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(71) **Applicant: TURKIYE SISE VE CAM FABRIKALARI ANONIM SIRKETI** [TR/TR]; Icmeler Mahallesi D-100 Karayolu Cad. No.44 A, 34947 Tuzla/Istanbul (TR).

(72) **Inventors: TURKUZ, Seniz**; Is Kuleleri Kule-3, 4 Levent, 34330 Istanbul (TR). **TUNA, Ocal**; Is Kuleleri Kule-3, 4 Levent, 34330 Istanbul (TR). **ERASLAN, Sinem**; Is Kuleleri Kule-3, 4 Levent, 34330 Istanbul (TR). **TURUTOGLU, Tuncay**; Is Kuleleri Kule-3, 4 Levent, 34330 Istanbul (TR).

(74) **Agent: KAYA, Erdem**; Konak Mh. Kudret Sok. Senyurt Is. Mrk. No:6 D:8, 16110 Nilufer/Bursa (TR).

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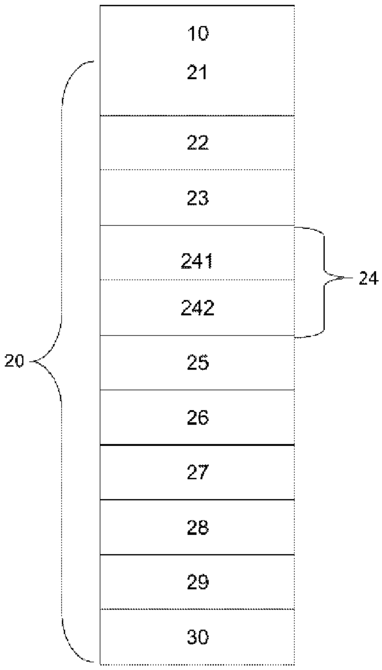

Figure 1

(57) **Abstract:** The present invention is a heat treatable low-e coated (20) glass (10) having single silver and developed for use in architecture and automotive glasses.

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LOW-E COATED GLASS WITH EFFICIENT THERMAL AND SOLAR CONTROL

TECHNICAL FIELD

The present invention relates to a low emissivity (low-e) coating having infrared reflective layers therein and used as thermal isolation glass and which transmits daylight.

PRIOR ART

One of the factors which differentiate optic characteristics of glasses is the coating applications which are applied onto the glass surface. One of the coating applications is the magnetic field supported sputtering method in vacuum medium. This is a method frequently used particularly in the production of architecture coatings having low-e characteristic. By means of said method, the transmittance and reflection values of the coated glasses in the visible, near infrared and infrared region of the solar energy spectrum can be obtained at the targeted levels.

Besides transmittance and reflection values, selectivity value is also an important parameter in coated glasses. In ISO 9050 (2003) standard, selectivity is defined as the ratio of the transmittance value of the visible region to the solar factor. The selectivity values of coatings can be kept at the targeted levels by means of the number of Ag layers included, the type of the seed layer used, and the parametric optimizations of the layers.

In the patent with publication number CN102806728, a neutral high-transmittance low-radiation coated glass is disclosed. A dielectric layer (I), a silver layer, a zinc aluminum oxide or titanium oxide ceramic barrier layer and a dielectric layer (II) are arranged on the surface of a glass sheet from bottom to top in sequence, wherein each of the dielectric layer (I) and the dielectric layer (II) is one or the combination of a titanium oxide layer, a zinc oxide layer and a silicon nitride layer. Compared with the prior art, the neutral high-transmittance low-radiation coated glass has the advantages of high visible light transmittance, neutral color, low radiation and the like as a titanium basic layer is taken as a glass film layer and the barrier layer made of zinc aluminum oxide or titanium oxide ceramic materials is adopted to protect the silver layer.

As a result, because of all of the abovementioned problems, an improvement is required in the related technical field.

BRIEF DESCRIPTION OF THE INVENTION

The present invention relates to a low-e coated glass, for bringing new advantages to the related technical field.

