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## (54) Light-transmissible plate shielding electromagnetic waves.

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| | |
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| **EP-A- 0 145 201** | **DE-A- 3 430 406** |
| **GB-A- 2 042 854** | **GB-A- 2 121 075** |
| **US-A- 3 760 215** | **US-A- 3 984 581** |
| **US-A- 4 128 303** | **US-A- 4 381 421** |
| **US-A- 4 422 721** | **US-A- 4 433 247** |

**THIN SOLID FILMS, vol.124, no. 3/4,February 1985, pages 323-333, Lausanne, CH; A.J. PERRY et al.: "Hardness, adhesion and abrasion resistance of TiO2 films on glass"**

**PATENT ABSTRACTS OF JAPAN, vol. 8, no. 97 (P-272)(1534), May 1984; & JP-A-59 10 901**

(73) Proprietor: **TORAY INDUSTRIES, INC.**
**2, Nihonbashi-Muromachi 2-chome**
**Chuo-ku**
**Tokyo 103(JP)**

(72) Inventor: **Saito, Takeshi**
**15-B4-15, Sonoyama 2-chome**
**Otsu-shi Shiga-ken, 520(JP)**
Inventor: **Okamoto, Kazuo**
**87, Obori, Biwanosho**
**Joyo-shi Kyoto-fu, 610-01(JP)**
Inventor: **Tsuchida, Masaki**
**23-7, Nishiyakura 3-chome**
**Kusatsu-shi Shiga-ken, 525(JP)**
Inventor: **Nagai, Satoshi**
**13-1, Sonoyama 2-chome**
**Otsu-shi Shiga-ken, 520(JP)**

(74) Representative: **Coleiro, Raymond et al**
**MEWBURN ELLIS**
**York House**
**23 Kingsway**
**London WC2B 6HP (GB)**



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Rank Xerox (UK) Business Services
(3.10/3.09/3.3.3)

**PATENT ABSTRACTS OF JAPAN, vol. 8, no. 92 (P-271)(1529), 27. April 1984;& JP-A-59 7902**

**PATENT ABSTRACTS OF JAPAN, vol. 9, no. 86 (P-349)(1809), 16. April 1985; JP-A-59 216 101**

## Description

The present invention relates to a light-transmissible plastic plate which shields electromagnetic waves. More particularly, the present invention relates to a light-transmissible plate capable of effectively shielding deleterious electromagnetic waves which are generated from a display or a Braun tube etc. Moreover, the present invention relates to a light-transmissible plate having durability and the function of reducing reflection.

Displays of office automation equipment, for example word processors or computers etc., or Braun tubes of game machines or television sets generate deleterious electromagnetic waves. There are some problems due to the electromagnetic waves, which are often pointed out, for example, problems with respect to health and noises which influence other equipment. For instance, it often happens that false signals due to noises come into a computer. It also happens that noises of a stereo are generated when both the stereo and a television set are operating at the same time.

Many improvements have been carried out to solve the problems. One of the improvements is a method of covering the equipment which generates electromagnetic waves with electroconductive material such as a metal. For example, a cloth capable of shielding electromagnetic waves and an "Eyesaver" (the trade name of a product of Chori Kabushiki Kaisha, a Japanese company) are known. The cloth is constructed by adhering carbon onto a fiber with small diameter and then weaving the fiber to form a meshed structure, and the cloth is applied on equipment which generates electromagnetic waves. "Eyesaver" is constructed of glass sheets and metal wire positioned between the sheets.

However, since the above methods cause a partial intercepting of the ray from a display, it becomes rather difficult for an operator of the equipment to look at the display clearly.

A method of forming an evaporation coating layer of electroconductive material on a glass plate is also known. Such a method is disclosed, for example, in Japanese Patent Publication No. SHO 49-18447. Likewise GB-A-2121075 discloses a method of forming a heatwave shielding lamination coating of electroconductive material on a glass window using the DC magnetron sputtering method. In this method a car window pane is heated to 370 °C in an atmosphere at a pressure of 3 x $10^{-3}$ Torr. The lamination coating includes layers of the same refractive index at visible wavelengths but different refractive indices at infrared wavelengths. However, when such methods are applied to a plastic base plate, the base plate is liable to soften or to melt, and is liable to be damaged at the surface. Therefore, the method cannot be applied for manufacturing a light-transmissible plastic plate.

Moreover, with respect to anti-reflection film technology, various forming methods and various structures thereof are disclosed. US-A-4422721 describes the application to glass of anti-reflection coatings each comprising a layer of low refractive index carrying an electroconductive layer of high refractive index. EP-A-0145210 describes anti-reflection optical coatings provided on an anti-reflective panel of unspecified material and bonded to the viewing screen of a cathode ray tube. The anti-reflection optical coatings each include an electroconductive layer and a free surface layer of a material having a refractive index lower than that of the electroconductive layer. This document is acknowledged under Art 54(3) EPC. Japanese Patent Publication No. SHO 59-48702, SHO 59-78301 and SHO 59-78304 disclose a method of providing anti-reflection coatings wherein a hard coating film comprising a polyorganosilane or a hardened film comprising an epoxy resin is formed on a plastic base plate and then an anti-reflection film comprising inorganic material is coated on the above hard coating layer. Japanese Patent Publication No. SHO 56-113101 discloses a structure wherein an anti-reflection film comprising a plurality of oxide compound layers is provided on a plastic base plate. The structure has high hardness at the surface and a satisfactory anti-reflection function, but adhesion between the base plate and the film, heat resistance, shock resistance, hot water resistance and weather resistance thereof are not satisfactory. Japanese Patent Publication Nos. SHO 45-6193, SHO 59-48702, SHO 59-78301 and SHO 59-78304 disclose other structures including other anti-reflection films, but the adhesion between the base plate and the anti-reflection film in these structures is also unsatisfactory, and the surfaces of anti-reflection films are liable to be damaged. Moreover, the plates are liable to be damaged by water or alcohol, and the structures have adhesion problems between the base plate and the film after dipping the plate into hot water and also in severe weather.

Although several conventional technologies have been described, all of these technologies have a problem in connection with adhesion between a hard coating layer provided on a base plate and a layer of anti-reflection film provided on the hard coating layer. Therefore, the anti-reflection film tends to separate from the hard coating layer over a long period of time.

The present invention seeks to provide a light-transmissible plate which can shield electromagnetic waves wherein an electroconductive layer is coated on a base plate, even if the base plate is constructed of a plastic material.

The present invention in one of its aspects also seeks to provide a technology wherein hardness at a surface of the light-transmissible plate can be increased.

Furthermore the invention seeks to provide a technology wherein the light-transmissible plate can also have a function of anti-reflection.

In particular, the present invention, according to another aspect, seeks to provide a light-transmissible plate which includes an anti-reflection film having excellent physical properties in various respects.

Thus, the present invention provides, according to one aspect, a light-transmissible plate capable of transmitting visible light and yet shielding electromagnetic waves generated by electronic equipment and having:

a transparent plastic base plate;

on a surface of the transparent base plate, a first hard coating layer having scratch resistance;

on a surface of the hard coating layer remote from the transparent plastic base plate, an electroconductive layer, which electroconductive layer contains indium oxide and tin oxide;

on a surface of the electroconductive layer remote from the transparent plastic base plate, a layer having a refractive index in the visible light region which is lower than that of said electroconductive layer;

on a surface of the transparent plastic base plate which is to face a viewer, a second hard coating layer; and

on a surface of the second hard coating layer remote from the transparent plastic base plate, an antireflective coating, which antireflective coating consists of a plurality of layers, wherein the first hard coating layer on which is disposed the electroconductive layer is disposed on a surface of the transparent base plate which is to face the source of visible light, being opposite to the surface of the transparent base plate on which the second hard coating layer is disposed.

According to other aspects, the invention provides (i) an electronic device having a source of visible light and including the above light transmissible plate, and (ii) the use, for the transmission of light from a light source of an electronic device while at the same time shielding electromagnetic waves from the electronic device, of the above light transmissible plate.

According to another aspect, the invention provides a method of preparing the above plate, which method comprises the steps of

(i) forming, on a first surface of a transparent plastic base plate, a first hard coating layer having scratch resistance;

(ii) forming, on a surface of the hard coating layer remote from the transparent plastic base plate, an electroconductive layer containing indium oxide and tin oxide, which step is carried out by evaporation coating using plasma due to high-frequency electric discharge, in an atmosphere of oxygen and at a temperature of less than 150 °C, with the assistance of an ion gun;

(iii) forming, on a surface of the electroconductive layer remote from the transparent plastic base plate, a layer having a refractive index in the visible light region which is lower than that of the electroconductive layer;

(iv) forming, on a second surface of the transparent plastic base plate opposite to the first surface thereof, the second hard coating layer; and

(v) forming, on a surface of the second hard coating layer remote from the transparent plastic base plate, an antireflective coating consisting of a plurality of layers.

