atom% to 80 atom%, with respect to the total amount of metal atoms. When the content of tin atoms (tin oxide) is excessively small, the chemical durability of the metal oxide layer tends to decrease. On the other hand, when the content of tin atoms (tin oxide) is excessively large, the resistance of the sputtering target used in deposition tends to become high, making it difficult to deposit the metal oxide layer by a DC sputtering method.

[0032] The metal oxide layer 21 may contain metals such as Ti, Zr, Hf, Nb, Al, Ga, In, Tl and Ga or metal oxides thereof in addition to zinc oxide and tin oxide. These metals or metal oxides can be added for the purpose of raising the electric conductivity of the target at the time of sputtering deposition to increase the deposition rate, enhancing the transparency of the metal oxide layer or the like purpose. A sum of the content of ~~oxidized~~zinc atoms and the content of tin atoms in the metal oxide layer is preferably 40 atom% or more, more preferably 50 atom% or more, and further preferably 60 atom% or more, with respect to the total amount of metal atoms.

[0033] The thickness of the metal oxide layer 21 is preferably 2 nm or more, and more preferably 3 nm or more. When the thickness is 2 nm or more, the coverage of the metal oxide layer 21 on the transparent film substrate 10 becomes good, so that the adhesion tends to be enhanced. Although an upper limit of the thickness of the metal oxide layer 21 is not particularly limited, the metal oxide layer with a large thickness may cause decrease in the productivity by increase in the deposition time. Therefore, the thickness of the metal oxide layer 21 is preferably as small as possible within a range that can ensure the adhesion between the transparent film substrate and the infrared reflecting layer. Specifically, the thickness of the metal oxide layer 21 is preferably 15 nm or less, more preferably 10 nm or less, and further preferably 8 nm or less.

[0034] Although a method for forming the metal oxide layer 21 is not particularly limited, deposition by a dry process such as a sputtering method, a vacuum vapor deposition method, a CVD method or an electron beam vapor deposition method is preferable, since a thin-film having a uniform thickness can be formed. From the viewpoint of realizing a high deposition rate, the metal oxide layer 21 is preferably deposited by a DC sputtering method and, in particular, the metal oxide layer 21 is preferably deposited by a DC sputtering method using a target containing a metal and a metal oxide.

[0046] As the light absorptive metal layer 25, a metal layer containing at least one selected from the group consisting of nickel (Ni), chromium (Cr), niobium (Nb), tantalum (Ta) and titanium (Ti) is used. Among these, a material of the light absorptive metal layer is preferably a metal containing Ni and/or chromium, particularly preferably a Ni-Cr alloy, from the viewpoint of enhancing the property of protecting the infrared reflecting layer. A sum of the content of Ni and the content of Cr in the Ni-Cr alloy is preferably 50 wt% or more, more preferably 60 wt% or more, further preferably 70 wt% or more, and particularly preferably 80 wt% or more. The Ni-Cr alloy may contain other metals such as Ta, Ti, Fe, Mo, Co, Cu and W in addition to Ni and Cr.

[0047] The thickness of the light absorptive metal layer 25 is preferably 2 nm or more, more preferably 3 nm or more. When the thickness of the light absorptive metal layer 25 is 2 nm or more, the property of protecting the infrared reflecting layer 23 is enhanced to suppress degradation of the infrared reflecting layer 23, and also the visibility of the infrared reflecting film is improved by reduction of the reflectance. On the other hand, when the thickness of the light absorptive metal layer 25 increases, absorption of visible light by the light absorptive metal layer increases, and the visible light transmittance (transparency) of the infrared reflecting film tends to decrease. Therefore, the thickness of the light absorptive metal layer 25 is preferably 15 nm or less, more preferably 10 nm or less, further preferably 8 nm or less, and particularly preferably 6 nm or less.

[0048] Although the method for forming the light absorptive metal layer 25 is not particularly limited, a dry process such as a sputtering method, a vacuum vapor deposition method, a CVD method or an electron-beam deposition method is preferred. Particularly, it is preferred to form the light absorptive metal layer 25 by the DC sputtering method, as with the formation of the metal oxide layer 21 and the infrared reflecting layer 23. In the case where all of the metal oxide layer 21, infrared reflecting layer 23 and the light absorptive metal layer 25 that constitute the functional thin-film 20 are deposited by DC sputtering, it is effective to use a roll-to-roll sputtering apparatus provided with a plurality of deposition chambers since these layers can be formed in one path process. Therefore, the productivity of the infrared reflecting film can be greatly improved.

[0049] <Overall Configuration of Functional Thin-Film and Thickness>

cases for botanical companions or the like, or showcases of freezing or cold storage, to cause the effects of cooling/heating and to prevent rapid changes in temperature.