An object of the present invention is to provide a low-e coated glass which provides a strong solar control together with efficient thermal control.

In order to realize all of the abovementioned objects and the objects which are to be deducted from the detailed description below, the present invention is a heat treatable low-e coated glass with single silver in order to be used in architectural and automotive glasses. Accordingly, said invention is characterized in that the coating side reflection a* value is between -7.5 and -2.0; the glass side reflection a* value is between -7.5 and -2.0; the coating side reflection b* value is between -13 and -2.4; the glass side reflection b* value is between -35 and -14; and Tb value is between -2.0 and +2.2 and the followings are respectively provided outwardly from the glass:

- a first dielectric layer selected from Si_xN_y, SiO_xN_y, $ZnSnO_x$, TiO_x, TiN_x, ZrN_x,
- a first absorbing layer selected from NiCr, $NiCrO_x$,
- a second dielectric layer selected from Si_xN_y, SiO_xN_y, $ZnSnO_x$, TiO_x, TiN_x, ZrN_x,
- a seed layer selected from NiCr, $NiCrO_x$, TiO_x, $ZnAlO_x$, ZnO_x,
- a second absorbing layer selected from NiCr, $NiCrO_x$,
- an infrared reflective layer,
- a barrier layer selected from NiCr, $NiCrO_x$, TiO_x, $ZnAlO_x$, ZnO_x,
- a third dielectric layer selected from NiCr, $NiCrO_x$, TiO_x, $ZnAlO_x$, ZnO_x,
- a fourth dielectric layer selected from Si_xN_y, SiO_xN_y, $ZnSnO_x$, TiO_x, TiN_x, ZrN_x,
- a fifth dielectric layer selected from Si_xN_y, SiO_xN_y, $ZnSnO_x$, TiO_x, TiN_x, ZrN_x,
- an upper dielectric layer selected from Si_xN_y, SiO_xN_y, $ZnSnO_x$, TiO_x, TiN_x, ZrN_x.

In another preferred embodiment of the present invention, the coating side reflection a* value is between -7.0 and -2.5 and the glass side reflection a* value is between -7.0 and -2.5.

In another preferred embodiment of the present invention, the coating side reflection b* value is between -10 and -2.8 and the glass side reflection b* value is between -32 and -17.

In another preferred embodiment of the present invention, Tb value is between -1.5 and 1.2.

In another preferred embodiment of the present invention, the followings are respectively provided outwardly from the glass:

- first dielectric layer comprising Si_xN_y,
- first absorbing layer comprising NiCr,
- second dielectric layer comprising Si_xN_y,
- seed layer comprising $ZnAlO_x$,
- second absorbing layer comprising NiCr,
- infrared reflective layer comprising Ag,
- barrier layer comprising $NiCrO_x$,
- third dielectric layer comprising $ZnAlO_x$,
- fourth dielectric layer comprising Si_xN_y,
- fifth dielectric layer comprising SiO_xN_y,
- upper dielectric layer comprising TiO_x.

In another preferred embodiment of the present invention,

- the thickness of the first dielectric layer comprising Si_xN_y is between 16 nm and 40 nm,
- the thickness of the first absorbing layer comprising NiCr is between 2.5 nm and 5.5 nm,
- the thickness of the second dielectric layer comprising Si_xN_y is between 35 nm and 65 nm,
- the thickness of the seed layer comprising $ZnAlO_x$ is between 10 nm and 35 nm,
- the thickness of the second absorbing layer comprising NiCr is between 1 nm and 3 nm,
- the thickness of the infrared reflective layer comprising Ag is between 9 nm and 18 nm,
- the thickness of the barrier layer comprising $NiCrO_x$ is between 1 nm and 2 nm,
- the thickness of the third dielectric layer comprising $ZnAlO_x$ is between 6 nm and 27 nm,
- the thickness of the fourth dielectric layer comprising Si_xN_y is between 12 nm and 32 nm,
- the thickness of the fifth dielectric layer comprising SiO_xN_y is between 8 nm and 22 nm,
- the thickness of the upper dielectric layer comprising TiO_x is between 3.5 nm and 8.5 nm.

