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DECORATIVE SHEET AND DISPLAY DEVICE INCLUDING DECORATIVE SHEET

Abstract

The decorative sheet according to the present disclosure comprises a first pattern layer and a second pattern layer each including an interference pigment that reflects light incident and develops color with reflected interference light in a first wavelength region. The first pattern layer including a first area with a first light intensity and a second area with a second light intensity. The second pattern layer including a third area with a third light intensity and a fourth area with a second light intensity. The first region and the third region are overlapped each other, and the second region and the fourth region are overlapped each other. The first light intensity is greater than the second light intensity, and the third light intensity is less than the fourth light intensity.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority of Japanese Patent Application No. 2024-022958 filed on Feb. 19, 2024, the content of which is incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure relates to a decorative sheet. In particular, the present disclosure relates to a decorative sheet capable of being backlighted and a display device including the decorative sheet.

BACKGROUND

[0003] A decorative sheet capable of being backlighted has conventionally been used for an electrical appliance product, an automobile part, or the like. When the back surface of this type of decorative sheet is illuminated with a light source, light passes through the whole or a part of the decorative sheet and is visually recognized from the front surface side of the decorative sheet. On the other hand, in a state where the back surface is not illuminated with a light source, a decoration pattern provided on the front surface of the decorative sheet, for example, the color tone of natural wood, is visually recognized, and the structure such as the light source on the back surface side is not visually recognized from the front surface side through the material.

[0004] One of this type of decorative sheet, for example, a decorative sheet is described in Japanese Patent Publication No. 2021-178341 A. The decorative sheet described in the above patent document includes a pattern layer containing an interference pigment having a property of developing color by interference of a part of reflected light of the light incident on the surface.

[0005] In the decorative sheet described in the above patent document, light transmission properties may vary depending on different areas on the pattern layer constituted by the interference pigment. As a result, when viewing from the front surface side of the decorative sheet, the visibility of the light incident on the back surface and transmitted through the decorative sheet can be impaired. Thus, problems including, for example, patterns appearing overlapped on the optical display, or un-uniform displaying may occur.

SUMMARY

[0006] The present disclosure is aimed to solve the above-described conventional problem, and an object of the present disclosure is to provide a decorative sheet that improves visibility of displaying with transmitted light.

[0007] According to one aspect of the present disclosure, a decorative sheet including a number of layers between a front surface and a back surface is provided. The decorative sheet includes a first pattern layer and a second pattern layer. The first pattern layer includes an interference pigment that reflects light incident and develops color with reflected interference light in a first wavelength, and includes a first area that develops color with the reflected interference light of a first light intensity and a second area that develops color with the reflected interference light of a second light intensity. The second pattern layer includes an interference pigment that reflects light incident and develops color with reflected interference light in the first wavelength region, and includes a third area that develops color with the reflected interference light of a third light intensity and a fourth area that develops color with the reflected interference light of a fourth light intensity. In a

thickness direction of the decorative sheet, the first region and the third region are disposed to overlap each other, and the second region and the fourth region are disposed to overlap each other. The first light intensity is greater than the second light intensity, and the third light intensity is less than the fourth light intensity.

[0008] According to another aspect of the present disclosure, a decorative sheet including a number of layers between a front surface and a back surface is provided. The decorative sheet includes a first pattern layer and a second pattern layer. The first pattern layer includes an interference pigment that reflects light incident and develops color with reflected interference light, and includes two or more first areas that each develop color with the reflected interference light in a wavelength region different from each other. The second pattern layer includes an interference pigment that reflects light incident and develops color with reflected interference light, and includes two or more second areas that are disposed to overlap each of the first areas in a thickness direction of the decorative sheet. At least a part of the first areas and the second areas overlapping each other include interference pigments that develop complementary colors with each other.

[0009] In the present specification, the term “sheet” is intended to refer to an object with sufficiently small thickness, meaning an object whose thickness is significantly smaller than its planar dimensions. A “sheet” may include, for example, film, cover, layer, or panel, but it is not limited to these. The material or intended use of such objects is not taken into consideration.

[0010] Some aspects of the present disclosure provide decorative sheets that improve visibility of displaying with transmitted light, and other aspects of the present disclosure provide display devices including the decorative sheets.

[0011] Additional benefits and advantages of the disclosed embodiments will be apparent from the specification and figures. The benefits and/or advantages may be individually provided by the various embodiments and features of the specification and drawings disclosure, and need not all be provided in order to obtain one or more of the same.

Description

BRIEF DESCRIPTION OF DRAWINGS

[0012] The present disclosure will become readily understood from the following description of non-limiting and exemplary embodiments thereof made with reference to the accompanying drawings, in which like parts are designated by like reference numeral and in which:

[0013] FIG. **1**A is a conceptual sectional view of a display device including a decorative sheet according to an embodiment of the present disclosure without light irradiation from the back surface;

[0014] FIG. **1**B is an example of the decoration pattern appearing on the front surface side of the display device in FIG. **1**A;

[0015] FIG. **2**A is a conceptual sectional view of the display device including the decorative sheet according to an embodiment of the present disclosure with light irradiation from the back surface;

[0016] FIG. **2**B is an example of the displaying on the front surface side of the display device in FIG. **2**A;

[0017] FIG. **3** is a conceptual diagram for describing reflection and transmission of light at an interference pigment particle;

[0018] FIG. **4** is a conceptual sectional view for describing the influence of the transmission properties of the interference pigment;

[0019] FIG. **5** is a conceptual sectional view of a display device according to a first embodiment of the present disclosure, illustrating a decorative sheet included and transmission properties thereof in a first configuration example;

[0020] FIG. **6** is a conceptual sectional view of a display device according to the first embodiment

of the present disclosure, illustrating a decorative sheet included and transmission properties thereof in a second configuration example;
[0021] FIG. **7** is a conceptual sectional view of a display device according to the first embodiment of the present disclosure, illustrating a decorative sheet in a third configuration example;
[0022] FIG. **8** is a conceptual sectional view of a display device according to the first embodiment of the present disclosure, illustrating a decorative sheet in a fourth configuration example;
[0023] FIG. **9** is a conceptual sectional view for describing the influence of the transmission properties of the interference pigment;
[0024] FIG. **10** is a conceptual sectional view illustrating a display device according to a second embodiment of the present disclosure;
[0025] FIG. **11** is a conceptual sectional view illustrating a configuration of a pattern layer of a decorative sheet according to the second embodiment; and
[0026] FIG. **12** is a conceptual sectional view of the display device according to the second embodiment of the present disclosure, illustrating a decorative sheet included and the transmission properties thereof.

DETAILED DESCRIPTION

[0027] In a first embodiment, a decorative sheet according to one aspect of the present disclosure including a number of layers between a front surface and a back surface is provided. The decorative sheet includes a first pattern layer and a second pattern layer. The first pattern layer includes an interference pigment that reflects light incident and develops color with reflected interference light in a first wavelength region, and includes a first area that develops color with the reflected interference light of a first light intensity and a second area that develops color with the reflected interference light of a second light intensity. The second pattern layer includes an interference pigment that reflects light incident and develops color with reflected interference light in the first wavelength region, and includes a third area that develops color with the reflected interference light of a third light intensity and a fourth area that develops color with the reflected interference light of a fourth light intensity. In a thickness direction of the decorative sheet, the first region and the third region are disposed to overlap each other, and the second region and the fourth region are disposed to overlap each other. The first light intensity is greater than the second light intensity, and the third light intensity is less than the fourth light intensity.
[0028] In addition, a decorative sheet according to another aspect in the first embodiment of the present disclosure is provided, wherein a relative standard deviation value for a total value of the first light intensity and the third light intensity, and a total value of the second light intensity and the fourth light intensity is less than 10%.
[0029] In addition, a decorative sheet according to another aspect in the first embodiment of the present disclosure is provided. The decorative sheet further includes a light shielding layer disposed between the first pattern layer and the second pattern layer, wherein the light shielding layer has a transmittance of less than 50% for incident light in a visible region.
[0030] In addition, a decorative sheet according to another aspect in the first embodiment of the present disclosure is provided. The decorative sheet further includes a chromaticity compensation layer disposed between the light shielding layer and the back surface of the decorative sheet, wherein the chromaticity compensation layer has a lower transmittance for light in a wavelength region different from the first wavelength region than that for light in the first wavelength region.
[0031] In addition, a decorative sheet according to another aspect in the first embodiment of the present disclosure is provided, wherein the light shielding layer and the chromaticity compensation layer are integrally formed.
[0032] In addition, a decorative sheet according to another aspect in the first embodiment of the present disclosure is provided, wherein the first pattern layer includes two or more layers each including an interference pigment that reflects light incident and develops color with reflected interference light in a wavelength region different from each other, the second pattern layer

includes two or more layers each corresponding to one of the plurality of layers of the first pattern layer, the two or more layers of the second pattern layer each including an interference pigment that reflects light incident and develops color with reflected interference light in a substantially same wavelength region as the wavelength region of the reflected interference light with which the interference pigment of a corresponding one of the two or more layers of the first pattern layers develops color, and each layer of the two or more layers of the second pattern layer includes areas disposed to overlap each of the areas included in the corresponding one of the two or more layers of the first pattern layer as viewed in the thickness direction.

