

WINDOW FILM

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a window film which absorbs infrared rays.

Description of the Prior Art

Light reflecting window films have been adhered onto glass windows such as automotive window pane. Such light reflecting window films are useful in that they reflect sunlight, especially infrared rays and prevent room temperatures from rising.

In recent years, curved glass has been used as glass window for recreation vehicles and the like, and light reflecting window films have frequently been adhered to the inside (concave) surface of the curved glass.

If a door with a curved glass window is kept open, sunlight irradiates the light reflecting window film adhered onto the inside surface of the curved glass window, and reflected and condensed to burn interior materials.

In order to prevent the reflection of light only to the inside surface of the light reflecting window film, the application of mat paint or black colored paint is considered.

However, since these methods also prevent light from transmitting, seeing outside from the inside of the room will become difficult, and these methods are difficult to be used practically.

SUMMARY OF THE INVENTION

The present invention addresses a window film which

minimizes the reflection of infrared rays and reduces the intensity of condensed infrared rays even when the inside surface of the curved glass window is irradiated by sunlight.

The inventors of the present invention studied the solutions of the above problems, and found that the above problems were solved by adhering a window film comprising a light reflecting layer and an infrared absorbing layer onto the inside surface of a curved glass window with the light reflecting layer inside, the infrared absorbing layer outside, leading to the completion of the present invention.

The present invention provides a window film comprising a light reflecting layer and an infrared absorbing layer.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a sectional view of an embodiment of a window film according to the present invention ;

FIG. 2 shows a sectional view of another embodiment of a window film according to the present invention ;

FIG. 3 shows a sectional view of another embodiment of a window film according to the present invention ; and

FIG. 4 shows a sectional view of another embodiment of a window film according to the present invention.

PREFERRED EMBODIMENTS OF THE INVENTION

The present invention will be described in detail below.

The light reflecting layer of the window film of the present invention does not reflect all visible lights, but reflects a part of or most part of visible lights, and transmits the rest of the visible lights. The visible light transmittance of the light reflecting

layer is preferably 10 to 80 percent, most preferably 15 to 55 percent.

The examples of light reflecting layers include metal vapor deposited layers, metal spattered layers, ion plated layers, metal powder incorporated layers, electrical plated layers and chemical plated layers, of which metal vapor deposited layers are preferred. The examples of metals used in these layers include aluminum, gold, silver, copper, nickel, cobalt, chromium, tin and indium, of which aluminum is most preferred.

The thickness of the light reflecting layer is preferably in the range between 0.001 and 0.1 micrometers, more preferably in the range between 0.005 and 0.05 micrometers.

The infrared absorbing layer of the window film of the present invention is a layer which can absorb infrared rays, and the infrared absorbency is preferably 80 percent or more, more preferably 90 percent or more. The infrared absorbing layer is required to transmit visible lights, and the transmittance of visible lights is preferably 50 percent or more, more preferably 60 percent or more.

An example of infrared absorbing layer is a layer containing an infrared absorbing agent, more specifically, a transparent base film layer in which an infrared absorbing agent is incorporated, a coat layer containing an infrared absorbing agent, or a print layer containing an infrared absorbing agent. The coat layer containing an infrared absorbing agent, or the print layer containing an infrared absorbing agent is preferably provided on at least one surface of a transparent base film.

Infrared absorbing agents include inorganic infrared absorbing agents such as tin oxide, indium oxide, magnesium oxide,

titanium oxide, chromium oxide, zirconium oxide, nickel oxide, aluminum oxide, zinc oxide, iron oxide, antimony oxide, lead oxide and bismuth oxide; and organic infrared absorbing agents such as phthalocyanines, naphthalocyanines and anthraquinones.

Inorganic infrared absorbing agents are preferably particulate, and their average particle diameter is preferably in a range between 0.005 and 1 micrometer, more preferably in a range between 0.01 and 0.5 micrometer. The particle diameter distribution of the inorganic infrared absorbing agents is preferably 1 micrometer or less for increasing the transmittance of visible lights.

