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(54) **MEMORY MEDIUM, CARD, BOOKLET, IMAGE AUTHENTICATION SYSTEM AND IMAGE AUTHENTICATION METHOD**

(57) A recording medium whose authenticity can be assessed is provided.

The recording medium includes a base material and a recording layer. The recording layer has an irregular surface including random irregularities, and includes an electron-donating coloration compound, an electron-accepting color developer, and a matrix resin.

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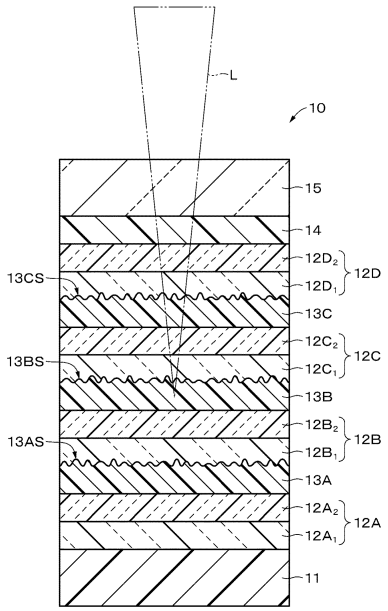

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Description

[Technical Field]

[0001] The present disclosure relates to a recording medium, a card, a booklet, an image authentication system, and an image authentication method.

[Background Art]

[0002] Recording media including a recording layer on which a photograph or the like can be drawn by use of laser light have been proposed. Cards such as financial payment cards or ID cards and booklets such as passports which include such a recording medium have been under examination in recent years. It is desirable that cards and booklets like the ones described above provide enhanced security.

[0003] PTL 1 discloses a multilayer heat sensitive label characterized in that an upper base material and a lower base material are stacked one on another in such a manner as to form a front surface and a back surface, adhesive layers 1 and 2 are stacked adjacent to each other inside each of the upper base material and the lower base material, at least two or more heat sensitive recording layers are stacked between the adhesive layer 1 and the adhesive layer 2, and a peel layer is provided between two adjacent heat sensitive recording layers. In addition, according to the disclosure, the multilayer heat sensitive label having the configuration described above is pasted as a seal label onto an adherend, and, when the adherend is opened thereafter, the label is peeled off at the peel layer and is separated into two, one of which remains on a body section of an envelope, and the other of which remains on a flap section of the envelope, thereby achieving high security.

[Citation List]

[Patent Literature]

[0004] [PTL 1]
JP 2008-268380A

[Summary]

[Technical Problem]

[0005] In terms of enhancement of security, it is desirable that cards such as financial payment cards or ID cards and booklets such as passports have a recording medium whose authenticity can be assessed. However, PTL 1 described above does not describe a technology that makes it possible to assess the authenticity of the recording medium (multilayer heat sensitive label).

[0006] An object of the present disclosure is to provide a recording medium, a card, a booklet, an image authentication system, and an image authentication method that make it possible to assess authenticity.

[Solution to Problem]

[0007] In order to solve the problem described above, a recording medium of the present disclosure includes a base material and a recording layer. The recording layer has an irregular surface including random irregularities, and includes an electron-donating coloration compound, an electron-accepting color developer, and a matrix resin.

[0008] A card of the present disclosure includes the recording medium of the present disclosure.

[0009] A booklet of the present disclosure includes the recording medium of the present disclosure.

[0010] An image authentication system of the present disclosure includes a first terminal device, a second terminal device, and an image authenticating device. The first terminal device causes an image drawing device to draw an image on a first recording medium including a recording layer having an irregular surface including random irregularities, and thereafter causes a first image capturing device to focus on the recording layer of the first recording medium, capture an image of a partial area of the first recording medium, acquire a first image, and transmit the first image to the image authenticating device. The second terminal device causes a second image capturing device to focus on a recording layer having an irregular surface including random irregularities, capture an image of a partial area of a second recording medium including the recording layer, acquire a second image, and transmit the second image to the image authenticating device. The image authenticating device collates the first image received from the first terminal device and the second image received from the second terminal device, and notifies the second terminal device of a result of the collation.

[0011] An image authentication method of the present disclosure includes, by a first terminal device, causing an image drawing device to draw an image on a first recording medium including a recording layer having an irregular surface including random irregularities, and thereafter causing a first image capturing device to focus on the recording layer of the first recording medium, capture an image of a partial area of the first recording medium, acquire a first image, and transmit the first image to an image authenticating device, by a second terminal device, causing a second image capturing device to focus on a recording layer having an irregular surface including random irregularities, capture an image of a partial area of a second recording medium including the recording layer, acquire a second image, and transmit the second image to the image authenticating device, and, by the image authenticating device, collating the first image received from the first terminal device and the second image received from the second terminal device, and notifying the second terminal device of a result of the collation.

[Brief Description of Drawings]

[0012]

[FIG. 1]
FIG. 1 is a plan view depicting an example of the external appearance of a recording medium according to a first embodiment.
[FIG. 2]
FIG. 2 is a cross-sectional view depicting an example of a configuration of the recording medium according to the first embodiment.
[FIG. 3]
FIG. 3 is a plan view depicting an example of the front surface shape of a recording layer in the unrecorded state.
[FIG. 4]
FIG. 4 is a figure of a test device for 90-degree peel tests.
[FIG. 5]
FIG. 5 is a cross-sectional view depicting a configuration of a recording medium according to a reference example.
[FIG. 6]
FIG. 6 is a figure depicting an example of an image observed when a recording layer of the recording medium according to the first embodiment is focused on.
[FIG. 7]
FIG. 7A is a cross-sectional view depicting a first example of a configuration of the recording medium according to a first modification example. FIG. 7B is a cross-sectional view depicting a second example of a configuration of the recording medium according to the first modification example. FIG. 7C is a cross-sectional view depicting a third example of a configuration of the recording medium according to the first modification example.
[FIG. 8]
FIG. 8A is a cross-sectional view depicting a fourth example of a configuration of the recording medium according to the first modification example. FIG. 8B is a cross-sectional view depicting a fifth example of a configuration of the recording medium according to the first modification example. FIG. 8C is a cross-sectional view depicting a sixth example of a configuration of the recording medium according to the first modification example.
[FIG. 9]
FIG. 9 is a cross-sectional view depicting an example of a configuration of the recording medium according to a second modification example.
[FIG. 10]
FIG. 10A is a plan view depicting an example of the external appearance of a card according to a second embodiment. FIG. 10B is a cross-sectional view taken along a line XB-XB in FIG. 10A.
[FIG. 11]
FIG. 11 is a cross-sectional view depicting an example of a configuration of the card according to a first modification example.
[FIG. 12]
FIG. 12 is a cross-sectional view depicting an example of a configuration of a card according to a third embodiment.
[FIG. 13]
FIG. 13 is a perspective view depicting an example of the external appearance of a booklet according to a fourth embodiment.
[FIG. 14]
FIG. 14 is a figure depicting an example of a configuration of an image authentication system according to a fifth embodiment.
[FIG. 15]

FIG. 15 is a figure for explaining an example of an image registration operation performed by the image authentication system according to the fifth embodiment.

[FIG. 16]

FIG. 16 is a figure for explaining an example of an image authentication operation performed by the image authentication system according to the fifth embodiment.

[Description of Embodiments]

[0013] Embodiments of the present disclosure are explained in the following order with reference to the figures. Note that identical or corresponding portions in all the figures of the following embodiments are given identical reference signs.

<1 First Embodiment>

[1.1 Configuration of Recording Medium]

[0014] FIG. 1 is a plan view depicting an example of the external appearance of a recording medium 10 according to a first embodiment. For example, the recording medium 10 is a recording medium for cards or passports, and a face photograph is drawn on the recording medium 10. The recording medium 10 is configured such that its colored state can be changed by being irradiated with laser light (external stimulus). Owing to this change of the colored state, an image can be drawn on the recording medium 10. Whereas the image is a face photograph in the example explained in the first embodiment, the image may be a photograph other than a face photograph. The image is not limited to a

photograph, and may be a drawing pattern, a color pattern, or the like, or may be text such as characters or symbols, for example. The image may include a combination of two or more types selected from photographs, drawing patterns, color patterns, and text.

[0015] The laser light is preferably near-infrared laser light. In the present specification, near-infrared laser light means laser light with a peak wavelength in the wavelength region from 780 nm not inclusive to 2.5 μm inclusive. The change of the colored state may be a reversible change, or may be an irreversible change. That is, the scheme adopted for the recording medium 10 may be a rewritable scheme in which the image or the like can be rewritten, or may be a writeonce scheme in which the image or the like can be written only once. In terms of falsification prevention, the change of the colored state is preferably an irreversible change.

[0016] FIG. 2 is a cross-sectional view depicting an example of a configuration of the recording medium 10 according to the first embodiment. The recording medium 10 includes a base material 11, an intermediate layer 12A, a recording layer 13A, an intermediate layer 12B, a recording layer 13B, an intermediate layer 12C, a recording layer 13C, an intermediate layer 12D, a UV cut layer 14, and a cover layer 15 in this order. Note that the intermediate layer 12D, the UV cut layer 14, and the cover layer 15 are included as necessary. For example, the UV cut layer 14 may not be included, or the intermediate layer 12D, the UV cut layer 14, and the cover layer 15 may not be included. In the present specification, in a case where the intermediate layers 12A, 12B, 12C, and 12D are referred to collectively without particular distinctions being made therebetween, they may be referred to as intermediate layers 12 in some cases. Similarly, in a case where the recording layers 13A, 13B, and 13C are referred to collectively without particular distinctions being made therebetween, they are referred to as recording layers 13 in some cases. The recording layer 13A, the recording layer 13B, and the recording layer 13C are examples of a first recording layer, a second recording layer, and a third recording layer, respectively.

(Base Material 11)

[0017] The base material 11 supports the intermediate layer 12A, the recording layer 13A, the intermediate layer 12B, the recording layer 13B, the intermediate layer 12C, the recording layer 13C, the intermediate layer 12D, the UV cut layer 14, and the cover layer 15. The base material 11 preferably includes a material that excels in heat-resistant properties and excels in dimensional stability in the plane direction. The base material 11 may have properties that make it either transparent or not transparent to visible light. In the present specification, visible light means light in the wavelength region from 360 to 780 nm both inclusive. The base material 11 may have a predetermined color such as white. For example, the base material 11 has a plate-like or film-like shape. In the present disclosure, films are defined as including sheets as well.

[0018] For example, the base material 11 may be rigid, or may be flexible. In a case where the base material 11 is flexible, a flexible recording medium 10 can be realized. For example, as the rigid base material 11, a wafer, a glass substrate, or the like can be used. For example, as the flexible base material 11, a flexible glass, a film, paper, or the like can be used.

[0019] For example, the base material 11 includes at least one type selected from a group including inorganic materials, metallic materials, polymer materials, and the like. For example, the inorganic materials include at least one type selected from a group including silicon (Si), silicon oxides (SiO_X), silicon nitrides (SiN_X), aluminum oxides (AlO_X), and the like. For example, the silicon oxides include at least one type selected from a group including glass, spin-on glass (SOG), and the like. For example, the metallic materials include at least one type selected from a group including aluminum (Al), nickel (Ni), stainless, and the like. For example, the polymer materials include at least one type selected from a group including polycarbonates (PC), polyethylene terephthalates (PET), polyethylene naphthalates (PEN), polyethyl ether ketones (PEEK), polyvinyl chlorides (PVC), and the like.

[0020] Note that at least one of a first surface and a second surface of the base material 11 may be provided with a reflective layer (not depicted), or the base material 11 itself may have a function as a reflective layer as well. The base material 11 having such a configuration makes it possible to display more vivid colors.

(Recording Layers 13A, 13B, and 13C)

[0021] The recording layers 13A, 13B, and 13C in the recorded state are in the colored state, and the recording layers 13A, 13B, and 13C in the unrecorded state are in the decolored state. The recording layers 13A, 13B, and 13C can change from the decolored state to the colored state owing to irradiation with laser light. The decolored state may be state where the laser light and visible light described above can be transmitted through the recording layers 13A, 13B, and 13C.

[0022] The recording layers 13A, 13B, and 13C can exhibit mutually different hues in the colored state. Specifically, the recording layer 13A can be colored in magenta in the colored state. The recording layer 13B can be colored in cyan in the colored state. The recording layer 13C can be colored in yellow in the colored state. Magenta, cyan, and yellow

are examples of a first primary color, a second primary color, and a third primary color, respectively. The first primary color, the second primary color, and the third primary color may be the three primary colors of colors. The first primary color, the second primary color, and the third primary color may be colors other than magenta, cyan, and yellow. Laser light that can change the state of the recording layer 13A into the colored state, laser light that can change the state of the recording layer 13B into the colored state, and laser light that can change the state of the recording layer 13C into the colored state have mutually different peak wavelengths.

[0023] FIG. 3 is a plan view depicting an example of the front surface of the recording layer 13A in the unrecorded state (uncolored state). The recording layer 13A has an irregular surface 13AS on its front surface side. The front surface of the recording layer 13A means a surface on a side where an image recorded on the recording layer 13A is observed. It is assumed that the front surfaces of the recording layer 13B and the recording layer 13C also mean surfaces having content similar to that of the front surface of the recording layer 13A. The recording layer 13A having the irregular surface 13AS can increase the peel strength of the interface between the recording layer 13A and the intermediate layer 12B.

[0024] The recording layer 13B has an irregular surface 13BS on its front surface side. The recording layer 13B having the irregular surface 13BS can increase the peel strength of the interface between the recording layer 13B and the intermediate layer 12C.

[0025] The recording layer 13C has an irregular surface 13CS on its front surface side. The recording layer 13C having the irregular surface 13CS can increase the peel strength of the interface between the recording layer 13C and the intermediate layer 12C.

[0026] The irregular surfaces 13AS, 13BS, and 13CS include random irregularities. For example, the random irregularities are formed by Benard cells. The random irregularities formed by Benard cells or the like are structures which are unique to each recording medium 10, and are difficult to forge. In the present specification, in a case where the irregular surfaces 13AS, 13BS, and 13CS are referred to collectively without particular distinctions being made therebetween, they are referred to as irregular surfaces 13S in some cases.

[0027] For example, the sizes of the random irregularities on the irregular surface 13AS, the irregular surface 13BS, and the irregular surface 13CS are equal to or greater than 50 μm and equal to or smaller than 100 μm. For example, the heights of the random irregularities on the irregular surface 13AS, the irregular surface 13BS, and the irregular surface 13CS are equal to or greater than 2 μm and equal to or smaller than 3 μm.

[0028] The sizes of the random irregularities are determined by any of the following methods (1) to (3).

(1) Image data is acquired by focus stacking, in the height direction, of irregular shapes of a recording layer front surface with use of a microscope having a high definition camera mounted thereon. The lengths in the widthwise direction of the acquired irregular shapes are measured, and the sizes of irregularities are measured.
(2) A cross-section is acquired by a microtome or the like, and the sizes of irregularities of the recording layer 13 are measured by an SEM (Scanning Electron Microscope).
(3) An image with spots is obtained by observing, with a microscope, a portion that is colored in a uniform color tone after drawing. Since the sizes of the spots are attributable to irregularities of the recording layer 13, the sizes can be considered as representing the sizes of the irregularities.

[0029] The heights of the random irregularities are determined by any of the following methods (4) and (5).

(4) Image data is acquired by focus stacking, in the height direction, of irregular shapes of a recording layer front surface with use of a microscope having a high definition camera mounted thereon. The differences in height between peaks and troughs of the acquired irregular shapes are measured, and the heights of irregularities are measured.
(5) A cross-section is acquired by a microtome or the like, and the heights of irregularities of the recording layer 13 are measured by an SEM (Scanning Electron Microscope).

[0030] First pixels that form an image such as a face photograph are formed on the recording layer 13A in the recorded state. The first pixels include dot-shaped first colored portions. The first pixels, that is, the first colored portions, of the recording layer 13A are colored in magenta.

[0031] Second pixels that form an image such as a face photograph are formed on the recording layer 13B in the recorded state. The second pixels include dot-shaped second colored portions. The second pixels, that is, the second colored portions, of the recording layer 13B are colored in cyan.

[0032] Third pixels that form an image such as a face photograph are formed on the recording layer 13C in the recorded state. The third pixels include dot-shaped third colored portions. The third pixels, that is, the third colored portions, of the recording layer 13C are colored in yellow.

[0033] The thicknesses of the recording layers 13A, 13B, and 13C are preferably equal to or greater than 1 μm and equal to or smaller than 20 μm, more preferably equal to or greater than 2 μm and equal to or smaller than 15 μm, and further preferably equal to or greater than 3 μm and equal to or smaller than 7 μm, and are approximately 5 μm, for

example. If the thicknesses of the recording layers 13A, 13B, and 13C are equal to or greater than 1 μm, the color optical densities can be enhanced. On the other hand, if the thicknesses of the recording layers 13A, 13B, and 13C are equal to or smaller than 20 μm, increase in the amounts of used heat of the recording layers 13A, 13B, and 13C can be reduced, and deterioration of the chromogenic properties can be reduced.

[0034] The recording layer 13A includes an electron-donating first coloration compound, an electron-accepting first color developer, and a first photothermal conversion agent. The recording layer 13A preferably further includes a first matrix resin.

[0035] The recording layer 13B includes an electron-donating second coloration compound, an electron-accepting second color developer, and a second photothermal conversion agent. The recording layer 13B preferably further includes a second matrix resin.

[0036] The recording layer 13C includes an electron-donating third coloration compound, an electron-accepting third color developer, and a third photothermal conversion agent. The recording layer 13C preferably further includes a third matrix resin.

(First, Second, and Third Coloration Compounds)

[0037] The first, second, and third coloration compounds can be colored by reacting with the first, second, and third color developers, respectively. The first, second, and third coloration compounds can exhibit mutually different hues in the colored state. Specifically, the first coloration compound can be colored in magenta in the colored state. The second coloration compound can be colored in cyan in the colored state. The third coloration compound can be colored in yellow in the colored state.

[0038] For example, the first, second, and third coloration compounds are leuco dyes. The leuco dyes are colored when lactone rings in the molecules are decyclized upon reaction of the lactone rings with acid. The leuco dyes may be decolored when the decyclized lactone rings are cyclized upon reaction with a base. For example, the leuco dyes may be existing dyes for heat sensitive paper.