[0033] A display device according to another aspect in the first embodiment of the present disclosure is provided. The display device comprises a decorative sheet described above, and an optical device that emits light. The optical device is disposed to face the back surface of the decorative sheet.

[0034] In a second embodiment, a decorative sheet according to another aspect of the present disclosure including a number of layers between a front surface and a back surface is provided. The decorative sheet includes a first pattern layer and a second pattern layer. The first pattern layer includes an interference pigment that reflects light incident and develops color with reflected interference light, and includes two or more first areas that each develop color with the reflected interference light in a wavelength region different from each other. The second pattern layer includes an interference pigment that reflects light incident and develops color with reflected interference light, and includes two or more second areas that are disposed to overlap each of the first areas in a thickness direction of the decorative sheet. At least a part of the first areas and the second areas overlapping each other include interference pigments that develop complementary colors with each other.

[0035] In addition, a decorative sheet according to another aspect in the second embodiment of the present disclosure is provided. The decorative sheet further includes a light shielding layer disposed between the first pattern layer and the second pattern layer, wherein the light shielding layer has a transmittance of less than 50% for incident light in a visible region.

[0036] Further, a display device according to another aspect in the second embodiment of the present disclosure is provided. The display device includes a decorative sheet described above, and an optical device that emits light. The optical device is disposed to face the back surface of the decorative sheet.

[0037] With the decorative sheets and the display devices according to the present disclosure, the visibility of displaying with transmitted light can be improved.

[0038] By appropriately combining any embodiments among the various embodiments described above, the effects of the respective embodiments can be achieved.

[0039] Hereinafter, embodiments will be described in detail with reference to the drawings. Unnecessarily detailed description may be omitted. For example, a detailed description of a well-known matter and a repeated description of substantially the same configuration may be omitted. This is to avoid unnecessary redundancy of the following description and to facilitate understanding of the skilled person.

[0040] A decorative sheet and a display device according to the embodiments of the present disclosure will be described with reference to FIGS. **1**A to **12**. The accompanying drawings and the following description are provided for the skilled person to fully understand the present disclosure, and they are not intended to limit the subject matter described in the claims. In each drawing, each element is exaggerated to facilitate the description. Substantially the same members in the drawings are denoted by the same reference numerals.

Display Device Including Decorative Sheet

[0041] A configuration of a display device including a decorative sheet according to an embodiment of the present disclosure will be described with reference to FIGS. **1**A, **1**B and FIGS. **2**A, **2**B. FIG. **1**A is a conceptual sectional view of a display device **100** including a decorative sheet

according to an embodiment of the present disclosure without light irradiation from the back surface. FIG. **1**B is an example of the decoration pattern appearing on the front surface side of the display device in FIG. **1**A. FIG. **2**A is a conceptual sectional view of the display device **100** including the decorative sheet according to an embodiment of the present disclosure with light irradiation from the back surface. FIG. **2**B is an example of the displaying on the front surface side of the display device in FIG. **2**A.

[0042] As shown by FIGS. **1**A and **2**A, the display device **100** according to an embodiment of the present disclosure includes a decorative sheet **20** and an optical device **30**. The optical device **30** is disposed facing a back surface **20**Fb of the decorative sheet **20** and can emit light to irradiate the back surface **20**Fb of the decorative sheet **20**.

[0043] In FIG. **1**A, when the optical device **30** is turned off, a front surface **20**Fa of the decorative sheet **20** is irradiated with light L**1** that may be, for example, natural light from an external light source **50**. At this time, the front surface **20**Fa exhibits only a decoration pattern, for example, the woodgrain pattern shown by FIG. **1**B. The decoration pattern exhibited on the front surface **20**Fa when the optical device **30** is turned off may be a pattern designed on a pattern layer of the decorative sheet **20**. The configuration of the decorative sheet **20** will be described in detail later.

[0044] In FIG. **2**A, when the optical device **30** is turned on, the front surface **20**Fa of the decorative sheet **20** is irradiated with the light L**1** from the external light source **50**, and at the same time, the decorative sheet **20** is irradiated with the light L**2** from the optical device **30**. The light L**2** enters the back surface **20**Fb of the decorative sheet **20**, and a part of the light L**2** is transmitted through the decorative sheet **20**. At this time, illumination lights **11** and **12** and a display mark **13** are displayed in the woodgrain pattern on the front surface **20**Fa as shown by FIG. **2**B. The woodgrain pattern shown by FIG. **1**B or the illumination lights and the display mark shown by FIG. **2**B are just examples for describing a pattern or displaying of the display device **100**, and the present disclosure is not limited to these.

[0045] The pattern exhibited on the front surface **20**Fa of the decorative sheet **20** can be formed by a pattern layer containing an interference pigment. The properties of the interference pigment will be described below with reference to FIG. **3**. FIG. **3** is a conceptual diagram for describing reflection and transmission of light at an interference pigment particle **210**.

[0046] The interference pigment is a pigment that develops color via optical physical phenomena such as optical reflection and interference. The interference pigment particles constituting such an interference pigment can have a core-shell structure. Interference pigment particles can be constructed by coating a core portion having a relatively low refractive index with a metal oxide having a relatively high refractive index. The base material serving as the core portion is formed of, for example, plate-shaped mica, and the periphery of the base material is covered by a metal oxide, such as titanium dioxide (TiO.sub.2) or iron oxide (Fe.sub.2O.sub.3).

[0047] As conceptually illustrated in FIG. **3**, the interference pigment particle **210** include, for example, a core portion **211** and a shell portion **212** covering the core portion **211**. Both the core portion **211** and the shell portion **212** transmit light in the visible region. The core portion **211** and the shell portion **212** are made of materials having different refractive indexes, and for example, the refractive index of the core portion **211** is smaller than the refractive index of the shell portion **212**.

[0048] As shown in the figure, when incident lights Lf**1** and Lf**2** from a front surface side Fa are obliquely incident on the interference pigment particle **210**, on a surface **212***a* of the shell portion **212**, a part of the incident light Lf**1** travels into the shell portion **212** and is reflected by a surface **211***a* of the core portion **211** to become reflected light Lf**11**. A part of the incident light Lf**2** is reflected by the surface **212***a* of the shell portion **212** to become reflected light Lf**21**. When the reflected light Lf**11** and the reflected light Lf**21** interfere with each other, and reflected light having a wavelength λa in the reflected lights Lf**11** and Lf**21** satisfies an interference condition on which the light is mutually intensified, the reflected interference light having the wavelength λa is visually recognized strongly. At this time, the interference pigment particles **210** can develop color with the

reflected interference light having the wavelength λa. Here, the "reflected interference light" of the interference pigment particles is light satisfying the interference condition on which the light is mutually intensified within the lights reflected by the interference pigment particles. The interference pigment develops a "reflected color" which is a color in which the reflected interference light is visually recognized.

[0049] On the other hand, the other part of the incident light Lf**1** transmitted through the surface **211***a* of the core portion **211** travels into the core portion **211**, and a part thereof further transmits through the shell portion **212** on a back surface side Fb to become the transmitted light Lf**12**. The color in which the transmitted light Lf**12** is visually recognized is a "transmitted color", and the "reflected color" of the reflected interference light of the interference pigment particles and the "transmitted color" of the transmitted light are complementary colors with each other. Here, the "complementary colors" or "light having a complementary color relationship" refers to a pair of colors at diametrical positions opposite to each other in a color wheel. In this manner, the transmitted light having a complementary color relationship with the color of the reflected interference light of the interference pigment particles is transmitted through the interference pigment particles, and the combination of the reflected interference light and the transmitted light results to a spectrum of substantially white light.

[0050] Similarly, as shown in the figure, when incident light Lb**1** from a light source element **310** on the back surface side Fb is incident on the interference pigment particles **210**, the reflected interference light having the wavelength λa is reflected by the back surface side Fb, and the transmitted light Lb**12** is emitted from the interference pigment particles **210** on the front surface side Fa and visually recognized. At this time, the transmitted light Lb **12** emitted on the front surface side Fa is constituted by light having a complementary color relationship with the reflected interference light of the interference pigment particles, and it contributes to displaying for the light source element **310** on the front surface side Fa.