BRIEF DESCRIPTION OF THE FIGURE

Figure 1 is a representative view of the low-e coated glass.

REFERENCE NUMBERS

10	Glass
20	Low-e coating
21	First dielectric layer
22	First absorbing layer
23	Second dielectric layer
24	Seed structure
241	Seed layer
242	Second absorbing layer
25	Infrared reflective layer
26	Barrier layer
27	Third dielectric layer
28	Fourth dielectric layer
29	Fifth dielectric layer
30	Upper dielectric layer

DETAILED DESCRIPTION OF THE INVENTION

In this detailed description, the subject matter low-e coated (20) glass (10) is explained with references to examples without forming any restrictive effect only in order to make the subject more understandable.

The production of low-e coated (20) glasses (10) related to architecture and automotive is realized by means of “sputtering” method. The present invention essentially relates to low-e coated (20) glasses (10) with single silver whose thermal process resistance is high and used as thermal isolation glass (10) which transmits daylight and relates to the ingredient and application of said low-e coating (20).

In the present invention, a low-e coating (20) is developed comprising pluralities of metal, metal oxide and metal nitride/oxy-nitride layers positioned on the glass (10) surface by using sputtering method in order to obtain a low-e coated (20) glass (10) designed in a heat treatable manner and having medium visible light transmittance in order to be applied onto the surface of a glass (10). Said layers are collected on each other respectively under vacuum. As the thermal process, at least one of and/or a number of tempering, partial tempering, annealing, bending and lamination processes can be used. The subject matter low-e coated (20) glass (10) can be used as architecture and automotive glass (10).

In terms of the production easiness and in terms of optic characteristics, in order to develop an ideal low-e coating (20) sequencing which is heat treatable, the following data has been detected as a result of experimental studies.

In the subject matter low-e coating (20); there is an infrared reflective layer (26) which transmits the visible region at the targeted level and which provides reflection (less transmittance) of thermal radiation in the infrared spectrum. The infrared reflective layer (26) comprises Ag and its thermal emissivity is low. The thickness of the infrared reflective layer (26) including Ag is between 9 nm and 18 nm. In the preferred application, the thickness of the infrared reflective layer (26) including Ag is between 12 nm and 15 nm.

In the subject matter low-e coated (20) glass (10), the refraction indices of all layers are determined by using calculation methods through optic constants obtained from single layer measurements taken. Said refraction indices are the refraction index data at 550 nm.

In the subject matter coating, a first dielectric layer (21) is used as the lowermost layer in a manner contacting the glass (10). Said first dielectric layer (21) comprises at least one of Si_xN_y, SiO_xN_y, $ZnSnO_x$, TiO_x, TiN_x, ZrN_x layers. In the preferred application, the first dielectric layer (21) comprises Si_xN_y. The first dielectric layer (21) including Si_xN_y behaves as diffusion barrier and serves to prevent alkali ion migration which is facilitated at high temperature. Thus, the first dielectric layer (21) including Si_xN_y supports the resistance of the coating (20) against the thermal processes. The variation range for the refraction index of the first dielectric layer (21) including Si_xN_y is between 2.00 and 2.10.

The thickness of the first dielectric layer (21) including Si_xN_y is between 16 nm and 40 nm. In the preferred application, the thickness of the first dielectric layer (21) including Si_xN_y is between 20 nm and 36 nm. In a further preferred application, the thickness of the first dielectric layer (21) including Si_xN_y is between 24 nm and 32 nm.

A first absorbing layer (22) is positioned on the first dielectric layer (21) including Si_xN_y. Said first absorbing layer (22) comprises at least one of NiCr, NiCrOx, ZnAlO layers. In the preferred application, the first absorbing layer (22) comprises NiCr. The thickness of the first absorbing layer (22) including NiCr is between 2.5 nm and 5.5 nm. In the preferred application, the thickness of the first absorbing layer (22) including NiCr is between 3.0 nm and 5.0 nm. In a further preferred application, the thickness of the first absorbing layer (22) including NiCr is between 3.2 nm and 4.5 nm.