Embodiments of the present invention will now be described in some detail with reference to the accompanying drawings.

FIG. 1 is a sectional view of a light-transmissible plate having the function of shielding electromagnetic waves and the function of resisting static charge according to one embodiment of the present invention. Hard coating layer 2 is provided on one surface of the transparent base plate 1, and the hard coating layer 2 has scratch resistance. Electroconductive layer 3 is provided on a surface of the hard coating layer 2. Layer 4 is provided on a surface of the electroconductive layer 3, and layer 4 has a lower refractive index than the refractive index of the electroconductive layer 3. On another surface of base plate 1, hard coating layer 2' having scratch resistance is provided, and an anti-reflection film 4' is provided on the hard coating layer 2'. Numeral 5 refers to a portion of an exposed surface of electroconductive layer 3. Light-transmissible plate 100 is disposed so as to direct a surface having electroconductive layer 3 toward a surface generating picture image, for example, a surface of a cathode-ray tube.

FIG. 2 is a plan view of the light-transmissible plate 100 in FIG. 1. Exposed surface 5 of electroconductive layer 3 may be formed either along the entire periphery of the light-transmissible plate 100, or along only a part of the periphery. For shielding electromagnetic waves and/or for eliminating static electricity, a metal frame (not shown) is provided around the plate 100 so as to contact with electroconductive layer 3, or an earthing wire 6 is connected to the electroconductive layer 3. The earthing wire 6 is connected desirably to a corner of electroconductive layer 3.

FIG. 3 - 7 show preferred embodiments according to the present invention in relation to connecting an earthing wire. In FIG. 3, hole 9 is provided through the light-transmissible plate 100, and an earthing wire 15 is connected thereto via metal fitting piece 6a. In the connection, it is desirable to use a metal packing 7. Metal fitting piece 6a is fixed by a fixing means, for example, set screw 10a and nut 10b (FIG.3), or a caulking piece 8 (FIG. 4). Then the portion of the connection is covered by a plastic cover 11. FIG. 5 shows an embodiment wherein metal fitting piece 6a is fixed nearly parallel to light-transmissible plate 100 in plastic cover 11. FIG. 6 shows an embodiment wherein helical insert 12 is fitted into hole 9 and earthing wire 15 is fixed by screw 13 via metal fitting piece 6a. In this case, providing a hole 11a on the cover 11 facilitates removing the screw 13, and the structure is convenient for removing light-transmissible plate 100 from equipment or cleaning the plate 100. FIG. 7 shows an embodiment wherein earthing wire 15 is connected to the plate 100 via adjuster 14a and 14b.

FIG. 8 is a partial sectional view of a light-transmissible plate having an anti-reflection film constituted by a plurality of layers according to a second embodiment of the present invention. On one surface of transparent plastic base plate 1, hard coating layer 2, electroconductive layer 3 and layer 4 having a lower refractive index than the refractive index of electroconductive layer 3 are provided, and on another surface of base plate 1, hard coating layer 2' having scratch resistance and anti-reflection film 20 are provided. Anti-reflection film 20 is constructed of No. 1 layer 21, No. 2 layer 22, No. 3 layer 23 and No. 4 layer 24.

A particular embodiment of the present invention is now described.

A first hard coating layer having scratch resistance is provided on a first surface of a transparent plastic base plate. A plastic constituting the base plate may be any conventional plastic. The transparent base plate means any plastic plate capable of transmitting light. In the case where a light-transmissible plate is used for a display of a word processor etc., it is desirable to apply a base plate set to the transmittance of visible rays of 25 - 70% by its own color or dyeing. Fatigue of the eyes of an operator is reduced by the above restriction. The hard coating layer having scratch resistance means a coating layer having high hardness, for example, a layer including polyorganosiloxane, silica or alumina, or a coating layer constructed of a hardening paint, for example, an acrylic paint. Although the surface of a plastic plate is generally liable to be damaged, characteristics of the surface can be improved by the hard coating layer, and at the same time, adhesion or a layer shielding electromagnetic waves is raised by under-coating the hard coating layer. Most preferably, the hard coating layer consists of a polyorganosiloxane which is produced by heat-condensing after coating methyltrimethoxysilane and vinyltriethoxysilane or after coating a hydrolysis compound thereof. A desirable film thickness of the hard coating layer is in the range of about 1 - 10 µm. The hard coating layer including the acrylic is constructed of, for example, a compound crosslinked with an acrylic compound and an ester compound. The acrylic compound is constructed of, for example, methacrylic acid and the ester compound is constructed of, for example, an ester compound produced from an ester and a polyfunctional glycol, for example, pentaerythritol or glycerin.

Next, an electroconductive layer is provided on a surface of the hard coating layer. Any material having electroconductivity and capable of transmitting light can be used for the electroconductive layer, but preferably the layer is constructed of a mixture with indium oxide ($In_2O_3$) and tin oxide ($SnO_2$), referred to hereinafter as "ITO". "ITO" has high electroconductivity, can shield electromagnetic waves effectively and can transmit visible rays. A film thickness of the "ITO" layer may be any thickness as long as the layer can satisfy the above functions. A desirable thickness is in the range of 100 - 3000Å (10-300nm) If a thickness of more than 300 nm is utilized, cracking is liable to occur. The "ITO" layer can be coated by sputtering. Other methods can be applied for forming the "ITO" layer. For example, the "ITO" layer is formed by evaporation coating using plasma due to high-frequency electric discharge in an atmosphere of oxygen and in a temperature condition of less than 150 °C, with the assistance of an ion gun.

Next, a layer having a lower refractive index than the refractive index of the electroconductive layer is provided on the surface of the electroconductive layer. Generally, since an electroconductive layer includes metal, the refractive index of the layer is high. For example, the refractive index of the "ITO" layer is about 2.0. As an amount of reflection becomes larger due to the high refractive index, fatigue of the eyes of the operator also becomes larger. Therefore, it is necessary to provide a layer having a low refractive index on the surface of the electroconductive layer, thereby preventing reflection to the light-transmissible plate. The layer having a low refractive index may be any conventional layer of low refractive index, but desirably the layer is a layer including inorganic silica. The layer including inorganic silica can be formed by sputtering the silica or by vacuum evaporation coating of the silica. The film thickness of the layer may be any thickness as long as the layer can appropriately prevent reflection.

The first hard coating layer, the electroconductive layer and the layer having the low refractive index are provided on the first surface of the base plate, while on a second surface of the base plate opposite the first surface at least a second hard coating layer is provided and on this second hard coating layer an anti-reflection coating is provided.

The anti-reflection coating is a film composed of a plurality of layers which in turn may be referred to as a No. 1 layer, No. 2 layer, No. 3 layer and a No. 4 layer. The No. 1 layer is provided on the surface of the second hard coating layer. The principal ingredient of the No. 1 layer is zirconium oxide. The No. 2 layer is provided on the surface of the No. 1 layer, and the principal ingredient of the No. 2 layer is silicon dioxide. The No. 1 layer serves as a binder between the hard coating layer and the No. 2 layer, and the strength of both adhesions between the hard coating layer and the No. 1 layer and between the No. 1 layer and the No. 2 layer is increased. The No. 2 layer raises the strength of adhesion to both the No. 1 layer and the No. 3 layer. Alternatively, if the No. 1 layer and the No. 2 layer are constructed as a single film equivalent to a film provided by separate No. 1 and No. 2 layers, the equivalent film can be a film having a middle refractive index, ie a refractive index between that of the No. 3 layer having a high refractive index and that of the No. 4 layer having a low refractive index. The No. 3 layer is provided on a surface of the No. 2 layer, and the principal ingredient of the No. 3 layer is titanium oxide. The No. 4 layer is provided on a surface of the No. 3 layer, and the principal ingredient of the No. 4 layer is silicon dioxide. The film equivalent to No. 1 layer and No. 2 layer and having the middle refractive index, the No. 3 layer having the high index and the No. 4 layer having the low index, constitute the anti-reflection film as a whole, with the film having the excellent function of preventing reflection.

The above anti-reflection film can be coated by vacuum evaporation or sputtering. Vacuum evaporation is better than sputtering. The assistance of an ion beam may be utilized for forming the film. Titanium oxide can be added into the No. 1 layer including zirconium oxide as long as the effect desired for a light transmissible plate of the present invention is not reduced. In the same manner, $Ta_2O_5$ can be added to the No. 3 layer including titanium oxide.

The thickness of the anti-reflection film may be any thickness as long as the film can prevent the reflection of visible rays. Preferable optical film thicknesses are as follows when the design wave length $\lambda_0$ is within 450 - 550 nm.