[0039] The first, second, and third coloration compounds are not particularly limited to any kind, and any compounds can be selected as appropriate depending on purposes. For example, the first, second, and third coloration compounds include at least one type selected from a group including fluoran compounds, triphenyl methane phthalide compounds, azaphthalide compounds, phenothiazine compounds, leuco auramine compounds, indolinophthalide compounds, and the like. Other than these, for example, the first, second, and third coloration compounds may include at least one type selected from a group including 2-anilino-3-methyl-6-diethylaminofluoran, 2-anilino-3-methyl-6-di(n-butylamino)fluoran, 2-anilino-3-methyl-6-(N-n-propyl-N-methylamino)fluoran, 2-anilino-3-methyl-6-(N-isopropyl-N-methylamino)fluoran, 2-anilino-3-methyl-6-(N-isobutyl-N-methylamino)fluoran, 2-anilino-3-methyl-6-(N-n-amyl-N-methylamino)fluoran, 2-anilino-3-methyl-6-(N-sec-butyl-N-methylamino)fluoran, 2-anilino-3-methyl-6-(N-n-amyl-N-ethylamino)fluoran, 2-anilino-3-methyl-6-(N-iso-amyl-N-ethylamino)fluoran, 2-anilino-3-methyl-6-(N-n-propyl-N-isopropylamino)fluoran, 2-anilino-3-methyl-6-(N-cyclohexyl-N-methylamino)fluoran, 2-anilino-3-methyl-6-(N-ethyl-p-toluidino)fluoran, 2-anilino-3-methyl-6-(N-methyl-p-toluidino)fluoran, 2-(m-trichloromethylanilino)-3-methyl-6-diethylaminofluoran, 2-(m-trifluoromethylanilino)-3-methyl-6-diethylaminofluoran, 2-(m-trichloromethylanilino)-3-methyl-6-(N-cyclohexyl-N-methylamino)fluoran, 2-(2,4-dimethylanilino)-3-methyl-6-diethylaminofluoran, 2-(N-ethyl-p-toluidino)-3-methyl-6-(N-ethylanilino)fluoran, 2-(N-ethyl-p-toluidino)-3-methyl-6-(N-propyl-p-toluidino)fluoran, 2-anilino-6-(N-n-hexyl-N-ethylamino)fluoran, 2-(o-chloroanilino)-6-diethylaminofluoran, 2-(o-chloroanilino)-6-dibutylaminofluoran, 2-(m-trifluoromethylanilino)-6-diethylaminofluoran, 2,3-dimethyl-6-dimethylaminofluoran, 3-methyl-6-(N-ethyl-p-toluidino)fluoran, 2-chloro-6-diethylaminofluoran, 2-bromo-6-diethylaminofluoran, 2-chloro-6-dipropylaminofluoran, 3-chloro-6-cyclohexylaminofluoran, 3-bromo-6-cyclohexylaminofluoran, 2-chloro-6-(N-ethyl-N-isoamylamino)fluoran, 2-chloro-3-methyl-6-diethylaminofluoran, 2-anilino-3-chloro-6-diethylaminofluoran, 2-(o-chloroanilino)-3-chloro-6-cyclohexylaminofluoran, 2-(m-trifluoromethylanilino)-3-chloro-6-diethylaminofluoran, 2-(2,3-dichloroanilino)-3-chloro-6-diethylaminofluoran, 1,2-benzo-6-diethylaminofluoran, 3-diethylamino-6-(m-trifluoromethylanilino)fluoran, 3-(1-ethyl-2-methylindol-3-yl)-3-(2-ethoxy-4-diethylaminophenyl)-4-azaphthalide, 3-(1-ethyl-2-methylindol-3-yl)-3-(2-ethoxy-4-diethylaminophenyl)-7-azaphthalide, 3-(1-octyl-2-methylindol-3-yl)-3-(2-ethoxy-4-diethylaminophenyl)-4-azaphthalide, 3-(1-ethyl-2-methylindol-3-yl)-3-(2-methyl-4-diethylaminophenyl)-4-azaphthalide, 3-(1-ethyl-2-methylindol-3-yl)-3-(2-methyl-4-diethylaminophenyl)-7-azaphthalide, 3-(1-ethyl-2-methylindol-3-yl)-3-(4-diethylaminophenyl)-4-azaphthalide, 3-(1-ethyl-2-methylindol-3-yl)-3-(4-N-n-amyl-N-methylaminophenyl)-4-azaphthalide, 3-(1-methyl-2-methylindol-3-yl)-3-(2-hexyloxy-4-diethylaminophenyl)-4-azaphthalide, 3,3-bis(2-ethoxy-4-diethylaminophenyl)-4-azaphthalide, 3,3-bis(2-ethoxy-4-diethylaminophenyl)-7-azaphthalide, 2-(p-acetylanilino)-6-(N-n-amyl-N-n-butylamino)fluoran, 2-benzylamino-6-(N-ethyl-p-toluidino)fluoran, 2-benzylamino-6-(N-methyl-2,4-dimethylanilino)fluoran, 2-benzylamino-6-(N-ethyl-2,4-dimethylanilino)fluoran, 2-benzylamino-6-(N-methyl-p-toluidino)fluoran, 2-benzylamino-6-(N-ethyl-p-toluidino)fluoran, 2-(di-p-methylbenzylamino)-6-(N-ethyl-p-toluidino)fluoran, 2-(α-phenylethylamino)-6-(N-ethyl-p-toluidino)fluoran, 2-methylamino-6-(N-methylanilino)fluoran, 2-methylamino-6-(N-ethylanilino)fluoran, 2-methylamino-6-(N-propylanilino)fluoran, 2-ethylamino-6-(N-

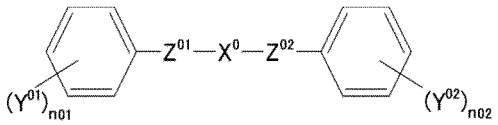
methyl-p-toluidino)fluoran, 2-methylamino-6-(N-methyl-2,4-dimethylanilino)fluoran, 2-ethylamino-6-(N-ethyl-2,4-dimethylanilino)fluoran, 2-dimethylamino-6-(N-methylanilino)fluoran, 2-dimethylamino-6-(N-ethylanilino)fluoran, 2-diethylamino-6-(N-methyl-p-toluidino)fluoran, 2-diethylamino-6-(N-ethyl-p-toluidino)fluoran, 2-dipropylamino-6-(N-methylanilino)fluoran, 2-dipropylamino-6-(N-ethylanilino)fluoran, 2-amino-6-(N-methylanilino)fluoran, 2-amino-6-(N-ethylanilino)fluoran, 2-amino-6-(N-propylanilino)fluoran, 2-amino-6-(N-methyl-p-toluidino)fluoran, 2-amino-6-(N-ethyl-p-toluidino)fluoran, 2-amino-6-(N-propyl-p-toluidino)fluoran, 2-amino-6-(N-methyl-p-ethylanilino)fluoran, 2-amino-6-(N-ethyl-p-ethylanilino)fluoran, 2-amino-6-(N-propyl-p-ethylanilino)fluoran, 2-amino-6-(N-methyl-2,4-dimethylanilino)fluoran, 2-amino-6-(N-ethyl-2,4-dimethylanilino)fluoran, 2-amino-6-(N-propyl-2,4-dimethylanilino)fluoran, 2-amino-6-(N-methyl-p-chloroanilino)fluoran, 2-amino-6-(N-ethyl-p-chloroanilino)fluoran, 2-amino-6-(N-propyl-p-chloroanilino)fluoran, 1,2-benzo-6-(N-ethyl-N-isoamylamino)fluoran, 1,2-benzo-6-dibutylaminofluoran, 1,2-benzo-6-(N-methyl-N-cyclohexylamino)fluoran, 1,2-benzo-6-(N-ethyl-N-toluidino)fluoran, and the like.

(First, Second, and Third Color Developers)

[0040] The first, second, and third color developers can make the first, second, and third coloration compounds in the decolored state colored. The types of the first, second, and third color developers may be identical to each other, or the types of the first, second, and third color developers may be mutually different. The first, second, and third color developers are compounds including electron-accepting bases in the molecules. The first, second, and third coloration compounds are colored when electron-accepting portions of the first, second, and third color developers react with the lactone rings of the first, second, and third coloration compounds, respectively, and the lactone rings are decyclized. For example, the first, second, and third color developers include at least one type selected from a group including phenol derivatives, salicylic acid derivatives, urea derivatives, and the like.

[0041] Specifically, for example, the color developers include a compound represented by the following Formula (1).

[Chem. 1]



...(1)

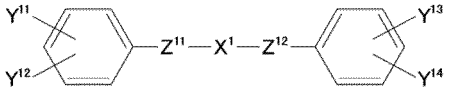
[0042] (n.b. X^0 in Formula (1) is a divalent base including at least one benzene ring. Y^{01} and Y^{02} are each independently a monovalent base. n01 and n02 are each independently any integer from 0 to 5. In a case where n01 is any integer from 2 to 5, Y^{01}s may be mutually identical, or may be mutually different. In a case where n02 is any integer from 2 to 5, Y^{02}s may be mutually identical, or may be mutually different. Z^{01} and Z^{02} are each independently a hydrogen bonding group.)

[0043] Since X^0 including the at least one benzene ring can raise the melting point as compared to a case where X^0 is an aliphatic hydrocarbon group (e.g. a normal alkyl chain), the developed-color maintaining properties at the time of high-temperature/high-humidity storage (hereinafter, referred to as "high-temperature/high-humidity storage properties") can be enhanced. In terms of enhancement of the high-temperature/high-humidity storage properties and the heat-resistant properties, X^0 preferably includes at least two benzene rings. For example, the high-temperature/high-humidity storage properties are storage properties in an environment with 80°C and 60 %RH. By enhancing the heat-resistant properties, the tolerance of the recording medium 10 against severe processes (e.g. hot pressing, monolithic molding using a molten resin or the like, etc.) is enhanced. In a case where X^0 includes the at least two benzene rings, the at least two benzene rings may be condensed. For example, X^0 may be naphthalene, anthracene, or the like.

[0044] Since Z^{01} and Z^{02} being each independently a hydrogen bonding group make it easier for the color developers to be present in a state where the color developers are bonded to each other to some degree via hydrogen bonds, the stability of the color developers in the recording layers 13 is enhanced. In the present specification, the hydrogen bonding groups mean functional groups including atoms that can form hydrogen bonds with atoms present in other functional groups, other compounds, or the like.

[0045] The color developers preferably include a compound represented by the following Formula (2).

[Chem. 2]



...(2)

[0046] (n.b. X^1 in Formula (2) is a divalent base including at least one benzene ring. Y^{11}, Y^{12}, Y^{13}, and Y^{14} are each independently a monovalent base. Z^{11} and Z^{12} are each independently a hydrogen bonding group.)

[0047] Since X^1 including the at least one benzene ring can raise the melting point as compared to a case where X^1 is an aliphatic hydrocarbon group (e.g. a normal alkyl chain), the high-temperature/high-humidity storage properties can be enhanced. In terms of enhancement of the high-temperature/high-humidity storage properties and the heat-resistant properties, X^1 preferably includes at least two benzene rings. In a case where X^1 includes the at least two benzene rings, the at least two benzene rings may be condensed. For example, X^1 may be naphthalene, anthracene, or the like.

[0048] Since Z^{11} and Z^{12} being each independently a hydrogen bonding group make it easier for the color developers to be present in a state where the color developers are bonded to each other to some degree via hydrogen bonds, the stability of the color developers in the recording layers 13 is enhanced.

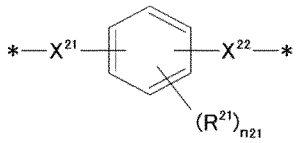
[0049] In a case where Formula (1) and Formula (2) include a hydrocarbon group, the hydrocarbon group is a term used to collectively refer to groups including carbon (C) and hydrogen (H). The hydrocarbon group may be a saturated hydrocarbon group, or may be an unsaturated hydrocarbon group. The saturated hydrocarbon group is an aliphatic hydrocarbon group not having carbon-carbon multiple bonds, and the unsaturated hydrocarbon group is an aliphatic hydrocarbon group having carbon-carbon multiple bonds (carbon-carbon double bonds or carbon-carbon triple bonds).

[0050] In a case where Formula (1) and Formula (2) include a hydrocarbon group, the hydrocarbon group may be a chain hydrocarbon group, or may include one ring or two or more rings. The chain hydrocarbon group may be a linear-chain hydrocarbon group, or may be a branched hydrocarbon group having one side chain, two or more side chains, or the like.

(X° and X^1 Including One Benzene Ring)

[0051] For example, X^0 in Formula (1) and X^1 in Formula (2) are divalent bases including one benzene ring. For example, the divalent bases are represented by the following Formula (3).

[Chem. 3]



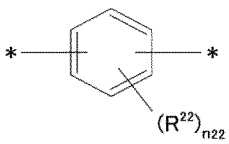
$$*-X^{21}-\text{C}_6\text{H}_3(-X^{22}-*)(-(R^{21})_{n21})\quad \cdots(3)$$

[0052] (n.b. there may be or may not be X^{21} in Formula (3), and, in a case where there is X^{21}, X^{21} is a divalent base. There may be or may not be X^{22}, and, in a case where there is X^{22}, X^{22} is a divalent base. R^{21} is a monovalent base. n21 is any integer from 0 to 4. In a case where n21 is any integer from 2 to 4, R^{21}s may be mutually identical, or may be mutually different. The mark "*" represents a bonding portion.)

[0053] In Formula (3), there are no limitations on the positions at which X^{21} and X^{22} are bonded with the benzene ring. That is, the positions at which X^{21} and X^{22} are bonded with the benzene ring may be any of the ortho position, the meta position, and the para position.

[0054] The above-described divalent bases including the one benzene ring are preferably represented by the following Formula (4) in terms of enhancement of the high-temperature/high-humidity storage properties.

[Chem. 4]



$$*-\text{C}_6\text{H}_3(-*)(-(R^{22})_{n22})\quad \cdots(4)$$

(n.b. R^{22} in Formula (4) is a monovalent base. n22 is any integer from 0 to 4. In a case where n22 is any integer from 2 to 4, R^{22}s may be mutually identical, or may be mutually different. The mark "*" represents a bonding portion.)

[0055] In a case where X^0 in Formula (1) is a divalent base including one benzene ring, in Formula (4), there are no limitations on the positions at which Z^{01} and Z^{02} are bonded with the benzene ring. That is, the positions at which Z^{01} and Z^{02} are bonded with the benzene ring may be any of the ortho position, the meta position, and the para position.

[0056] In a case where X^1 in Formula (2) is a divalent base including one benzene ring, in Formula (4), there are no limitations on the positions at which Z^{11} and Z^{12} are bonded with the benzene ring. That is, the positions at which Z^{11}

and Z^{12} are bonded with the benzene ring may be any of the ortho position, the meta position, and the para position.

(X^{21} and X^{22})

[0057] Whereas it is sufficient if X^{21} and X^{22} in Formula (3) are each independently a divalent base and there are no particular limitations on them, an example thereof is a hydrocarbon group that may have a substituent. The hydrocarbon group is preferably a chain hydrocarbon group. Since the hydrocarbon group being a chain hydrocarbon group can lower the melting points of the color developers, it becomes easier to melt the color developers by irradiation with laser light and make the coloration compounds colored. In terms of lowering of the melting points of the color developers, a normal alkyl chain is particularly preferable among chain hydrocarbon groups.

[0058] For example, the number of carbon atoms of the hydrocarbon group that may have the substituent is equal to or greater than 1 and equal to or smaller than 15, equal to or greater than 1 and equal to or smaller than 13, equal to or greater than 1 and equal to or smaller than 12, equal to or greater than 1 and equal to or smaller than 10, equal to or greater than 1 and equal to or smaller than 6, or equal to or greater than 1 and equal to or smaller than 3.

[0059] In a case where X^{21} and X^{22} in Formula (3) are normal alkyl groups, in terms of the high-temperature storage stability, the number of carbon atoms of the normal alkyl groups are preferably equal to or smaller than 8, more preferably equal to or smaller than 6, still further preferably equal to or smaller than 5, and particularly preferably equal to or smaller than 3. Since, if the number of carbon atoms of an normal alkyl group is equal to or smaller than 8, the length of the normal alkyl group is short, it is considered that color developers are unlikely to experience thermal disturbance at the time of high temperature storage and that portions that have interacted with the coloration compounds such as leuco dyes at the time of being colored are unlikely to be disengaged. Accordingly, since the coloration compounds such as leuco dyes are unlikely to be decolored at the time of high temperature storage, the high-temperature storage stability is enhanced.

[0060] For example, examples of the substituent that the hydrocarbon group may have include halogen groups (e.g. fluorine groups), alkyl groups having a halogen group (e.g. a fluorine group), and the like. The hydrocarbon group that may have the substituent may be one in which part of carbon of the hydrocarbon group (e.g. part of carbon included in the main chain of the hydrocarbon group) is replaced with an element such as oxygen.

(R^{21})

[0061] Whereas it is sufficient if R^{21} in Formula (3) is a monovalent base and there are no particular limitations on it, an example thereof is a halogen group or a hydrocarbon group that may have a substituent.

[0062] For example, the halogen group is a fluorine group (-F), a chlorine group (-Cl), a bromine group (-Br), or an iodine group (-I).

[0063] For example, the number of carbon atoms of the hydrocarbon group that may have the substituent is equal to or greater than 1 and equal to or smaller than 15, equal to or greater than 1 and equal to or smaller than 13, equal to or greater than 1 and equal to or smaller than 12, equal to or greater than 1 and equal to or smaller than 10, equal to or greater than 1 and equal to or smaller than 6, or equal to or greater than 1 and equal to or smaller than 3.

[0064] For example, examples of the substituent that the hydrocarbon group may have include halogen groups (e.g. fluorine groups), alkyl groups having a halogen group (e.g. a fluorine group), and the like. The hydrocarbon group that may have the substituent may be one in which part of carbon of the hydrocarbon group (e.g. part of carbon included in the main chain of the hydrocarbon group) is replaced with an element such as oxygen.

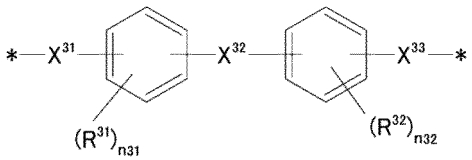
(R22)

[0065] Whereas it is sufficient if R^{22} in Formula (4) is a monovalent base and there are no particular limitations on it, an example thereof is a halogen group or a hydrocarbon group that may have a substituent. The halogen group and the hydrocarbon group that may have the substituent are similar to those of R^{21} in Formula (3) described above.

(X° and X^{1} Including Two Benzene Rings)

[0066] For example, X^{0} in Formula (1) and X^{1} in Formula (2) are divalent bases including two benzene rings. For example, the divalent bases are represented by the following Formula (5).

[Chem. 5]



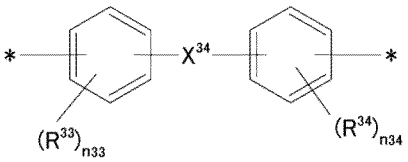
...(5)

[0067] (n.b. there may be or may not be X^{31} in Formula (5), and, in a case where there is X^{31}, X^{31} is a divalent base. There may be or may not be X^{32}, and, in a case where there is X^{32}, X^{32} is a divalent base. There may be or may not be X^{33}, and, in a case where there is X^{33}, X^{33} is a divalent base. R^{31} and R^{32} are each independently a monovalent base. n31 and n32 are each independently any integer from 0 to 4. In a case where n31 is any integer from 2 to 4, R^{31}s may be mutually identical, or may be mutually different. In a case where n32 is any integer from 2 to 4, R^{32}s may be mutually identical, or may be mutually different. The mark "*" represents a bonding portion.)

[0068] In Formula (5), there are no limitations on the positions at which X^{31} and X^{32} are bonded with a benzene ring. That is, the positions at which X^{31} and X^{32} are bonded with the benzene ring may be any of the ortho position, the meta position, and the para position. Similarly, in Formula (5), there are no limitations on the positions at which X^{32} and X^{33} are bonded with a benzene ring. That is, the positions at which X^{32} and X^{33} are bonded with the benzene ring may be any of the ortho position, the meta position, and the para position.