[0074] As described before with reference to FIG. 3, the infrared reflecting film 100 of the present invention produces a heat-shielding effect and a heat insulating effect by transmitting and introducing indoors the visible light (VIS) from the outdoors and reflecting the near-infrared rays (NIR) from the outdoors with the functional thin-film 20 including the infrared reflecting layer. Further, the infrared reflecting ~~substrate~~film of the present invention has a light absorptive metal layer and thus visible light reflectance is reduced. When the infrared reflecting film is used for a display case, a store window or the like, the heat shielding properties and the heat insulating properties can be imparted without degrading the visibility of commercial products and the like.

[0075] A surface opposite to the functional thin-film 20-forming surface of the transparent film substrate 10 may be provided with an adhesive layer 60 or the like to be used for bonding the infrared reflecting film to a window glass or the like. As the adhesive layer, an adhesive having a high visible light transmittance and a small difference in refractive index with the transparent film substrate 10 is suitably used. For example, an acryl-based pressure sensitive adhesive is suitable as a material of the adhesive layer provided for the transparent film substrate, since it has excellent optical transparency, exhibits appropriate wettability, cohesive property, and adhesion properties, and is excellent in weatherability and heat resistance.

[0076] The adhesive layer preferably has a high visible light transmittance and low ultraviolet transmittance. The degradation of the infrared reflecting layer caused by ultraviolet rays of the sunlight or the like can be suppressed by reducing the ultraviolet transmittance of the adhesive layer. From the viewpoint of reducing the ultraviolet transmittance of the adhesive layer, the adhesive layer preferably contains an ultraviolet absorber. The degradation of the infrared reflecting layer caused by ultraviolet rays from the outdoors can also be suppressed by using a transparent film substrate containing an ultraviolet absorber. An exposed surface of the adhesive layer is preferably temporarily attached with a separator to be covered for the purpose of preventing the contamination of the exposed surface until the infrared reflecting ~~substrate~~film is put into practical use. This can prevent the contamination of the exposed surface of the adhesive layer due to contact with external during usual handling.

[0095] [Table 1]

	Functional thin-film		Transparent protective layer	Finger fat immersion test	Transmittance (%)	Reflectance (%)
	stacking configuration	t (nm)				
Example 1	ZTO (4) / Ag-Pd (16) / Ni-Cr (5)	25	Present	Good	30	26
Example 2	ZTO (4) / Ag-Pd (16) / Ni-Cr (5)	25	Absent	Good	20	49
Example 3	ZTO (4) / Ag-Pd (16) / Ni-Cr (3)	23	Present	Good	38	27
Example 4	ZTO (4) / Ag-Pd (16) / Ni-Cr (10)	30	Present	Good	17	28
Example 5	ZTO (4) / Ag-Pd (16) / Ni-Cr (5) / ZTO (4)	29	Present	Good	30	24
Comparative Example 1	Ni-Cr (4) / Ag-Pd (16) / Ni-Cr (4)	24	Present	Released	25	33
Comparative Example ~~1~~2	ITO (6) / Ap-Pd (16) / Ni-Cr (5)	27	Present	Released	32	25
Comparative Example ~~1~~3	IZO (6) / Ap-Pd (16) / Ni-Cr (5)	27	Present	Released	32	25
Comparative Example 4	Nb_2O_5 (6) / Ap-Pd (16) / Ni-Cr (5)	27	Present	Released	32	25
Comparative Example 5	ZTO (6) / Ag-Pd (16) / Ni-Cr (1)	23	Present	Degraded	51	30
Comparative Example 6	ZTO (6) / Ag-Pd (16) / ZTO (15)	37	Present	Degraded	62	29
Comparative Example 7	ZTO (6) / Ag-Pd (16) / ZTO (30)	52	Present	Good	59	32
Comparative Example 8	ZTO (4) / Ni-Cr (2) / Ag-Pd (16) / Ni-Cr (1)	23	Present	Degraded	39	31

[0096] From the results shown in Table 1, it will be understood that, despite the total thickness of the metal layers and the metal oxide layers being 30 nm or less, the infrared reflecting films of the Examples of the present invention are all excellent in durability without provoking the occurrence of the film releasing or the degradation of the infrared reflecting layer even after the finger fat immersion test. Even in Example 2 in which the infrared reflecting film does not have a transparent protective layer, a finger fat immersion test result equivalent to that of Example 1 was obtained. It can be stated that the improvement in durability provided by the present invention is attributable to the stacking configuration of the metal oxide layers and the metal layers.

[0097] In Comparative Example 1 in which the infrared reflecting film had only a Ni-Cr layer between the substrate film and the infrared reflecting layer, releasing occurred at the interface between the substrate film and the Ni-Cr layer after the finger fat immersion test. Equivalent results were obtained in Comparative Examples 2 to 4 in which the infrared reflecting film was provided with a metal oxide layer other than ZTO between the substrate film and the infrared reflecting layer. From these results, it will be understood that a composite metal oxide layer containing zinc oxide and tin oxide specifically performs a function of enhancing the adhesion between the substrate and the infrared reflecting layer.