No. 1 layer; 0.05 - 0.15 $\lambda_0$,
No. 2 layer; 0.05 - 0.15 $\lambda_0$,
No. 3 layer; 0.36 - 0.49 $\lambda_0$, and
No. 4 layer; 0.15 - 0.35 $\lambda_0$.

Particularly, the thickness of No. 4 layer is desirably 0.25 $\lambda_0$.

Thus, the anti-reflection film constructed of a plurality of layers is provided on one surface of the plastic base plate, while the indium oxide-tin oxide layer ("ITO" layer) and the layer including silicon dioxide are provided on the opposite surface. In such a light-transmissible plate, a layer having the function of preventing reflection is formed on one surface and a layer having the function of shielding electromagnetic waves is formed on the opposite surface. In such a structure, in which the layer including silicon dioxide is provided on the "ITO" layer, the film thickness of the "ITO" layer is formed to a large size relatively, for example, 500 - 1000Å (50-100nm).

In the light-transmissible plate according to the present invention, an earthing means may be connected thereto to eliminate static electricity. In the case where an "ITO" layer is provided, an earthing wire may be connected to the "ITO" layer directly, or continuity via a particular electroconductive component between the "ITO" layer and the earthing wire may be ensured. As another means, an outer frame constructed of metal may be provided around the plate, and static electricity may be discharged via the frame. Also in this case, the metal frame may preferably come into contact with the "ITO" layer directly, or continuity via a particular electroconductive component between the metal frame and "ITO" layer may be maintained.

As described above, providing the hard coating layer on the transparent plastic base plate can raise the hardness of the light-transmissible plate, thereby providing characteristics of abrasion resistance and wear resistance to the plate, even if the base plate consists of a plastic having low hardness. Providing the electroconductive layer formed on the hard coating layer and the layer having a low refractive index formed on the electroconductive layer, can shield electromagnetic waves, and at the same time can prevent reflection.

Furthermore, since an anti-reflection film having excellent static charge resistance is provided on the surface opposite to the surface on which the electroconductive layer is provided, a light-transmissible plate which shields electromagnetic waves can also eliminate static electricity and prevent reflection. Moreover, since the anti-reflection film constructed of a plurality of layers also has excellent strength of adhesion, durability, abrasion resistance, wear resistance, shock resistance, chemical resistance, flexibility, heat resistance, light resistance and weather resistance, excellent optical products can be obtained as a whole.

A representative analysis of components of the electroconductive layer or the anti-reflection film according to the present invention can be carried out by applying Auger electron spectrophotometry. In this method, an electron beam is irradiated onto a surface of a sample positioned in a high vacuum, and the Auger electron released from the surface is measured by an analyzer with a partition of energy. Conditions of the measurement are as follows.

| | |
|---|---|
| analyzer | "JAMP-10S" produced by Nippon Denshi Kabushiki Kaisha (Japanese company) |
| degree of vacuum (when measuring an outermost surface) | $1 \times 10^{-7}$ Pa |
| degree of vacuum (when measuring in a direction of depth) | $6 \times 10^{-6}$ Pa (argon atmosphere) |
| sampling | to fix a sample on a sample stand holding an edge of the sample down with a copper plate |
| acceleration voltage | 3.0 kV |
| current flowing through a sample | $1 \times 10^{-8}$ A |
| diameter of the electron beam | 1 µm |
| slit used for the measurement | No. 5 |
| angle of inclination of a sample | 40 - 70 degree |
| etching condition of Ar ion acceleration voltage | 3.0 kV |
| current flowing through a sample | $3 \times 10^{-7}$ A |
| etching speed | 200Å/min (20nm/min) (when $SiO_2$) |

The light-transmissible plate shielding electromagnetic waves according to the present invention is effective, particularly when used as a filter for a television set or a display. As other uses, it is possible to apply the plate as a lens, and it is also possible to form it into various shapes, for example, a film, a block, etc.

## EXAMPLES

Embodiments of present invention will be more readily appreciate from the following detailed description of the examples.

### EXAMPLE 1

A polymethacrylate plate on the market is used as a transparent plastic base plate. (The plate is "Acrylite" (trade mark) LN-084, produced by Mitsubishi Rayon Kabushiki Kaisha, colored to gray, thickness; 2 mm.) A mixture of two compounds (one is obtained by hydrolyzing vinyltriethoxysilane with glacial acetic acids and the other is obtained by hydrolyzing methyltriethoxysilane with glacial acetic acid) is used as the film forming component of a paint for providing a hard coating, as shown in example 1 of Japanese Patent Publication No. SHO 59-114501. The paint is made by adding sodium acetate, which is a hardener, to the mixture and then by adding a surface lubricant including silicon to the mixture. The paint is coated onto a surface of the base plate to thickness of 2 µm, and it is cured by heating. Thus a hard coating layer is formed.

Next, as an electroconductive layer, a mixture of $In_2O_3$ and $SnO_2$ is coated on the hard coating layer, and the mixture is coated with film thickness of 700Å (70nm) by sputtering. The sputtering conditions are the same as those shown in example 7 - 9 of Japanese Patent Publication No. SHO 60-32053. That is, the target utilized is an indium-tin alloy, a magnetron-sputtering apparatus is used, the atmosphere is a gas mixture of argon and oxygen (oxygen: 30 vol.%), and the vacuum pressure of the atmosphere is $1 \times 10^{-3}$ Torr.

Next, as a layer having low refractive index, a film constructed of silicon dioxide is formed on the electroconductive layer. The film is formed by the electron-beam method, using vacuum evaporation coating apparatus (BMC-800T, produced by Shinku Kikai Kogyo Kabushiki Kaisha). The film thickness is 940Å (94nm).

On the other surface of the base plate, the same hard coating layer as the above is provided. Then, a film of aluminium oxide and a film of silicon dioxide are formed in order on the hard coating layer, thereby giving a function of hardening the surface and preventing reflection to the plate.

The light-transmissible plate obtained as above has the following functions. Volume of transmission of electromagnetic waves in the frequency of 10 GHz is reduced to about 1/10 volume, compared with only a transparent plastic base plate. When the plate is used as an optical filter for a word processor, it is excellent with respect to preventing reflection, and fatigue of the eyes of the operator is effectively reduced. Hardness of the surface is increased, is that the plate is toughened against abrasion.

EXAMPLE 2

A hard coating layer on the base plate is formed in the same manner as in Example 1. Next, a film of silicon dioxide with thickness of 100Å (10nm) is formed as an undercoating layer on the hard coating layer by sputtering. Then, on the undercoating layer, an "ITO" layer, film thickness 1400Å (140nm) and coated by sputtering, and a film of silicon dioxide, coated by vacuum evaporation coating, are formed in the same manner as in Example 1. On the opposite surface of the base plate, a hard coating layer is formed in the same manner as in Example 1. Then, on the hard coating layer, layers of $Y_2O_3$ ($\lambda/4$), $TiO_2$ ($\lambda/2$), $SIO_2$ ($\lambda/4$) are provided in order. $\lambda$ is a design wave length.

The light-transmissible plate obtained as the above had the following functions. The volume of transmission of electromagnetic waves at a frequency of 10 GHz is reduced to about 1/22 volume, as compared with a transparent plastic base plate alone. When the plate is used as an optical filter for a word processor, it is more effective with respect to preventing reflection and preventing abrasion than that of Example 1.

EXAMPLE 3

In this Example, a polymethacrylate plate having a hard coating layer thereon, being on the market, is used as a base plate. (The plate is "Acrylite" (trade mark) LN-084, produced by Mitsubishi Rayon Kabushiki Kaisha, colored to gray, thickness; 2 mm.) Other layers, that is, the "ITO" layer and the layer having a low refractive index are formed in the same manner as in Example 1. The plate of Example 3 is as excellent in its properties as that of Example 1.

EXAMPLE 4

A polymethacrylate plate ("Acrylite" (trade mark) LN-084, colored to grey, thickness; 2 mm) is used as a base plate. A paint for providing a hard coating, containing as film forming component a mixture of two compounds (one is obtained by hydrolyzing vinyltriethoxysilane with glacial acetic acid and the other is obtained by hydrolyzing methyltriethoxysilane with glacial acetic acid) is used, as shown in example 1 of Japanese Patent Publication No. SHO 59-114501. The paint is made by adding sodium acetate, which is a hardener, to the mixture, and then by adding surface lubricant including silicon to the mixture.

The paint is coated onto both surfaces of the base plate to a thickness of 2 $\mu$m, and is then cured for 3 hours at 90 °C. Thus hard coating layers are formed.

Next, an "ITO" layer is coated on the hard coating layer on one surface of the base plate, and then the $SiO_2$ layer is provided on the "ITO" layer by vacuum evaporation coating. Referring now to the other hard coating layer on the other surface of the base plate, the surface is set in a vacuum evaporation coating tank. After the tank is heated to 60 °C and vacuumed to 133 • $10^{-5}$ Pa (1 x $10^{-5}$ Torr), the surface is cleaned with an Argon ion beam generated from the ion beam generating device of the Kafman type, at an acceleration voltage of 500 V. Then, the following four layers are formed by the electron-beam method, in order, from the surface of the base plate.