[0069] The above-described divalent bases including the two benzene rings are preferably represented by the following Formula (6) in terms of enhancement of the high-temperature/high-humidity storage properties.

[Chem. 6]



...(6)

[0070] (n.b. X^{34} in Formula (6) is a divalent base. R^{33} and R^{34} are each independently a monovalent base. n33 and n34 are each independently any integer from 0 to 4. In a case where n33 is any integer from 2 to 4, R^{33}s may be mutually identical, or may be mutually different. In a case where n34 is any integer from 2 to 4, R^{34}s may be mutually identical, or may be mutually different. The mark "*" represents a bonding portion.)

[0071] In a case where X^0 in Formula (1) is a divalent base including two benzene rings, in Formula (6), there are no limitations on the positions at which Z^{01} and X^{34} are bonded with a benzene ring. That is, the positions at which Z^{01} and X^{34} are bonded with the benzene ring may be any of the ortho position, the meta position, and the para position. Similarly, in Formula (6), there are no limitations on the positions at which Z^{02} and X^{34} are bonded with a benzene ring. That is, the positions at which Z^{02} and X^{34} are bonded with the benzene ring may be any of the ortho position, the meta position, and the para position.

[0072] In a case where X^1 in Formula (2) is a divalent base including two benzene rings, in Formula (6), there are no limitations on the positions at which Z^{11} and X^{34} are bonded with a benzene ring. That is, the positions at which Z^{11} and X^{34} are bonded with the benzene ring may be any of the ortho position, the meta position, and the para position. Similarly, in Formula (6), there are no limitations on the positions at which Z^{12} and X^{34} are bonded with a benzene ring. That is, the positions at which Z^{12} and X^{34} are bonded with the benzene ring may be any of the ortho position, the meta position, and the para position.

(X^{31}, X^{32}, and X^{33})

[0073] Whereas it is sufficient if X^{31}, X^{32}, and X^{33} in Formula (5) are each independently a divalent base and there are no particular limitations on them, an example thereof is a hydrocarbon group that may have a substituent. The hydrocarbon group is similar to that of X^{21} and X^{22} in Formula (3) described above.

(X^{34})

[0074] Whereas it is sufficient if X^{34} in Formula (6) is a divalent base and there are no particular limitations on it, an example thereof is a hydrocarbon group that may have a substituent. The hydrocarbon group is similar to that of X^{21} and X^{22} in Formula (3) described above.

(R^{31} and R^{32})

[0075] Whereas it is sufficient if R^{31} and R^{32} in Formula (5) are monovalent bases and there are no particular limitations on them, an example thereof is a halogen group or a hydrocarbon group that may have a substituent. The halogen group and the hydrocarbon group that may have the substituent are similar to those of R^{21} in Formula (3) described above.

(R^{33} and R^{34})

[0076] Whereas it is sufficient if R^{33} and R^{34} in Formula (6) are monovalent bases and there are no particular limitations on them, an example thereof is a halogen group or a hydrocarbon group that may have a substituent. The halogen group and the hydrocarbon group that may have the substituent are similar to those of R^{21} in Formula (3) described above.

(Y^{01} and Y^{02})

[0077] For example, Y^{01} and Y^{02} in Formula (1) are each independently a hydrogen group (-H), a hydroxy group (-OH), a halogen group (-X), a carboxy group (-COOH), an ester group (-COOR), or a hydrocarbon group that may have a substituent.

[0078] For example, the halogen group is a fluorine group (-F), a chlorine group (-Cl), a bromine group (-Br), or an iodine group (-I).

[0079] For example, the number of carbon atoms of the hydrocarbon group that may have the substituent is equal to or greater than 1 and equal to or smaller than 15, equal to or greater than 1 and equal to or smaller than 13, equal to or greater than 1 and equal to or smaller than 12, equal to or greater than 1 and equal to or smaller than 10, equal to or greater than 1 and equal to or smaller than 6, or equal to or greater than 1 and equal to or smaller than 3.

[0080] For example, examples of the substituent that the hydrocarbon group may have include halogen groups (e.g. fluorine groups), alkyl groups having a halogen group (e.g. a fluorine group), and the like. The hydrocarbon group that may have the substituent may be one in which part of carbon of the hydrocarbon group (e.g. part of carbon included in the main chain of the hydrocarbon group) is replaced with an element such as oxygen.

[0081] In Formula (1), one of $(Y^{01})_{n01}$s and and/or one of $(Y^{02})_{n02}$s are/is preferably a hydroxy group (-OH). The one of $(Y^{01})_{n01}$s and/or the one of $(Y^{02})_{n02}$s being a hydroxy group (-OH) can enhance display quality and light fastness.

(Y^{11}, Y^{12}, Y^{13}, and Y^{14})

[0082] In Formula (2), there are no limitations on the positions at which Y^{11} and Y^{12} are bonded with a benzene ring. That is, the positions at which Y^{11} and Y^{12} are bonded with the benzene ring may be any of the ortho position, the meta position, and the para position. Similarly, in Formula (2), there also are no limitations on the positions at which Y^{13} and Y^{14} are bonded with a benzene ring. That is, the positions at which Y^{13} and Y^{14} are bonded with the benzene ring may also be any of the ortho position, the meta position, and the para position. In Formula (2), the positions at which Y^{11} and Y^{12} are bonded with one benzene and the positions at which Y^{13} and Y^{14} are bonded with the other benzene may be identical to each other, or may be different from each other.

[0083] For example, Y^{11}, Y^{12}, Y^{13}, and Y^{14} in Formula (2) are each independently a hydrogen group (-H), a hydroxy group (-OH), a halogen group, a carboxy group (-COOH), an ester group (-COOR), or a hydrocarbon group that may have a substituent. The halogen group and the hydrocarbon group that may have the substituent is similar to those of Y^{01} and Y^{02} in Formula (1) described above.

[0084] In Formula (2), Y^{11} and and/or Y^{13} are/is preferably a hydroxy group (-OH). Y^{11} and/or Y^{13} being a hydroxy group (-OH) can enhance display quality and light fastness.

(Z^{01} and Z^{02})

[0085] For example, Z^{01} and Z^{02} in Formula (1) are each independently a urea bond (-NHCONH-), an amide bond (-NHCO-, -OCHN-), or a hydrazide bond (-NHCOCONH-). In terms of enhancement of the high-temperature/high-humidity storage properties, Z^{01} and Z^{02} are preferably urea bonds. In a case where Z^{01} is an amide bond, nitrogen included in the amide bond may be bonded with a benzene, or carbon included in the amide bond may be bonded with a benzene.

In a case where Z^{02} is an amide bond, nitrogen included in the amide bond may be bonded with a benzene, or carbon included in the amide bond may be bonded with a benzene.

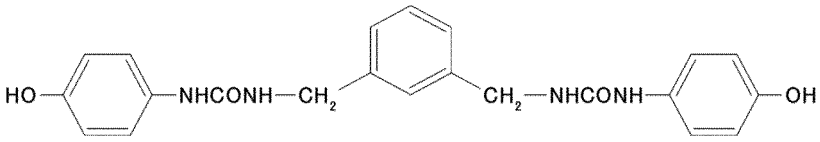
(Z^{11} and Z^{12})

[0086] For example, Z^{11} and Z^{12} in Formula (2) are each independently a urea bond (-NHCONH-), an amide bond (-NHCO-, -OCHN-), or a hydrazide bond (-NHCOCONH-). In terms of enhancement of the high-temperature/high-humidity storage properties, Z^{11} and Z^{12} are preferably urea bonds. In a case where Z^{11} is an amide bond, nitrogen included in the amide bond may be bonded with a benzene, or carbon included in the amide bond may be bonded with a benzene. In a case where Z^{12} is an amide bond, nitrogen included in the amide bond may be bonded with a benzene, or carbon included in the amide bond may be bonded with a benzene.

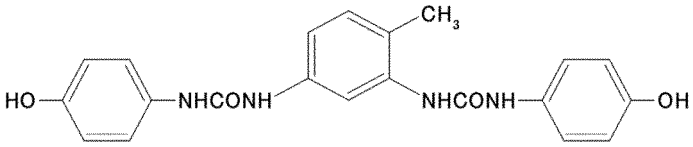
(Specific Examples of Color Developers)

[0087] Specifically, for example, color developers in which X^0 in Formula (1) and X^1 in Formula (2) include one benzene ring include at least one type selected from a group including compounds represented by the following Formulae (7-1) to (7-6).

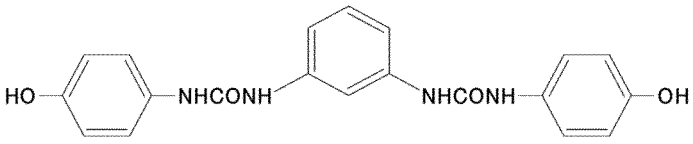
[Chem. 7]



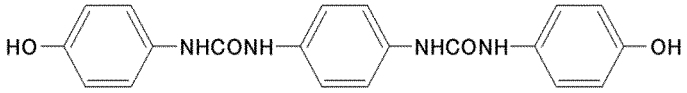
···(7-1)



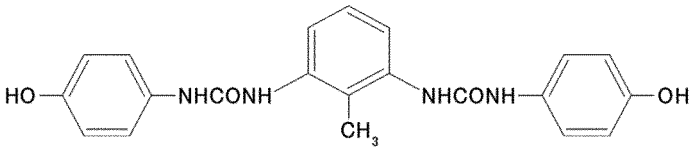
···(7-2)



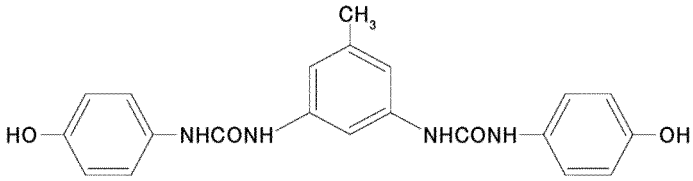
···(7-3)



···(7-4)



···(7-5)

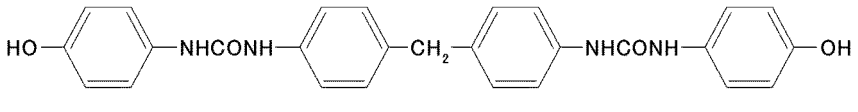


···(7-6)

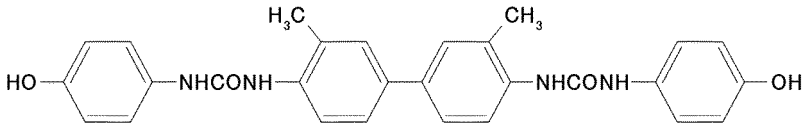
[0088] Specifically, for example, color developers in which X^0 in Formula (1) and X^1 in Formula (2) include two benzene rings include at least one type selected from a group including compounds represented by the following Formulae (8-1)

to (8-8).

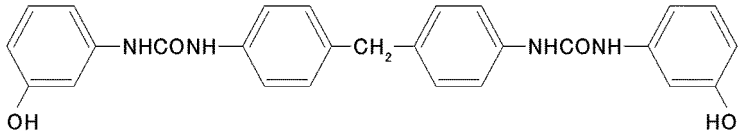
[Chem. 8]



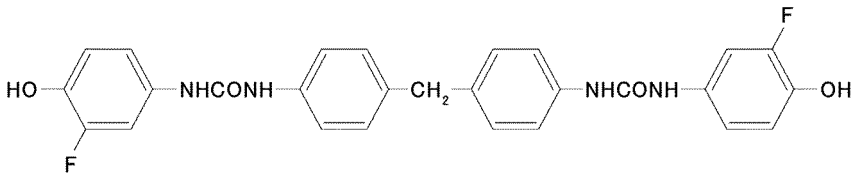
···(8-1)



···(8-2)



···(8-3)



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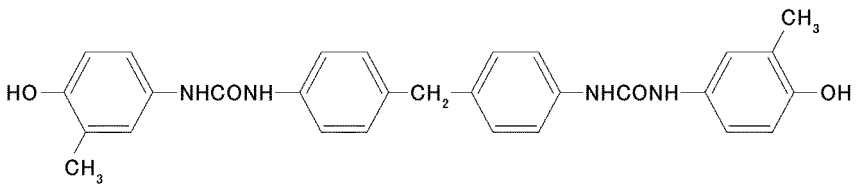

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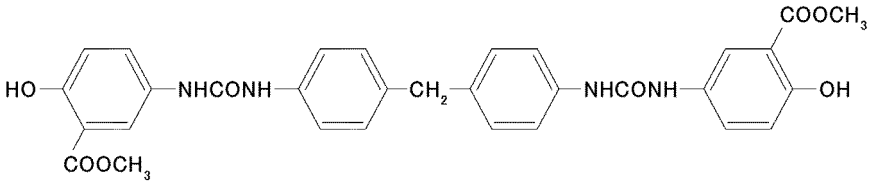
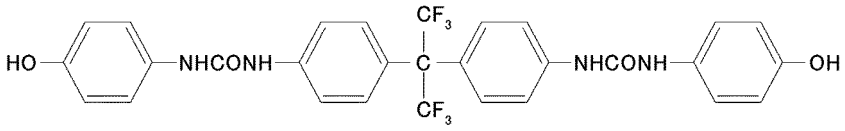
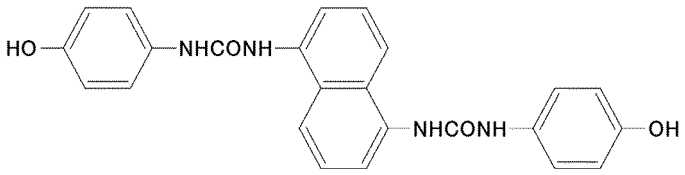


···(8-6)



···(8-7)



···(8-8)

(First, Second, and Third Photothermal Conversion Agents)

[0089] The first, second, and third photothermal conversion agents can absorb light in predetermined wavelength

regions such as a near-infrared region and generate heat. The first, second, and third photothermal conversion agents have mutually different absorption wavelength peaks. Specifically, the first photothermal conversion agent has an absorption wavelength peak at a wavelength λ_1. The second photothermal conversion agent has an absorption wavelength peak at a wavelength λ_2. The third photothermal conversion agent has an absorption wavelength peak at a wavelength λ_3. The wavelengths λ_1, λ_2, and λ_3 are mutually different. The absorption wavelength peaks are preferably in the near-infrared region. For example, the near-infrared region is a wavelength range of 700 to 2000 nm both inclusive. The first, second, and third photothermal conversion agents having the mutually different absorption wavelength peaks as described above make it possible to make a desired layer of the recording layers 13A, 13B, and 13C colored selectively by irradiation with laser light. Near-infrared ray absorption dyes that do not absorb light in the visible region almost at all are preferably used as the first, second, and third photothermal conversion agents.

[0090] For example, the first, second, and third photothermal conversion agents include at least one type selected from a group including compounds having a phthalocyanine backbone (phthalocyanine dyes), compounds having a squarylium backbone (squarylium dyes), inorganic compounds, and the like.

[0091] For example, the inorganic compounds include at least one type selected from a group including metallic complexes such as dithio complexes, diimonium salt, aminium salt, graphite, carbon black, metallic powder particles, metallic oxides such as tricobalt tetroxide, iron oxide, chromium oxide, copper oxide, black titanium oxide, or ITO (Indium Tin Oxide), metallic nitrides such as niobium nitride, metallic carbides such as tantalum carbide, metallic sulfides, various types of magnetic powder, and the like. Other than these, the inorganic compounds may include compounds having a cyanine backbone having excellent light fastness and heat-resistant properties (cyanine dyes). Note that excellent light fastness here means that a compound is not decomposed due to irradiation with light of a fluorescent lamp or the like in a use environment, for example. Excellent heat-resistant properties means that, when a film of a compound is formed along with, for example, a polymer material and is stored, for example, at 150°C for 30 minutes, a change which is equal to or greater than 20% does not occur to the maximum absorption peak value of the absorption spectrum. For example, examples of such compounds having a cyanine backbone include one having, in its molecule, at least either of a counter ion of any of SbF_6, PF_6, BF_4, ClO_4, CF_3SO_3, and $(CF_3SO_3)_2N$ and a methine chain including a five-membered ring or a six-membered ring. Note that, whereas a compound having a cyanine backbone used for the recording medium 10 in the first embodiment preferably includes both any of the counter ions described above and the ring structure such as a five-membered ring or a six-membered ring in the methine chain, sufficient light fastness and heat-resistant properties are ensured as long as the compound includes at least either of them.

(First, Second, and Third Matrix Resins)

[0092] The first, second, and third matrix resins preferably function as binders. The first matrix resin is preferably one with which the first coloration compound, the first color developer, and the first photothermal conversion agent are easily homogeneously dispersed. The second matrix resin is preferably one with which the second coloration compound, the second color developer, and the second photothermal conversion agent are easily homogeneously dispersed. The third matrix resin is preferably one with which the third coloration compound, the third color developer, and the third photothermal conversion agent are easily homogeneously dispersed. The types of the first, second, and third matrix resins may be identical to each other, or the types of the first, second, and third matrix resins may be mutually different.

[0093] For example, the first, second, and third matrix resins include at least one type selected from a group including thermosetting resins, thermoplastic resins, and the like. The first, second, and third matrix resins preferably include a polycarbonate resin. The first, second, and third matrix resins including the polycarbonate resin can enhance the light fastness of the skin of the recording medium 10. Here, the polycarbonate resin is a resin having, as a structural unit, a carbonate group (-O-(C=O)-O-) at least in its main chain. Accordingly, the polycarbonate resin may have another structural unit other than the carbonate group in the main chain.

[0094] Instead of the polycarbonate resin or along with the polycarbonate resin, the first, second, and third matrix resins may include at least one type selected from a group including polyvinyl chlorides, polyvinyl acetates, vinyl chloride-vinyl acetate copolymers, ethyl celluloses, polystyrenes, styrene copolymers, phenoxy resins, polyesters, aromatic polyesters, polyurethanes, polyacrylic esters, polymethacrylic acid esters, acrylic acid copolymers, maleic acid polymers, polyvinyl alcohol, modified polyvinyl alcohol, hydroxyethyl celluloses, carboxymethyl celluloses, starches, and the like.

(Additives)

[0095] The recording layers 13A, 13B, and 13C may further include, as necessary, at least one type of additive selected from a group including sensitizers, ultraviolet ray absorbing materials, and the like. In terms of reduction of coloring of the skins, the recording layers 13A, 13B, and 13C preferably include an amine compound.

[0096] In a case where the recording layers 13A, 13B, and 13C include the amine compound, the recording layers 13A, 13B, and 13C preferably include, along with the amine compound, at least one type of compound selected from a

group including epoxy compounds and carbodiimide compounds. Whereas there is a risk that the reliability of the colored portions at the time of high-temperature/high-humidity storage deteriorates if the recording layers 13A, 13B, and 13C include the amine compound, the deterioration of the reliability of the colored portions at the time of high-temperature/high-humidity storage due to the amine compound can be reduced if the recording layers 13A, 13B, and 13C include, along with the amine compound, at least one type of compound selected from a group including epoxy compounds and carbodiimide compounds.