It is preferred that infrared absorbing agents are highly dispersed.

The amount of an infrared absorbing agent is preferably in a range between 0.5 and 20 g/m², more preferably in a range between 1 and 10 g/m² relative to the unit area of the window film.

The thickness of the infrared absorbing layer is not limited, but in the case of a coat layer containing an infrared absorbing agent or a print layer containing an infrared absorbing agent, the thickness of the infrared absorbing layer is in a range between 0.5 and 15 micrometers, preferably in a range between 1 and 10 micrometers. In the case of a film layer comprising a transparent base film in which an infrared absorbing agent is incorporated, the thickness of the film layer is in a range between 5 and 200 micrometers, preferably in a range between 10 and 100 micrometers.

Examples of transparent base films in which an infrared absorbing agents are incorporated include films or laminated film of various resins including polyolefin resins such as polyethylene and

polypropylene, vinyl chloride resins, styrene resins, ABS resins, polyvinyl alcohol, acrylic resins, acrylonitrile - styrene resins, vinylidene chloride resins, AAS resins, AES resins, polyurethane resins, polyvinyl butyral resins, poly - 4 - methylpentene - 1 resins, polybutene - 1 resins, vinylidene fluoride resins, vinyl fluoride resins, fluorocarbon resins, polycarbonate resins, polyamide resins, polyacetal resins, polyphenylene oxide resins, polyester resins such as polybutylene terephthalate and polyethylene terephthalate, polyphenylene sulfide resins, polyimide resins, polysulfone resins, polyether sulfone resins, aromatic polyester resins and polyallylate resins. Among these films, polyester resin films, vinyl chloride resin films and polyolefin resin films are preferred and polyester resin films are most preferred.

A coat layer containing an infrared absorbing agent or a print layer containing an infrared absorbing agent is a layer comprising an infrared absorbing agent and a binder. The binder includes, for example, a thermoplastic resin and an ultraviolet curing resin such as acrylic resins, polyester resins, epoxy resins, phenolic resins, polyurethane resins, butyral resins, diallyl phthalate resins and silicone resins. Preferred binders are acrylic resins, polyester resins and butyral resins.

A coat layer containing an infrared absorbing agent or a print layer containing an infrared absorbing agent is preferably provided on at least one surface of a transparent base film. The transparent base film is the same as the film in which an infrared absorbing agent is incorporated described above.

The thickness of the transparent base film may be selected suitably, and is normally in a range between 5 and 200 micrometers, and is preferably in a range between 10 and 100 micrometers.

The window film of the present invention may be provided with a protective layer for protecting the surface of the infrared absorbing layer. The protective layer may be any layer which prevents contamination or damage, and is preferably a transparent base film layer or a transparent coat layer.

The window film of the present invention is preferably provided with an infrared absorbing layer on one surface of the light reflecting layer and an adhesive layer on the other surface of the light reflecting layer for adhesion onto the glass surface.

The adhesive layer includes, for example, a layer containing an adhesive such as pressure sensitive adhesives, heat sensitive adhesives and moisture sensitive adhesives. The pressure sensitive adhesives may be natural rubber, synthetic rubber, acrylic, polyvinyl ether, urethane, or silicone pressure sensitive adhesives. The examples of synthetic rubber pressure sensitive adhesives are styrene - butadiene rubber, polyisobutylene rubber, isobutylene - isoprene rubber, isoprene rubber, styrene - isoprene block copolymer, styrene - butadiene block copolymer, styrene - ethylene - butylene block copolymer and ethylene - vinyl acetate thermoplastic elastomer. The examples of acrylic pressure sensitive adhesives are the polymers or copolymers of acrylic acid, methyl acrylate, ethyl acrylate, propyl acrylate, butyl acrylate, 2 - ethylhexyl acrylate, ethyl methacrylate, butyl methacrylate and acrylonitrile. The examples of polyvinyl ether resin pressure sensitive adhesives are polyvinyl ether and polyvinyl isobutyl ether. An example of silicone pressure sensitive adhesives is dimethyl polysiloxane. Among these pressure sensitive adhesives, an acrylic resin pressure sensitive adhesive is preferred.