(1) No. 1 layer; the principal ingredient of the layer is zirconium oxide, the optical film thickness is about 42 nm, and the vacuum condition when forming the layer is 4 • $10^{-3}$ Pa (3 x $10^{-5}$ Torr).

(2) No. 2 layer; the principal ingredient of the layer is silicon dioxide, the optical film thickness is about 42 nm, and the vacuum condition when forming the layer is 133 • $10^{-5}$ Pa (1 x $10^{-5}$ Torr).

(3) No. 3 layer; the principal ingredient of the layer is titanium oxide, the optical film thickness is about 216 nm, and the vacuum condition when forming the layer is 533 • $10^{-5}$ Pa (4 x $10^{-5}$ Torr).

(4) No. 4 layer; the principal ingredient of the layer is silicon dioxide, the optical film thickness is about 120 nm, and the vacuum condition when forming the layer is 133 • $10^{-5}$ Pa (1 x $10^{-5}$ Torr).

In the above paragraphs (1) - (4), a design wave length in accordance with the optical film thicknesses is 480 nm.

The plate obtained in the above manner has a reflection interference color of royal purple, and has an extremely excellent function of preventing reflection whereby the surface reflection factor at 550 nm is about 0.2%. The plate also has an excellent hardness at the surface. A sheet of polyester fiber, which is formed into a square having sides of 2 cm and which is dropped into water, is positioned on the surface of the plate, a load of 2 Kg is placed on the sheet, and the sheet is then moved reciprocally while maintaining the above load condition. No abrasion ocurred.

An atmospheric exposure test is carried out by exposing the plate outdoors for one month. The result is that there is no break away of the anti-reflection film and no damage to the surface. When the plate is used as an optical filter for a word processor, it is extremely excellent with respect to preventing reflection, and fatigue of eyes of an operator is highly reduced. Durability of the plate is also excellent.

The following measurement is also carried out with respect to the property of static charge resistance. An electrostatic voltmeter ("Statiron M", produced by Shishido Seidenki Kabushiki Kaisha, Japanese company) is positioned 53 mm from the front surface of a CRT. The CRT (NEC-KD551K) is connected to a personal computer (PC-9801E, produced by Nihon Denki Kabushiki Kaisha). When the switch of the personal computer is on, the electrostatic potential measured by "Statiron M" is more than 9 kV. Next, a plate according to the present invention is positioned between the CRT and "Statiron M", at a position 30 mm from "Statiron M". The plate is grounded. Then, the personal computer is switched on, but the electrostatic potential measured by "Statiron M" is maintained at 0. The effect of static resistance due to the plate was especially excellent.

## Claims

**1.** A light transmissible plate (100) capable of transmitting visible light from a source thereof and yet shielding electromagnetic waves generated by electronic equipment and having:

a transparent plastic base plate (1);

on a surface of the transparent plastic base plate (1), a first hard coating layer (2) having scratch resistance;

on a surface of the hard cOating layer (2) remote from the transparent plastic base plate (1), an electroconductive layer (3), which electroconductive layer (3) contains indium oxide and tin oxide; and

on a surface of the electroconductive layer (3) remote from the transparent plastic base plate (1), a layer (4) having a refractive index in the visible light region which is lower than that of the electroconductive layer (3);

characterized in that

a) the plate further comprises on a surface of the transparent plastic base plate (1) which is to face a viewer, a second hard coating layer (2'), and

on a surface of the second hard coating layer (2') remote from the transparent plastic base plate (1), an antireflective coating (4',20), which antireflective coating consists of a plurality of layers (21-24); and

b) the first hard coating layer (2) on which is disposed the electroconductive layer (3) is disposed on a surface of the transparent base plate (1) which is to face the source of visible light, which surface is opposite to the surface of the transparent base plate on which the second hard coating layer (2') is disposed.

**2.** A light-transmissible plate according to claim 1, wherein the film thickness of the electroconductive layer (3) is within the range of 10 to 300nm.

**3.** A light-transmissible plate according to claim 1 or claim 2, wherein the hard coating layers (2, 2') are layers containing organopolysiloxane.

**4.** A light-transmissible plate according to claim 1, claim 2 or claim 3, wherein the hard coating layers (2, 2') are formed by coating with a hardening paint.

**5.** A light-transmissible plate according to any preceding claim, wherein the transparent plastic base plate (1) is a coloured plate.

**6.** A light-transmissible plate according to any preceding claim, wherein the layer (4) having a low refractive index is a layer constructed of inorganic silica.

**7.** A light-transmissible plate according to claim 6, wherein the layer constructed of inorganic silica is formed by a vacuum evaporation coating.

**8.** A light-transmissible plate according to any preceding claim, wherein a ground wire (6, 15) is connected to the electroconductive layer (3).

**9.** A light-transmissible plate according to any preceding claim, wherein an outer frame is provided around the light-transmissible plate, the outer frame extending along the edge of the light-transmissible plate and coming into contact with the electroconductive layer.

**10.** A light-transmissible plate according to any preceding claim, wherein the anti-reflective coating consists of the following layers:

a first layer (21) provided on a surface of the second hard coating layer (2'), the principal ingredient of the first layer (21) being zirconium oxide;

a second layer (22) provided on a surface of the first layer (21), the principal ingredient of the second layer (22) being silicon dioxide;

a third layer (23) provided on a surface of the second layer (22), the principal ingredient of the third layer (23) being titanium oxide; and

a fourth layer (24) provided on a surface of the third layer (23), the principal ingredient of the fourth layer (24) being silicon dioxide.

**11.** A light-transmissible plate according to claim 10, wherein the optical film thicknesses of the first to fourth layers (21,22,23,24) are the following thicknesses in relation to a design wavelength $\lambda_0$ within 450 - 550 nm:

First layer: 0.05 - 0.15 $\lambda_0$'
Second layer: 0.05 - 015 $\lambda_0$'
Third layer: 0.36 - 0.49 $\lambda_0$' and
Fourth layer: 0.15 - 0.35 $\lambda_0$'

**12.** A light-transmissible plate according to any one of claims 1 to 9, wherein the antireflective coating consists of the following layers

a single adhesive layer provided on a surface of said second hard coating layer (2');
a layer of high refractive index provided on the surface of the single adhesive layer; and
a layer of low refractive index provided on the surface of the layer of high refractive index;
the said single adhesive layer having a refractive index intermediate that of the said respective layers of high and low refractive index.

**13.** A light-transmissible plate according to any preceding claim, wherein the light-transmissible plate is an optical filter for a cathode-ray tube.

**14.** A method of preparing a plate as defined in claim 1; which method comprises the steps of

i) forming, on a first surface of a transparent plastic base plate (1), a first hard coating layer (2) having scratch resistance;

ii) forming, on a surface of the hard coating layer (2) remote from the transparent plastic base plate (1), an electroconductive layer (3) containing indium oxide and tin oxide, which step is carried out by evaporation coating using plasma due to high-frequency electric discharge, in an atmosphere of oxygen and at a temperature of less than 150 °C, with the assistance of an ion gun;

iii) forming, on a surface of the electroconductive layer (3) remote from the transparent plastic base plate (1), a layer (4) having a refractive index in the visible light region which is lower than that of the electroconductive layer (3);

iv) forming, on a second surface of the transparent plastic base plate (1) opposite to the first surface thereof, the second hard coating layer (2'); and

v) forming, on a surface of the second hard coating layer (2') remote from the transparent plastic base plate (1), an antireflective coating (4') consisting of a plurality of layers (21-24).

**15.** A method according to claim 14, wherein the film thickness of the electroconductive layer (3) is within the range of 10 to 300nm.

**16.** A method according to claim 14 or claim 15, wherein the hard coating layers (2, 2') are layers containing organopolysiloxane.

**17.** A method according to claim 14 or claim 15, wherein the hard coating layers (2, 2') are formed by coating with a hardening paint.

**18.** A method according to any one of claims 14 to 17, wherein the transparent plastic base plate (1) is a coloured plate.

**19.** A method according to any one of claims 14 to 18 wherein the layer (4) having a low refractive index is a layer constructed of inorganic silica.

**20.** A method according to claim 19, wherein the layer constructed of inorganic silica is formed by a vacuum evaporation coating.

**21.** A method according to any one of claims 14 to 20, which additionally comprises connecting a ground wire (6, 15) to the electroconductive layer (3).

**22.** A method according to any one of claims 14 to 21, which additionally comprises providing an outer frame around the light-transmissible plate, the outer frame extending along the edge of the light-transmissible plate and coming into contact with the electroconductive layer.