(Intermediate Layers 12A, 12B, 12C, and 12D)

[0097] The intermediate layer 12A is provided between the base material 11 and the recording layer 13A. The intermediate layer 12A can thermally insulate the base material 11 and the recording layer 13A from each other, and can reduce diffusion of constituent materials between the base material 11 and the recording layer 13A. The intermediate layer 12B is provided between the recording layer 13A and the recording layer 13B. The intermediate layer 12B can thermally insulate the recording layer 13A and the recording layer 13B from each other, and can reduce diffusion of constituent materials between the recording layer 13A and the recording layer 13B. The intermediate layer 12C is provided between the recording layer 13B and the recording layer 13C. The intermediate layer 12C can thermally insulate the recording layer 13B and the recording layer 13C from each other, and can reduce diffusion of constituent materials between the recording layer 13B and the recording layer 13C. The intermediate layer 12D is provided between the recording layer 13C and the UV cut layer 14. The intermediate layer 12D can thermally insulate the recording layer 13C and the UV cut layer 14 from each other, and can reduce diffusion of constituent materials between the recording layer 13C and the UV cut layer 14.

[0098] The intermediate layer 12A may be transparent to or may be not transparent to laser light and visible light used for drawing on the recording medium 10. The intermediate layers 12B, 12C, and 12D are transparent to the laser light and the visible light used for the drawing on the recording medium 10.

[0099] The thicknesses of the intermediate layers 12A, 12B, 12C, and 12D are each independently preferably equal to or greater than 3 μm and equal to or smaller than 100 μm, more preferably equal to or greater than 5 μm and equal to or smaller than 50 μm, and further preferably equal to or greater than 7 μm and equal to or smaller than 15 μm, and are approximately 10 μm, for example. The thicknesses of the intermediate layers 12A, 12B, 12C, and 12D being equal to or greater than 3 μm can achieve sufficient thermal insulation effects, and can achieve sufficient diffusion reduction effects. On the other hand, the thicknesses of the intermediate layers 12A, 12B, 12C, and 12D being equal to or smaller than 50 μm can reduce deterioration of the light-transmitting properties. In addition, such thicknesses can also reduce deterioration of the bend resistance of the recording medium 10 and make defects such as cracks unlikely to occur. The thicknesses of the intermediate layers 12A, 12B, 12C, and 12D may be identical to each other, or may be mutually different.

[0100] The intermediate layer 12A includes, on the base material 11, an adhesive layer $12A_1$ and a ultraviolet curing resin layer $12A_2$ in this order. The adhesive layer $12A_1$ pastes together the base material 11 and the ultraviolet curing resin layer $12A_2$. The adhesive layer $12A_1$ may be able to thermally insulate the base material 11 and the recording layer 13A from each other. The ultraviolet curing resin layer $12A_2$ can thermally insulate the base material 11 and the recording layer 13A from each other, and can reduce diffusion of constituent materials (e.g. the first coloration compound, etc.) between the base material 11 and the recording layer 13A. The intermediate layer 12A may further include a film (not depicted). For example, the film is provided between the adhesive layer $12A_1$ and the ultraviolet curing resin layer $12A_2$. Materials similar to those listed as examples of the polymer materials of the base material 11 can be listed as examples of the material of the film.

[0101] The intermediate layer 12B includes, on the recording layer 13A, an adhesive layer $12B_1$ and a ultraviolet curing resin layer $12B_2$ in this order. The adhesive layer $12B_1$ pastes together the recording layer 13A and the ultraviolet curing resin layer $12B_2$. The adhesive layer $12B_1$ is adjacent to the irregular surface 13AS. The adhesive layer $12B_1$ may be able to thermally insulate the recording layer 13A and the recording layer 13B from each other. The ultraviolet curing resin layer $12B_2$ can thermally insulate the recording layer 13A and the recording layer 13B from each other, and can reduce diffusion of constituent materials (e.g. the first and second coloration compounds, etc.) between the recording layer 13A and the recording layer 13B. The intermediate layer 12B may further include a film (not depicted). For example, the film is provided between the adhesive layer $12B_1$ and the ultraviolet curing resin layer $12B_2$. Materials similar to those listed as examples of the polymer materials of the base material 11 can be listed as examples of the material of the film.

[0102] The intermediate layer 12C includes, on the recording layer 13B, an adhesive layer $12C_1$ and a ultraviolet curing resin layer $12C_2$ in this order. The adhesive layer $12C_1$ pastes together the recording layer 13B and the ultraviolet curing resin layer $12C_2$. The adhesive layer $12C_1$ is adjacent to the irregular surface 13BS. The adhesive layer $12C_1$ may be able to thermally insulate the recording layer 13B and the recording layer 13C from each other. The ultraviolet curing resin layer $12C_2$ can thermally insulate the recording layer 13B and the recording layer 13C from each other, and can reduce diffusion of constituent materials (e.g. the second and third coloration compounds, etc.) between the recording

layer 13B and the recording layer 13C. The intermediate layer 12C may further include a film (not depicted). For example, the film is provided between the adhesive layer $12C_1$ and the ultraviolet curing resin layer $12C_2$. Materials similar to those listed as examples of the polymer materials of the base material 11 can be listed as examples of the material of the film.

[0103] The intermediate layer 12D includes, on the recording layer 13C, an adhesive layer $12D_1$ and a ultraviolet curing resin layer $12D_2$ in this order. The adhesive layer $12D_1$ pastes together the recording layer 13C and the ultraviolet curing resin layer $12D_2$. The adhesive layer $12D_1$ is adjacent to the irregular surface 13CS. The adhesive layer $12D_1$ may be able to thermally insulate the recording layer 13C and the UV cut layer 14 from each other. The ultraviolet curing resin layer $12D_2$ can thermally insulate the recording layer 13C and the UV cut layer 14 from each other, and can reduce diffusion of constituent materials (e.g. the third coloration compound, etc.) between the recording layer 13C and the UV cut layer 14.

[0104] For example, the adhesive layers $12A_1$, $12B_1$, $12C_1$, and $12D_1$ are a double-sided adhesive film such as an OCA (Optical Clear Adhesive).

[0105] The ultraviolet curing resin layers $12A_2$, $12B_2$, $12C_2$, and $12D_2$ include a ultraviolet curing resin that is solidified by a polymerization reaction. More specifically, for example, the ultraviolet curing resin layers $12A_2$, $12B_2$, $12C_2$, and $12D_2$ include a polymer of a polymerizable compound and a polymerization initiator that has experienced a structural change by generation of a free radical due to irradiation with external energy (ultraviolet ray). For example, the ultraviolet curing resin composition includes at least one type selected from a group including radical-polymerization-type ultraviolet curing resin compositions, cation-polymerization-type ultraviolet curing resin compositions, and the like. The ultraviolet curing resin composition may include, as necessary, at least one type selected from a group including a sensitizer, a filler, a stabilizer, a leveling agent, a defoamer, a viscosity modifier, and the like.

(Average Peel Strength)

[0106] The average peel strength of the interface between the recording layer 13A and the intermediate layer 12B, the average peel strength of the interface between the recording layer 13B and the intermediate layer 12C, and the average peel strength of the interface between the recording layer 13C and the intermediate layer 12D are each preferably equal to or greater than 3.5 N/cm, more preferably equal to or greater than 4.0 N/cm, and further preferably equal to or greater than 5.0 N/cm. The average peel strength of each interface described above being equal to or greater than 3.5 N/cm can reduce peeling at each interface described above. Accordingly, falsification of the recording medium 10 can be prevented.

[0107] The average peel strength of the interface between the recording layer 13A and the intermediate layer 12B is determined by performing a 90-degree peel test. Hereinbelow, the 90-degree peel test is explained with reference to FIG. 4.

[0108] First, a strip-like piece with a width of 10 mm and a length of 100 mm is taken out from the recording medium 10 to create a test piece 60, which is left 24 hours or longer in an atmosphere of standard conditions with a temperature of 23±1°C and a relative humidity of 50±5%. Hereinbelow, a stack in the test piece 60 which is below the interface between the recording layer 13A and the intermediate layer 12B is referred to as an adherend 60A, and a stack in the test piece 60 which is above the interface is referred to as an adherend 60B. Next, at one end of the test piece 60 in the longitudinal direction, a cut is formed between the adherend 60A and the adherend 60B with a sharp edged tool such as a cutter, the adherend 60B is peeled off by a length of 20 mm in the longitudinal direction to create a grip margin, and thereafter, a surface of the test piece 60 on the side of the adherend 60A is fixed to a test bench 71 by a strong adhesive. As the adhesive, one that provides such a sufficiently high adhesive force that the test piece 60 is not peeled off from the test bench 71 when the peel strength between the recording layer 13A and the intermediate layer 12B is measured, for example, a strong adhesive tape scotch (registered trademark) manufactured by 3M, is chosen.

[0109] Next, one end of a pulling member 61 is pasted onto a surface of the adherend 60B on the side of the intermediate layer 12B. As the pulling member 61, a strip-like film having such a sufficient strength as not to be expanded or broken when the peel strength is measured is used. In addition, the one end of the pulling member 61 is pasted onto the adherend 60B with such a sufficiently high adhesive force that the pulling member 61 is not peeled off from the adherend 60A when the peel strength is measured. Whereas FIG. 4 depicts an example in which the pulling member 61 is a grip margin, in a case where there is a stroke sufficient for sandwiching the adherend 60B with a clamp device (metallic plate) 62, the adherend 60B may be clamped directly without using the pulling member 61.

[0110] Next, after the grip margin of the pulling member 61 is inserted between a set of movable rolls 73A and 73B of a jig 72, a portion, with a length equal to or greater than 10 mm, of the grip margin is sandwiched and fixed by the clamp device (metallic plate) 62 of a tensile/compression testing machine SV-55C 2H manufactured by IMADA SEI-SAKUSHO CO., LTD. The movable rolls 73A and 73B function as a fulcrum of peeling in the 90-degree peel test. Next, the 90-degree peel test is performed by use of the tensile/compression testing machine, and the test force [N/cm] and the stroke [mm] are monitored as voltage values with a data logger manufactured by KEYENCE CORPORATION, for

example, and are converted into forces and stored on a memory as CSV output data. Note that the 90-degree peel test described above is performed with a pulling speed of 5 mm/sec. in a standard condition with a temperature of 23±1°C and a relative humidity of 50±5%. The stroke is set to 50 mm or greater.

[0111] The 90-degree peel test described above is performed three times in total, a location where the peel strength is stabilized (a location where the rise of a force becomes gentle) is set as the start point (0 mm), and arithmetic mean calculation is performed on CSV output data regarding positions between the location and a relative position which is at a distance of 50 mm from the location, to calculate the average. As a result, the average peel strength between the recording layer 13A and the intermediate layer 12B is determined. It should be noted that, in a case where there is a point (spike) where the peeling force lowers instantaneously in the CSV output data, the point (spike) is excluded from the CSV output data to calculate the average peel strength.

[0112] The peel strength of the interface between the recording layer 13B and the intermediate layer 12C, and the peel strength of the interface between the recording layer 13C and the intermediate layer 12D are determined by a procedure similar to that for the peel strength of the interface between the recording layer 13A and the intermediate layer 12B.

[1.2 Features of Image of Recording Medium]

[0113] Hereinbelow, differences between enlarged images of the recording medium 10 according to the first embodiment and a recording medium 110 according to a reference example are explained. The recording medium 110 according to the reference example is different from the recording medium 10 according to the first embodiment in that recording layers 113A, 113B, and 113C do not have the irregular surfaces 13AS, 13BS, and 13CS on the front surfaces (see FIG. 2) but have planar surfaces 113AS, 113BS, and 113CS as depicted in FIG. 5.

[0114] FIG. 6 is a figure schematically depicting an example of an image 10P (hereinafter, referred to as an "internal image 10P") captured with high magnification by focusing an optical microscope on the recording layer 13B of the recording medium 10 as represented by a ray of light L in FIG. 2. In FIG. 6, areas with diagonal lines represent colored areas. On the internal image 10P of the recording medium 10, colored portions are observed as spots. In contrast, on the internal image of the recording medium 110, such spot-like colored portions as those on the internal image 10P of the recording medium 10 are not observed.

[0115] As described above, the recording medium 10 according to the first embodiment is configured to enable acquisition of a spot image (internal image 10P) attributable to the irregular surface 13S by focusing on the recording layer 13 and capturing the recording medium 10. On the internal image 10P of the recording medium 10 according to the first embodiment, colored portions are observed as spots. The spots described above form a pattern unique to each recording medium 10. Owing to this, the spots described above can be used for assessing the authenticity of the recording medium 10, or assessing the authenticity of a card or a booklet including the recording medium 10.

[1.3 Method of Manufacturing Recording Medium]

[0116] Hereinbelow, an example of a method of manufacturing the recording medium 10 according to the first embodiment is explained. In the example explained here, the recording medium 10 includes films between the adhesive layer $12A_1$ and the ultraviolet curing resin layer $12A_2$, between the adhesive layer $12B_1$ and the ultraviolet curing resin layer $12B_2$, and between the adhesive layer $12C_1$ and the ultraviolet curing resin layer $12C_2$. Note that illustration of the films is omitted in FIG. 2.

(Step of Forming First Stacked Film)

[0117] First, the first matrix resin is dissolved in a solvent (e.g. methyl ethyl ketone). Next, the first coloration compound in the decolored state, the first color developer, and the first photothermal conversion agent are added to and dispersed in the solution. As a result, a coating material for forming the first recording layer is prepared. Next, a film such as a PET film is coated with the ultraviolet curing resin, and thereafter, the ultraviolet curing resin is irradiated with a ultraviolet ray and cured to thereby form the ultraviolet curing resin layer $12A_2$. Next, the ultraviolet curing resin layer $12A_2$ is coated with the coating material for forming the first recording layer and dried to thereby form the recording layer 13A having the irregular surface 13AS. As a result, the first stacked film including the film, the ultraviolet curing resin layer $12A_2$, and the recording layer 13A having the irregular surface 13AS on the front surface is obtained.

[0118] For example, the irregular surface 13AS of the recording layer 13A is formed by adjusting coating conditions and drying conditions of the coating material for forming the first recording layer, and generating Benard cells on the coating film. An example of the coating conditions and drying conditions of the coating material for forming the first recording layer is depicted below.

Coating method: gravure coating method
Coating thickness: equal to or greater than 30 μm and equal to or smaller than 40 μm (a coating thickness in a case where the thickness of the recording layer 13A after drying is equal to or greater than 5 μm and equal to or smaller than 6 μm)
Drying temperature: equal to or higher than 80°C and equal to or lower than 110°C

[0119] The irregular surface 13AS of the recording layer 13A can also be formed by generating Benard cells by mixture of an additive to the coating material for forming the first recording layer, selection of the type of the color developer, selection of the type of a dispersion medium, selection of the type of the matrix resin, adjustment of the granularity distribution of the color developer, or adjustment of the viscosity of a dispersion liquid. Two or more of the formation methods of the irregular surface 13AS described above (the adjustment of the coating conditions and the drying conditions, the mixture of the additive, the selection of the type of the color developer, the selection of the type of the dispersion medium, the selection of the type of the matrix resin, the adjustment of the granularity distribution of the color developer, and the adjustment of the viscosity of the dispersion liquid) can also be combined.

(Step of Forming Second Stacked Film)

[0120] The second stacked film including a film, the ultraviolet curing resin layer $12B_2$, and the recording layer 13B having the irregular surface 13BS is obtained in a manner similar to that of the step of forming the first stacked film, except that the second matrix resin, the second coloration compound, the second color developer, and the second photothermal conversion agent are used instead of the first matrix resin, the first coloration compound, the first color developer, and the first photothermal conversion agent.

(Step of Forming Third Stacked Film)

[0121] The third stacked film including a film, the ultraviolet curing resin layer $12C_2$, and the recording layer 13C having the irregular surface 13CS is obtained in a manner similar to that of the step of forming the first stacked film, except that the third matrix resin, the third coloration compound, the third color developer, and the third photothermal conversion agent are used instead of the first matrix resin, the first coloration compound, the first color developer, and the first photothermal conversion agent.

(Stacking Process)

[0122] First, a fourth stacked film including the cover layer 15, the UV cut layer 14, and the ultraviolet curing resin layer $12D_2$ in this order is prepared. Next, after the adhesive layer $12D_1$ is formed on the ultraviolet curing resin layer $12D_2$ of the fourth stacked film, the third stacked film is pasted onto the adhesive layer $12D_1$ such that the adhesive layer $12D_1$ and the recording layer 13C contact each other.

[0123] Next, after the adhesive layer $12C_1$ is formed on the ultraviolet curing resin layer $12C_2$, the second stacked film is pasted onto the adhesive layer $12C_1$ such that the adhesive layer $12C_1$ and the recording layer 13B contact each other.

[0124] Next, after the adhesive layer $12B_1$ is formed on the ultraviolet curing resin layer $12B_2$, the first stacked film is pasted onto the adhesive layer $12B_1$ such that the adhesive layer $12B_1$ and the recording layer 13A contact each other.

[0125] Next, after the adhesive layer $12A_1$ is formed on the ultraviolet curing resin layer $12A_2$, the base material 11 is pasted onto the adhesive layer $12A_1$. As a result, the recording medium 10 depicted in FIG. 2 is obtained.

[1.4 Method of Recording on Recording Medium]

[0126] Hereinbelow, an example of a method of recording on the recording medium 10 according to the first embodiment is explained.

[0127] The recording layer 13A is colored in magenta in the following manner. When predetermined positions of the recording layer 13A are irradiated with near-infrared laser light with the peak wavelength λ_1, the first photothermal conversion agent included in portions irradiated with the laser light absorbs the near-infrared laser light, and generates heat. Owing to this heat generation, the first color developer is melted, a coloration reaction (coloring reaction) occurs between the first color developer and the first coloration compound, and the portions irradiated with the laser light are colored in magenta.

[0128] The recording layer 13B is colored in cyan in the following manner. When predetermined positions of the recording layer 13B are irradiated with near-infrared laser light with the peak wavelength λ_2, portions irradiated with the laser light are colored in cyan owing to a reaction similar to that of the recording layer 13A described above.

[0129] The recording layer 13C is colored in yellow in the following manner. When predetermined positions of the recording layer 13B are irradiated with near-infrared laser light with the peak wavelength λ_3, portions irradiated with the laser light are colored in yellow owing to a reaction similar to that of the recording layer 13A described above.

[0130] Owing to the predetermined positions of the recording layers 13A, 13B, and 13C being colored in magenta, cyan, and yellow, respectively, as described above, a desired full-color image is drawn on the recording medium 10.

[1.5 Effects and Advantages]

[0131] As described above, in the recording medium 10 according to the first embodiment, the recording layers 13A, 13B, and 13C have the irregular surfaces 13AS, 13BS, and 13CS, respectively, on the front surface sides. The irregular surfaces 13AS, 13BS, and 13CS include random irregularities. The random irregularities are structures which are unique to each recording medium 10 and are difficult to forge. Accordingly, it is possible to assess the authenticity of the recording medium 10 by using the irregular surfaces 13AS, 13BS, and 13CS, patterns (spot images) attributable to their shapes, or the like.

[0132] Since the recording layers 13A, 13B, and 13Cs have the irregular surfaces 13AS, 13BS, and 13CS, respectively, on the front surface sides, the peel strengths of the interface between the recording layer 13A and the intermediate layer 12B, the interface between the recording layer 13B and the intermediate layer 12C, and the interface between the recording layer 13C and the intermediate layer 12D can be increased. Accordingly, the falsification preventing properties can be enhanced.