[0051] The wavelength λa of the reflected interference light can be changed by adjusting a thickness T of the shell portion **212** of the interference pigment particles, and interference pigment particles having different reflected colors are obtained. By mixing the interference pigment particles having different reflected colors, an interference pigment that reflects light incident and develops color with reflected interference light in a predetermined wavelength region can be formed.

[0052] The interference pigment can be used to form the pattern layer that forms a pattern or displaying exhibited on the front surface of the display device **100** shown in FIGS. **1**B and **2**B. However, the visibility of displaying of the display device **100** may be affected by the transmission properties of the interference pigment. This will be described below with reference to FIG. **4**. FIG. **4** is a conceptual sectional view for describing the influence of the transmission properties of the interference pigment.

[0053] FIG. **4** illustrates a display device **100***a* including the optical device **30** and a decorative sheet **20***a*. The decorative thin material **20***a* includes a pattern layer **25** containing an interference pigment. The decorative sheet **20***a* includes a hard coat layer **22**, a base layer **23**, the pattern layer **25**, and a light shielding layer **27** in the thickness direction from the front surface side Fa to the back surface side Fb. The hard coat layer **22**, the base layer **23**, and the light shielding layer **27** will be described in detail later.

[0054] The pattern layer **25** of the decorative sheet **20***a* in FIG. **4** contains, for example, an interference pigment that reflects light incident and develops color with reflected interference light in the wavelength region λ**1**. The pattern layer **25** includes areas **25***a*, **25***b*, and **25***c*, and the areas **25***a*, **25***b*, and **25***c* are configured to contain interference pigments that develop colors with reflected interference lights having different light intensities but substantially in the same wavelength region λ**1**. The present disclosure is not limited to the configuration of the areas in which colors are developed with reflected interference lights having different light intensities but

substantially in the same wavelength region λ**1**. For example, such areas can be formed by containing interference pigment particles having similar shell portion thicknesses and adjusting the contents of the interference pigment particles, for example, the wt % of the interference pigments. Alternatively, for example, such areas can be formed by changing the types of the interference pigment particles to be contained.

[0055] The optical device **30** at the back surface side Fb emits light **35**, which enter the decorative sheet **20***a* including the pattern layer **25** configured as described above. The incident light **35** includes incident light **31**, **32**, in which incident light **31** is in the wavelength region λ**1**, and incident light **32** is in a wavelength region λ**2** different from the wavelength region λ**1**. The incident light **35** is incident on the back surface of the decorative sheet **20***a* with substantially uniform luminance. Within the incident light **35**, the incident light **31** in the wavelength region λ**1** satisfies the interference condition on which the light is mutually intensified, and a part thereof is reflected as reflected interference lights **31***a*F, **31***b*F, and **31***c*F at the areas **25***a*, **25***b*, and **25***c* of the pattern layer **25**. Since the areas **25***a*, **25***b*, and **25***c* have properties of developing color with different light intensities, the light intensities of the reflected interference lights **31***a*F, **31***b*F, and **31***c*F are different. For example, as indicated by the thicknesses of the arrows shown in FIG. **4**, the light intensities of the reflected interference lights **31***a*F, **31***b*F, and **31***c*F may satisfy S**1***a*>S**1***b*>S**1***c*. On the other hand, within the incident light **35**, the incident light **32** in the wavelength region λ**2** does not satisfy the interference condition on which the light is mutually intensified, and is transmitted through the areas **25***a*, **25***b*, and **25***c* of the pattern layer **25** with substantially uniform light intensity.

[0056] On the front surface side Fa, transmitted lights **35***a*, **35***b*, and **35***c* including lights in the complementary colors with the reflected interference lights **31***a*F, **31***b*F, and **31***c*F are emitted from the areas **25***a*, **25***b*, and **25***c*, respectively. The transmitted lights **35***a*, **35***b*, and **35***c* include transmitted lights **31***a*T, **31***b*T, and **31***c*T in the wavelength region λ**1** and transmitted lights **32***a*T, **32***b*T, and **32***c*T in the wavelength region λ**2**. The transmitted lights **32***a*T, **32***b*T, and **32***c*T in the wavelength region λ**2** have substantially uniform light intensity, but the light intensities of the transmitted lights **31***a*T, **31***b*T, and **31***c*T in the wavelength region λ**1** satisfy T**1***a*<T**1***b*<T**1***c*. Thus, on the front surface side Fa, the transmitted lights **35***a*, **35***b*, and **35***c* from the areas **25***a*, **25***b*, and **25***c* are emitted with non-uniform luminance.

[0057] Further, since the incident light **31** in the wavelength region λ**1** satisfies the interference condition on which the light is mutually intensified, and a part of the incident light **31** is reflected as the reflected interference light. Then the transmitted lights **31***a*T, **31***b*T, and **31***c*T have a lower light intensity than the transmitted lights **32***a*T, **32***b*T, and **32***c*T in the wavelength region λ**2** that does not satisfy the interference condition. Thus, for the transmitted lights **35***a*, **35***b*, and **35***c* on the front surface side Fa, the light component in the wavelength region λ**1** is attenuated, and chromaticity shifts occur in the transmitted lights **35***a*, **35***b*, and **35***c*. Here, the chromaticity is a color property ignoring brightness, and is a numerical representation of the color, hue, and saturation of a light excluding lightness.

[0058] In this manner, the light incident on the back surface of the decorative sheet **20***a* including the pattern layer **25** including the areas that develop color with reflected interference lights of different light intensities but substantially in the same wavelength region λ**1**, is transmitted through the decorative sheet **20***a* and emitted with non-uniform luminance. In addition, in the transmitted light, light components of the wavelength region λ**1** is attenuated, and thus chromaticity shifts occur. These non-uniform luminance and chromaticity shifts may impair the visibility of displaying.

[0059] In the present specification, “substantially equal” or “substantially the same” is not intended to merely indicate a completely same value, but also in consideration of actual tolerance in processing. For example, when “substantially equal” or “substantially the same” is mentioned, an error of about ±10% may be included, and preferably, an error of about ±5% may be included.

[0060] The decorative sheet according to a first embodiment of the present disclosure can improve the above problem in the decorative sheet **20***a* and improve the visibility of displaying with transmitted light. Hereinafter, the configuration of the decorative sheet according to the first embodiment will be described with reference to FIGS. **5** to **8**. In FIGS. **5** to **8**, substantially the same components as that shown in FIG. **4** are denoted by the same reference numerals, and associated detailed description thereof will be omitted.

First Embodiment

Configuration of Display Device and First Configuration Example of a Decorative Sheet

[0061] FIG. **5** is a conceptual sectional view of a display device according to a first embodiment of the present disclosure, illustrating a decorative sheet **200***a* included and transmission properties thereof in a first configuration example. The display device **100**A shown in FIG. **5** includes the decorative sheet **200***a* and an optical device **30** emitting light, which is disposed on a back surface side Fb of the decorative sheet **200***a*. Similarly, to the display device **100** shown in FIG. **1**, the display device **100**A exhibits a pattern on a front surface of the decorative sheet **200***a* when the optical device **30** is turned off, and displaying of the optical device **30** appears on the front surface of the decorative sheet **200***a* when the optical device **30** is turned on.

[0062] The decorative sheet **200***a* includes a hard coat layer **22**, a base layer **23**, a first pattern layer **25**A, a light shielding layer **27**, and a second pattern layer **25**B in the thickness direction from the front surface side Fa to the back surface side Fb. In the present embodiment, the second pattern layer **25**B constitutes the back surface of the decorative sheet **200***a*, and the optical device **30** is disposed to face the second pattern layer **25**B.

[0063] The hard coat layer **22** is made of a material having a protective function and having transparency for incident lights from both the front surface side Fa and the back surface side Fb. The hard coat layer **22** can be made of, for example, a transparent resin having high hardness, and can include, for example, a tactile feel imparting configuration according to the pattern design shown by the decorative sheet **200***a*. As shown in the drawings, for example, a textured pattern **21** such as fine irregularities representing a wood pattern or the like can be formed on the surface of the hard coat layer **22**.

[0064] The base layer **23** is made of a material having transparency to incident lights from both the front surface side Fa and the back surface side Fb, and may have a flat plate shape or a three-dimensional shape. The base layer **23** can be formed using a material having light transparency such as polycarbonate resin, polyethylene terephthalate resin, or acrylic resin. The base layer **23** provides support for the pattern layers **25**A and **25**B and the light shielding layer **27**, and can provide the necessary strength for the entire decorative sheet **200***a*.

[0065] The first pattern layer **25**A includes an interference pigment that reflects light incident and develops color with reflected interference light in a predetermined wavelength region, and can form a pattern, for example, a woodgrain pattern and exhibit the pattern on the surface. In the present embodiment, the first pattern layer **25**A includes first areas **25***a***1**, **25***b***1**, and **25***c***1** that are a plurality of color development areas. The first areas **25***a***1**, **25***b***1**, and **25***c***1** are configured to include interference pigments that develop color with reflected interference lights of different light intensities S**1***a*, S**1***b*, and S**1***c* but substantially in the same wavelength region λ**1**.