[0098] In Comparative Example 5 in which a Ni-Cr layer having a thickness of 1 nm was formed on the infrared reflecting layer, no releasing occurred after the finger fat immersion test; however, degradation of the infrared reflecting layer was observed. Equivalent result was obtained in Comparative Example 8 in which a Ni-Cr layer was formed on both of the front and back surfaces of the infrared reflecting layer. In Example ~~2~~3 and Comparative Example 8, a total thickness of the Ni-Cr layers is the same. However, in Comparative Example 8 in which the thickness of the Ni-Cr layer on the infrared reflecting layer was 1 nm, degradation of the infrared reflecting layer was observed, though the durability was good in Example ~~2~~3 in which the infrared reflecting film had a Ni-Cr layer having a thickness of 3 nm only on one surface of the infrared reflecting layer. From these results, it will be understood that, in the present invention, the light absorptive metal layer on the infrared reflecting layer performs a function of suppressing degradation of silver

that constitutes the infrared reflecting layer, and the thickness of the light absorptive metal layer is preferably 2 nm or more.

[0099] It is to be noted that, in Example 23 and Comparative Example 8, the visible light transmittance also exhibits an approximately equal value, since the total thickness of the Ni-Cr layers is the same. In other words, it will be understood that the configuration of the present invention, in which no metal layer is present between the film substrate and the infrared reflecting layer and in which the metal layer is provided only on the front surface side of the infrared reflecting layer, enhances the durability of the infrared reflecting film without decreasing the transparency as compared with the case in which a metal layer is provided on both surfaces of the infrared reflecting layer. The configuration of the present invention can reduce the number of stacked layers in the functional thin-film as compared with the configuration in which a metal layer is provided on both surfaces of the infrared reflecting layer, so that it can be stated that the configuration of the present invention gives a high productivity of the infrared reflecting film, and the durability, visible light transmittance and productivity are excellent.

[0100] Also in Comparative Example 6 in which ZTO having a thickness of 15 nm was formed on the infrared reflecting layer, the infrared reflecting layer was degraded after the finger fat immersion test as in Comparative Example 5. On the other hand, in Comparative Example 7 in which the thickness of ZTO on the infrared reflecting layer was increased to 30 nm, the result of the finger fat immersion test was good. However, it will be understood that, in Comparative Example 7, the total thickness of the functional thin-film exceeds 50 nm, thereby giving a poor productivity. On the other hand, in Example 3, a good result was obtained even though the thickness of the Ni-Cr layer is 3 nm. From these results, it will be understood that, in the case of forming a metal layer on the infrared reflecting layer, durability can be improved with a smaller thickness than in the case of forming a metal oxide layer, so that the former case gives an excellent productivity of the infrared reflecting film.

DESCRIPTION OF REFERENCE CHARACTERS

[0101] 100, 101: infrared reflecting film

10: transparent film substrate

CLAIMS

1. An infrared reflecting film comprising: a metal oxide layer; an infrared reflecting layer mainly made of silver; and a light absorptive metal layer, in this order on a transparent film substrate, wherein

~~the transparent film substrate includes a cured resin layer on a surface at a side where the metal oxide layer is provided,~~

the metal oxide layer is formed of a composite metal oxide containing zinc oxide and tin oxide,

the light absorptive metal layer has a thickness of 2 nm to 10 nm, and contains at least one selected from the group consisting of nickel, chromium, niobium, tantalum and titanium, and

no metal layer is deposited between the transparent film substrate and the infrared reflecting layer.

2. The infrared reflecting film according to claim 1, wherein the transparent film substrate includes a cured resin layer on a surface at a side where the metal oxide layer is provided, and the cured resin layer ~~of the transparent film substrate~~ and the metal oxide layer are in direct contact with each other.

3. The infrared reflecting film according to claim 1 or 2, wherein the metal oxide layer and the infrared reflecting layer are in direct contact with each other.

4. The infrared reflecting film according to any one of claims 1 to 3, wherein the metal oxide layer has a thickness of 2 nm to 15 nm.

5. The infrared reflecting film according to any one of claims 1 to 4, wherein a sum of thicknesses of the metal layer and the metal oxide layer on the transparent film substrate is 50 nm or less.

6. The infrared reflecting film according to any one of claims 1 to 5, further comprising a transparent resin layer on a surface of the light absorptive metal layer at a side opposite to the infrared reflecting layer.

7. The infrared reflecting film according to any one of claims 1 to 6, having a visible light transmittance of 10% to 50%.