[0133] In the recording medium 10 according to the first embodiment, the recording layers 13A, 13B, and 13C can be colored in magenta, cyan, and yellow, respectively, in the colored state. Accordingly, desired full-color images can be drawn.

[1.6 Modification Examples]

(First Modification Example)

[0134] Whereas all the three recording layers 13 have the irregular surfaces 13S on the front surface sides in the example explained in the first embodiment, one or two of the three recording layers 13 may have the irregular surfaces 13S on the front surface sides.

[0135] For example, as depicted in FIG. 7A, while, among the recording layers 13A, 13B, and 13C, the recording layer 13C closest to the cover layer 15 may have the irregular surface 13CS on the front surface side, the recording layers 13A and 13B other than the recording layer 13C may have the planar surfaces 113AS and 113BS, respectively, on the front surface sides.

[0136] For example, as depicted in FIG. 7B, while, among the recording layers 13A, 13B, and 13C, the recording layer 13B second closest to the cover layer 15 may have the irregular surface 13BS on the front surface side, the recording layers 13A and 13C other than the recording layer 13B may have the planar surfaces 113AS and 113CS, respectively, on the front surface sides.

[0137] For example, as depicted in FIG. 7C, while, among the recording layers 13A, 13B, and 13C, the recording layer 13A farthest from the cover layer 15 may have the irregular surface 13AS on the front surface side, the recording layers 13B and 13C other than the recording layer 13A may have the planar surfaces 113BS and 113CS, respectively, on the front surface sides.

[0138] For example, as depicted in FIG. 8A, while, among the recording layers 13A, 13B, and 13C, the recording layer 13C closest to the cover layer 15 and the recording layer 13B second closest to the cover layer 15 may have the irregular surface 13CS and the irregular surface 13BS, respectively, on the front surface sides, the recording layer 13A farthest from the cover layer 15 may have the planar surface 113AS on the front surface side.

[0139] For example, as depicted in FIG. 8B, while, among the recording layers 13A, 13B, and 13C, the recording layer 13C closest to the cover layer 15 and the recording layer 13A farthest from the cover layer 15 may have the irregular surface 13CS and the irregular surface 13AS, respectively, on the front surface sides, the recording layer 13B second closest to the cover layer 15 may have the planar surface 113BS on the front surface side.

[0140] For example, as depicted in FIG. 8C, while, among the recording layers 13A, 13B, and 13C, the recording layer 13B second closest to the cover layer 15 and the recording layer 13A farthest from the cover layer 15 may have the irregular surface 13BS and the irregular surface 13AS, respectively, on the front surface sides, the recording layer 13C closest to the cover layer 15 may have the planar surface 113CS on the front surface side.

(Second Modification Example)

[0141] Whereas the recording medium 10 includes the three recording layers 13 in the example explained in the first

embodiment, the recording medium 10 may include one recording layer 13.

[0142] FIG. 9 is a cross-sectional view depicting an example of a configuration of the recording medium 10 including one recording layer 13D. The recording medium 10 may include the base material 11, the intermediate layer 12A, the recording layer 13D, the intermediate layer 12D, the UV cut layer 14, and the cover layer 15 in this order.

[0143] The recording layer 13D has an irregular surface 13DS on the front surface side. The irregular surface 13DS is similar to the irregular surface 13AS of the recording layer 13A in the first embodiment. The recording layer 13D can be colored in a predetermined color in the colored state. For example, as the predetermined color, black, cyan, magenta, yellow, red, green, or blue can be used, but is not limited to these colors. The recording layer 13D is similar to the recording layer 13A in the first embodiment except that the recording layer 13D can be colored in the predetermined color in the colored state. That is, the recording layer 13D is similar to the recording layer 13A in the first embodiment except that the recording layer 13D includes a coloration compound that can be colored in the predetermined color in the colored state.

(Third Modification Example)

[0144] Whereas the recording medium 10 includes the three recording layers 13 in the example explained in the first embodiment, the recording medium 10 may include a plurality of, but not three, recording layers 13 (i.e. two recording layers 13 or four or more recording layers 13). Also in this case, intermediate layers 12 may be included between stacked recording layers 13. The plurality of recording layers 13 may be able to exhibit mutually different hues in the colored state. That is, coloration compounds included in the plurality of recording layers 13 may be able to exhibit mutually different hues in the colored state. Photothermal conversion agents included in the plurality of recording layers 13 may have mutually different absorption wavelength peaks.

[0145] At least one layer of the plurality of recording layers 13 may have an irregular surface on the front surface side. Specifically, for example, all the plurality of recording layers 13 may have irregular surfaces on the front surface sides, or, while particular layers among the plurality of recording layers 13 may have irregular surfaces on the front surface sides, layers other than the particular layers may not have irregular surfaces on the front surface sides. For example, the layers other than the particular layers may have planar surfaces on the front surface sides. The number of layers of the particular layers may be one, or may be equal to or greater than two. The irregular surfaces are similar to the irregular surface 13AS of the recording layer 13A in the first embodiment.

<2 Second Embodiment>

[0146] In a second embodiment, an example of a card including the recording medium 10 according to the first embodiment is explained.

[2.1 Configuration of Card]

[0147] Hereinbelow, an example of a configuration of a card 30 according to the second embodiment is explained with reference to FIG. 10A and FIG. 10B. The card 30 includes a base material (card base material) 31, an adhesion layer 32, an intermediate layer 33, an adhesion layer 34, and an overlay layer 35 in this order. The intermediate layer 33 includes the recording medium 10.

[0148] The card 30 is an ID card (e.g. an employee ID card, a membership card, a student ID card, etc.). The ID card is an example of a card-type identification card. Whereas the card 30 is an ID card in the example explained in the second embodiment, the type of a card including the recording medium 10 is not limited to this. For example, the card including the recording medium 10 may be a card such as a security card, a financial payment card (e.g. a credit cart, a cash card, etc.), a driver's license, a health insurance card, a basic resident registration card, an personal number card (My Number Card), or a personal transaction card (e.g. a prepaid card, a point card, etc.). The card 30 may be a non-contact-type IC card.

(Base Material 31)

[0149] The base material 31 is a support that supports the intermediate layer 33. The base material 31 has a rectangular thin-plate-like shape. The base material 31 has a first surface (front surface) on which the adhesion layer 32, the intermediate layer 33, the adhesion layer 34, and the overlay layer 35 are stacked and a second surface (back surface) on a side opposite to the first surface. The base material 31 may have such a color as white. A drawing pattern, a picture, a photograph, characters, a combination of any two or more of these, or the like (hereinafter, referred to as a "drawing pattern or the like") may be printed on the first surface of the base material 31. The base material 31 may include an IC (integrated circuit) chip, an antenna coil, or the like on the first surface.

[0150] For example, the base material 31 includes a plastic. As necessary, the base material 31 may include at least one type selected from a group including a colorant, an antistatic agent, a flame retardant, a surface modifier, and the like.

[0151] For example, the plastic includes at least one type selected from a group including ester resins, amide resins, olefin resins, vinyl resins, acrylic resins, imide resins, styrene resins, engineering plastics, and the like. In a case where the base material 31 includes two or more types of resins, the two or more types resin may be mixed, may be copolymerized, or may be stacked one on another.

[0152] For example, the ester resins include at least one type selected from a group including polyethylene terephthalates (PET), polybutylene terephthalates (PBT), polyethylene naphthalates (PEN), polyethylene terephthalate-isophthalate copolymers, terephthalic acid-cyclohexanedimethanol-ethylene glycol copolymers, and the like. For example, the amide resins include at least one type selected from a group including nylon 6, nylon 66, nylon 610, and the like. For example, the olefin resins include at least one type selected from a group including polyethylenes (PE), polypropylenes (PP), polymethylpentenes (PMP), and the like. For example, the vinyl resins include polyvinyl chlorides (PVC).

[0153] For example, the acrylic resins include at least one type selected from a group including polyacrylates, poly(meth)acrylates, polymethylmethacrylates (PMMA), and the like. For example, the imide resins include at least one type selected from a group including polyimides (PI), polyamideimides (PAI), polyetherimides (PEI), and the like. For example, the styrene resins include at least one type selected from a group including polystyrenes (PS), high impact polystyrenes, acrylonitrile-styrene resins (AS resins), acrylonitrile-butadiene-styrene resins (ABS resins), and the like. For example, the engineering plastics include at least one type selected from a group including polycarbonates (PC), polyarylates (PAR), polysulfones (PSF), polyether sulfones (PES), polyphenylene ethers (PPE), polyphenylene sulfides (PPS), polyether ketones (PEK), polyether-ether ketones (PEEK), polyphenylene oxide (PPO), polyether sulfites, and the like.

(Intermediate Layer 33)

[0154] The intermediate layer 33 is provided between the base material 31 and the overlay layer 35. More specifically, the intermediate layer 33 is provided on the first surface of the base material 31, and the adhesion layer 32 is sandwiched between the base material 31 and the intermediate layer 33. The intermediate layer 33 has a housing section 33A for housing the recording medium 10. The housing section 33A is provided at part in the surface of the intermediate layer 33. The housing section 33A may be a through-hole penetrating in the thickness direction of the intermediate layer 33. The intermediate layer 33 is for preventing a step from being formed due to the recording medium 10 when the recording medium 10 is sandwiched between the base material 31 and the overlay layer 35. The intermediate layer 33 has a thickness which is substantially identical to that of the recording medium 10, and covers areas of the first surface of the base material 31 other than an area where the recording medium 10 is provided.

[0155] The intermediate layer 33 has a film-like shape. The intermediate layer 33 may be transparent to visible light. The intermediate layer 33 includes a plastic. Materials similar to those listed as examples of the material of the base material 31 can be listed as examples of the plastic.

(Overlay Layer 35)

[0156] The overlay layer 35 is provided on the intermediate layer 33 and the recording medium 10, and covers the intermediate layer 33 and the recording medium 10. The adhesion layer 34 is sandwiched between the intermediate layer 33 and recording medium 10 and the overlay layer 35. The overlay layer 35 protects members inside the card 30 (i.e. the recording medium 10 and the intermediate layer 33), and maintains the mechanical reliability of the card 30.

[0157] The overlay layer 35 has a film-like shape. The overlay layer 35 is transparent to visible light. The overlay layer 35 includes a plastic. Materials similar to those listed as examples of the material of the base material 31 can be listed as examples of the plastic. A drawing pattern or the like may be printed on at least one surface of the overlay layer 35.

(Adhesion Layers 32 and 34)

[0158] The adhesion layer 32 is provided between the base material 31 and the intermediate layer 33, and bonds together the base material 31 and the intermediate layer 33. The adhesion layer 34 is provided between the intermediate layer 33 and the overlay layer 35, and bonds together the intermediate layer 33 and the overlay layer 35. The adhesion layers 32 and 34 include a thermosetting adhesive. The thermosetting adhesive includes a thermosetting resin. For example, the thermosetting resin includes at least one type selected from a group including epoxy resins, urethane resins, and the like. The curing temperature of the thermal adhesive is preferably within the temperature range of 100°C to 120°C both inclusive, in terms of reduction of damage to the recording medium 10.

(Recording Medium 10)

[0159] The recording medium 10 is provided between the base material 31 and the overlay layer 35. The recording medium 10 is housed in the housing section 33A such that the base material 11 of the recording medium 10 faces the base material 31. A face photograph or the like is drawn on the recording medium 10. It should be noted that information drawn on the recording medium 10 is not limited to a face photograph, and may be ID information for security or the like.

[0160] The recording medium 10 has a first surface that faces the overlay layer 35 and a second surface that faces the base material 31. The first surface and/or the second surface of the recording medium 10 are/is preferably treated for easy bonding by plasma treatment or the like, in terms of enhancement of bonding force. In the present specification, "and/or" means "at least either," and, for example, "X and/or Y" means three patterns, which are "only X," "only Y," and "X and Y."

[2.2 Method of Manufacturing Card]

[0161] Hereinbelow, an example of a method of manufacturing the card 30 according to the second embodiment is explained.

[0162] First, the first surface of the base material 31 is coated with a thermosetting resin as a thermosetting adhesive to form the adhesion layer 32. Next, the intermediate layer 33 is placed on the adhesion layer 32, and thereafter, the recording medium 10 is fit into the housing section 33A of the intermediate layer 33. Note that the intermediate layer 33 in which the recording medium 10 is fit in advance into the housing section 33A may be placed on the adhesion layer 32. In addition, the adhesion layer 32 may be formed by coating, with the thermosetting resin, the intermediate layer 33 in which the recording medium 10 is fit in advance into the housing section 33A and thereafter placing the intermediate layer 33 on the first surface of the base material 31 such that the coating film is sandwiched therebetween. Alternatively, the adhesion layer 32 may be formed by pasting a sheet formed by coating, for example, a separator in advance with the thermosetting resin onto the first surface of the base material 31 or onto the intermediate layer 33 in which the recording medium 10 is fit in advance into the housing section 33A, by such means as thermal lamination.

[0163] Next, the intermediate layer 33 is coated with a thermosetting resin as a thermosetting adhesive to form the adhesion layer 34, and thereafter, the overlay layer 35 is placed on the adhesion layer 34. Next, the obtained stack is sandwiched by metallic plates, and is pressurized while being heated, to thereby thermally cure the adhesion layer 32 and the adhesion layer 34. A temperature to which the stack is heated at the time of the thermal curing is preferably equal to or higher than 100°C and equal to or lower than 120°C, in terms of reduction of damage to the recording medium 10. As a result, the card 30 that is intended to be obtained is obtained. The adhesion layer 34 may be formed by coating the overlay layer 35 with the thermosetting resin and placing the overlay layer 35 on the intermediate layer 33 such that the coating film is sandwiched therebetween. In addition, the adhesion layer 34 may be formed by pasting a sheet formed by coating, for example, a separator in advance with the thermosetting resin onto the overlay layer 35 or the intermediate layer 33 by such means as thermal lamination.

[2.3 Effects and Advantages]

[0164] As described above, the card 30 according to the second embodiment includes the recording medium 10 according to the first embodiment. Accordingly, it is possible to assess the authenticity of the card 30 by using the irregular surfaces 13AS, 13BS, and 13CS of the recording medium 10, patterns (spot images) attributable to their shapes, or the like.

[0165] In the card 30 according to the second embodiment, the base material 31 and the intermediate layer 33 are pasted together by the adhesion layer 32 including the thermosetting adhesive, and the intermediate layer 33 and the overlay layer 35 are pasted together by the adhesion layer 32 including the thermosetting adhesive. This makes it possible for the base material 31 and the intermediate layer 33 as well as the intermediate layer 33 and the overlay layer 35 to be rigidly bonded together. Accordingly, the falsification preventing properties can be enhanced.

[0166] Since the recording medium 10 is fit into the housing section 33A of the intermediate layer 33, it is possible to make it difficult to see the boundary between the recording medium 10 and the intermediate layer 33 in the in-plane direction of the card 30. Accordingly, it becomes difficult to identify which portion in the surface of the card 30 the recording medium 10 is provided at. Therefore, the falsification preventing properties can be enhanced.

[0167] Since the recording medium 10 is sealed inside the card 30, the influence of moisture on the recording medium 10 can be reduced.

[2.4 Modification Examples]

(First Modification Example)

[0168] Whereas the card 30 includes the recording medium 10 in a partial area of the first surface of the base material 31 in the example explained in the second embodiment, the card 30 may include the recording medium 10 over the substantially overall area of the first surface of the base material 31 as depicted in FIG. 11. Specifically, the card 30 may include, between the adhesion layer 32 and the adhesion layer 34, the recording medium 10 with substantially the same size as that of the base material 31.

(Second Modification Example)

[0169] Whereas the card 30 includes the recording medium 10 according to the first embodiment in the example explained in the second embodiment, the card 30 may include the recording medium 10 according to the modification examples of the first embodiment.

<3 Third Embodiment>

[0170] An example of a card configured in a manner different from that of the card according the second embodiment is explained in a third embodiment.

[3.1 Configuration of Card]

[0171] Hereinbelow, an example of a configuration of a card 30A according to the third embodiment is explained with reference to FIG. 12. The card 30A is different from the card 30 according to the second embodiment in that the card 30A does not include the adhesion layer 32 and the adhesion layer 34 and that the base material 31 and the intermediate layer 33 as well as the intermediate layer 33 and the overlay layer 35 are pasted together by fusion.

[0172] In the third embodiment, the base material 31, the intermediate layer 33, and the overlay layer 35 preferably include thermoplastic resins as plastics. The base material 31, the intermediate layer 33, and the overlay layer 35 including the thermoplastic resins can increase the inter-layer adhesion strengths of the fusion. The thermoplastic resins are preferably ones that can thermally fuse together the layers of the card 30A within the temperature range of 130°C to 200°C both inclusive, in terms of reduction of damage to the recording medium 10.

[0173] The base material 31, the intermediate layer 33, and the overlay layer 35 may include the same type of thermoplastic resin, or the base material 31, the intermediate layer 33, and the overlay layer 35 may not include the same type of thermoplastic resin. In a case where the base material 31, the intermediate layer 33, and the overlay layer 35 do not include the same type of thermoplastic resin, one layer of the base material 31, the intermediate layer 33, the overlay layer 35 may include a type of thermoplastic resin different from the type of thermoplastic resin of the other two layers, or each of the base material 31, the intermediate layer 33, and the overlay layer 35 may include a different type of thermoplastic resin.

[0174] In a case where the base material 31, the intermediate layer 33, and the overlay layer 35 include the same type of thermoplastic resin, the base material 31, the intermediate layer 33, and the overlay layer 35 preferably include at least one type selected from a group including semi-crystalline thermoplastic resins and amorphous thermoplastic resins, in terms of enhancement of the inter-layer adhesion strengths of the fusion.

[0175] For example, the semi-crystalline thermoplastic resins include at least one type selected from a group including polypropylenes (PP), polyethylenes (PE), polyacetals (POM), polyethylene terephthalates (PET), polybutylene terephthalates (PBT), polyphenylene sulfides (PPS), polyetheretherketones (PEEK), and the like.

[0176] For example, the amorphous thermoplastic resins include at least one type selected from a group including ABS resins, polycarbonates (PC), polymer alloys of ABS resins and PC (hereinafter, referred to as "ABS/PC polymer alloys"), AS resins, polystyrenes (PS), polymethylmethacrylates (PMMA), polyphenylene oxides (PPO), polysulfones (PSU), polyvinyl chlorides (PVC), polyetherimides (PEI), polyether sulfones (PES), and the like.

[0177] In a case where the base material 31, the intermediate layer 33, and the overlay layer 35 do not include the same type of thermoplastic resin, the base material 31, the intermediate layer 33, and the overlay layer 35 preferably include amorphous thermoplastic resins, in terms of enhancement of the inter-layer adhesion strengths of the fusion.

[0178] The following are preferable combinations of the amorphous thermoplastic resins included in two adjacent layers in the card 30A. In a case where one layer of the two adjacent layers in the card 30A includes an ABS resin, the other layer preferably includes at least one type selected from a group including ABS/PC polymer alloys, polycarbonates (PC), AS resins, polystyrenes (PS), polymethylmethacrylates (PMMA), and polyvinyl chlorides (PVC).