These adhesives may be used alone, or in combination of two or more adhesives.

These adhesives may contain tackifiers, fillers, softening agents, heat and light stabilizers, antioxidants, or crosslinking agents as required. The tackifiers include rosins, terpene - phenolic resins, terpene resins, aromatic hydrocarbon modified terpene resins, petroleum resins, cumarone - inden resins, styrene resins, phenolic resins and xylene resins. The fillers include zinc oxide, titanium oxide, silica, calcium carbonate and barium sulfate. The softening agent includes process oil, liquid rubber and plasticizers. The heat and light stabilizers include benzophenones, benzotriazoles and hindered amines. The antioxidants include anilides, phenols, phosphites and thioesters.

The adhesive layer may be provided by various methods including the method in which an adhesive dissolved in a suitable solvent is applied to the base film, the method in which an adhesive dispersed or emulsified in a suitable medium is applied to the base film, the method in which an adhesive is applied with calendar rolls without using solvents, the method in which an adhesive layer formed on release liner is transferred, and the method in which a double - sided adhesive tape is overlaid on a base film.

The thickness of the adhesive layer is not limited to a specific thickness, and is normally in a range between 10 and 100 micrometers, preferably in a range between 20 and 50 micrometers.

Release liner may be applied on the surface of the adhesive layer.

The window film of the present invention may be provided with a heat sensitive adhesive layer or a moisture sensitive adhesive layer as the adhesive layer described above.

Heat sensitive adhesives used in the heat sensitive adhesive layer may be various heat sensitive homopolymers or copolymers,

such as ethylene – vinyl acetate copolymers, ethylene – acrylic ester copolymers, phenoxy resins, nylon 11, nylon 12, saturated polyesters, cumarone – inden resins, rosins, styrene – isoprene – styrene copolymer rubber, styrene – butadiene – styrene copolymer rubber, polyethylene resins and polyurethane resins. Among these materials, ethylene – vinyl acetate copolymers and ethylene – acrylic ester copolymers are preferred.

Moisture sensitive adhesives used in the moisture sensitive adhesive layer may be various moisture sensitive adhesives such as polyacrylic amide, polyacrylic acid, polyacrylate ester, polyvinyl alcohol, polyvinyl ether, cellulose derivatives and processed starch. These may be used alone or in combination with one or more other materials.

The heat sensitive and moisture sensitive adhesive layers may contain tackifiers, fillers, softening agents, heat and light stabilizers, antioxidants, or cross – linking agents as required. These additives are same as additives for the above – mentioned adhesives.

The adhesion force of the heat sensitive adhesives is revealed by heating, and adheres to articles firmly. The adhesion force of the moisture sensitive adhesives is revealed by solvents such as water, and adheres to articles firmly.

The thickness of the heat sensitive and moisture sensitive adhesive layers may be selected suitably, and is normally in a range between 3 and 100 micrometers, preferably in a range between 5 and 50 micrometers.

Since the heat sensitive adhesives have no adhesion force at a normal temperature, and the moisture sensitive adhesives have no adhesion force unless they are exposed to solvents, they do not adhere to articles even if they are contacted with other members,

and therefore, the application of release liner on the surface is not required.

The heat sensitive and moisture sensitive adhesive layers may be provided by various methods. For example, these layers may be provided by the same method as in the method for providing the above adhesive layers.

When a double - sided adhesive tape on which the heat sensitive or moisture sensitive adhesive layers are provided is used for lamination, the heat sensitive or moisture sensitive adhesive layer on either side may be replaced by a pressure sensitive adhesive layer.

In the window film of the present invention, the light reflecting layer and the adhesive layer may be laminated directly, or may be laminated via the intervening transparent base film.

The transparent base film may be the same as the one described above.

The thickness of the transparent base film may be selected suitably, and is normally in a range between 5 and 200 micrometers, preferably in a range between 10 and 100 micrometers.