**23.** A method according to any one of claims 14 to 22, wherein the anti-reflective coating consists of the following layers

a first layer (21) provided on a surface of the second hard coating layer (2'), the principal ingredient of the first layer (21) being zirconium oxide;

a second layer (22) provided on a surface of the first layer (21), the principal ingredient of the second layer (22) being silicon dioxide;

a third layer (23) provided on a surface of the second layer (22), the principal ingredient of the third layer (23) being titanium oxide; and

a fourth layer (24) provided on a surface of the third layer (23), the principal ingredient of the fourth layer (24) being silicon dioxide.

**24.** A method according to claim 23, wherein the optical film thicknesses of the first to fourth layers (21,22,23,24) are the following thicknesses in relation to a design wavelength $\lambda_0$ within 450 - 550 nm:

First layer: 0.05 - 0.15 $\lambda_0$'
Second layer: 0.05 - 0.15 $\lambda_0$'
Third layer: 0.36 - 0.49 $\lambda_0$' and
Fourth layer: 0.15 - 0.35 $\lambda_0$'.

**25.** A method according to any one of claims 14 to 22, wherein the anti-reflective coating consists of the following layers

a single adhesive layer provided on a surface of the second hard coating later (2');

a layer of high refractive index provided on the surface of the single adhesive layer; and

a layer of low refractive index provided on the surface of the layer of high refractive index;

the single adhesive layer having a refractive index intermediate that of the respective layers of high and low refractive index.

**26.** A method according to any one of claims 14 to 25, wherein the layers of the anti-reflective coating are films formed by evaporation coating.

**27.** A method according to claim 26, wherein the evaporation coating is carried out by vacuum coating using an electron beam.

**28.** A method according to any one of claims 14 to 25, wherein the anti-reflective coating is at least one film layer formed by sputtering.

**29.** A method according to any one of claims 14 to 28, wherein said light-transmissible plate is an optical filter for a cathode-ray tube.

**30.** An electronic device having a source of visible light, which device includes a light-transmissible plate (100) according to any one of claims 1 to 13.

**31.** Use of a light-transmissible plate (100) according to any one of claims 1 to 16 in an electronic device to allow transmission of light from a light source of said electronic device while at the same time shielding electromagnetic waves from said electronic device.

**Patentansprüche**

**1.** Lichtdurchlässige Platte (100), die dazu fähig ist, sichtbares Licht von einer Quelle dafür durchzulassen und dennoch von elektronischen Geräten erzeugte elektromagnetische Wellen abzuschirmen, und die aufweist:
eine transparente Kunststoffbasisplatte (1);
auf einer Oberfläche der transparenten Kunststoffbasisplatte (1) eine erste harte überzugssschicht (2), die Kratzfestigkeit aufweist;
auf einer von der transparenten Kunststoffbasisplatte (1) entfernten Oberfläche der harten überzugsschicht (2) eine elektrisch leitende Schicht (3), die Indiumoxid und Zinnoxid enthält; und
auf einer von der transparenten Kunststoffbasisplatte (1) entfernten Oberfläche der elektrisch leitenden Schicht (3) eine Schicht (4) mit einem Brechungsindex im sichtbaren Lichtbereich, der geringer ist als jener der elektrisch leitenden Schicht (3);
dadurch gekennzeichnet, daß
a) die Platte weiters auf einer Oberfläche der transparenten Kunststoffbasisplatte (1), die einem Betrachter zugewandt sein soll, eine zweite harte überzugsschicht (2') und
auf einer von der transparenten Kunststoffbasislatte (1) entfernten Oberfläche der zweiten harten Überzugsschicht (21) einen nichtspiegelnden Überzug (4',20) umfaßt, der aus einer Vielzahl von Schichten (21-24) besteht; und
b) die erste harte Überzugsschicht (2), auf der die elektrisch leitende Schicht (3) angebracht ist, auf einer Oberfläche der transparenten Basisplatte (1) angebracht ist, die der Quelle für sichtbares Licht zugewandt sein soll, welche Oberfläche der Oberfläche der transparenten Basisplatte gegenüberliegt, auf der die zweite harte überzugsschicht (2') angebracht ist.

**2.** Lichtdurchlässige Platte nach Anspruch 1, worin die Filmdicke der elektrisch leitenden Schicht (3) im Bereich von 10 bis 300 nm liegt.

**3.** Lichtdurchlässige Platte nach Anspruch 1 oder 2, worin die harten Überzugsschichten (2,2') Schichten sind, die Organopolysiloxan enthalten.

**4.** Lichtdurchlässige Platte nach Anspruch 1, 2 oder 3, worin die harten überzugsschichten (2,2') durch Beschichtung mit einem Härtungsanstrich gebildet werden.

**5.** Lichtdurchlässige Platte nach einem der vorhergehenden Ansprüche, worin die transparente Kunststoffbasisplatte (1) eine farbige Platte ist.

**6.** Lichtdurchlässige Platte nach einem der vorhergehenden Ansprüche, worin die Schicht (4) mit einem niedrigen Brechungsindex eine aus anorganischer Silika konstruierte Schicht ist.

**7.** Lichtdurchlässige Platte nach Anspruch 6, worin die aus anorganischer Silika konstruierte Schicht durch Vakuumverdampfungsbeschichtung gebildet ist.

**8.** Lichtdurchlässige Platte nach einem der vorhergehenden Ansprüche, worin ein Erdungsdraht (6,15) an die elektrisch leitende Schicht (3) angeschlossen ist.

**9.** Lichtdurchlässige Platte nach einem der vorhergehenden Ansprüche, worin ein Außenrahmen um die lichtdurchlässige Platte vorgesehen ist, wobei der Außenrahmen sich entlang der Kante der lichtdurchlässigen Platte erstreckt und die elektrisch leitende Schicht berührt.

**10.** Lichtdurchlässige Platte nach einem der vorhergehenden Ansprüche, worin der nichtspiegelnde Überzug aus den folgenden Schichten besteht:
einer auf einer Oberfläche der zweiten harten Überzugsschicht (2') vorgesehenen ersten Schicht (21), wobei der Hauptbestandteil der ersten Schicht (21) Zirkonoxid ist;
einer auf einer Oberfläche der ersten Schicht (21) vorgesehenen zweiten Schicht (22), wobei der Hauptbestandteil der zweiten Schicht (22) Siliziumdioxid ist;
einer auf einer Oberfläche der zweiten Schicht (22) vorgesehenen dritten Schicht (23), wobei der Hauptbestandteil der dritten Schicht (23) Titanoxid ist; und
einer auf einer Oberfläche der dritten Schicht (23) vorgesehenen vierten Schicht (24), wobei der Hauptbestandteil der vierten Schicht (24) Siliziumdioxid ist.

**11.** Lichtdurchlässige Platte nach Anspruch 10, worin die optischen Filmdicken der ersten bis vierten Schicht (21,22,23,24) die folgenden Dicken bezogen auf eine Konstruktionswellenlänge $\lambda_0$ im Bereich 450-550 nm sind:
erste Schicht: 0,05 - 0,15 $\lambda_0$,
zweite Schicht: 0,05 - 0,15 $\lambda_0$
dritte Schicht: 0,36- 0,49 $\lambda_0$ und
vierte Schicht: 0,15 - 0,35 $\lambda_0$.

**12.** Lichtdurchlässige Platte nach einem der Ansprüche 1 bis 9, worin der nichtspiegelnde Überzug aus den folgenden Schichten besteht:
einer auf einer Oberfläche der genannten zweiten harten Überzugsschicht (2') vorgesehenen einzelnen Klebeschicht;
einer auf der Oberfläche der einzelnen Klebeschicht vorgesehenen Schicht mit hohem Brechungsindex; und
einer auf der Oberfläche der Schicht mit hohem Brechungsindex vorgesehenen Schicht mit niedrigem Brechungsindex;
wobei die genannte einzelne Klebeschicht einen Brechungsindex aufweist, der zwischen dem der genannten jeweiligen Schichten mit hohem und niedrigem Brechungsindex liegt.

**13.** Lichtdurchlässige Platte nach einem der vorhergehenden Ansprüche, worin die lichtdurchlässige Platte ein optisches Filter für eine Kathodenstrahlröhre ist.