The second dielectric layer (23) is positioned on the first absorbing layer (22) including NiCr. Said second dielectric layer (23) comprises at least one of Si_xN_y, SiO_xN_y, $ZnSnO_x$, TiO_x, TiN_x, ZrN_x layers. In the preferred application, the second dielectric layer (23) comprises Si_xN_y. The thickness of the second dielectric layer (23) including Si_xN_y is between 35 nm and 65 nm. In the preferred application, the thickness of the second dielectric layer (23) including Si_xN_y is between 40 nm and 60 nm. In a further preferred application, the thickness of the second dielectric layer (23) including Si_xN_y is between 45 nm and 56 nm.

A seed structure (24) is positioned on the second dielectric layer (23) including Si_xN_y. The seed structure (24) comprises at least one of NiCr, $NiCrO_x$, TiO_x, $ZnAlO_x$, ZnO_x. The seed structure (24) comprises at least one seed layer (241). At least one of NiCr, $NiCrO_x$, TiO_x, $ZnAlO_x$, ZnO_x is used as said seed layer (241). In the preferred application, the seed layer (241) comprises $ZnAlO_x$.

In another embodiment of the present invention, in the seed structure (24), the seed layer (241) including $ZnAlO_x$ and a second absorbing layer (242) are used together. In the preferred embodiment, at least one of NiCr, $NiCrO_x$, TiO_x, $ZnAlO_x$, ZnO_x is used as the second absorbing layer (242). In the preferred application, the second absorbing layer (242) comprises NiCr. As the seed structure (24), in case the second absorbing layer (242) including NiCr is used together with the seed layer (241), the thickness of the second absorbing layer (242) including NiCr is between 1 nm and 3.0 nm. In the preferred application, the thickness of the second absorbing layer (242) including NiCr is between 1.2 nm and 2.7 nm. In a further preferred application, the thickness of the second absorbing layer (242) including NiCr is between 1.5 nm and 2.4 nm. The thickness of the seed layer (241) including $ZnAlO_x$ is between 10 nm and 35 nm. In the preferred application, the thickness of the seed layer (241) including $ZnAlO_x$ is between 14 nm and 30 nm. In a further preferred application, the thickness of the seed layer (241) including $ZnAlO_x$ is between 18 nm and 26 nm. In the subject matter low-e coating (20), the second absorbing layer (242) including NiCr is used for obtaining the targeted color and low transmittance.

A barrier layer (26) is positioned on the infrared reflective layer (25) including Ag. At least one of NiCr, $NiCrO_x$, TiO_x, $ZnAlO_x$, ZnO_x is used as said barrier layer (26). In the preferred application, the barrier layer (26) comprises $NiCrO_x$. The thickness of the barrier layer (26) including $NiCrO_x$ is between 1 nm and 2 nm. In the preferred application, the thickness of the barrier layer (26) including $NiCrO_x$ is between 1 nm and 1.8 nm. In a further preferred application, the thickness of the barrier layer (26) including $NiCrO_x$ is between 1 nm and 1.6 nm.

A third dielectric layer (27) is positioned on the barrier layer (26) including $NiCrO_x$. At least one of NiCr, $NiCrO_x$, TiO_x, $ZnAlO_x$, ZnO_x is used as said third dielectric layer (27). In the preferred application, the third dielectric layer (27) comprises $ZnAlO_x$. The thickness of the third dielectric layer (27) including $ZnAlO_x$ is between 6 nm and 27 nm. In the preferred application, the thickness of the third dielectric layer (27) including $ZnAlO_x$ is between 10 nm and 23 nm. In a further preferred application, the thickness of the third dielectric layer (27) including $ZnAlO_x$ is between 14 nm and 19 nm.

