the infrared reflecting layer 23 is preferably 3 nm or more, more preferably 5 nm or more, and further preferably 10 nm or more. An upper limit of the thickness of the infrared reflecting layer 23 is not particularly limited. In consideration of the visible light transmittance and the productivity, the thickness of the infrared reflecting layer 23 is preferably 30 nm or less, more preferably 25 nm or less, and further preferably 20 nm or less.

[0038] Although the method for forming the infrared reflecting layer 23 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 infrared reflecting layer 23 by the sputtering method.

[0039] [Light Absorptive Metal Layer]

The light absorptive metal layer 25 is formed on the infrared reflecting layer 23. The light absorptive metal layer 25 functions as a protective layer for the infrared reflecting layer 23 and performs a function of reducing the visible light reflectance to enhance the visibility of a window glass or the like that is provided with the infrared reflecting substrate.

[0040] A metal layer mainly made of nickel (Ni), chromium (Cr) or a Ni-Cr alloy is preferably used as the light absorptive metal layer 25. These metals reduce the visible light reflectance of the infrared reflecting substrate by absorbing visible light and also can function as a protective layer for the infrared reflecting layer 23. Further, since these metals have low absorptivity of far-infrared rays, these metals perform a function of maintaining the emittance of the infrared reflecting substrate to be low, thereby enhancing the heat insulating properties. In the light absorptive metal layer 25, a sum of the content of Ni and the content of Cr 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 light absorptive metal layer 25 is particularly preferably made of a Ni-Cr alloy in which the content of Ni and Cr is within the above range. The Ni-Cr alloy may contain other metals such as Ta, Ti, Fe, Mo, Co, Cu and W in addition to Ni and Cr.

[0041] 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. When the thickness of the light absorptive metal layer 25

Further, when the content of zinc atoms (zinc oxide) is small, the resistance tends to become high, so that the electric conductivity of a sputtering target in depositing the metal oxide layer by a sputtering method tends to decrease, making it difficult to deposit the metal oxide layer by DC sputtering. On the other hand, when the content of zinc atoms is excessively large, the adhesion to the light absorptive metal layer 25 or the transparent protective layer 30 may decrease.

[0066] The content of tin atoms in the metal oxide layer 27 is preferably 30 atom% to 90 atom%, more preferably 40 atom% to 85 atom%, and further preferably 50 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.

[0067] The metal oxide layer 27 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.

[0068] The thickness of the metal oxide layer 27 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 27 on the light absorptive metal layer 25 becomes good, so that the adhesion tends to be enhanced. The thickness of the metal oxide layer 27 is 25 nm or less. A large thickness of the metal oxide layer leads to increase in the deposition time to reduce productivity. Further, when the thickness of the metal oxide layer is excessively increased, the adhesion rather tends to decrease. Therefore, the thickness of the metal oxide layer 27 is preferably as small as possible within a range that can ensure the adhesion between the metal layer and the transparent protective layer. Specifically, the thickness of the metal oxide layer

viewpoint of enhancing the heat shielding properties, the visible light transmittance is preferably 50% or less, more preferably 45% or less, and further preferably 40% or less. As described above, when the infrared reflecting substrate has a configuration in which the light absorptive metal layer 25 is provided only between the infrared reflecting layer 23 and the transparent protective layer 30 and having no light absorptive metal layer between the transparent substrate 10 and the infrared reflecting layer 23, reflection of visible light can be suppressed while absorption of visible light is suppressed, thereby setting the visible light transmittance to be within the above-mentioned range. In the infrared reflecting substrate of the present invention, the visible light reflectance is preferably 40% or less, more preferably 35% or less, and further preferably 30% or less.

[0085] [Usage]

As described above, the infrared reflecting substrate of the present invention includes the infrared reflecting layer 23, the light absorptive metal layer 25 and the transparent protective layer 30 on one main surface of the transparent substrate 10, and may include other layers between these layers in accordance as necessary. The infrared reflecting substrate of the present invention can be used for windows of buildings, vehicles or the like, transparent 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.

[0086] As described before with reference to FIG. 3, the infrared reflecting ~~film~~substrate 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 infrared reflecting layer 23. Further, the infrared reflecting substrate of the present invention has a light absorptive metal layer and thus visible light reflectance is reduced. When the infrared reflecting substrate 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.

[0087] When the transparent substrate 10 is a rigid body such as a glass plate, the infrared reflecting substrate can be inserted and fitted into a frame body or the like as it is, so as to form a heat-shielding and heat-insulating window. When the