[0066] The color development with the reflected interference light having different light intensities can be expressed by the density of the visually recognized color. An area that develops color with reflected interference light having a relatively strong light intensity is visually recognized as a relatively dark color, and an area that develops color with reflected interference light having a relatively weak light intensity is visually recognized as a relatively light color. In the present embodiment, the first pattern layer **25**A is configured to develop color with reflected interference lights with different light intensities but substantially in the same wavelength region λ**1**, and is visually recognized to have areas of substantially the same color but with different color densities.

[0067] The second pattern layer **25**B includes interference pigments that develop color with

reflected interference light substantially in the same wavelength region as that for the first pattern layer **25**A. Further, the second pattern layer **25**B includes second areas **25***a***2**, **25***b***2**, and **25***c***2** that are a plurality of color development areas that develop color with different light intensities S**2***a*, S**2***b*, and S**2***c*. Each of the second areas **25***a***2**, **25***b***2**, and **25***c***2** of the second pattern layer **25**B is disposed to overlap the corresponding one of the first areas **25***a***1**, **25***b***1**, and **25***c***1** of the first pattern layer **25**A when viewed from the thickness directions (directions indicated by the illustrated arrows) of the decorative sheet. Thus, when the optical device **30** is turned on, a part of the incident light **35** incident from the back surface side Fb can be transmitted through each overlapping second area and first area on the second pattern layer **25**B and the first pattern layer **25**A and output on the front surface side Fa.

[0068] The present disclosure is not limited to the configuration of the plurality of color development areas or the number of the areas on the first pattern layer **25**A and the second pattern layer **25**B. These color development areas may be configured, for example, by adjusting the content of the interference pigment particles, for example, the wt % of the interference pigment, or may be configured by including different types of interference pigment particles. The first pattern layer **25**A and the second pattern layer **25**B may be configured to include any number of two or more color development areas, and each color development area can have any shape and/or dimension. The color development areas in the same pattern layer can be freely defined but not overlapping with each other, and each pattern layer can be configured with any thickness according to intended uses.

[0069] In the measurement of the light intensity of the reflected interference light in each of the color development areas on the first pattern layer **25**A and the second pattern layer **25**B, for example, inputting the reflected interference light to a light receiving element disposed at a predetermined position at the emission direction of the reflected interference light, then the amount of light received by the light receiving element can be measured by a photodetector. The light receiving surface of the light receiving element can be disposed in a perpendicular direction to the reflected interference light. As the photodetector, for example, a sensing device such as a photodiode using the photoelectric effect can be used, and for example, the light intensity of the received reflected interference light can be output as an electric signal. The light intensity of the reflected interference light of each color development area can be an average value of a plurality of light intensity values measured for the light beams of the reflected interference light of the same.

[0070] The light shielding layer **27** can be used to shield a part of light incident on the decorative sheet **200***a*. In the present embodiment, the light shielding layer **27** has a transmittance of less than 50% for visible incident light on the decorative sheet **200***a*. The light shielding layer **27** can be configured to have substantially uniform transmittance over the spectrum of visible incident light on the decorative sheet **200***a*. With this configuration, the light shielding layer **27** can transmit a part of visible incident light without introducing chromaticity shifts. Since the light shielding layer **27** has a transmittance of less than 50% for visible light, it is possible to conceal the components disposed on the back surface side of the light shielding layer **27** such that the components are not visually recognized from the front surface side Fa. In the present embodiment, the light shielding layer **27** is disposed between the first pattern layer **25**A and the second pattern layer **25**B, and the light shielding layer **27** conceals both second pattern layer **25**B and the optical device **30** such that they are not visually recognized from the front surface side Fa.

[0071] The decorative sheet **200***a* may be produced by stacking each constituent layer with an adhesive layer having light transparency in the visible region interposed therebetween, or may be produced through lamination printing of each constituent layer using a printing method such as screen printing or gravure printing.

Configuration of Overlapped Color Development Areas on First Pattern Layer and Second Pattern Layer

[0072] In the present embodiment, in general, the first pattern layer of the decorative sheet may

include a plurality of color development areas developing color with reflected interference light of different first light intensities, and the second pattern layer may include a plurality of color development areas developing color with reflected interference light of different second light intensities. When the first light intensities include a light intensity S**11** and a light intensity S**12**, and the second light intensities include a light intensity S**21** and a light intensity S**22**, the first light intensities S**11** and S**12** and the second light intensities S**21** and S**22** can be configured to satisfy the condition (1) of S**11**>S**12** and S**21**<S**22**.

[0073] Further, in the present embodiment, in general, the first light intensities S**11**, S**12** of the first pattern layer and the second light intensities S**21**, S**22** of the second pattern layer can be configured to satisfy the condition (2) that the relative standard deviation (RSD) value for the total value of the light intensity S**11** and S**21**, and the total value of the light intensity S**12** and S**22** is less than 10%. Here, the total value of the light intensity S**11** and S**21**, and the total value of the light intensity S**12** and S**22** indicates the total value of the light intensities at an overlapping color development area pair, respectively. Preferably, the light intensities S**11**, S**12** and the light intensities S**21**, S**22** can be configured such that the RSD value for the total value of the light intensity S**11** and S**21** and the total value of the light intensity S**12** and S**22** is less than 3%.

[0074] Here, The RSD value for the total values of the light intensities of a plurality of overlapping color development area pairs is a relative values of the standard deviation (SD) value of each total values of the light intensities at the individual overlapping color development area pair to the mean value of the total values of the light intensities at the plurality of overlapping color development area pairs, and can be expressed by percentage. Generally, RSD value for each individual data in a data group can be calculated by: RSD value for each individual data (%)=(SD value of the individual data/mean value of the data group)×100. Thus, considering a plurality of overlapping color development area pairs including for example, two or more overlapping color development area pairs, the smaller the RSD value for the total values of the light intensities, the smaller variation around the mean value of the light intensities for the plurality of the overlapping color development areas is indicated.

[0075] The first light intensities S**11** and S**12** and the second light intensities S**21** and S**22** respectively indicate the light intensity of the reflected interference light at the overlapping color development areas as viewed in the thickness directions. Specifically, the color development area in the first pattern layer that develops color with the light of the light intensity S**11** is disposed to overlap the color development area in the second pattern layer that develops color with the light of the light intensity S**21**, and the color development area in the first pattern layer that develops color with the light of the light intensity S**12** is disposed to overlap the color development area in the second pattern layer that develops color with the light of g the light intensity S**22**. In the present specification, S**11** and S**12** indicating the first light intensities, and S**21** and S**22** indicating the second light intensities are intended to merely indicate the overlapping relationship of the corresponding color development areas of the first pattern layer and second pattern layer, but not intended to limit the arrangement position of the color development areas on the pattern layers. For example, each of the color development areas developing color with the reflected interference light of the first light intensities S**11** and S**12** can be disposed at any position on the first pattern layer, and each of the color development areas developing color with the reflected interference light of the second light intensities S**21** and S**22** can be disposed at any position on the second pattern layer so long they are disposed to overlap the corresponding one of the color development areas on the first pattern layer that develop color with the reflected interference light of the first light intensities S**11** and S**12**.

[0076] The present disclosure is not limited to the number of overlapping color development area pairs configured such that the light intensities of the reflected interference light satisfy the above condition (1) or the condition (2). Among the plurality of color development area pairs included in the first pattern layer and the second pattern layer, a portion of overlapping area pairs may be

configured to satisfy the condition (1) or the condition (2), or all the overlapping area pairs may be configured to satisfy the condition (1) or the condition (2).

[0077] Specifically, for example, in the configuration example of the decorative sheet **200***a* in which three overlapping color development areas are included in the first pattern layer **25**A and the second pattern layer **25**B shown in FIG. **5**, the light intensities of the reflected interference light between any two color development area pairs, for example, the area pair **25***a***1**, **25***b***1** and the area pair **25***a***2**, **25***b***2** among the overlapping color development area pairs **25***a***1** and **25***a***2**, **25***b***1** and **25***b***2**, and **25***c***1** and **25***c***2**, can satisfy the above condition (1) or condition (2). In this case, for example, when the condition (1) is satisfied, for example, the first pattern layer **25**A and the second pattern layer **25**B can be configured to, but are not limited to, satisfy S**1***a*>S**1***b* and S**2***a*<S**2***b*, for example. Further, when the condition (2) is satisfied, for example, the first pattern layer **25**A and the second pattern layer **25**B can be configured such that, RSD value for the total value of the light intensity S**1***a*, S**2***a* and the total value of the light intensity S**1***b*, S**2***b* is less than 10%, and preferably less than 3%.

