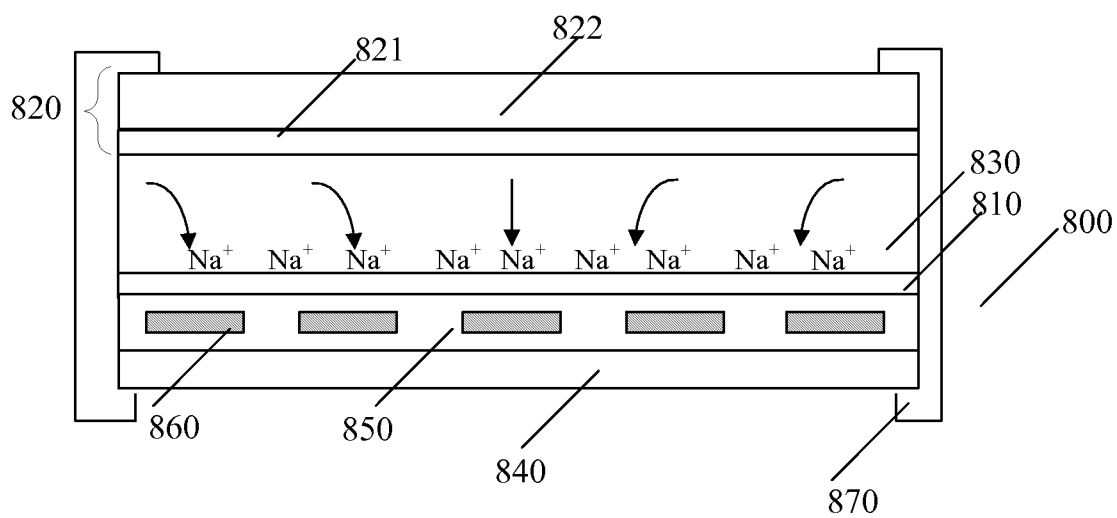


FIG. 8

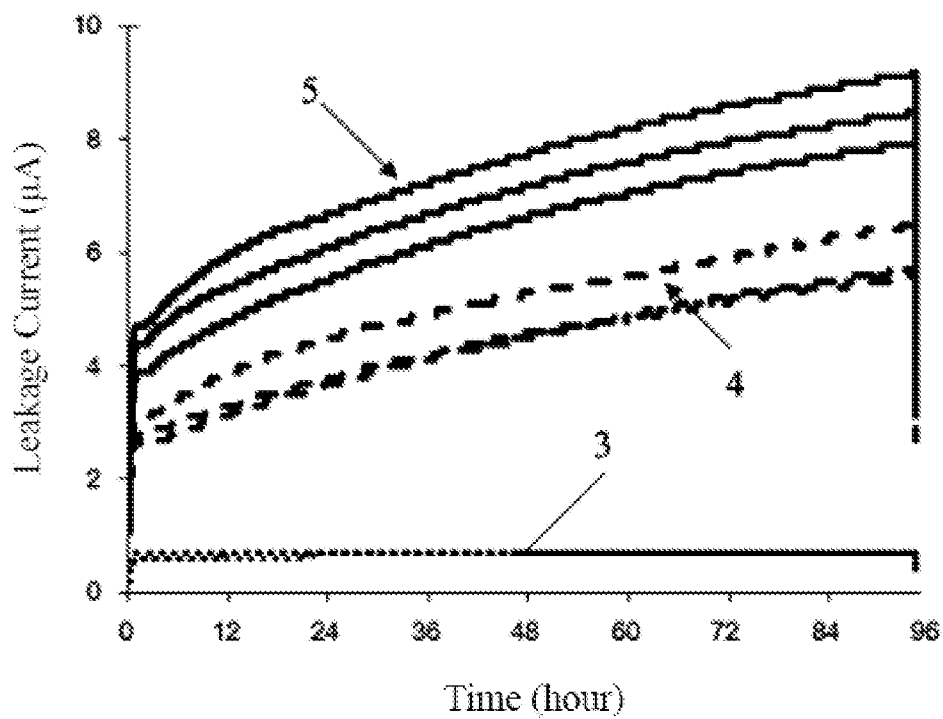


FIG. 9

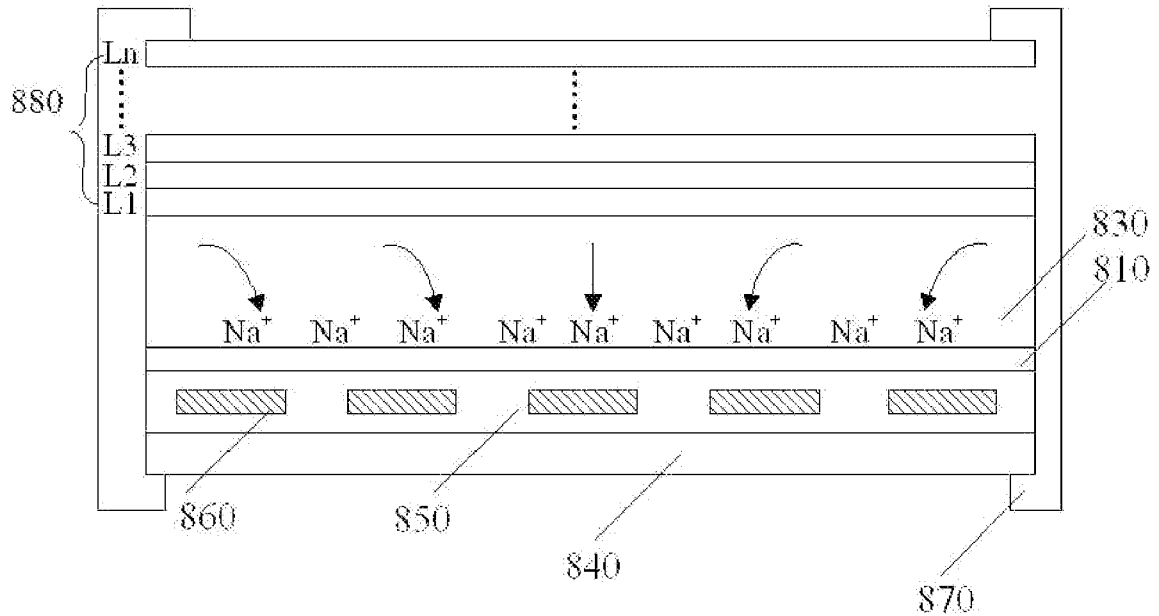


FIG. 10

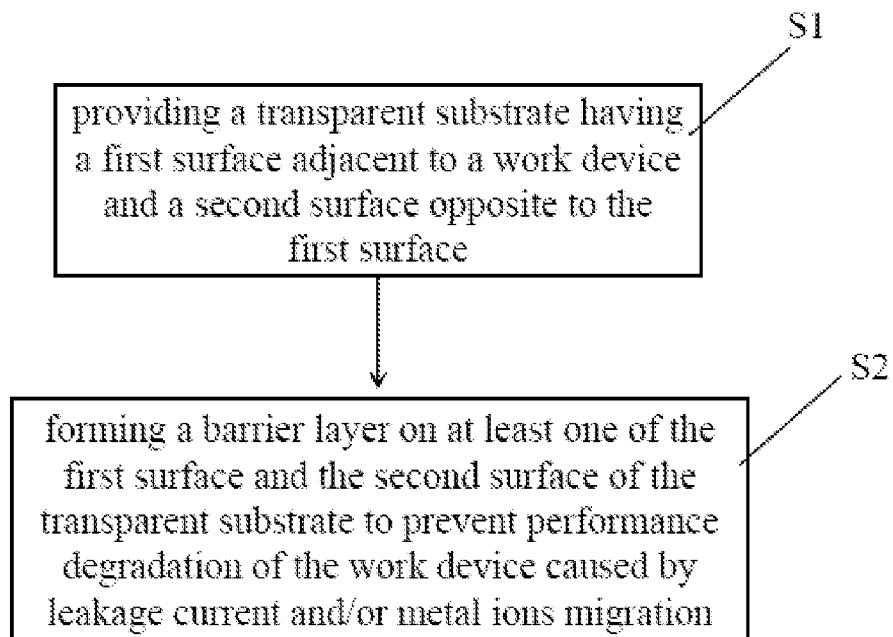


FIG. 11

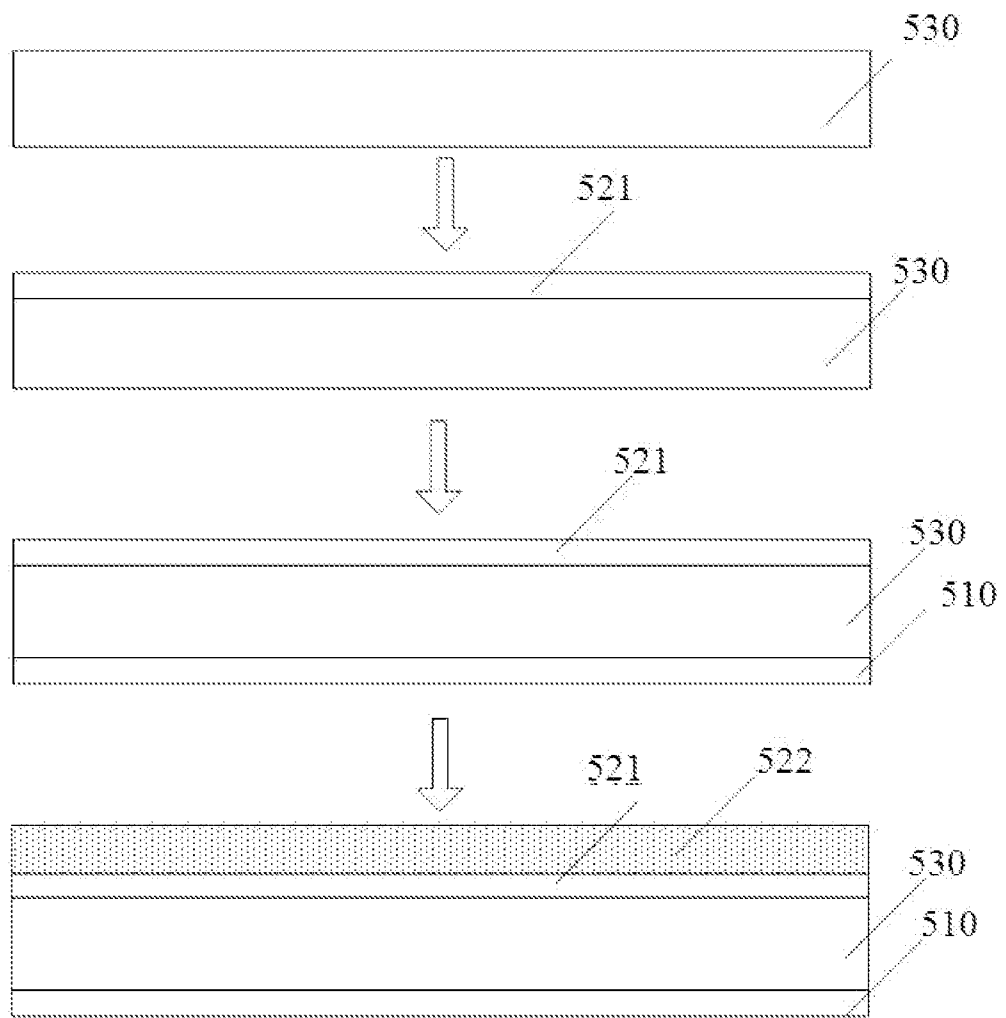


FIG. 12

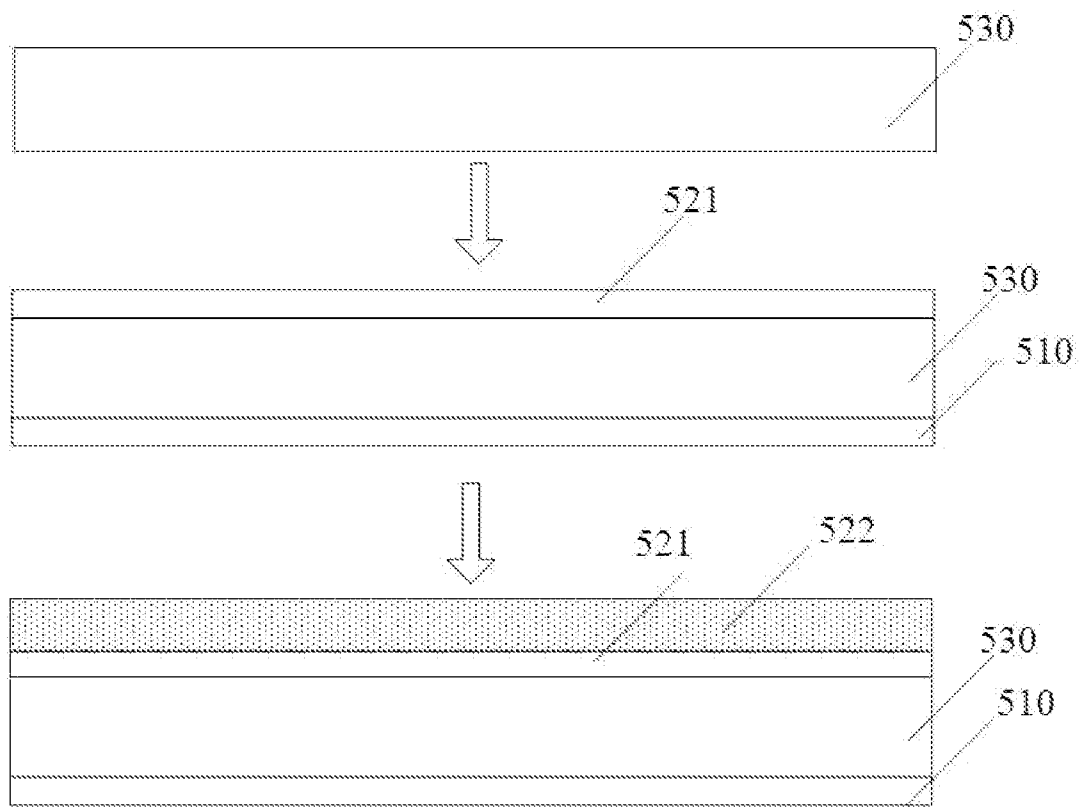


FIG. 13

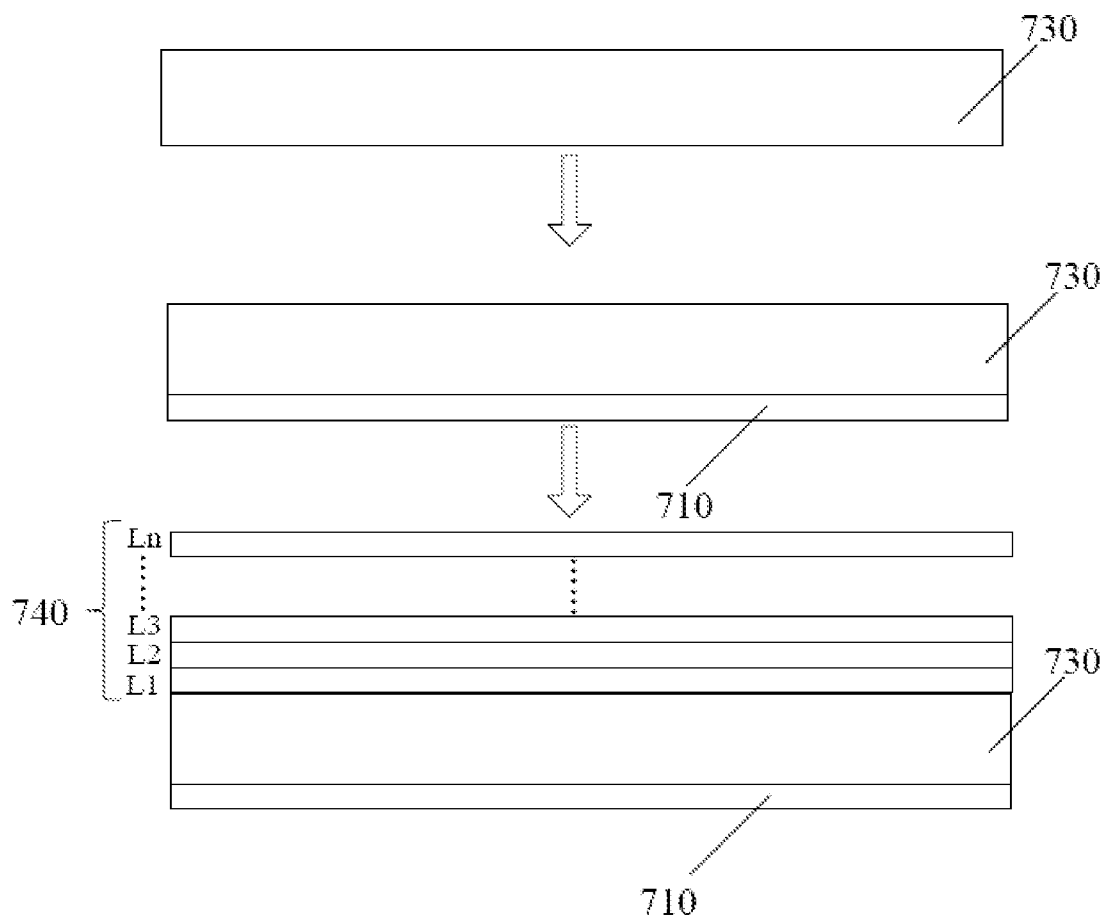


FIG. 14

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2013/073994

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H01L 31/-; H01L 21/-; H01L 33/-

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