The barrier layer (26) including $NiCrO_x$ is used for not affecting the infrared reflective layer (25) including Ag from the layers provided thereafter and from the process gases used for production of these layers. At the same time, the barrier layer (26) including $NiCrO_x$ provides structural compliancy in the metallic and dielectric passage between the dielectric layers which will be provided after the infrared reflective layer (25) including Ag. In order for the infrared reflective layer (25) including Ag to be affected by the medium gas at the minimum level during the coating of the barrier layer (26) including $NiCrO_x$, the amount of O_2 used as reactive gas is optimized. Moreover, in order to provide the infrared reflective layer (25) including Ag to be affected at the minimum level from the reactive O_2 gas, the speed of passage under the target is optimized.

A fourth dielectric layer (28) is positioned on the third dielectric layer (27) including $ZnAlO_x$. At least one of Si_xN_y, SiO_xN_y, $ZnSnO_x$, TiO_x, TiN_x, ZrN_x is used as said fourth dielectric layer (28). In the preferred application, the fourth dielectric layer (28) comprises Si_xN_y. The thickness of the fourth dielectric layer (28) including Si_xN_y is between 12 nm and 32 nm. In the preferred application, the thickness of the fourth dielectric layer (28) including Si_xN_y is between 14 nm and 28 nm. In a further preferred application, the thickness of the fourth dielectric layer (28) including Si_xN_y is between 16 nm and 24 nm.

A fifth dielectric layer (29) is positioned on the fourth dielectric layer (28) including Si_xN_y. At least one of Si_xN_y, SiO_xN_y, $ZnSnO_x$, TiO_x, TiN_x, ZrN_x is used as said fifth dielectric layer (29). In the preferred application, the fifth dielectric layer (29) comprises SiO_xN_y. The thickness of the fifth dielectric layer (29) including SiO_xN_y is between 8 nm and 22 nm. In the preferred application, the thickness of the fifth dielectric layer (29) including SiO_xN_y is between 10 nm and 20 nm. In a further preferred application, the thickness of the fifth dielectric layer (29) including SiO_xN_y is between 12 nm and 18 nm.

An upper dielectric layer (30) is positioned on the fifth dielectric layer (29) including SiO_xN_y. At least one of Si_xN_y, SiO_xN_y, $ZnSnO_x$, TiO_x, TiN_x, ZrN_x is used as said upper dielectric layer (30). In the preferred application, the upper dielectric layer (30) comprises TiO_x. The thickness of the upper dielectric layer (30) including TiO_x is between 3.5 nm and 8.5 nm. In the preferred application, the thickness of the upper dielectric layer (30) including TiO_x is between 4.0 nm and 7.5 nm. In a further preferred application, the thickness of the upper dielectric layer (30) including TiO_x is between 4.5 nm and 6.5 nm.

The color performance values, which are related to double glass application with thickness of 6 mm obtained by means of the low-e coating (20) realized in the abovementioned arrangement and method, have been described below.

The glass (10) side reflection b* value changes between -35 and -14. In the preferred application of the present invention, the glass (10) side reflection b* value changes between -32 and -17. More preferably, the glass (10) side reflection b* value changes between -29 and -20. The coating side reflection b* value is between -13 and -2.4. In the preferred application of the present invention, the coating side reflection b* value changes between -10 and -2.8. More preferably, the coating side reflection b* value changes between -6 and -3.2.

As the layers are positioned one above the other as mentioned above, the transmittance Tb value of the low-e coated (20) glass (10) is obtained between -2.0 and 2.2. In the preferred application of the present invention, the transmittance Tb value of the low-e coated (20) glass (10) is obtained between -1.5 and 1.2.

The glass side reflection a* value changes between -7.5 and -2.0. In the preferred application of the present invention, the glass (10) side reflection a* value changes between -7 and -2.5. More preferably, the glass (10) side reflection a* value changes between -6.5 and -3.0. The coating side reflection a* value is between -7.5 and -2.0. In the preferred application of the present invention, the coating side reflection a* value changes between -7.0 and -2.5. More preferably, the coating side reflection a* value changes between -6.5 and -3.0.