[0078] A part of the overlapping color development area pairs **25***a***1** and **25***a***2**, **25***b***1** and **25***b***2**, and **25***c***1** and **25***c***2**, of the decorative sheet **200***a* shown in FIG. **5**, for example, any two color development area pairs, such as the area pair **25***a***1** and **25***b***1** and the area pair **25***a***2** and **25***b***2**, the area pair **25***a***1** and **25***c***1** and the area pair **25***a***2** and **25***c***2**, can be configured such that the light intensities of the reflected interference light satisfy the above condition (1) or condition (2). In this case, for example, when the condition (1) is satisfied, for example, the first pattern layer **25**A and the second pattern layer **25**B can be configured to, but are not limited to, satisfy S**1***a*>S**1***b* and S**2***a*<S**2***b*, and S**1***a*>S**1***c* and S**2***a*<S**2***c*, for example. Further, when the condition (2) is satisfied, for example, the first pattern layer **25**A and the second pattern layer **25**B can be configured such that, RSD value for the total value of the light intensity S**1***a*, S**2***a* and the total value of the light intensity S**1***b*, S**2***b* is less than 10%, and preferably less than 3%, and further, RSD value for the total value of the light intensity S**1***a*, S**2***a* and the total value of the light intensity S**1***c*, S**2***c* is less than 10%, and preferably less than 3%.

[0079] Further, all of the overlapping color development area pairs **25***a***1** and **25***a***2**, **25***b***1** and **25***b***2**, and **25***c***1** and **25***c***2** of the decorative sheet **200***a* illustrated in FIG. **5** can be configured such that the light intensities of the reflected interference light satisfy the above condition (1) or condition (2). In this case, for example, when the condition (1) is satisfied, for example, the first pattern layer **25**A and the second pattern layer **25**B can be configured to, but are not limited to, satisfy S**1***a*>S**1***b*>S**1***c* and S**2***a*<S**2***b*<S**2***c*. Further, when the condition (2) is satisfied, for example, the first pattern layer **25**A and the second pattern layer **25**B can be configured such that RSD value for the total value of the light intensity S**1***a*, S**2***a*, the total value of the light intensity S**1***b*, S**2***b*, and the total value of the light intensity S**1***c*, S**2***c* is less than 10%, and preferably less than 3%.

[0080] The disposition of the overlapping color development area pairs configured to satisfy the above condition (1) or condition (2) is not limited to the configuration example shown in FIG. **5**. The overlapping color development area pairs configured to satisfy the condition (1) or the condition (2) can be disposed at any position on the first pattern layer **25**A and the second pattern layer **25**B.

[0081] Since the first pattern layer **25**A and the second pattern layer **25**B of the decorative sheet **200***a* include the overlapping color development area pairs configured to satisfy the above condition (1), when the incident light **35** incident from the back surface side Fb sequentially passes through the second pattern layer **25**B and the first pattern layer **25**A, nonuniformity of the light intensity of the transmitted lights **31***a*T, **31***b*T, and **31***c*T in the wavelength region λ**1** output from different color development areas is reduced, and the uniformity of the luminance of the output transmitted lights **35***a*, **35***b*, and **35***c* can be improved.

[0082] Further, since the first pattern layer **25**A and the second pattern layer **25**B of the decorative sheet **200***a* include the overlapped color development areas configured to satisfy the above

condition (2), when the incident light **35** incident from the back surface side Fb sequentially passes through the second pattern layer **25**B and the first pattern layer **25**A, variation in the light intensity of the transmitted lights **31***a*T, **31***b*T, and **31***c*T in the wavelength region λ**1** output from different color development areas is suppressed, and the uniformity of the luminance of the output transmitted lights **35***a*, **35***b*, and **35***c* can be further improved.

[0083] The color development areas satisfying the above condition (1) or condition (2) may be configured, for example, by adjusting the content of the interference pigment particles contained in the overlapped color development areas, for example, the wt % of the interference pigment, or may be configured by adjusting the type of the interference pigment particles contained in the overlapped color development areas.

Transmission Property of First Configuration Example of Decorative Sheet

[0084] In the decorative sheet **200***a* of the first configuration example of the display device **100**A according to the first embodiment of the present disclosure shown in FIG. **5**, the incident light **35** from the optical device **30** includes the incident light **31** in the wavelength region λ**1** and the incident light **32** in the wavelength region λ**2** different from the wavelength region λ**1**. The incident light **35** is incident to the second pattern layer **25**B on the back surface of the decorative sheet **200***a* with substantially uniform luminance. Within the incident light **35**, the incident light **31** in the wavelength region λ**1** satisfies the interference condition on which the light is mutually intensified, and a part of which is reflected as reflected interference lights S**2***a*, S**2***b*, and S**2***c* at the second areas **25***a***2**, **25***b***2**, and **25***c***2** of the second pattern layer **25**B. The other part of the incident light **35** transmit through the second pattern layer **25**B and advance in the decorative sheet **200***a*, and further, a part of which is reflected as the reflected interference lights S**1***a*, S**1***b*, and S**1***c* at the first areas **25***a***1**, **25***b***1**, and **25***c***1** on the first pattern layer **25**A. Then, light transmitted through the decorative sheet **200***a* is output. On the other hand, within the incident light **35**, the incident light **32** in the wavelength region λ**2** does not satisfy the interference condition, and transmit through the decorative sheet **200***a* with substantially uniform light intensity.

[0085] The lights **35***a*, **35***b*, and **35***c* respectively transmitted through the overlapping second area on the second pattern layer **25**B and the first area on the first pattern layer **25**A includes transmitted lights **31***a*T, **31***b*T, and **31***c*T in the wavelength region λ**1** and transmitted light **32**T in the wavelength region λ**2** with substantially uniform light intensity. Since the first pattern layer **25**A and the second pattern layer **25**B include the overlapping color development area pairs configured to satisfy the condition (1), the nonuniformity of the light intensity in the wavelength region λ**1** generated in the transmitted light at different areas on the second pattern layer is at least partially reduced when the light transmit through the corresponding overlapping area on the first pattern layer, thus the uniformity of the luminance of the output transmitted lights **35***a*, **35***b*, **35***c* is enhanced.

[0086] Further, since the first pattern layer **25**A and the second pattern layer **25**B include the overlapping color development area pairs configured to satisfy the above condition (2), variation in the light intensity of the transmitted light in the wavelength region λ**1** is suppressed, and the uniformity of the luminance of the output transmitted lights **35***a*, **35***b*, and **35***c* can be further enhanced.

[0087] According to the decorative sheet **200***a* of the display device **100**A of the first embodiment, as described above, the uniformity of the luminance of output transmitted light is enhanced, and the visibility of displaying with the transmitted light can be improved.

Second Configuration Example of Decorative Sheet and its Transmission Property

[0088] FIG. **6** is a conceptual sectional view of a display device **100**B according to the first embodiment of the present disclosure, illustrating a decorative sheet **200***b* included and transmission properties thereof in a second configuration example. The display device **100**B illustrated in FIG. **6** includes the decorative sheet **200***b* and the optical device **30** emitting light, which is disposed on a back surface side Fb of the decorative sheet **200***b*. The display device **100**B

is different from the display device **100**A of FIG. **5** in that the decorative sheet **200***b* further includes a chromaticity compensation layer **28**. Hereinafter, the display device **100**B will be described focusing on the configurations different from the display device **100**A. In FIG. **6**, substantially the same components as those of the display device **100**A in FIG. **5** are denoted by the same reference numerals, and associated detailed description will be omitted.

[0089] In the present embodiment, the chromaticity compensation layer **28** is disposed on the back surface side of the light shielding layer **27**. In FIG. **6**, the chromaticity compensation layer **28** is shown to be disposed between the light shielding layer **27** and the second pattern layer **25**B, but the present disclosure is not limited to this configuration. The chromaticity compensation layer **28** may be disposed on the back surface side of the light shielding layer **27**, and for example, it may be disposed on the back surface side of the second pattern layer **25**B.

[0090] The chromaticity compensation layer **28** is configured to have a lower transmittance for light in a wavelength region different from the wavelength region λ**1** of the reflected interference light of the first pattern layer **25**A and the second pattern layer **25**B in the visible incident light included in the incident light **35** decorative sheet The chromaticity compensation layer **28** can be formed as, but not limited to, an ink layer or a film layer, and can be uniformly formed as a whole. The chromaticity compensation layer **28** may include a plurality of layers.