[0179] In a case where one layer of two adjacent layers in the card 30A includes an ABS/PC polymer alloy, the other

layer preferably includes at least one type selected from a group including ABS resins, polycarbonates (PC), and polymethylmethacrylates (PMMA). In a case where one layer of two adjacent layers in the card 30A includes a polycarbonate (PC), the other layer preferably includes at least one type selected from a group including ABS resins, ABS/PC polymer alloys, and polymethylmethacrylates (PMMA).

[0180] In a case where one layer of two adjacent layers in the card 30A includes an AS resin, the other layer preferably includes at least one type selected from a group including ABS resins, polystyrenes (PS), polymethylmethacrylates (PMMA), and polyphenylene oxides (PPO). In a case where one layer of two adjacent layers in the card 30A includes a polystyrene (PS), the other layer preferably includes at least one type selected from a group including AS resins and polyphenylene oxides (PPO).

[0181] In a case where one layer of two adjacent layers in the card 30A includes a polymethylmethacrylate (PMMA), the other layer preferably includes at least one type selected from a group including ABS resins, ABS/PC polymer alloys, AS resins, and polyphenylene oxides (PPO). In a case where one layer of two adjacent layers in the card 30A includes a polyphenylene oxide (PPO), the other layer preferably includes at least one type selected from a group including polycarbonates (PC), AS resins, polystyrenes (PS), and polymethylmethacrylates (PMMA).

[0182] In a case where one layer of two adjacent layers in the card 30A includes a polysulfone (PSU), the other layer preferably includes a polycarbonate (PC). In a case where one layer of two adjacent layers in the card 30A includes a polyvinyl chloride (PVC), the other layer preferably includes an ABS resin.

[3.2 Method of Manufacturing Card]

[0183] Hereinbelow, an example of a method of manufacturing the card 30A according to the third embodiment is explained.

[0184] First, the intermediate layer 33 is placed on the first surface of the base material 31, and thereafter, the recording medium 10 is fit into the housing section 33A of the intermediate layer 33. Note that the intermediate layer 33 in which the recording medium 10 is fit in advance into the housing section 33A may be placed on the first surface of the base material 31. Next, the overlay layer 35 is placed on the intermediate layer 33. Next, the obtained stack is sandwiched by metallic plates, and is pressurized while being heated, to thereby thermally fuse together the base material 31 and the intermediate layer 33 as well as the intermediate layer 33 and the overlay layer 35. A temperature to which the stack is heated at the time of the thermal fusion is preferably equal to or higher than 110°C and equal to or lower than 200°C, in terms of reduction of damage to the recording medium 10 and in terms of sufficient fusion strength. As a result, the card 30A that is intended to be obtained is obtained.

[3.3 Effects and Advantages]

[0185] As described above, in the card 30A according to the third embodiment, the base material 31 and the intermediate layer 33 as well as the intermediate layer 33 and the overlay layer 35 are fused together. As a result, the base material 31 and the intermediate layer 33 as well as the intermediate layer 33 and the overlay layer 35 can be rigidly pasted together. Accordingly, the falsification preventing properties can be enhanced.

[3.4 Modification Examples]

(First Modification Example)

[0186] Whereas the card 30 includes the recording medium 10 in a partial area of the first surface of the base material 31 in the example explained in the second embodiment, the card 30A may include a recording medium 36 over the substantially overall area of the first surface of the base material 31. Specifically, the card 30A may include, between the base material 31 and the overlay layer 35, the recording medium 36 with substantially the same size as that of the base material 31.

(Second Modification Example)

[0187] Whereas the card 30 includes the recording medium 10 according to the first embodiment in the example explained in the third embodiment, the card 30 may include the recording medium 10 according to the modification examples of the first embodiment.

<4 Fourth Embodiment>

[0188] Whereas examples of the cards 30 and 30A including the recording medium 10 according to the recording

medium 10 according to the first embodiment are explained in the second and third embodiments, the recording medium 10 may be included in a booklet.

[4.1 Configuration of Booklet]

[0189] FIG. 13 is a perspective view depicting an example of a configuration of a booklet 40 according to a fourth embodiment. The booklet 40 is a passport. The passport is an example of a booklet-type identification card. The booklet 40 includes a plurality of sheets 41. The plurality of sheets 41 are saddle-stitched. At least one surface or both surfaces of the sheet 41 is provided with the recording medium 10. A face photograph or the like is drawn on the recording medium 10. The sheet 41 may have a layer configuration similar to that of the card 30 according to the third embodiment or the card 30A of the fourth embodiment. In this case, the base material may be paper or the like.

[4.2 Effects and Advantages]

[0190] As described above, the booklet 40 according to the fourth embodiment includes the recording medium 10 according to the first embodiment. Accordingly, it is possible to assess the authenticity of the booklet 40 by using the irregular surfaces 13AS, 13BS, and 13CS of the recording medium 10, patterns (spot images) attributable to their shapes, or the like.

[4.3 Modification Examples]

(First Modification Example)

[0191] Whereas the booklet 40 includes the recording medium 10 in a partial area of the main surface of the sheet 41 in the example explained in the third embodiment, the booklet 40 may include the recording medium 10 over the substantially overall area of the main surface of the sheet 41. Specifically, the booklet 40 may include the recording medium 10 with substantially the same size as that of the sheet 41.

(Second Modification Example)

[0192] Whereas the booklet 40 includes the recording medium 10 according to the first embodiment in the example explained in the third embodiment, the booklet 40 may include the recording medium 10 according to the modification examples of the first embodiment.

<5 Fifth Embodiment>

[5.1 Configuration of Image Authentication System]

[0193] Hereinbelow, an example of a configuration of an image authentication system according to a fifth embodiment is explained with reference to FIG. 14. The image authentication system includes a first terminal device 51, a second terminal device 52, and an image authenticating device 53.

(First Terminal Device 51)

[0194] The first terminal device 51 can transmit information such as images to the image authenticating device 53 via a network such as the Internet, and can receive information from the image authenticating device 53.

[0195] A drawing device 51A and an image capturing device 51B are connected to the first terminal device 51. The first terminal device 51 can control the drawing device 51A to cause the drawing device 51A to perform image drawing on the recording medium 10. The first terminal device 51 can control the image capturing device 51B to cause the image capturing device 51B to capture the overall image drawn on the recording medium 10. The first terminal device 51 can control the image capturing device 51B to cause a prescribed recording layer 13 among the recording layers 13A, 13B, and 13C of the recording medium 10 to be focused on, to thereby cause the image capturing device 51B to capture an enlarged image of a prescribed area in the overall image drawn on the recording medium 10 (i.e. part of the overall image). As a result, it is possible to acquire a spot image (first image (see FIG. 6)) attributable to irregularities of the irregular surface 13S of the prescribed recording layer 13. The acquisition of the enlarged image of the prescribed area may be performed with use of positional information regarding the overall image or the like. The first terminal device 51 can transmit, to the image authenticating device 53, the overall image and the spot image acquired by the image capturing device 51B.

[0196] The first terminal device 51 includes a storage device 51C. For example, the storage device 51C is a hard disk drive or the like. The first terminal device 51 can store, on the storage device 51C, the overall image and the spot image acquired by the image capturing device 51B.

[0197] The first terminal device 51 may be a general-purpose terminal device such as a personal computer, or may be a dedicated terminal device for controlling the drawing device 51A and the image capturing device 51B.

(Drawing Device 51A)

[0198] The drawing device 51A can draw images by irradiating the recording layers 13A, 13B, and 13C with first laser light, the second laser light, and the third laser light, respectively, from the side of the cover layer 15 of the recording medium 10 on the basis of control of the first terminal device 51. The first laser light, the second laser light, and the third laser light are preferably near-infrared laser light. The first laser light, the second laser light, and the third laser light preferably have mutually different peak wavelengths. This makes it possible to selectively draw an image on a desired recording layer 13 in the recording layers 13A, 13B, and 13C.

[0199] Specifically, the drawing device 51A can cause the recording layer 13A to be colored in magenta by irradiating the recording layer 13A with the first laser light with a peak wavelength of the wavelength λ_1. The drawing device 51A can cause the recording layer 13B to be colored in cyan by irradiating the recording layer 13B with the second laser light with a peak wavelength of the wavelength λ_2. The drawing device 51A can cause the recording layer 13C to be colored in yellow by irradiating the recording layer 13C with the third laser light with a peak wavelength of the wavelength λ_3. The focal points of the first laser light, the second laser light, and the third laser light are adjusted to be positioned on the recording layers 13A, 13B, and 13C, respectively.

(Image Capturing Device 51B)

[0200] The image capturing device 51B captures the overall image drawn on the recording medium 10 and an enlarged image of a prescribed area of the overall image (i.e. part of the overall image) and transmits the captured image and the enlarged image to the first terminal device 51, on the basis of control of the first terminal device 51. For example, the image capturing device 51B is a camera or the like. The enlarged image of the prescribed area is captured by focusing on the prescribed recording layer 13 among the recording layers 13A, 13B, and 13C. By adjusting the focal position and capturing the enlarged image in such a manner, the spot image attributable to the irregularities of the irregular surface 13S of the prescribed recording layer 13 can be acquired.

(Second Terminal Device 52)

[0201] The second terminal device 52 can transmit information such as images to the image authenticating device 53 via a network such as the Internet, and can receive information such as authentication results from the image authenticating device 53.

[0202] An image capturing device 52B is connected to the second terminal device 52. The second terminal device 52 can control the image capturing device 52B to cause the image capturing device 52B to capture the overall image drawn on the recording medium 10. The second terminal device 52 can control the image capturing device 52B to cause a prescribed recording layer 13 among the recording layers 13A, 13B, and 13C of the recording medium 10 to be focused on, to thereby cause the image capturing device 52B to capture an enlarged image of a prescribed area in the overall image drawn on the recording medium 10 (i.e. part of the overall image). As a result, it is possible to acquire a spot image (second image (see FIG. 6)) attributable to irregularities of the irregular surface 13S of the prescribed recording layer 13. The acquisition of the enlarged image of the prescribed area may be performed with use of positional information regarding the overall image or the like. The second terminal device 52 can transmit, to the image authenticating device 53, the overall image and the spot image acquired by the image capturing device 52B.

[0203] The second terminal device 52 may be a general-purpose terminal device such as a personal computer, or may be a dedicated terminal device for controlling the image capturing device 52B.

(Image Capturing Device 52B)

[0204] The image capturing device 52B captures the overall image drawn on the recording medium 10 and an enlarged image of a prescribed area of the overall image (i.e. part of the overall image) and transmits the captured image and the enlarged image to the second terminal device 52, on the basis of control of the second terminal device 52. For example, the image capturing device 52B is a camera or the like. The enlarged image of the prescribed area is captured by focusing on the prescribed recording layer 13 among the recording layers 13A, 13B, and 13C. By adjusting the focal position and capturing the enlarged image in such a manner, the spot image attributable to the irregularities of the

irregular surface 13S of the prescribed recording layer 13 can be acquired.

(Image Authenticating Device 53)

[0205] The image authenticating device 53 can receive information such as images from the first terminal device 51 and the second terminal device 52 via a network such as the Internet, and can transmit information such as authentication results to the first terminal device 51 and the second terminal device 52.

[0206] The image authenticating device 53 includes a storage device 53A. For example, the storage device 53A is a hard disk drive or the like. The image authenticating device 53 can store, on the storage device 53A, the overall image and the spot image (enlarged image) received from the first terminal device 51.

[0207] The image authenticating device 53 can collate the spot image received from the second terminal device 52 and the spot image stored on the storage device 53A and notify the second terminal device 52 of a result of the collation. Specifically, the image authenticating device 53 collates the spot image received from the second terminal device 52 and the spot image stored on the storage device 53A and, in a case where it is assessed as a result of the collation that the spot images match, notifies the second terminal device 52 that the recording medium 10 is valid. Meanwhile, in a case where it is assessed as a result of the collation that the spot images do not match, the image authenticating device 53 notifies the second terminal device 52 that the recording medium 10 is invalid. The image authenticating device 53 may be a server such as a cloud server.

[5.2 Image Registration Operation]

[0208] Hereinbelow, an example of an image registration operation performed by the image authentication system according to the fifth embodiment is explained with reference to FIG. 15.

[0209] First, in Step S1, the first terminal device 51 controls the drawing device 51A to cause the drawing device 51A to perform image drawing on the recording medium 10. Next, in Step S2, the first terminal device 51 controls the image capturing device 51B to cause the image capturing device 51B to capture the overall image drawn on the recording medium 10. Next, the first terminal device 51 stores, on the storage device 511C, the overall image captured by the image capturing device 51B.

[0210] Next, in Step S3, the first terminal device 51 controls the image capturing device 51B to cause a prescribed recording layer 13 among the recording layers 13A, 13B, and 13C of the recording medium 10 to be focused on, to thereby cause the image capturing device 51B to capture an enlarged image of a prescribed area in the overall image drawn on the recording medium 10 (i.e. part of the overall image). As a result, a spot image attributable to irregularities of the irregular surface 13S of the prescribed recording layer 13 is acquired. Next, the first terminal device 51 stores, on the storage device 51C, the spot image acquired in Step S3. Next, in Step S4, the first terminal device 51 transmits, to the image authenticating device 53, the overall image and the spot image acquired in Step S2 and Step S3. Next, the image authenticating device 53 stores, on the storage device 53A, the overall image and the spot image received from the first terminal device 51.

[5.3 Image Authentication Operation]

[0211] Hereinbelow, an example of an image authentication operation performed by the image authentication system according to the fifth embodiment is explained with reference to FIG. 16.

[0212] First, in Step S11, the second terminal device 52 controls the image capturing device 52B to cause the image capturing device 51B to capture the overall image drawn on the recording medium 10.

[0213] Next, in Step S12, the second terminal device 52 controls the image capturing device 52B to cause a prescribed recording layer 13 among the recording layers 13A, 13B, and 13C of the recording medium 10 to be focused on, to thereby cause the image capturing device 52B to capture an enlarged image of a prescribed area in the overall image drawn on the recording medium 10 (i.e. part of the overall image). As a result, a spot image attributable to irregularities of the irregular surface 13S of the prescribed recording layer 13 is acquired.

[0214] Next, in Step S13, the second terminal device 52 transmits, to the image authenticating device 53, the overall image and the spot image acquired in Step S11 and Step S12. Next, the image authenticating device 53 collates the spot image received from the second terminal device 52 and the spot image stored on the storage device 53A, and notify the second terminal device 52 of a result of the collation.

[5.4 Effects and Advantages]

[0215] As described above, in the image authentication system according to the fifth embodiment, the first terminal device 51 causes the drawing device 51A to draw an image on the recording medium 10 including the recording layer

13 having the irregular surface 13S including random irregularities, and thereafter causes the image capturing device 51B to focus on the recording layer 13, capture an image of a partial area (prescribed area) of the recording medium 10, acquire a spot image as the first image, and transmit the spot image to the image authenticating device 53. The second terminal device 52 causes the image capturing device 52B to focus on the recording layer 13, capture an image of a partial area (prescribed area) of the recording medium 10 including the recording layer 13 having the irregular surface 13S including random irregularities, acquire a spot image as the second image, and transmit the spot image to the image authenticating device 53. The image authenticating device 53 collates the spot image as the first image received from the first terminal device 51 and the spot image as the second image received from the second terminal device 52, and notifies the second terminal device 52 of a result of the collation. Accordingly, it is possible to assess the authenticity of the recording medium 10 on which an image such as a face photograph is drawn, via a network such as the Internet.

[5.5 Modification Examples]

(First Modification Example)

[0216] After an image such as a face photograph is drawn on the recording medium 10 by the image capturing device 51B, the recording medium 10 may be included in the card 30, the card 30A, or the booklet 40. Alternatively, an image such as a face photograph may be directly drawn, by the image capturing device 51B, on the recording medium 10 included in advance in the card 30, the card 30A, or the booklet 40.

[0217] An image of the recording medium 10 included in the card 30, the card 30A, or the booklet 40 may be captured by the image capturing devices 51B and 52B. In this case, it is possible to assess the authenticity of the card 30, the card 30A, or the booklet 40 including the recording medium 10, via a network such as the Internet.

(Second Modification Example)

[0218] The first terminal device 51 may acquire a two-dimensional spot image (hereinafter, referred to as a "2D spot image") as an enlarged image, thereafter convert the 2D spot image into a three-dimensional spot image (hereinafter, referred to as a "3D spot image"), store the 3D spot image on the storage device 51C, and transmit the 3D spot image to the image authenticating device 53. The second terminal device 52 may acquire a 2D spot image as an enlarged image, thereafter convert the 2D spot image into a 3D spot image, and transmit the 3D spot image to the image authenticating device 53.

[0219] The image authenticating device 53 may store, on the storage device 53A, the 3D spot image received from the first terminal device 51. The image authenticating device 53 may collate the 3D spot image received from the second terminal device 52 and the 3D spot image stored on the storage device 53A, and notify the second terminal device 52 of a result of the collation.

[0220] Note that the image authenticating device 53 may receive a 2D spot image from the first terminal device 51, convert the 2D spot image into a 3D spot image, and thereafter store the 3D spot image on the storage device 53A. The image authenticating device 53 may receive a 2D spot image from the second terminal device 52, convert the 2D spot image into a 3D spot image, thereafter collates the 3D spot image obtained after the conversion and the 3D spot image stored on the storage device 53A, and notify the second terminal device 52 of a result of the collation.

[0221] The image authenticating device 53 can acquire height information regarding spots from a 3D spot image. The image authenticating device 53 may acquire positional information and height information regarding spots from the 3D spot image received from the first terminal device 51, and acquire positional information and height information regarding spots acquired from the 3D spot image received from the second terminal device 52. In addition, the image authenticating device 53 may collate the acquired positional information and height information described above. By causing the image authenticating device 53 to collate the positional information and the height information in such a manner, the security can be enhanced.

(Third Modification Example)

[0222] Whereas the image authenticating device 53 collates a spot image received from the second terminal device 52 and a spot image stored on the storage device 53A and notifies the second terminal device 52 of a result of the collation in the example explained in the fifth embodiment, the image authentication method is not limited to this. For example, the image authenticating device 53 may collate a spot image received from the first terminal device 51 and a spot image stored on the storage device 53A and notify the first terminal device 51 of a result of the collation. Alternatively, the first terminal device 51 may collate a spot image acquired by the image capturing device 51B and a spot image stored in advance on the storage device 51C and cause a display device of the first terminal device 51 to display a result

of the collation.

(Fourth Modification Example)

[0223] Whereas the first terminal device 51 and the second terminal device 52 each acquire one spot image and transmit the spot image to the image authenticating device 53 in the example explained in the fifth embodiment, the first terminal device 51 and the second terminal device 52 may each acquire a plurality of spot images and transmit the plurality of spot images to the image authenticating device 53. In this case, the image authenticating device 53 may collate the plurality of spot images received from the first terminal device 51 and the plurality of spot images received from the second terminal device 52 and notify the second terminal device of a result of the collation. Note that, at the first terminal device 51 and the second terminal device 52, each spot image is acquired at a substantially identical position.

[0224] By causing the image authenticating device 53 to collate a plurality of spot images as described above, the security can be enhanced.