In order to obtain the targeted blue color in the subject matter glass, the coating and glass side b* values are important and besides, the coating and glass side a* values and the transmittance Tb value are also important. For instance, when the Tb value is kept close to "0", the shift of the low-e coated (20) glass (10) color to yellow is prevented and thus, the dominance of the blue color in the low-e coated (20) glass (10) is increased. In a similar manner, as the coating and the glass side a* values are kept in the negative region, the shift of the low-e coated (20) glass (10) color to red is prevented and thus, the dominance of the blue color in the low-e coated (20) glass (10) is increased.

In case of use over or under the second dielectric layer (23) thickness including Si_xN_y, the glass side b* shifts towards "0". Thus, coating of the second dielectric layer (23), including Si_xN_y, with a thickness which is outside of the mentioned thickness range, leads to weakening of the dominance of blue color of the low-e coated (20) glass (10) in an undesired manner.

In order to obtain the targeted blue color, the layers, provided under the infrared reflective layer (25) including Ag, play an important role. By means of using the first absorbing layer (22) including NiCr between two Si_xN_y used as the first dielectric layer (21) and the second dielectric layer (23), the formation of a thick Si_xN_y layer is prevented, and thus, increase in Tb transmittance value is prevented. Additionally, the coating and glass side b* value increases in the negative direction, and the color of the low-e coated (20) glass (10) is provided to stay in the blue region. At the same time, by means of usage of the first absorbing layer (22) including NiCr, the targeted low transmittance is obtained and low reflection values on the glass (10) side and on the film side are obtained.

By means of usage of the upper dielectric layer (30), including TiO_x, in the final layer, the a* value of the coating side of the glass (10) is decreased, and the color of the low-e coated (20) glass (10) is prevented from shifting to red color and the glass side and coating side b* values of the color is contributed to stay in the negative region and the color of the low-e coated (20) glass (10) stays in the blue region. TiO_x, which is used as the upper dielectric layer (30), contributes to the mechanical resistance of the low-e coating (20).

As can be seen in the layer arrangement of the subject matter low-e coating (20), the usage of two NiCr layers and one NiCrOx layer is required for reaching the targeted performance. Besides, the encircling of NiCr, which is the first absorbing layer (22), with Si_xN_y, which is the first dielectric layer (21) and the second dielectric layer (23), plays an important role in reaching the daylight transmittance and the total solar energy transmittance and in reaching the targeted color value. Besides, usage of optimum oxygen level in the barrier layer (26), including $NiCrO_x$, is important.

Coating of the third dielectric layer (27), including $ZnAlO_x$, and the fourth dielectric layer (28), including Si_xN_y, and the fifth dielectric layer (29), including SiO_xN_y, and the upper dielectric layer (30), including TiO_x, within the mentioned thickness value ranges provides the coating side b* value to stay in the negative region and contributes to the increase of the dominance of blue color in the low-e coated (20) glass (10).

For instance, in case the fourth dielectric layer (28), including Si_xN_y, is coated at a thickness which is more than the determined thickness range, the glass side and coating side b* values in the low-e coated (20) glass (10) shift towards “0” and the dominance of the blue color decreases. In case said fourth dielectric layer (28), including Si_xN_y, is coated at a lower thickness, the coating side a* value in the low-e coated (20) glass (10) increases towards the positive region and the red color increases and thus, this leads to moving away from the targeted color performance.

Coating of the third dielectric layer (27), including $ZnAlO_x$, and the fourth dielectric layer (28), including Si_xN_y, and the fifth dielectric layer (29), including SiO_xN_y, and the upper dielectric layer (30), including TiO_x, within the mentioned thickness value ranges provides the film and glass side reflection values of the low-e coated (20) glass (10) to stay in the targeted performance values.

The coating side reflection value of the 6 mm single glass for the low-e coated (20) glass (10) is between 20% and 35%. In the preferred application, the coating side reflection value of the 6 mm single glass for the low-e coated (20) glass (10) is between 25% and 30%. The glass (10) side reflection value of the 6 mm single glass for the low-e coated (20) glass (10) is between 10% and 25%. In the preferred application, the glass (10) side reflection value of the 6 mm single glass for the low-e coated (20) glass (10) is between 15% and 20%.