[0091] In the lights **35***a*, **35***b*, and **35***c* transmitted through the decorative sheet **200***a* illustrated in FIG. **5**, transmitted lights **31***a*T, **31***b*T, and **31***c*T in the wavelength region λ**1** have lower light intensity than transmitted light **32**T in the wavelength region λ**2**. Thus, in the transmitted lights **35***a*, **35***b*, and **35***c* on the front surface side Fa, the spectral component of the light in wavelength region λ**1** is attenuated, and the chromaticity shifts occurs. In the decorative sheet **200***b* illustrated in FIG. **6**, since the chromaticity compensation layer **28** having a low transmittance for the visible incident light **32** in the wavelength region λ**2** different from the wavelength region λ**1** within the lights **35***a*, **35***b*, and **35***c*, the light in the wavelength region λ**2** is attenuated by the chromaticity compensation layer **28** while transmitting through the decorative sheet **200***b*, and is output as transmitted light **32**T**1**. This can reduce the chromaticity shifts caused by the attenuation of the spectral component of the light in the wavelength region λ**1**. In addition, by adjusting the transmittance of the chromaticity compensation layer **28**, the chromaticity shifts occur when light is transmitted through the first pattern layer **25**A and the second pattern layer **25**B can be substantially cancelled. This allows the lights **35***a*, **35***b*, and **35***c* transmitted through the decorative sheet **200***a* to be output with a spectrum substantially similar to that of the incident light **35** from the optical device **30**.

[0092] According to the decorative sheet **200***b* of the display device **100**B of the first embodiment, as described above, the uniformity of the luminance of transmitted light is enhanced, the chromaticity shifts occur in transmitted light can be reduced, thus the visibility of displaying with the transmitted light can be improved.

Third Configuration Example of Decorative Sheet and its Transmission Property

[0093] FIG. **7** is a conceptual sectional view of a display device **100**C according to the first embodiment of the present disclosure, illustrating a decorative sheet **200***c* in a third configuration example. The display device **100**C illustrated in FIG. **7** includes the decorative sheet **200***c* and the optical device **30** emitting light, which is disposed on the back surface side Fb of the decorative sheet **200***c*. The display device **100**C is different from the display device **100**A of FIG. **5** in that the decorative sheet **200***c* further includes a chromaticity compensation light shielding layer **29**. Hereinafter, the display device **100**C will be described focusing on the configurations different from the display device **100**A. In FIG. **7**, substantially the same components as those of the display device **100**A in FIG. **5** are denoted by the same reference numerals, and associated detailed description will be omitted.

[0094] The chromaticity compensation light shielding layer **29** of the decorative sheet **200***c* is a layer in which the light shielding layer **27** of the decorative sheet **200***a* in FIG. **5** and the

chromaticity compensation layer **28** of the decorative sheet **200***b* in FIG. **6** are integrally formed, and similarly to the light shielding layer **27**, the layer is configured to have a transmittance of less than 50% for light in the visible region incident on the decorative sheet **200***c*, and can be used to conceal components disposed on the back surface side of the decorative sheet **200***c* such that the components are not visually recognized from the front surface side Fa. Similar to the chromaticity compensation layer **28**, the chromaticity compensation light shielding layer **29** is configured to attenuate the light intensity of transmitted visible light in a wavelength region different from the wavelength region λ**1**, and can reduce the chromaticity shifts generated when the light is transmitted through the first pattern layer **25**A and the second pattern layer **25**B. By integrally forming the light shielding layer and the chromaticity compensation layer **28**, a decorative sheet can be made compact.

[0095] According to the decorative sheet **200***c* of the display device **100**C of the first embodiment, as described above, the uniformity of the luminance of transmitted light is enhanced, the chromaticity shifts occur in transmitted light can be reduced, thus the visibility of displaying with the transmitted light can be improved.

Fourth Configuration Example of Decorative Sheet and its Transmission Property

[0096] FIG. **8** is a conceptual sectional view of a display device **100**D according to the first embodiment of the present disclosure, illustrating a decorative sheet **200***d* in a fourth configuration example. The display device **100**D illustrated in FIG. **8** includes the decorative sheet **200***d* and the optical device **30** emitting light, which is disposed on the back surface side Fb of the decorative sheet **200***d*. The display device **100**D is different from the display device **100**B in FIG. **6** in that the decorative sheet **200***d* includes a plurality of first pattern layers **25**A, **26**A and a plurality of second pattern layers **25**B, **26**B. Hereinafter, the display device **100**D will be described focusing on the configurations different from the display device **100**B. In FIG. **8**, substantially the same components as those of the display device **100**B in FIG. **6** are denoted by the same reference numerals, and associated detailed description thereof will be omitted.

[0097] The decorative sheet **200***d* in FIG. **8** includes the hard coat layer **22**, the base layer **23**, first pattern layers **25**A and **26**A, the light shielding layer **27**, the chromaticity compensation layer **28**, and second pattern layer **25**B and **26**B in the thickness direction from the front surface side Fa to the back surface side Fb.

[0098] The first pattern layer **25**A includes the first areas **25***a***1**, **25***b***1**, and **25***c***1** that are a plurality of color development areas, and the first areas **25***a***1**, **25***b***1**, and **25***c***1** are configured to contain interference pigments that develop color with reflected interference lights of different light intensities but substantially in the same wavelength region λ**11**. The first pattern layer **26**A includes first areas **26***a***1**, **26***b***1**, and **26***c***1** that are a plurality of color development areas, and the first areas **26***a***1**, **26***b***1**, and **26***c***1** are configured to contain interference pigments that develop color with reflected interference lights of different light intensities but substantially in the same wavelength region λ**12**.

[0099] The second pattern layer **25**B is configured to correspond to the first pattern layer **25**A, and is configured to contain an interference pigment that reflects light incident and develops color with reflected interference light substantially in the same wavelength region λ**11** as that for the first pattern layer **25**A. The second pattern layer **25**B includes the second areas **25***a***2**, **25***b***2**, and **25***c***2** that are a plurality of color development areas, and each of the second areas **25***a***2**, **25***b***2**, and **25***c***2** is disposed to overlap the corresponding one of the first areas **25***a***1**, **25***b***1**, and **25***c***1** on the first pattern layer **25**A when viewed from the thickness directions of the decorative sheet.

[0100] The second pattern layer **26**B is configured to correspond to the first pattern layer **26**A, and is configured to contain an interference pigment that reflects light incident and develops color with reflected interference light substantially in the same wavelength region λ**12** as that for the first pattern layer **26**A. The second pattern layer **26**B includes second areas **26***a***2**, **26***b***2**, and **26***c***2** that are a plurality of color development areas, and each of the second areas **26***a***2**, **26***b***2**, and **26***c***2** is

disposed to overlap the corresponding one of the first areas **26***a***1**, **26***b***1**, and **26***c***1** on the first pattern layer **26**A when viewed from the thickness directions of the decorative sheet.

[0101] The decorative sheet **200***d* in FIG. **8** is shown to include two layers of the first pattern layers and two layers of the second pattern layers, but the present disclosure is not limited to this configuration. The decorative sheet can include any number of first pattern layers and second pattern layers. The plurality of layers of the first pattern layers and the second pattern layers can be produced by lamination printing with a printing method such as screen printing or gravure printing.

[0102] The present disclosure is not limited to the configuration of the plurality of color development areas or the number of areas of each first pattern layer and second pattern layer. These color development areas may be configured, for example, by adjusting the content of the interference pigment particles, for example, the wt % of the interference pigment, or may be configured by including different types of interference pigment particles. Each first pattern layer and second pattern layer may be configured to include any number of two or more color development areas, and each color development area can have any shape and/or dimension. The color development areas in the same pattern layer can be freely defined but not overlapping with each other, different first pattern layer and different second pattern layer can include color development areas with different shapes and/or dimensions, and each pattern layer can be configured with any thickness according to intended uses.

[0103] In the decorative sheet **200***d*, the corresponding first pattern layer **25**A and second pattern layer **25**B can include color development areas configured to satisfy the condition (1) or the condition (2) to improve the uniformity of the luminance of the light in the wavelength region λ**11** respectively transmitted through the overlapping first areas **25***a***1**, **25***b***1**, and **25***c***1** and the second areas **25***a***2**, **25***b***2**, and **25***c***2**. Similarly, for the first pattern layer **25**A and the second pattern layer **25**B, the corresponding first pattern layer **26**A and second pattern layer **26**B also include color development areas configured to satisfy the condition (1) or the condition (2), and thus the uniformity of the luminance of the light in the wavelength region λ**12** respectively transmitted through the overlapping first areas **26***a***1**, **26***b***1**, and **26***c***1** and the second areas **26***a***2**, **26***b***2**, and **26***c***2** can be improved.

[0104] The decorative sheet **200***d* includes the chromaticity compensation layer **28**, and thus the light intensity of transmitted visible light in a wavelength region different from the wavelength regions λ**11** and λ**12** can be attenuated. Thus, the chromaticity shifts occur when the light is transmitted through the first pattern layers **25**A and **26**A and the second pattern layers **25**B and **26**B can be reduced.