**14.** Verfahren zur Herstellung einer Platte nach Anspruch 1, welches Verfahren folgende Schritte umfaßt:
i) das Ausbilden einer ersten harten kratzfesten Überzugsschicht (2) auf einer ersten Oberfläche einer transparenten Kunststoffbasisplatte (1);
ii) das Ausbilden einer Indiumoxid und Zinnoxid enthaltenden elektrisch leitenden Schicht (3) auf einer von der transparenten Kunststoffbasisplatte (1) entfernten Oberfläche der harten überzugsschicht (2), welcher Schritt durch Verdampfungsbeschichtung unter Verwendung von Plasma aufgrund elektrischer Hochfrequenzentladung in einer Sauerstoffatmosphäre und bei einer Temperatur von weniger als 150 °C mit Hilfe einer Ionenkanone durchgeführt wird;
iii) das Ausbilden einer Schicht (4) mit einem geringeren Brechungsindex im Bereich sichtbaren Lichtes als jenem der elektrisch leitenden Schicht (3) auf einer von der transparenten Kunststoffbasisplatte (1) entfernten Oberfläche der elektrisch leitenden Schicht (3);
iv) das Ausbilden derzweiten harten Überzugsschicht (2') auf einer zweiten Oberfläche der transparenten Kunststoffbasisplatte (1) gegenüber deren erster Oberfläche; und
v) das Ausbilden eines aus einer Vielzahl von Schichten (21-24) bestehenden nichtspiegelnden Überzugs (4') auf einer von der transparenten Kunststoffbasisplatte (1) entfernten Oberfläche derzweiten harten überzugsschicht (2').

**15.** Verfahren nach Anspruch 14, worin die Filmdicke der elektrisch leitenden Schicht (3) im Bereich von 10 bis 300 nm liegt.

**16.** Verfahren nach Anspruch 14 oder 15, worin die harten Überzugsschichten (2,2') Schichten sind, die Organopolysiloxan enthalten.

**17.** Verfahren nach Anspruch 14 oder 15, worin die harten überzugsschichten (2,2') durch Beschichtung mit einem Härtungsanstrich gebildet sind.

18. Verfahren nach einem der Ansprüche 14 bis 17, worin die transparente Kunststoffbasisplatte (1) eine farbige Platte ist.

19. Verfahren nach einem der Ansprüche 14 bis 18, worin die Schicht (4) mit einem niedrigen Brechungsindex eine aus anorganischer Silika konstruierte Schicht ist.

20. Verfahren nach Anspruch 19, worin die aus anorganischer Silika konstruierte Schicht durch Vakuumverdampfungsbeschichtung gebildet wird.

21. Verfahren nach einem der Ansprüche 14 bis 20, das zusätzlich das Anschließen eines Erdungsdrahtes (6,15) an die elektrisch leitende Schicht (3) umfaßt.

22. Verfahren nach einem der Ansprüche 14 bis 21, das zusätzlich das Vorsehen eines Außenrahmens um die lichtdurchlässige Platte umfaßt, wobei sich der Außenrahmen entlang der Kante der lichtdurchlässigen Platte erstreckt und die elektrisch leitende Schicht berührt.

23. Verfahren nach einem der Ansprüche 14 bis 22, worin der nichtspiegelnde Überzug aus den folgenden Schichten besteht:
einer auf einer Oberfläche der zweiten harten Überzugsschicht (2') vorgesehenen ersten Schicht (21), wobei der Hauptbestandteil der ersten Schicht (21) Zirkonoxid ist;
einer auf einer Oberfläche der ersten Schicht (21) vorgesehenen zweiten Schicht (22), wobei der Hauptbestandteil der zweiten Schicht (22) Siliziumdioxid ist;
einer auf einer Oberfläche der zweiten Schicht (22) vorgesehenen dritten Schicht (23), wobei der Hauptbestandteil der dritten Schicht (23) Titanoxid ist; und
einer auf einer Oberfläche der dritten Schicht (23) vorgesehenen vierten Schicht (24), wobei der Hauptbestandteil der vierten Schicht (24) Siliziumdioxid ist.

24. Verfahren nach Anspruch 23, worin die optischen Filmdicken der ersten bis vierten Schicht (21,22,23,24) die folgenden Dicken bezogen auf eine Konstruktionswellenlänge $\lambda_0$ im Bereich 450 - 550 nm sind:
erste Schicht: 0,05 - 0,15 $\lambda_0$,
zweite Schicht: 0,05 - 0,15 $\lambda_0$,
dritte Schicht: 0,36 - 0,49 $\lambda_0$ und
vierte Schicht: 0,15 - 0,35 $\lambda_0$.

25. Verfahren nach einem der Ansprüche 14 bis 22, worin der nichtspiegelnde Überzug aus den folgenden Schichten besteht:
einer auf einer Oberfläche der zweiten harten Überzugsschicht (2') vorgesehenen einzelnen Klebeschicht;
einer auf der Oberfläche der einzelnen Klebeschicht vorgesehenen Schicht mit hohem Brechungsindex; und
einer auf der Oberfläche der Schicht mit hohem Brechungsindex vorgesehenen Schicht mit niedrigem Brechungsindex;
wobei die einzelne Klebeschicht einen Brechungsindex aufweist, der zwischen jenen der jeweiligen Schichten mit hohem und niedrigem Brechungsindex liegt.

26. Verfahren nach einem der Ansprüche 14 bis 25, worin die Schichten des nichtspiegelnden Überzugs durch Verdampfungsbeschichtung gebildete Filme sind.

27. Verfahren nach Anspruch 26, worin die Verdampfungsbeschichtung durch Vakuumbeschichtung unter Verwendung eines Elektronenstrahls durchgeführt wird.

28. Verfahren nach einem der Ansprüche 14 bis 25, worin der nichtspiegelnde Überzug zumindest eine, durch Sputtern gebildete, Filmschicht ist.

29. Verfahren nach einem der Ansprüche 14 bis 28, worin die genannte lichtdurchlässige Platte ein optisches Filter für eine Kathodenstrahlröhre ist.

**30.** Elektronische Vorrichtung mit einer Quelle für sichtbares Licht, wobei die genannte Vorrichtung eine lichtdurchlässige Platte (100) nach einem der Ansprüche 1 bis 13 enthält.

**31.** Verwendung einer lichtdurchlässigen Platte (100) nach einem der Ansprüche 1 bis 16 in einer elektronischen Vorrichtung, um das Übertragen von Licht von einer Lichtquelle der genannten elektronischen Vorrichtung zuzulassen, während gleichzeitig elektromagnetische Wellen von der genannten elektronischen Vorrichtung abgeschirmt werden.

**Revendications**

**1.** Ecran transparent (100) susceptible de transmettre de la lumière visible d'une source de celle-ci et néanmoins d'assurer une protection contre des ondes électromagnétiques produites par un équipement électrique et ayant :

un écran de base en plastique transparent (1);

sur une surface de l'écran de base en plastique transparent (1), une première couche de revêtement dure (2) ayant une résistance aux rayures;

sur une surface de la couche de revêtement dure (2) éloignée de l'écran de base en plastique transparent (1), une couche électroconductrice (3), laquelle couche électroconductrice (3) contient de l'oxyde d'indium et de l'oxyde d'étain; et

sur une surface de la couche électroconductrice (3) éloignée de l'écran de base en plastique transparent (1), une couche (4) ayant un indice de réfraction dans la région de la lumière visible qui est plus faible que celui de la couche électroconductrice (3);

caractérisé en ce que

a) l'écran comprend de plus sur une surface de l'écran de base en plastique transparent (1) qui fait face à un spectateur, une seconde couche de revêtement dure (2'), et

sur une surface de la seconde couche de revêtement dure (2') éloignée de l'écran de base en plastique transparent (1), un revêtement antiréfléchissant (4', 20), lequel revêtement antiréfléchissant consiste en un certain nombre de couches (21-24); et

b) la première couche de revêtement dure (2) sur laquelle est disposée la couche électroconductrice (3) est disposée sur une surface de l'écran de base transparent (1) qui fait face à la source de lumière visible, laquelle surface est opposée à la surface de l'écran de base transparent sur laquelle la seconde couche de revêtement dure (2') est disposée.

**2.** Ecran transparent selon la revendication 1, dans lequel l'épaisseur de film de la couche électroconductrice (3) est dans la gamme de 10 à 300nm.

**3.** Ecran transparent selon la revendication 1 ou la revendication 2, dans lequel les couches de revêtement dure (2, 2') sont des couches contenant de l'organopolysiloxane.

**4.** Ecran transparent selon la revendication 1, la revendication 2 ou la revendication 3, dans lequel les couches de revêtement dur (2, 2') sont formées par recouvrement d'une peinture durcissante.

**5.** Ecran transparent selon l'une quelconque des revendications précédentes, dans lequel l'écran de base en plastique transparent (1) est un écran coloré.

**6.** Ecran transparent selon l'une quelconque des revendications précédentes, dans lequel la couche (4) ayant un indice de réfraction faible peut être une couche construite en silice inorganique.

**7.** Ecran transparent selon la revendication 6, dans lequel la couche construite en silice inorganique est formée par revêtement par évaporation sous vide.

**8.** Ecran transparent selon l'une quelconque des revendications précédentes, dans lequel un fil de masse (6, 15) est relié à la couche électroconductrice (3).

**9.** Ecran transparent selon l'une quelconque des revendications précédentes, dans lequel un châssis externe est réalisé autour de l'écran transparent, le châssis externe s'étendant le long du bord de l'écran transparent et venant en contact avec la couche électroconductrice.