Typical constitutions of the window films of the present invention will be described referring to sectional views of FIGS. 1 through 4.

The embodiment shown in FIG. 1 is a window film comprising an infrared absorbing layer 2 composed of a coat layer containing an infrared absorbing agent laminated on one side of a light reflecting layer 1, a transparent base film 3 laminated on the other side of the light reflecting layer 1, and a pressure sensitive adhesive layer as an adhesive layer 4 laminated of the surface of the transparent base film 3.

The embodiment shown in FIG. 2 is a window film comprising an infrared absorbing layer 2 composed of a transparent base film containing an infrared absorbing agent laminated on one side of a light reflecting layer 1, and a heat sensitive adhesive layer as an adhesive layer 4 laminated of the surface of the other side of the light reflecting layer 1.

The embodiment shown in FIG. 3 is a window film comprising an infrared absorbing layer 2 composed of a coat layer containing an infrared absorbing agent laminated on one side of a light reflecting layer 1, a transparent base film 3 laminated on the surface of the infrared absorbing layer 2, and a pressure sensitive adhesive layer as an adhesive layer 4 laminated of the other surface of the light reflecting layer 1.

The embodiment shown in FIG. 4 is a window film comprising a transparent base film 3 laminated on the one side of a light reflecting layer 1, an infrared absorbing layer 2 laminated on the transparent base film 3, and a moisture sensitive adhesive layer as an adhesive layer 4 laminated on the other surface of the light reflecting layer 1.

In the above embodiments shown in FIGS. 1 through 4, those comprising a print layer containing an infrared absorbing agent in place of a coat layer containing an infrared absorbing agent may be included as typical examples.

Each layer constituting the window films may be laminated via an intervening adhesive layer, or may be laminated directly without intervening adhesive layers.

If anchoring force between each layer and the adhesive layer is insufficient, the surface of each layer to be coated with the adhesive may be treated with corona discharge, or may be provided

with a primer layer by applying a primer mainly composed of polyester, urethane, or chlorinated polyolefin, and containing a filler as required. Various fillers may be used for this purpose including silica, calcium carbonate, magnesium carbonate, kaolin, sintered clay, bentonite, zeolite, talc and diatomaceous earth.

The transmittance of visible lights of the window film of the present invention is preferably in a range between 10 and 80 percent, more preferably in a range between 15 and 55 percent.

The window film of the present invention can be used in various applications. A particularly available application of the window film of the present invention is the curved glass window for doors of motor vehicles.

Accordingly, the present invention can also provides a method of adsorption of infrared rays by using the window film of the present invention on window glass, more preferably curved glass window for doors of motor vehicles.

The effect of the window film of the present invention when used for curved glass window for doors of motor vehicles will be described below.

When the doors of a motor vehicle are closed, a part of or most sunlight is reflected by the light reflecting layer of the window film adhered on the transparent curved glass window. The thickness of the light reflecting layer is adjusted to transmit a part of or most sunlight, and the rest of sunlight transmitted through the light reflecting layer is transmitted through the infrared absorbing layer, and enters into the vehicle. Therefore, the passenger can see outside from the vehicle.

On the other hand, when the door of the motor vehicle is open, sunlight irradiates the inside surface of the window film

adhered on the curved glass window, and infrared rays are absorbed by the infrared absorbing layer, and visible lights and ultraviolet rays and infrared rays that have not been absorbed are reflected by the light reflecting layer, transmitted through the infrared absorbing layer and enter into the vehicle. Thus, using the window film of the present invention, which is constituted by an infrared absorbing layer, a light reflecting layer, (and glass) in the order from inside, since sunlight passes through the infrared absorbing layer twice before coming out as reflected light, infrared rays are absorbed efficiently. Therefore, no or little infrared rays reach the inside of the vehicle, and rise in temperature of articles inside the vehicle, or fire may be prevented.

When an ultraviolet absorbing agent is added to the infrared absorbing layer, the transparent base film, or the adhesive layer, or when an ultraviolet absorbing layer is provided, the discoloration of articles or the suntan of passengers may be prevented.