[0105] According to the decorative sheet **200***d* of the display device **100**D of the first embodiment, as described above, the uniformity of the luminance of transmitted light is enhanced, the chromaticity shifts occur in transmitted light can be reduced, and thus the visibility of displaying with the transmitted light can be improved.

Second Embodiment

[0106] The pattern layer **25** of the decorative sheet **20***a* of the display device **100***a* shown in FIG. **4** is configured to include the areas **25***a*, **25***b*, and **25***c* developing color with reflected interference lights of different light intensities but substantially in the same wavelength region λ**1**. However, the present disclosure is not limited to this configuration. The pattern layer of the decorative sheet can also be configured to include areas developing color with reflected interference light in different wavelength regions. At this case, the visibility of displaying of the display device may be affected by the transmission properties of the interference pigment. This will be described below with reference to FIG. **9**. FIG. **9** is a conceptual sectional view for describing the influence of the transmission properties of the interference pigment.

[0107] FIG. **9** illustrates a display device **100***b* including the optical device **30** and a decorative sheet **20***b*. The decorative thin material **20***b* includes a pattern layer **55** containing an interference pigment. The decorative sheet **20***b* is different from the decorative sheet **20***a* illustrated in FIG. **4** in

the configuration of the pattern layer **55**. Hereinafter, the display device **100***b* will be described focusing on the configurations different from the display device **100***a*. In FIG. **9**, substantially the same components as those of the display device **100***a* in FIG. **4** are denoted by the same reference numerals, and associated detailed description thereof will be omitted.

[0108] The pattern layer **55** of the decorative sheet **20***b* is configured to include interference pigments that develop color with reflected interference light in different wavelength regions. As illustrated in the figure, the pattern layer **55** includes areas **55***a*, **55***b*, and **55***c*, and the areas **55***a*, **55***b*, and **55***c* are configured to include interference pigments that develop color with reflected interference lights in the different wavelength regions λ**1**, λ**2**, and λ**3**. The areas developing color with the reflected interference lights in different wavelength regions may be configured by, for example, adjusting the thickness of the shell portion of the interference pigment particles to be contained, or may be configured by containing different types of interference pigment particles.

[0109] The optical device **30** inputs light **35** to the decorative sheet **20***b* from the back surface side Fb. The incident light **35** includes incident lights **31**, **32**, and **33** in the different wavelength regions λ**1**, λ**2**, and λ**3**, and is incident on the back surface of the decorative sheet **20***a* with substantially uniform luminance. Within the incident light **35**, the incident light **31** in the wavelength region λ**1** satisfies the interference condition on which the light is mutually intensified in the area **55***a* of the pattern layer **55**, and the reflected interference light **31***a*F in the wavelength region λ**1** is reflected at the area **35***a*. Similarly, within the incident light **35**, the incident light **32** in the wavelength region λ**2** and the incident light **33** in the wavelength region **23** satisfy the interference condition on which the light is mutually intensified at the area **55***b* and the area **55***c* of the pattern layer **35**, respectively, and the reflected interference light **32***a*F in the wavelength region λ**2** and the reflected interference light **33***a*F in the wavelength region λ**3** are reflected at the area **55***b* and the area **55***c*, respectively.

[0110] On the front surface side Fa, transmitted lights **35***a*, **35***b*, and **35***c* including lights having complementary colors with the reflected interference lights **31***a*F, **31***b*F, and **31***c*F are output from the areas **55***a*, **55***b*, and **55***c*, respectively. In the transmitted light **35***a*, the transmitted light **31**T**1** in the wavelength region λ**1** has a lower light intensity than the transmitted lights **32**T and **33**T in the wavelength regions λ**2** and λ**3** that do not satisfy the interference condition, and the spectral component of the light in the wavelength region λ**1** is attenuated. Similarly, in each of the transmitted lights **35***b* and **35***c*, the spectral component of the light in the wavelength region λ**2** or λ**3** is attenuated. In this manner, when the incident light is transmitted through the decorative sheet **20***b*, the spectral components of the light in different wavelength regions are attenuated in different color development areas. As a result, on the surface of the decorative sheet **20***b*, un-uniformity occurs in the spectrum of the transmitted light output from different color development areas, and thus the visibility of displaying is impaired.

[0111] The decorative sheet according to a second embodiment of the present disclosure aims to solve the above problem in the decorative sheet **20***b* and improve the visibility of displaying with transmitted light. Hereinafter, the configuration of the decorative sheet according to the second embodiment will be described with reference to FIGS. **10** to **12**. In FIGS. **10** to **12**, substantially the same components are denoted by the same reference numerals, and associated detailed description thereof will be omitted.

Configuration of Display Device and Decorative Sheet

[0112] FIG. **10** is a conceptual sectional view illustrating a display device **100**E according to the second embodiment of the present disclosure. FIG. **11** is a conceptual sectional view illustrating a configuration of a pattern layer of a decorative sheet **300** according to the second embodiment. FIG. **12** is a conceptual sectional view of the display device **100**E according to the second embodiment, illustrating the decorative sheet **300** included and the transmission properties thereof.

[0113] The display device **100**E of the second embodiment illustrated in FIG. **10** includes the decorative sheet **300** and the optical device **30** emitting light, which is disposed on the back surface

side Fb of the decorative sheet **300**. The decorative sheet **300** includes the hard coat layer **22**, the base layer **23**, the first pattern layer **55**A, the light shielding layer **27**, and the second pattern layer **55**B in the thickness direction from the front surface side Fa to the back surface side Fb. The decorative sheet **300** may be produced by stacking each constituent layer with an adhesive layer having light transparency interposed therebetween, or may be produced through lamination printing of each constituent layer with a printing method such as screen printing or gravure printing.

[0114] The display device **100**E is different from the display device **100**A of FIG. **5** in the configuration of the first pattern layer **55**A and the second pattern layer **55**B of the decorative sheet **300**. Hereinafter, the display device **100**E will be described focusing on the configurations different from the display device **100**A. In FIG. **10**, substantially the same components as those of the display device **100**A in FIG. **5** are denoted by the same reference numerals, and associated detailed description thereof will be omitted.

[0115] As illustrated in FIG. **11**, the first pattern layer **55**A of the decorative sheet **300** is configured to include the first areas **55***a***1**, **55***b***1**, and **55***c***1**, which are a plurality of color development areas containing interference pigments that develop color with reflected interference light in the different wavelength regions λ**1**, λ**2**, and λ**3**.

[0116] The second pattern layer **35**B includes the second areas **55***a***2**, **55***b***2**, and **55***c***2**, which are a plurality of color development areas, and each of the second areas **55***a***2**, **55***b***2**, and **55***c***2** is disposed to overlap the corresponding one of the first areas **35***a***1**, **35***b***1**, and **35***c***1** on the first pattern layer **35**A when viewed from the thickness directions (directions indicated by the arrows in the figure) of the decorative sheet. Thus, when the optical device **30** is turned on, a part of the incident light **35** incident from the back surface side Fb can be transmitted through the overlapping second area on the second pattern layer **35**B and first area on the first pattern layer **35**A, and output at the front surface side Fa.

[0117] In the present embodiment, the overlapping area pairs on the first pattern layer **55**A and the second pattern layer **55**B, for example, as shown in the figure, at least a part of the first area **55***a***1** and the second area **55***a***2**, the first area **55***b***1** and the second area **55***b***2**, and the first area **55***c***1** and the second area **55***c***2** can be configured to contain interference pigments that develop colors having complementary colors with each other. That is, at least a part of the overlapping first area and the second area contains interference pigments that develop a pair of colors at diametrical positions opposite to each other in the color wheel. In generally, complementary colors with each other include color pairs having the largest hue difference therebetween such as, for example, the color pair of red and blue-green, or the color pair of yellow and blue-purple.

[0118] The combination of the reflected interference lights of the interference pigment particles that develop complementary colors results to a spectrum of substantially white light. Thus, as shown in FIG. **11**, when the incident light Lb is transmitted through the overlapping second area on the second pattern layer **55**B and first area the first pattern layer **35**A that are configured to develop complementary colors, the spectral component of the light in each wavelength region is substantially uniformly attenuated, and the transmitted lights Lt**1**, Lt**2**, and Lt**3** can be output with a substantially uniform spectrum.