**10.** Ecran transparent selon l'une quelconque des revendications précédentes, dans lequel le revêtement antiréfléchissant consiste en couches suivantes :

une première couche (21) réalisée sur une surface de la seconde couche de revêtement dur (2'), l'ingrédient principal de la première couche (21) étant l'oxyde de zirconium;

une seconde couche (22) réalisée sur une surface de la première couche (21), l'ingrédient principal de la seconde couche (22) étant du dioxyde de silicium;

une troisième couche (23) réalisée sur une surface de la seconde couche (22), l'ingrédient principal de la troisième couche (23) étant de l'oxyde de titane; et

une quatrième couche (24) réalisée sur une surface de la troisième couche (23), l'ingrédient principal de la quatrième couche (24) étant du dioxyde de silicium.

**11.** Ecran transparent selon la revendication 10, dans lequel des épaisseurs de films optiques des première aux quatrième couches (21, 22, 23, 24) ont les épaisseurs suivantes en relation à une longueur d'ondes établie $\lambda_o$ dans 450-550nm :

Première couche : 0,05 - 0,15$\lambda_o$'
Seconde couche : 0,05 - 0,15$\lambda_o$'
Troisième couche : 0,36 - 0,49$\lambda_o$' et
Quatrième couche : 0,15 - 0,35$\lambda_o$'

**12.** Ecran transparent selon l'une quelconque des revendications 1 à 9, dans lequel la couche antiréfléchissante consiste en couches suivantes

une couche adhésive unique réalisée sur une surface de la seconde couche de revêtement dur précitée (2');

une couche d'indice de réfraction élevé réalisée sur la surface de la couche adhésive unique; et

une couche d'indice de réfraction faible réalisée sur la surface de la couche d'indice de réfraction élevé;

ladite couche adhésive unique ayant un indice de réfraction intermédiaire à ceux desdites couches respectives d'indices de réfraction élevé et faible.

**13.** Ecran transparent selon l'une quelconque des revendications précédentes, dans lequel l'écran transparent est un filtre optique pour un tube à rayons cathodiques.

**14.** Procédé de préparation d'un écran tel que défini dans la revendication 1; lequel procédé comprend les étapes de

i) former, sur une première surface d'un écran de base en plastique transparent (1), une première couche de revêtement dur (2) ayant une résistance aux rayures;

ii) former, sur une surface de la couche de revêtement dur (2) éloignée de l'écran de base en plastique transparent (1), une couche électroconductrice (3) contenant de l'oxyde d'indium et de l'oxyde d'étain, laquelle étape est accomplie par revêtement par évaporation utilisant du plasma dû à la décharge électrique haute-fréquence, dans une atmosphère d'oxygène et à une température inférieure à 150 °C, avec l'assistance d'un canon à ions;

iii)former, sur une surface de la couche électroconductrice (3) éloignée de l'écran de base en plastique transparent (1), une couche (4) ayant un indice de réfraction dans la région de la lumière visible qui est plus faible que celui de la couche électroconductrice (3);

iv) former, sur une seconde surface de l'écran de base en plastique transparent (1) opposée à la première surface de celui-ci, la seconde couche de revêtement dur (2');

v) former, sur une surface de la seconde couche de revêtement dur (2') éloignée de l'écran de base en plastique transparent (1), un revêtement antiréfléchissant (4') consistant en un certain nombre de couches (21-24).

**15.** Procédé selon la revendication 14, dans lequel l'épaisseur de film de la couche électroconductrice (3) est dans la gamme de 10 à 300nm.

**16.** Procédé selon la revendication 14 ou la revendication 15, dans lequel les couches de revêtement dur (2, 2') sont des couches contenant de l'organopolysiloxane.

**17.** Procédé selon la revendication 14 ou la revendication 15, dans lequel les couches de revêtement dur (2, 2') sont formées par revêtement d'une peinture durcissante.

**18.** Procédé selon l'une quelconque des revendications 14 à 17, dans lequel l'écran de base en plastique transparent (1) est un écran coloré.

**19.** Procédé selon l'une quelconque des revendications 14 à 18, dans lequel la couche (4) ayant un indice de réfraction faible est une couche construite en silice inorganique.

**20.** Procédé selon la revendication 19, dans lequel la couche construite en silice inorganique est formée par revêtement par évaporation sous vide.

**21.** Procédé selon l'une quelconque des revendications 14 à 20, qui comprend additionnellement connecter un fil de masse (6, 15) à la couche électroconductrice (3).

**22.** Procédé selon l'une quelconque des revendications 14 à 21, qui comprend additionnellement réaliser un châssis externe autour de l'écran transparent, le châssis externe s'étendant le long du bord de l'écran transparent et venant en contact avec la couche électroconductrice.

**23.** Procédé selon l'une quelconque des revendications 14 à 22, dans lequel le revêtement antiréfléchissant consiste en couches suivantes

une première couche (21) réalisée sur une surface de la seconde couche de revêtement dur (2'), l'ingrédient principal de la première couche (21) étant de l'oxyde de zirconium;

une seconde couche (22) réalisée sur une surface de la première couche (21), l'ingrédient principal de la seconde couche (22) étant du dioxyde de silicium;

une troisième couche (23) réalisée sur une surface de la seconde couche (22), l'ingrédient principal de la troisième couche (23) étant de l'oxyde de titane; et

une quatrième couche (24) réalisée sur une surface de la troisième couche (23), l'ingrédient principal de la quatrième couche (24) étant du dioxyde de silicium.

**24.** Procédé selon la revendication 23, dans lequel les épaisseurs de film optique des première a quatrième couches (21, 22, 23, 24) ont les épaisseurs suivantes en relation à une longueur d'ondes étudiée $\lambda_o$ dans 450-550nm :

Première couche : 0,05-0,15$\lambda_o$'
Seconde couche : 0,05-0,15$\lambda_o$'
Troisième couche : 0,36-0,49$\lambda_o$' et
Quatrième couche : 0,15-0,35$\lambda_o$'.

**25.** Procédé selon l'une quelconque des revendications 14 à 22, dans lequel la couche anti-réfléchissante consiste en couches suivantes

une couche adhésive unique réalisée sur une surface de la seconde couche de revêtement dur (2');

une couche d'indice de réfraction élevé réalisée sur la surface de la couche adhésive unique; et

une couche d'indice de réfraction faible réalisée sur la surface de la couche d'indice de réfraction élevé;

la couche adhésive unique ayant un indice de réfraction intermédiaire à ceux des couches respectives d'indices de réfraction élevé et faible.

**26.** Procédé selon l'une quelconque des revendications 14 à 25, dans lequel les couches de revêtement antiréfléchissant sont des films formés par revêtement par évaporation.

**27.** Procédé selon la revendication 26, dans lequel le revêtement par évaporation est accompli par revêtement sous vide en utilisant un faisceau d'électrons.

**28.** Procédé selon l'une quelconque des revendications 14 à 25, dans lequel le revêtement antiréfléchissant est au moins une couche de film formée par pulvérisation.

**29.** Procédé selon l'une quelconque des revendications 14 à 28, dans lequel l'écran transparent est un filtre optique pour un tube à rayons cathodiques.

**30.** Dispositif électronique ayant une source de lumière visible, lequel dispositif comprend un écran transparent (100) selon l'une quelconque des revendications 1 à 13.

**31.** Utilisation, dans un dispositif électronique pour permettre la transmission de lumière à partir d'une source de lumière dudit dispositif électronique tout en assurant en même temps une protection contre les ondes électromagnétiques du dispositif électronique, d'un écran transparent (100) selon l'une quelconque des revendications 1 à 16.