The present invention will be described more specifically referring to embodiments. It should be noted that the present invention is not limited by these examples.

Example 1

On a transparent base film 3 (a polyester resin film, thickness: 50 micrometers, "Lumilar T-60" from Toray Industries Inc.), a light reflecting layer 1 was formed by the vapor deposition of aluminum to a visible light transmittance of 18 percent (thickness of aluminum layer: 0.018 micrometer), and the surface of the light reflecting layer 1 was coated with an ultraviolet curing acrylic resin ("SH-1" from Sumitomo Osaka Cement CO.,LTD.) in

which fine tin oxide powder (average particle diameter : 0.2 micrometer, particle diameter distribution : 0.01 to 0.5 micrometer) is dispersed, so that the thickness became 7 micrometers after curing using a Meyer bar, cured by the irradiation of ultraviolet rays to form an infrared absorbing layer 2. The amount of dispersed tin oxide was 3.5 g/m².

Next, an acrylic pressure sensitive adhesive comprising 100 parts by weight of an acrylic ester based copolymer, "T-717", from Sainen Chemical Industry CO.,LTD. and 1.0 part by weight of "Collonate L" from Nippon Polyurethane Industry CO.,LTD. was applied to the surface of the transparent base film 3 so that the thickness became 20 micrometers after drying to form a window film.

The resulting window film is adhered onto a transparent float glass of a thickness of 3 mm, and the index of light reflection was measured using a spectro photometer, "UV - 3100PC", from Shimadzu Corporation. The results are shown in Table 1. Light was radiated from the side of a transparent float glass on which no window film had been adhered, and the transmittance of light through the window film was measured. The results are shown in Table 2.

The index of light reflection and transmittance were measured in accordance with JIS R3106.

Comparative Example 1

A window film was fabricated in the same manner as in Example 1 except that the infrared absorbing layer 2 was not provided.

The index of light reflection and the transmittance of light of this window film were measured in the same manner as in Example 1. The results are shown in Tables 1 and 2.

Table 1

Wavelength of light	Index of reflection	
	Example 1	Comparative Example 1
550 nm	38 %	58 %
1000 nm	41 %	60 %
1500 nm	7 %	70 %
2000 nm	5 %	79 %
2500 nm	6 %	88 %

Table 2

Wavelength of light	Transmittance	
	Example 1	Comparative Example 1
550 nm	15 %	18 %
1000 nm	8 %	10 %
1500 nm	3 %	5 %
2000 nm	0 %	3 %
2500 nm	0 %	1 %

From Table 1, the index of light reflection of the window film of the present invention much decreases in the infrared region indicating that the window film absorbs much infrared rays.

Table 2 shows that the transmittance of light of the window film of the present invention is almost the same as the transmittance of light of the window film of Comparative Example 1, and that the transmittance of visible lights does not decrease to

a large extent.

The transmitted color of the window film of the present invention was only a little darker than that of the window film of Comparative Example 1, and the color was not so much changed and was practically acceptable.

The window film of the present invention, when adhered onto the inside of curved glass windows, decreases the reflection of infrared rays, and reduces the intensity of condensed infrared rays, even if sunlight is radiated on the surface of the window film.

The entire disclosure of Japanese Patent Application No. Hei 8-89066 filed on March 19, 1996 including specification, claims, drawings and summary are incorporated herein by reference in its entirety.



What is claimed is:

1. A window film comprising a light reflecting layer and an infrared absorbing layer.
2. A window film comprising an infrared absorbing layer provided on one surface of a light reflecting layer, and an adhesive layer provided on the other surface of the light reflecting layer.
3. A window film comprising an infrared absorbing layer provided on one surface of a light reflecting layer via an intervening transparent base film, and an adhesive layer provided on the other surface of the light reflecting layer.
4. A window film comprising an infrared absorbing layer provided on one surface of a light reflecting layer, and an adhesive layer provided on the other surface of the light reflecting layer via an intervening transparent base film.