The protection scope of the present invention is set forth in the annexed claims and cannot be restricted to the illustrative disclosures given above, under the detailed description. It is because a person skilled in the relevant art can obviously produce similar embodiments under the light of the foregoing disclosures, without departing from the main principles of the present invention.

CLAIMS

1. A heat treatable low-e coated (20) glass (10) with single silver in order to be used in architectural and automotive glasses, **wherein** the coating side reflection a* value is between -7.5 and -2.0; the glass side reflection a* value is between -7.5 and -2.0; the coating side reflection b* value is between -13 and -2.4; the glass side reflection b* value is between -35 and -14; and Tb value is between -2.0 and 2.2 and the followings are respectively provided outwardly from the glass (10):

- a first dielectric layer (21) selected from Si_xN_y, SiO_xN_y, $ZnSnO_x$, TiO_x, TiN_x, ZrN_x,
- a first absorbing layer (22) selected from NiCr, $NiCrO_x$,
- a second dielectric layer (23) selected from Si_xN_y, SiO_xN_y, $ZnSnO_x$, TiO_x, TiN_x, ZrN_x,
- a seed layer (241) selected from NiCr, $NiCrO_x$, TiO_x, $ZnAlO_x$, ZnO_x,
- a second absorbing layer (242) selected from NiCr, $NiCrO_x$,
- an infrared reflective layer (25),
- a barrier layer (26) selected from NiCr, $NiCrO_x$, TiO_x, $ZnAlO_x$, ZnO_x,
- a third dielectric layer (278) selected from NiCr, $NiCrO_x$, TiO_x, $ZnAlO_x$, ZnO_x,
- a fourth dielectric layer (28) selected from Si_xN_y, SiO_xN_y, $ZnSnO_x$, TiO_x, TiN_x, ZrN_x,
- a fifth dielectric layer (29) selected from Si_xN_y, SiO_xN_y, $ZnSnO_x$, TiO_x, TiN_x, ZrN_x,
- an upper dielectric layer (30) selected from Si_xN_y, SiO_xN_y, $ZnSnO_x$, TiO_x, TiN_x, ZrN_x.

2. A low-e coated (20) glass (10) according to claim 1, wherein the coating side reflection a* value is between -7.0 and -2.5 and the glass side reflection a* value is between -7.0 and -2.5.

3. A low-e coated (20) glass (10) according to claim 1, wherein the coating side reflection b* value is between -10 and -2.8 and the glass side reflection b* value is between -32 and -17.

4. A low-e coated (20) glass (10) according to claim 1, wherein Tb value is between -1.5 and 1.2.

5. A low-e coated (20) glass (10) according to claim 1, wherein the followings are respectively provided outwardly from the glass (10):

- first dielectric layer (21) comprising Si_xN_y,
- first absorbing layer (22) comprising NiCr,

- second dielectric layer (23) comprising Si_xN_y,
- seed layer (241) comprising $ZnAlO_x$,
- second absorbing layer (242) comprising NiCr,
- infrared reflective layer (25) comprising Ag,
- barrier layer (26) comprising $NiCrO_x$,
- third dielectric layer (27) comprising $ZnAlO_x$,
- fourth dielectric layer (28) comprising Si_xN_y,
- fifth dielectric layer (29) comprising SiO_xN_y,
- upper dielectric layer (30) comprising TiO_x.