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

WPI,EPODOC,CNPAT,CNKI: solar, photovoltaic, plate, barrier, metal, ion, alkali, soda, dense, porous

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 102655178 A (SAINT-GOBAIN GLASS FRANCE) 05 Sep.2012(05.09.2012) the whole document	1, 13-42, 48
X	US 2010/0258179 A1(WIETING) 14 Oct.2010(14.10.2010) paragraphs [0018]-[0043] of specification, figs.1-8	1-2, 13-43
X	US 2007/0068568 A1(OGAWA et al.) 29 Mar.2007(29.03.2007)the whole document	1-2, 13-43
A		3-12,44-49

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

* Special categories of cited documents:	“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
“A” document defining the general state of the art which is not considered to be of particular relevance	“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
“E” earlier application or patent but published on or after the international filing date	“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
“L” document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)	“&”document member of the same patent family
“O” document referring to an oral disclosure, use, exhibition or other means	
“P” document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 08 Jul.2013(08.07.2013)	Date of mailing of the international search report 18 Jul. 2013 (18.07.2013)
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer DAI, Lijuan Telephone No. (86-10)62411578

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2013/073994

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 102655178 A	05.09.2012	None	
US 2010/0258179 A1	14.10.2010	US 8217261 B2	10.07.2012
		WO 2010039880 A1	08.04.2010
		CN 102150276 A	10.08.2011
		DE 112009002289 T5	29.09.2011
US 2007/0068568 A1	29.03.2007	ES 2291523 T3	01.03.2008
		US 2005/0161075 A1	28.07.2005
		EP 1835546 A2	19.09.2007
		US 7868245 B2	11.01.2011
		EP 1570530 B1	15.08.2007
		WO 2004054002 A1	24.06.2004
		EP 1570530 A1	07.09.2005
		DE 60221915 D1	27.09.2007
		DE 60221915 T2	08.05.2008

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2013/073994

Continuous: **A. CLASSIFICATION OF SUBJECT MATTER**

H01L 31/0216 (2006.01) i

H01L 31/048 (2006.01) i

H01L 31/18 (2006.01) i