Implementation Examples

[0225] Hereinbelow, the present disclosure is explained specifically with reference to implementation examples, but the present disclosure is not limited to the implementation examples.

[First Implementation Example]

(Step of Forming First Stacked Film)

[0226] First, a polycarbonate (PC) was dissolved as a matrix resin in a methyl ethyl ketone (MEK), and further, a color developer was added thereto and was dispersed by use of a rocking mill. As the color developer, a bis (hydroxybenzoic acid) type compound was used. Next, a leuco dye that is colored in magenta in the colored state was added, and adjustments were made such that the ratio (mass ratio) among the leuco dye, the color developer, and the polycarbonate eventually becomes 1:2:4. Further, a photothermal conversion material having an absorption wavelength peak of the wavelength λ_1 and having a phthalocyanine backbone was added, and the coating material for forming the first recording layer was prepared. Note that the mixing amount of the photothermal conversion material was determined such that the absorbance at the time of film coating becomes 0.32.

[0227] Next, a PET film as a first film was coated with a ultraviolet curing resin, and thereafter, the ultraviolet curing resin was irradiated with a ultraviolet ray and cured to thereby form a first ultraviolet curing resin layer having a thickness of 3 μm. Next, the first ultraviolet curing resin layer was coated, by a gravure coating method, with the coating material for forming the first recording layer and dried, to thereby form the first recording layer having a thickness of 5 μm and having an irregular surface on the front surface. The irregular surface was formed by adjusting the coating conditions and the drying conditions and generating Benard cells on the coating film of the coating material for forming the first recording layer and generate random irregularities on the coating film front surface. As a result, the first stacked film including the first film, the first ultraviolet curing resin layer (PET film), and the first recording layer was obtained.

(Step of Forming Second Stacked Film)

[0228] As a leuco dye, a leuco dye that is colored in cyan in the colored state was used, and, as a photothermal conversion agent, a photothermal conversion material having an absorption wavelength peak of the wavelength λ_2 and having a phthalocyanine backbone was used. Except for these points, the second stacked film including a second film (PET film), a second ultraviolet curing resin layer, and a second recording layer was obtained in a manner similar to that of the step of forming the first stacked film.

(Step of Forming Third Stacked Film)

[0229] As a leuco dye, a leuco dye that is colored in yellow in the colored state was used, and, as a photothermal conversion agent, a photothermal conversion material having an absorption wavelength peak of the wavelength λ_3 and having a phthalocyanine backbone was used. Except for these points, the third stacked film including a third film (PET film), a third ultraviolet curing resin layer, and a third recording layer was obtained in a manner similar to that of the step of forming the first stacked film. Note that mutually different values were selected as the wavelengths λ_1, λ_2, and λ_3.

(Stacking Process)

[0230] First, the fourth stacked film including a cover layer (PET film) having a thickness of 23 μm, a UV cut layer having a thickness of 10 μm, and a fourth ultraviolet curing resin layer having a thickness of 3 μm in this order was prepared. Next, a fourth adhesive layer (OCA) having a thickness of 5 μm was formed on the ultraviolet curing resin layer of the fourth stacked film, and thereafter, the third stacked film was pasted on the fourth adhesive layer such that the fourth adhesive layer and the third recording layer contact with each other.

[0231] Next, a third adhesive layer was formed on the third ultraviolet curing resin layer, and thereafter, the second stacked film was pasted on the third adhesive layer such that the third adhesive layer and the second recording layer contact with each other.

[0232] Next, a second adhesive layer was formed on the second ultraviolet curing resin layer, and thereafter, the first stacked film was pasted on the second adhesive layer such that the second adhesive layer and the first recording layer contact with each other.

[0233] Next, a first adhesive layer was formed on the first ultraviolet curing resin layer, and thereafter, a base material film (PET film) having a thickness of 23 μm was pasted onto the first adhesive layer. As a result, a recording medium in which the first intermediate layer, the first recording layer, the second intermediate layer, the second recording layer, the third intermediate layer, the third recording layer, the fourth intermediate layer, the UV cut layer, and the cover layer were stacked on the base material film in this order was obtained.

[First Comparative Example]

[0234] In the step of forming the first stacked film, a first recording layer having a thickness of 5 μm and having a planar surface on the front surface was formed. In the step of forming the second stacked film, a second recording layer having a thickness of 5 μm and having a planar surface on the front surface was formed. In the step of forming the third stacked film, a third recording layer having a thickness of 5 μm and having a planar surface on the front surface was formed. The front surfaces (planar surfaces) of the first recording layer, the second recording layer, and the third recording layer were formed such that random irregularities attributable to Benard cells were not formed on the coating films by adjustments of the coating conditions and the drying conditions. Except for these points, a recording medium was obtained in a manner similar to that of the first implementation example.

[Evaluation]

[0235] The following evaluation was performed on the recording medium according to the first implementation example and the recording medium of the first comparative example obtained as described above.

(Surface Irregularities)

[0236] The surface irregularities were measured by the surface irregularity measurement method explained in the first embodiment. Results thereof are depicted in Table 1.

(Irregularity Diameters)

[0237] The irregularity diameters were measured by the irregularity diameter measurement method explained in the first embodiment. Results thereof are depicted in Table 1.

(Average Peel Strengths)

[0238] The average peel strengths between the interfaces between the first recording layers and the second intermediate layers were measured by the average peel strength measurement method explained in the first embodiment. Results thereof are depicted in Table 1.

(Enlarged Images)

[0239] First, the first recording layer, the second recording layer, and the third recording layer were irradiated with laser light with the wavelengths λ_1, λ_2, and λ_3, respectively, and images were drawn on the recording media. Next, the second recording layers were focused on, and enlarged images of partial areas of the recording media were thereby acquired. Results thereof are depicted in Table 1.

[0240] In addition, FIG. 6 depicts a schematic diagram of an enlarged image according to the first implementation

example.

[Table 1]

	Presence/a bsence of Benard cells	Surface irregularities	Irregularity diameter	Average peel strength	Enlarged image
First implementation example	Present	2 to 3 μm	50 to 150 μm	5.2 N/cm	With spots
First comparative example	Absent	Approx. Equal to or smaller than 1 μm	Approx. Equal to or smaller than 50 μm	4.0 N/cm	Without spots

[0241] From Table 1, it can be known that the recording medium having front surfaces of the recording layers which are irregular surfaces formed by Benard cells (irregular surfaces including random irregularities) can have a high peel strength as compared to the recording medium having front surfaces of the recording layers which are planar surfaces.

[0242] From Table 1 and FIG. 6, it can be known that, while spots are observed on the enlarged image of the recording medium having the front surfaces of the recording layers which are the irregular surfaces formed by the Benard cells, spots are not observed on the enlarged image of the recording medium having the front surfaces of the recording layers which are planar surfaces.

[0243] Although the embodiments and the modification examples of the present disclosure have been explained specifically thus far, the present disclosure is not limited to the embodiments and the modification examples described above, and various types of modification based on the technical idea of the present disclosure are possible.

[0244] For example, configurations, methods, steps, shapes, materials, numerical values, and the like described in the embodiments and the modification examples described above are merely examples, and configurations, methods, steps, shapes, materials, numerical values, and the like different from them may be used as necessary.

[0245] The configurations, the methods, the steps, the shapes, the materials, the numerical values, and the like of the embodiments and the modification examples described above can be combined with each other unless such combinations do not deviate from the gist of the present disclosure.

[0246] In numerical ranges that are described stepwise in the embodiments and the modification examples described above, the upper limit value or the lower limit value of a numerical range at a step may be replaced with the upper limit value or the lower limit value of a numerical range at another step.

[0247] Unless otherwise noted particularly, one type of materials illustrated in the embodiments and the modification examples described above can be used singly, or two or more types of the materials can be used in combination.

[0248] In addition, the present disclosure can also adopt the following configurations.

(1) A recording medium including:

a base material; and
a recording layer, in which
the recording layer has an irregular surface including random irregularities, and includes an electron-donating coloration compound, an electron-accepting color developer, and a matrix resin.

(2) The recording medium according to (1), in which the irregularities are formed by Benard cells.

(3) The recording medium according to (1) or (2), including:
a plurality of the recording layers.

(4) The recording medium according to (3), in which a plurality of the recording layers are able to exhibit mutually different hues in a colored state.

(5) The recording medium according to (3) or (4), in which

a plurality of the recording layers include a first recording layer, a second recording layer, and a third recording layer,
the first recording layer is able to be colored in a first primary color,
the second recording layer is able to be colored in a second primary color, and
the third recording layer is able to be colored in a third primary color.

(6) The recording medium according to any one of (3) to (5), in which

a plurality of the recording layers include photothermal conversion agents, and
the photothermal conversion agents, each of which is included in one of the plurality of recording layers, have mutually different absorption wavelength peaks.

(7) The recording medium according to any one of (3) to (6), further including:

a plurality of intermediate layers, in which
the intermediate layers are provided between the adjacent recording layers.

(8) The recording medium according to (7), in which the intermediate layers include adhesive layers and ultraviolet curing resin layers.

(9) The recording medium according to (8), in which

the adhesive layers are adjacent to the irregular surfaces, and
average peel strengths of interfaces between the recording layers and the intermediate layers are equal to or greater than 3.5 N/cm.

(10) The recording medium according to any one of (1) to (9), in which a spot image attributable to the irregularities is able to be acquired by focusing on the recording layer and capturing an image of the recording medium.

(11) A card including:
the recording medium according to any one of (1) to (10).

(12) A booklet including:
the recording medium according to any one of (1) to (10).

(13) An image authentication system including:

a first terminal device;
a second terminal device; and
an image authenticating device, in which
the first terminal device causes an image drawing device to draw an image on a first recording medium including a recording layer having an irregular surface including random irregularities, and thereafter causes a first image capturing device to focus on the recording layer of the first recording medium, capture an image of a partial area of the first recording medium, acquire a first image, and transmit the first image to the image authenticating device,
the second terminal device causes a second image capturing device to focus on a recording layer having an irregular surface including random irregularities, capture an image of a partial area of a second recording medium including the recording layer, acquire a second image, and transmit the second image to the image authenticating device, and
the image authenticating device collates the first image received from the first terminal device and the second image received from the second terminal device, and notifies the second terminal device of a result of the collation.

(14) The image authentication system according to (13), in which the recording layer of the first recording medium and the recording layer of the second recording medium include electron-donating coloration compounds, electron-accepting color developers, and matrix resins.

(15) The image authentication system according to (13) or (14), in which

the first image includes a first spot image attributable to the irregularities of the recording layer included in the first recording medium, and
the second image includes a second spot image attributable to the irregularities of the recording layer included in the second recording medium.

(16) An image authentication method including:

by a first terminal device, causing an image drawing device to draw an image on a first recording medium including a recording layer having an irregular surface including random irregularities, and thereafter causing a first image capturing device to focus on the recording layer of the first recording medium, capture an image of a partial area of the first recording medium, acquire a first image, and transmit the first image to an image

authenticating device;
by a second terminal device, causing a second image capturing device to focus on a recording layer having an irregular surface including random irregularities, capture an image of a partial area of a second recording medium including the recording layer, acquire a second image, and transmit the second image to the image authenticating device; and
by the image authenticating device, collating the first image received from the first terminal device and the second image received from the second terminal device, and notifying the second terminal device of a result of the collation.

[Reference Signs List]

[0249]

10, 110: Recording medium
10P: Image
11, 31: Base material
12A, 12B, 12C, 12D: Intermediate layer
$12A_1$, $12B_1$, $12C_1$, $12D_1$: Adhesive layer
$12A_2$, $12B_2$, $12C_2$, $12D_2$: Ultraviolet curing resin layer
13A, 13B, 13C, 13D, 113A, 113B, 113C: Recording layer
13AS, 13BS, 13CS: Irregular surface
13AR: Coloring area
113AS, 113BS, 113CS: Planar surface
14: UV cut layer
15: Cover layer
30, 30A: Card
32, 34: Adhesion layer
33: Intermediate layer
33A: Housing section
35: Overlay layer
40: Booklet
41: Sheet
51: First terminal
52: Second terminal
51A: Drawing device
51B, 52B: Image capturing device
51C, 53C: Storage device
53: Image authenticating device

Claims

1. A recording medium comprising:

a base material; and
a recording layer, wherein
the recording layer has an irregular surface including random irregularities, and includes an electron-donating coloration compound, an electron-accepting color developer, and a matrix resin.

2. The recording medium according to claim 1, wherein the irregularities are formed by Benard cells.

3. The recording medium according to claim 1, comprising:
a plurality of the recording layers.

4. The recording medium according to claim 3, wherein a plurality of the recording layers are able to exhibit mutually different hues in a colored state.

5. The recording medium according to claim 3, wherein

a plurality of the recording layers include a first recording layer, a second recording layer, and a third recording layer,
the first recording layer is able to be colored in a first primary color,
the second recording layer is able to be colored in a second primary color, and
the third recording layer is able to be colored in a third primary color.

6. The recording medium according to claim 3, wherein

a plurality of the recording layers include photothermal conversion agents, and
the photothermal conversion agents, each of which is included in one of the plurality of recording layers, have mutually different absorption wavelength peaks.

7. The recording medium according to claim 3, further comprising:

a plurality of intermediate layers, wherein
the intermediate layers are provided between the adjacent recording layers.

8. The recording medium according to claim 7, wherein the intermediate layers include adhesive layers and ultraviolet curing resin layers.

9. The recording medium according to claim 8, wherein

the adhesive layers are adjacent to the irregular surfaces, and
average peel strengths of interfaces between the recording layers and the intermediate layers are equal to or greater than 3.5 N/cm.

10. The recording medium according to claim 1, wherein a spot image attributable to the irregularities is able to be acquired by focusing on the recording layer and capturing an image of the recording medium.

11. A card comprising:
the recording medium according to claim 1.

12. A booklet comprising:
the recording medium according to claim 1.

13. An image authentication system comprising:

a first terminal device;
a second terminal device; and
an image authenticating device, wherein
the first terminal device causes an image drawing device to draw an image on a first recording medium including a recording layer having an irregular surface including random irregularities, and thereafter causes a first image capturing device to focus on the recording layer of the first recording medium, capture an image of a partial area of the first recording medium, acquire a first image, and transmit the first image to the image authenticating device,
the second terminal device causes a second image capturing device to focus on a recording layer having an irregular surface including random irregularities, capture an image of a partial area of a second recording medium including the recording layer, acquire a second image, and transmit the second image to the image authenticating device, and
the image authenticating device collates the first image received from the first terminal device and the second image received from the second terminal device, and notifies the second terminal device of a result of the collation.

14. The image authentication system according to claim 13, wherein the recording layer of the first recording medium and the recording layer of the second recording medium include electron-donating coloration compounds, electron-accepting color developers, and matrix resins.

15. The image authentication system according to claim 13, wherein

the first image includes a first spot image attributable to the irregularities of the recording layer included in the first recording medium, and
the second image includes a second spot image attributable to the irregularities of the recording layer included in the second recording medium.

16. An image authentication method comprising:

by a first terminal device, causing an image drawing device to draw an image on a first recording medium including a recording layer having an irregular surface including random irregularities, and thereafter causing a first image capturing device to focus on the recording layer of the first recording medium, capture an image of a partial area of the first recording medium, acquire a first image, and transmit the first image to an image authenticating device;
by a second terminal device, causing a second image capturing device to focus on a recording layer having an irregular surface including random irregularities, capture an image of a partial area of a second recording medium including the recording layer, acquire a second image, and transmit the second image to the image authenticating device; and
by the image authenticating device, collating the first image received from the first terminal device and the second image received from the second terminal device, and notifying the second terminal device of a result of the collation.

FIG. 1

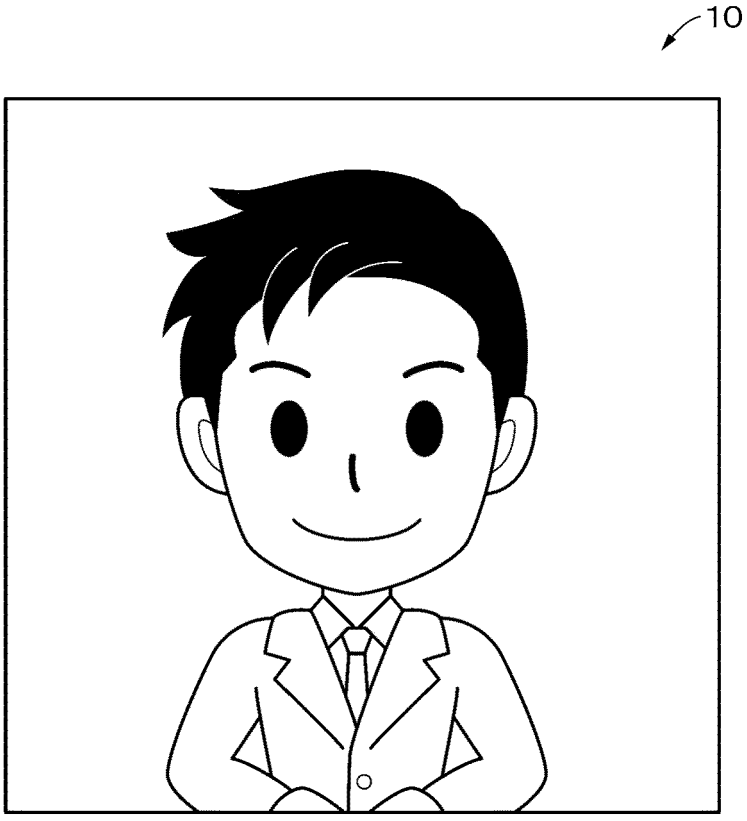
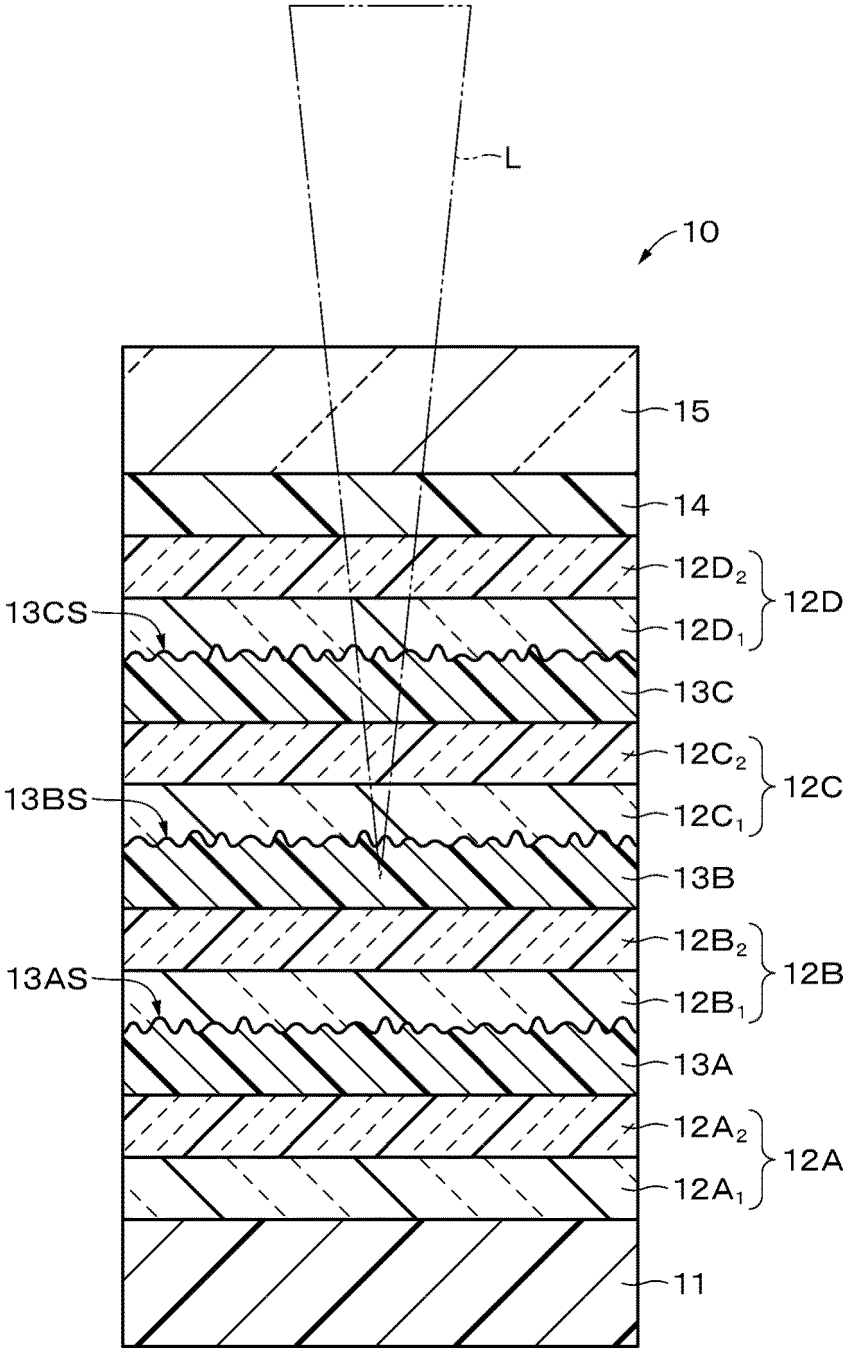