[0119] The present disclosure is not limited to the configuration of the plurality of color development areas or the number of areas of the first pattern layer **55**A and the second pattern layer **55**B. These color development areas may be configured, for example, by adjusting the content of the interference pigment particles, for example, the wt % of the interference pigment, or may be configured by including different types of interference pigment particles. The first pattern layer **55**A and the second pattern layer **55**B may be configured to include any number of two or more color development areas, and each color development area can have any shape and/or dimension. The color development areas in the same pattern layer can be freely defined but not overlapping with each other, and each pattern layer can be configured with any thickness according to intended uses. Further, the first pattern layer **55**A and the second pattern layer **55**B can be configured such

that incident light from the back surface side Fb is transmitted through the respective overlapping second areas and first areas and is output with substantially uniform luminance by adjusting the content of the interference pigment particles or the type of the interference pigment particles contained.

Transmission Property of Decorative Sheet

[0120] As illustrated in FIG. **12**, the optical device **30** inputs light **35** to the decorative sheet **300** from the back surface side Fb. The incident light **35** includes incident lights **31**, **32**, and **33** in the different wavelength regions λ**1**, λ**2**, and λ**3**, and is incident on the back surface of the decorative sheet **300** with substantially uniform luminance.

[0121] The first area **55***a***1** of the first pattern layer **55**A includes the interference pigment that reflects light incident and develops color with the reflected interference light in the wavelength region λ**1**. In the first area **55***a*, the incident light in the wavelength region λ**1** satisfies the interference condition on which the light is mutually intensified, and is reflected as reflected interference light. In the second area **35***a***2** including the interference pigment that reflects light incident and develops complementary color with that of the first area **35***a***1**, light in the wavelength regions λ**2** and λ**3** different from the wavelength region λ**1** satisfied the interference condition, and is reflected as reflected interference light. As a result, the light **35***a* transmitted through the overlapping second area **35***a***2** and first area **35***a***1** is output including transmitted light components **31**T**1**, **32**T**1**, and **33**T**1**, which are substantially uniformly attenuated from the incident light **31**, **32**, and **33** in each wavelength region λ**1**, λ**2**, and λ**3**. Similarly, the lights **35***b* and **35***c* transmitted through the overlapped second areas **35***b***2**, **35***c***2** and first areas **35***b***1**, **35***c***1** can be output including transmitted light components **31**T**1**, **32**T**1**, and **33**T**1**, which are substantially uniformly attenuated from the incident lights **31**, **32**, and **33** in each wavelength region λ**1**, λ**2**, and λ**3**. Thus, when the incident light is transmitted through the decorative sheet **300**, by passing the overlapping color development areas configured to develop complementary colors, the light component in each wavelength region is substantially uniformly attenuated, thus the uniformity of the spectrum of the transmitted light output from the surface of the decorative sheet **300** is enhanced, and the visibility of displaying can be improved.

[0122] According to the decorative sheet **300** of the display device **100**E of the second embodiment, as described above, the uniformity of the spectrum of transmitted light is enhanced, and the visibility of displaying with the transmitted light can be improved.

[0123] As described above, the above-described embodiments have been described as examples of the technique in the present disclosure. The drawings and the detailed description are provided for this purpose. Thus, the components described in the drawings and the detailed description may include not only components essential for solving the problem but also components that are not essential for solving the problem in order to illustrate the above-described technique. Thus, it should not be immediately recognized that these non-essential components are essential just from the fact that these non-essential components are described in the drawings and the detailed description.

[0124] In addition, since the above-described embodiments are intended to illustrate the technique in the present disclosure, various changes, replacements, additions, omissions, and the like can be made within the scope of the claims or equivalents thereof.

[0125] The present disclosure is applicable to a decorative sheet and a display device including the decorative sheet. The present disclosure is widely applicable in the fields including in-vehicle components, home electric appliances, and household equipment. [0126] **11**, **12**, **13** light displaying [0127] **20**, **20***a*, **20***b* decorative sheet [0128] **21** textured pattern [0129] **22** hard coat layer [0130] **23** base layer [0131] **25** pattern layer [0132] **25**A, **25**B, **26**A, **26**B pattern layer [0133] **55**, **55**A, **55**B pattern layer [0134] **27** light shielding layer [0135] **28** chromaticity compensation layer [0136] **29** chromaticity compensation light shielding layer [0137] **30** optical device [0138] **50** external light source [0139] **100**, **100***a*, **100***b* display device [0140] **100**A, **100**B, **100**C, **100**D, **100**E display

device [0141] **200***a*, **200***b*, **200***c*, **200***d*, **300** decorative sheet [0142] **210** interference pigment particle [0143] **211** core portion [0144] **212** shell portion

Claims

1. A decorative sheet including a number of layers between a front surface and a back surface, the decorative sheet comprising: a first pattern layer including an interference pigment that reflects light incident and develops color with reflected interference light in a first wavelength region, the first pattern layer including a first area that develops color with the reflected interference light of a first light intensity and a second area that develops color with the reflected interference light of a second light intensity; a second pattern layer including an interference pigment that reflects light incident and develops color with reflected interference light in the first wavelength region, the second pattern layer including a third area that develops color with the reflected interference light of a third light intensity and a fourth area that develops color with the reflected interference light of a fourth light intensity, wherein in a thickness direction of the decorative sheet, the first region and the third region are disposed to overlap each other, and the second region and the fourth region are disposed to overlap each other, the first light intensity is greater than the second light intensity, and the third light intensity is less than the fourth light intensity.
2. The decorative sheet according to claim 1, wherein a relative standard deviation value for a total value of the first light intensity and the third light intensity, and a total value of the second light intensity and the fourth light intensity is less than 10%.
3. The decorative sheet according to claim 1, further comprising a light shielding layer disposed between the first pattern layer and the second pattern layer, wherein the light shielding layer has a transmittance of less than 50% for incident light in a visible region.
4. The decorative sheet according to claim 3, further comprising a chromaticity compensation layer disposed between the light shielding layer and the back surface of the decorative sheet, wherein the chromaticity compensation layer has a lower transmittance for light in a wavelength region different from the first wavelength region than that for light in the first wavelength region.
5. The decorative sheet according to claim 4, wherein the light shielding layer and the chromaticity compensation layer are integrally formed.
6. The decorative sheet according to claim 1, wherein the first pattern layer includes two or more layers each including an interference pigment that reflects light incident and develops color with reflected interference light in a wavelength region different from each other, the second pattern layer includes two or more layers each corresponding to one of the plurality of layers of the first pattern layer, the two or more layers of the second pattern layer each including an interference pigment that reflects light incident and develops color with reflected interference light in a substantially same wavelength region as the wavelength region of the reflected interference light with which the interference pigment of a corresponding one of the two or more layers of the first pattern layers develops color, and each layer of the two or more layers of the second pattern layer includes areas disposed to overlap each of the areas included in the corresponding one of the two or more layers of the first pattern layer as viewed in the thickness direction.
7. A display device comprising: the decorative sheet according to claim 1; and an optical device that emits light, the optical device being disposed to face the back surface of the decorative sheet.
8. A decorative sheet including a number of layers between a front surface and a back surface, the decorative sheet comprising: a first pattern layer including an interference pigment that reflects light incident and develops color with reflected interference light, the first pattern layer including two or more first areas that each develop color with the reflected interference light a wavelength region different from each other; a second pattern layer including an interference pigment that reflects light incident and develops color with reflected interference light, the second pattern layer including two or more second areas that are disposed to overlap each of the first areas in a

thickness direction of the decorative sheet, wherein at least a part of the first areas and the second areas overlapping each other include interference pigments that develop complementary colors with each other.

9. The decorative sheet according to claim 8, further comprising a light shielding layer disposed between the first pattern layer and the second pattern layer, wherein the light shielding layer has a transmittance of less than 50% for incident light in a visible region.

10. A display device comprising: the decorative sheet according to claim 8; and an optical device that emits light, the optical device being disposed to face the back surface of the decorative sheet.

11. The decorative sheet according to claim 2, further comprising a light shielding layer disposed between the first pattern layer and the second pattern layer, wherein the light shielding layer has a transmittance of less than 50% for incident light in a visible region.

12. The decorative sheet according to claim 2, wherein the first pattern layer includes two or more layers each including an interference pigment that reflects light incident and develops color with reflected interference light in a wavelength region different from each other, the second pattern layer includes two or more layers each corresponding to one of the plurality of layers of the first pattern layer, the two or more layers of the second pattern layer each including an interference pigment that reflects light incident and develops color with reflected interference light in a substantially same wavelength region as the wavelength region of the reflected interference light with which the interference pigment of a corresponding one of the two or more layers of the first pattern layers develops color, and each layer of the two or more layers of the second pattern layer includes areas disposed to overlap each of the areas included in the corresponding one of the two or more layers of the first pattern layer as viewed in the thickness direction.

13. A display device comprising: the decorative sheet according to claim 2; and an optical device that emits light, the optical device being disposed to face the back surface of the decorative sheet.

14. A display device comprising: the decorative sheet according to claim 9; and an optical device that emits light, the optical device being disposed to face the back surface of the decorative sheet.