FIG. 2

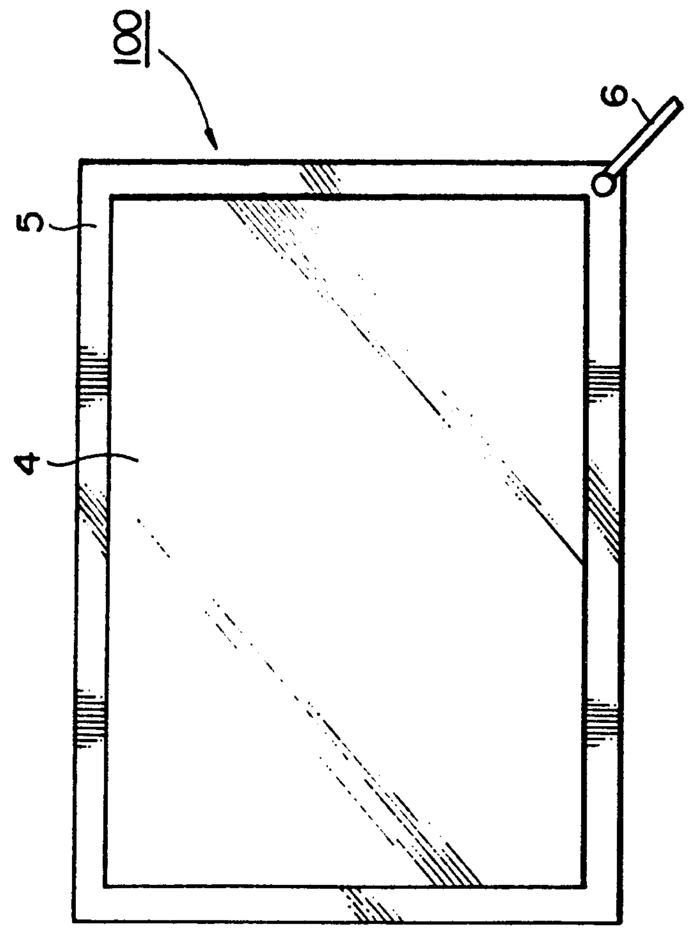


FIG. 1

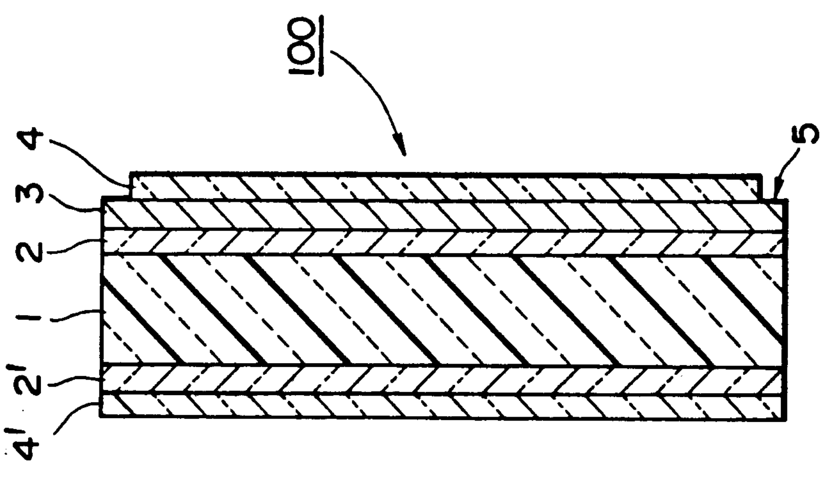

FIG. 3

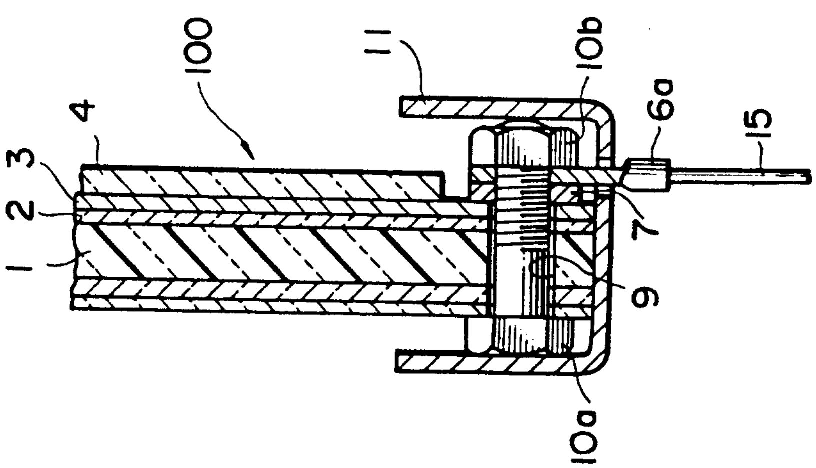


FIG. 4

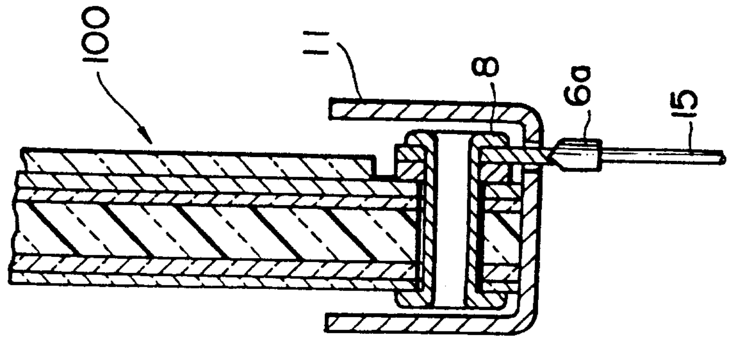


FIG. 5

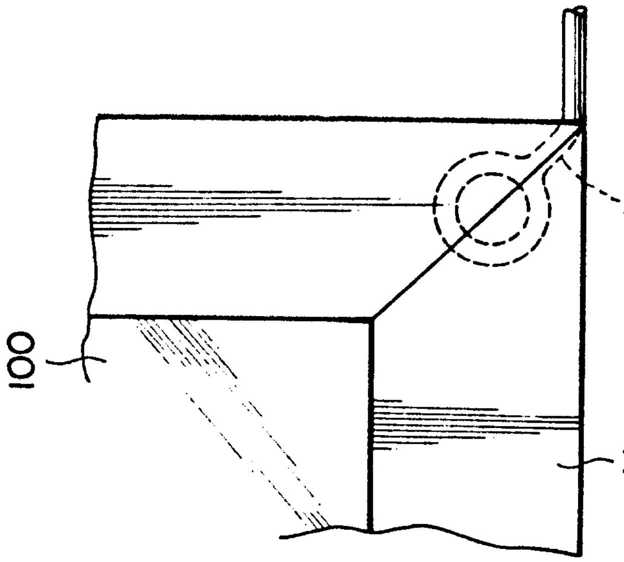

FIG. 8

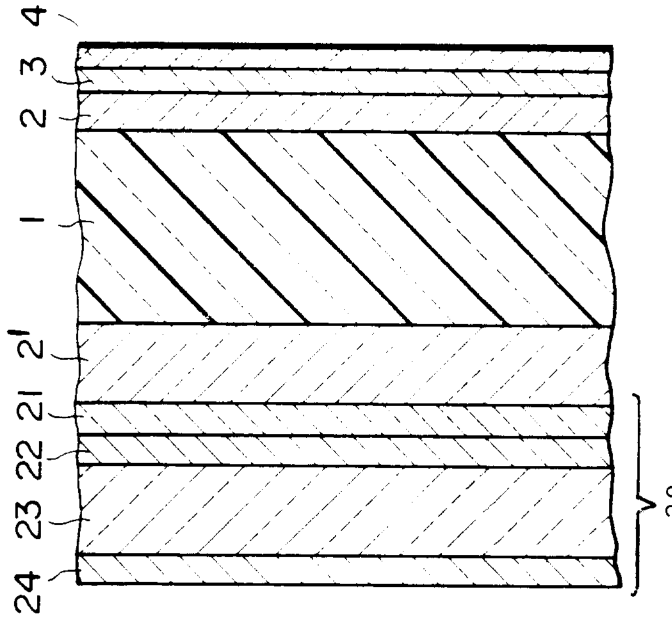


FIG. 7

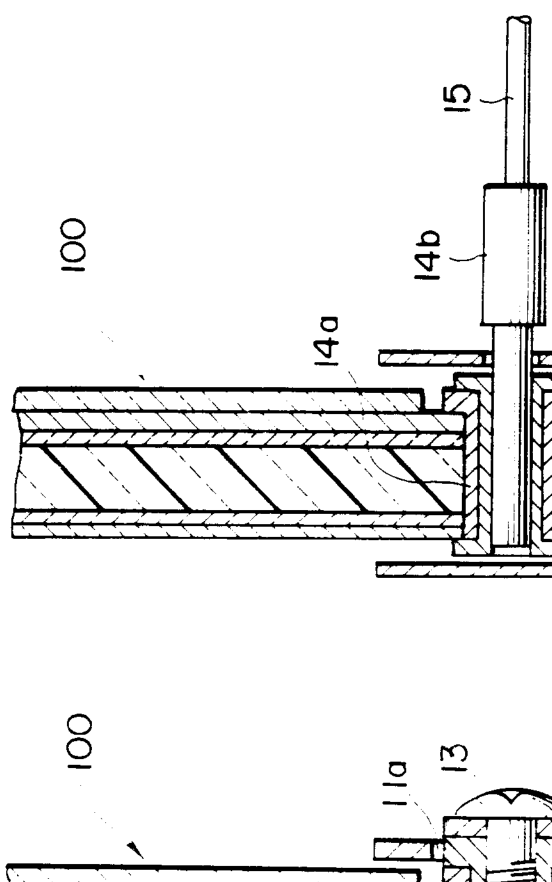


FIG. 6