6. A low-e coated (20) glass (10) according to claim 1, wherein:

- the thickness of the first dielectric layer (21) comprising Si_xN_y is between 16 nm and 40 nm,
- the thickness of the first absorbing layer (22) comprising NiCr is between 2.5 nm and 5.5 nm,
- the thickness of the second dielectric layer (23) comprising Si_xN_y is between 35 nm and 65 nm,
- the thickness of the seed layer (241) comprising $ZnAlO_x$ is between 10 nm and 35 nm,
- the thickness of the second absorbing layer (242) comprising NiCr is between 1 nm and 3.0 nm,
- the thickness of the infrared reflective layer (25) comprising Ag is between 9 nm and 18 nm,
- the thickness of the barrier layer (26) comprising $NiCrO_x$ is between 1 nm and 2 nm,
- the thickness of the third dielectric layer (27) comprising $ZnAlO_x$ is between 6 nm and 27 nm,
- the thickness of the fourth dielectric layer (28) comprising Si_xN_y is between 12 nm and 32 nm,
- the thickness of the fifth dielectric layer (29) comprising SiO_xN_y is between 8 nm and 22 nm,
- the thickness of the upper dielectric layer (30) comprising TiO_x is between 3.5 nm and 8.5 nm.

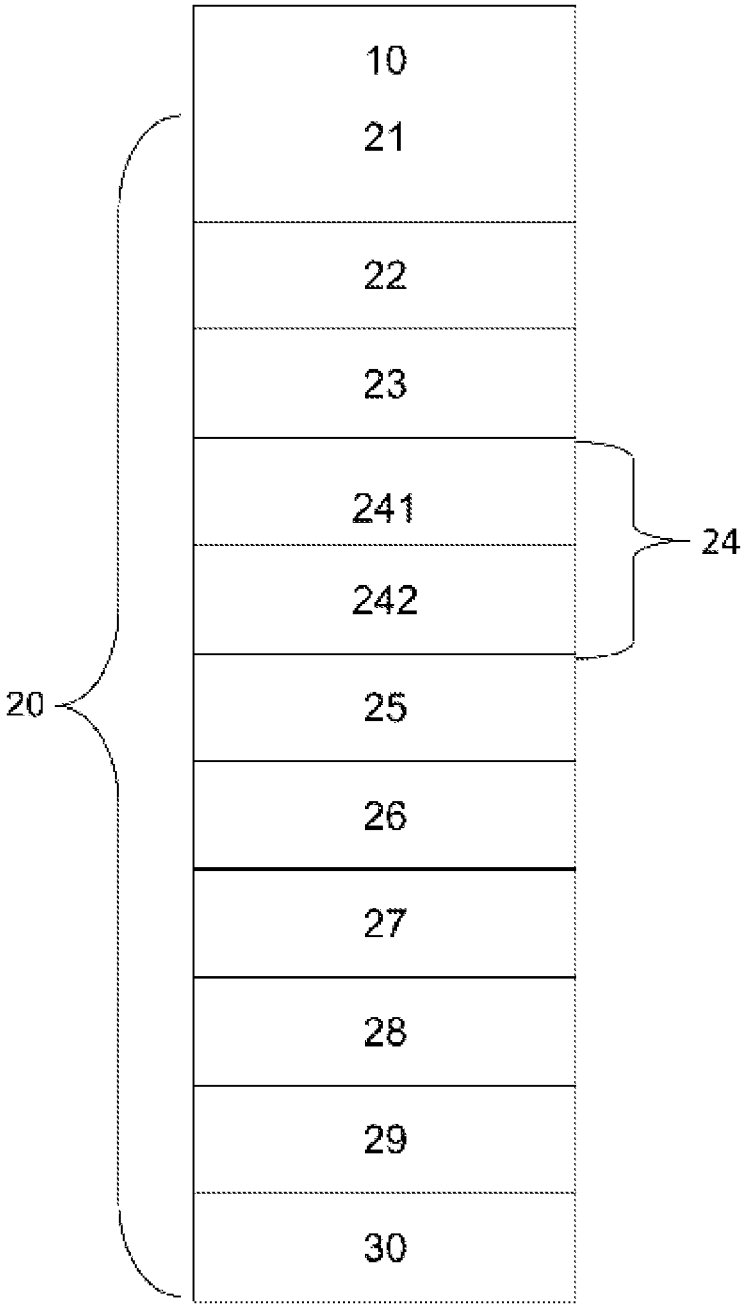

Figure 1