FIG. 2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12A
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FIG. 3

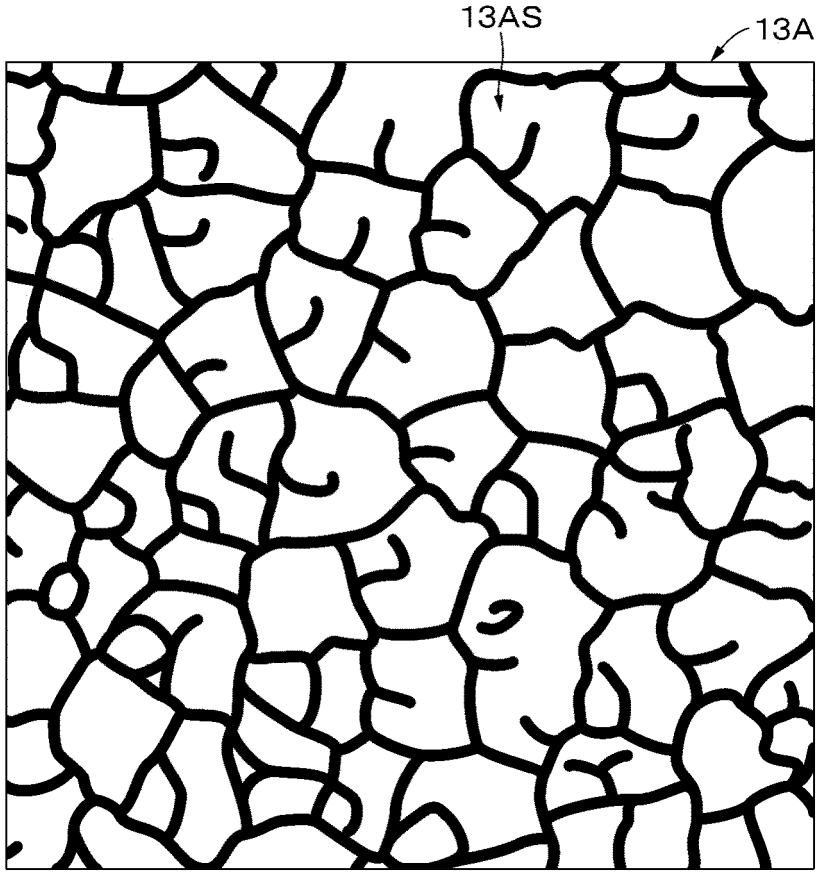

FIG. 4

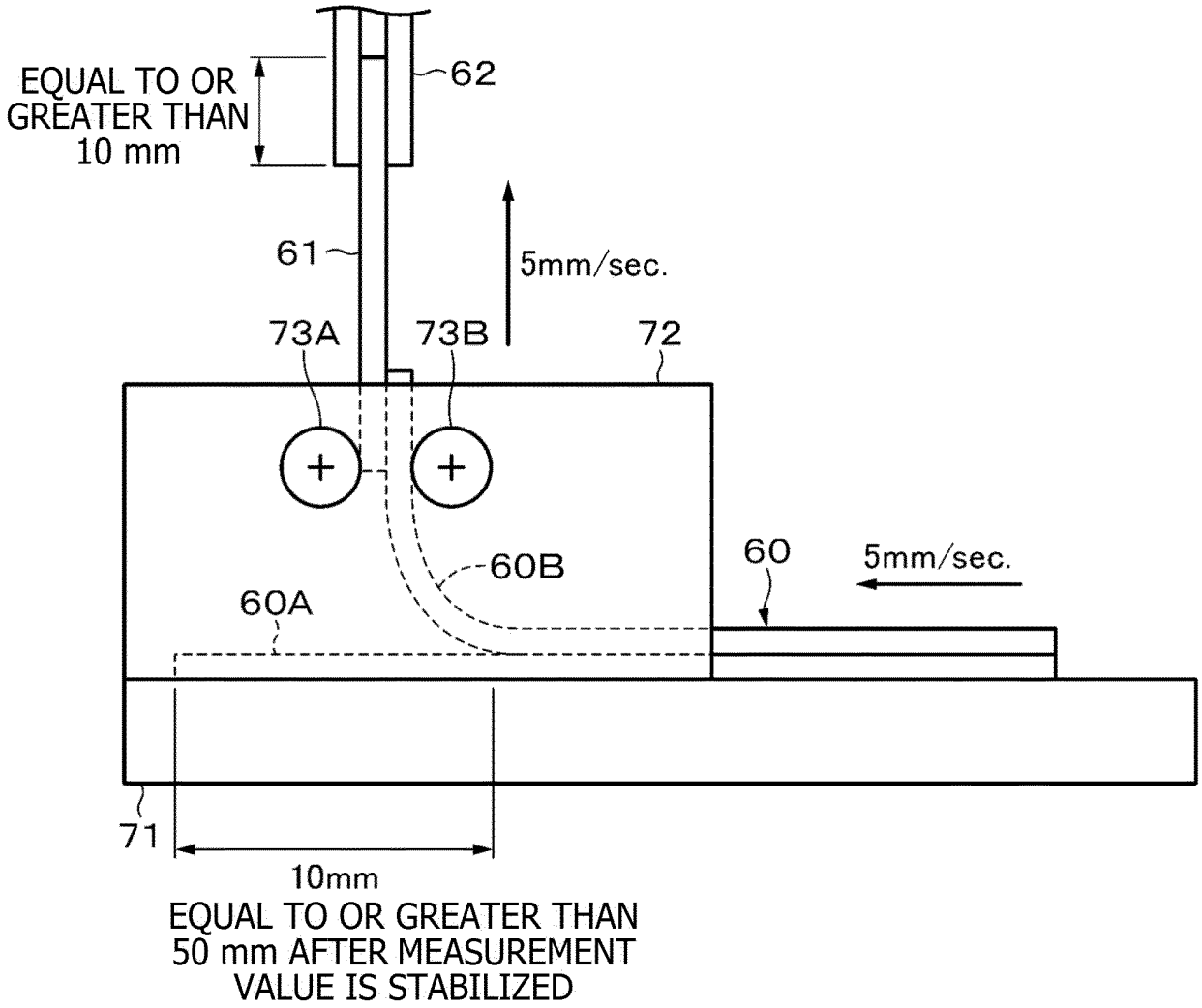
EQUAL TO OR GREATER THAN 10 mm
62
61
5mm/sec.
73A
73B
72
60B
60
5mm/sec.
60A
71
10mm
EQUAL TO OR GREATER THAN 50 mm AFTER MEASUREMENT VALUE IS STABILIZED

FIG. 5

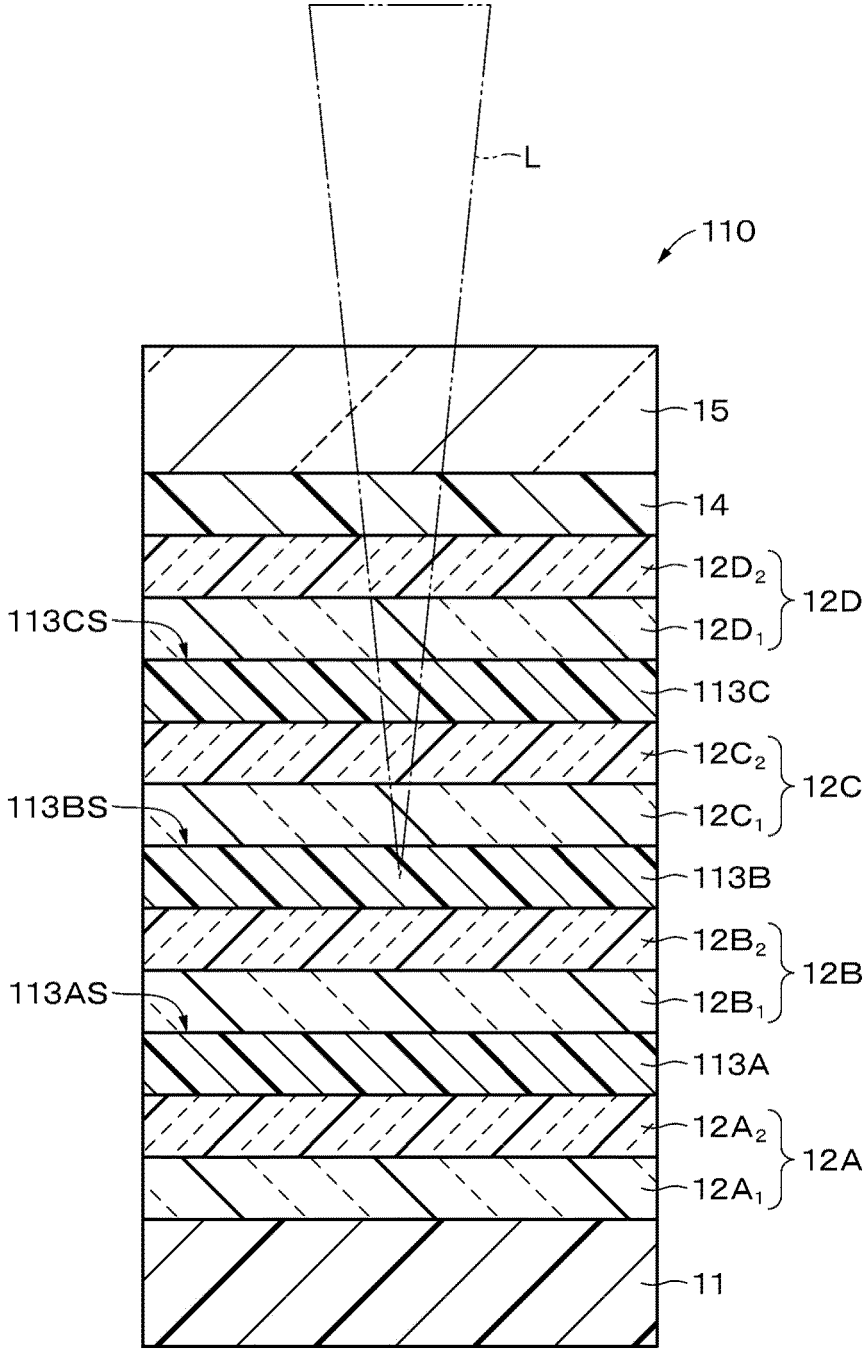
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FIG. 6

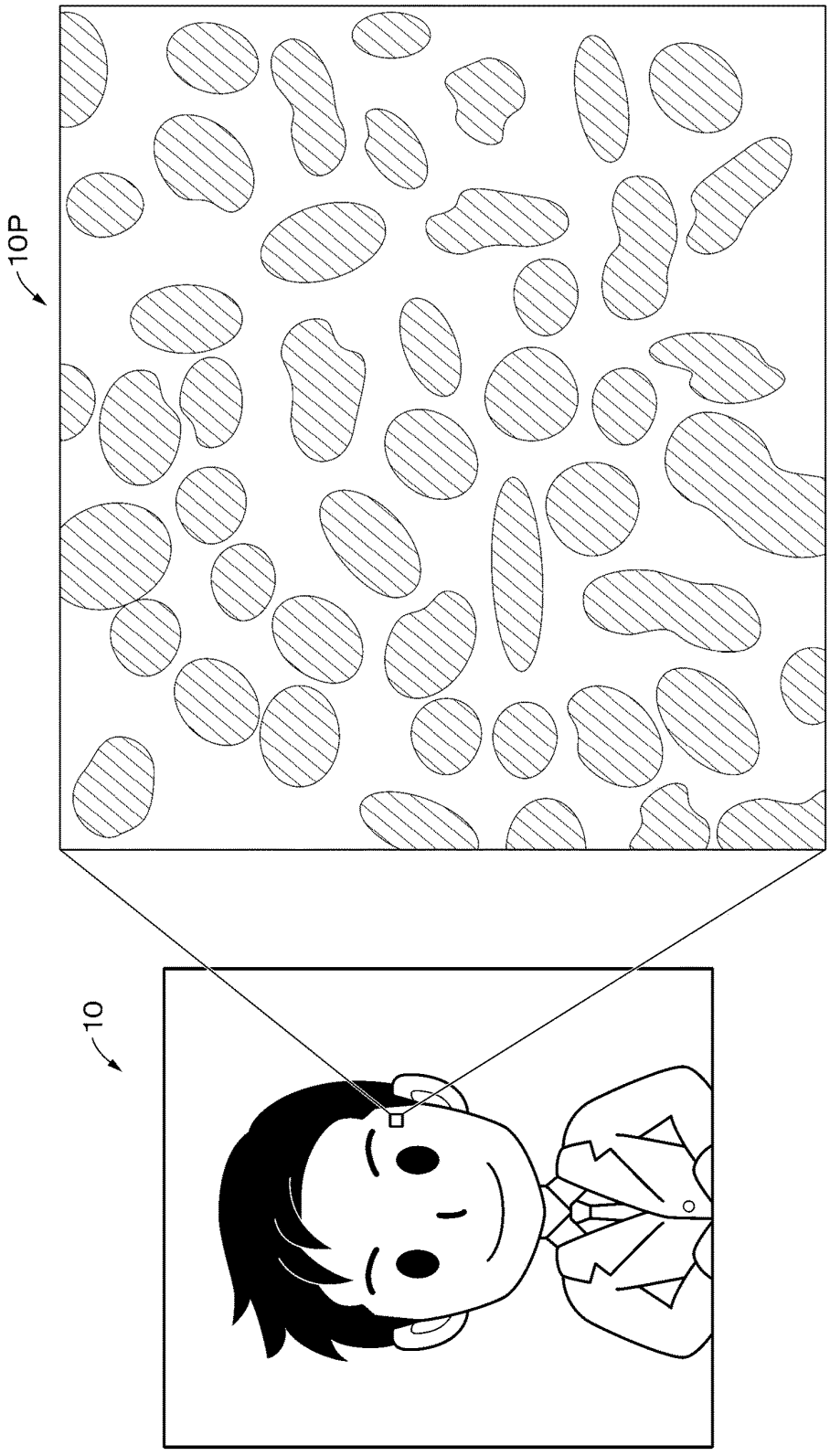
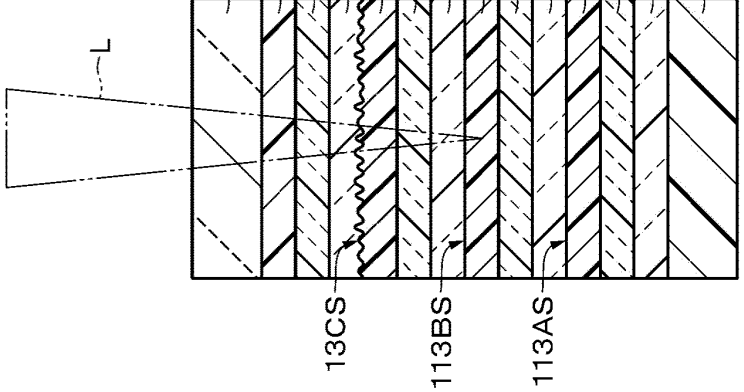


FIG. 7

A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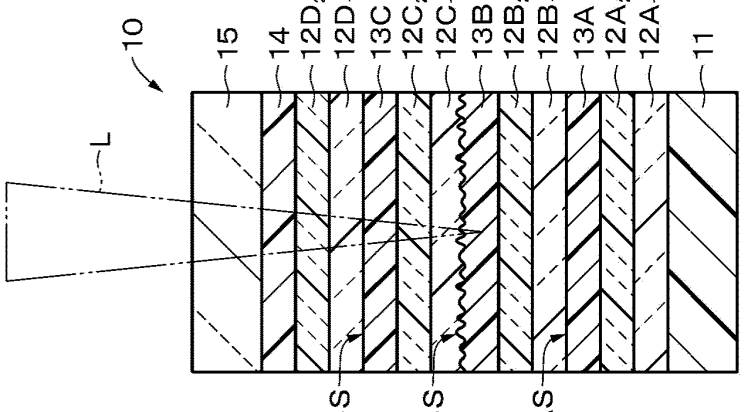
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11
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113AS

C

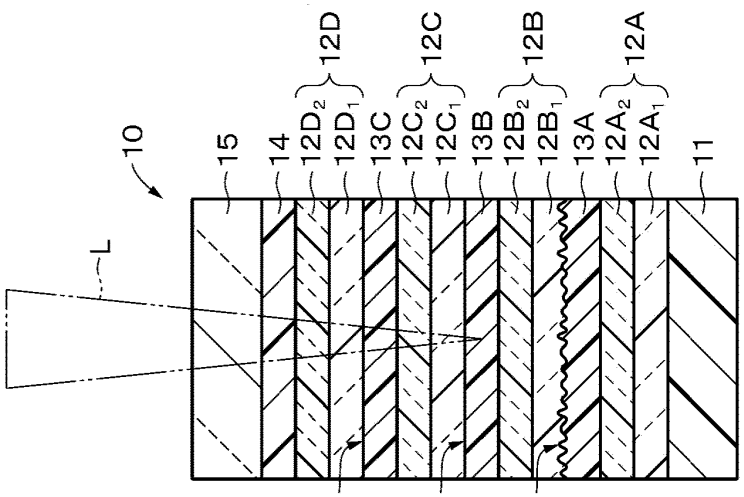
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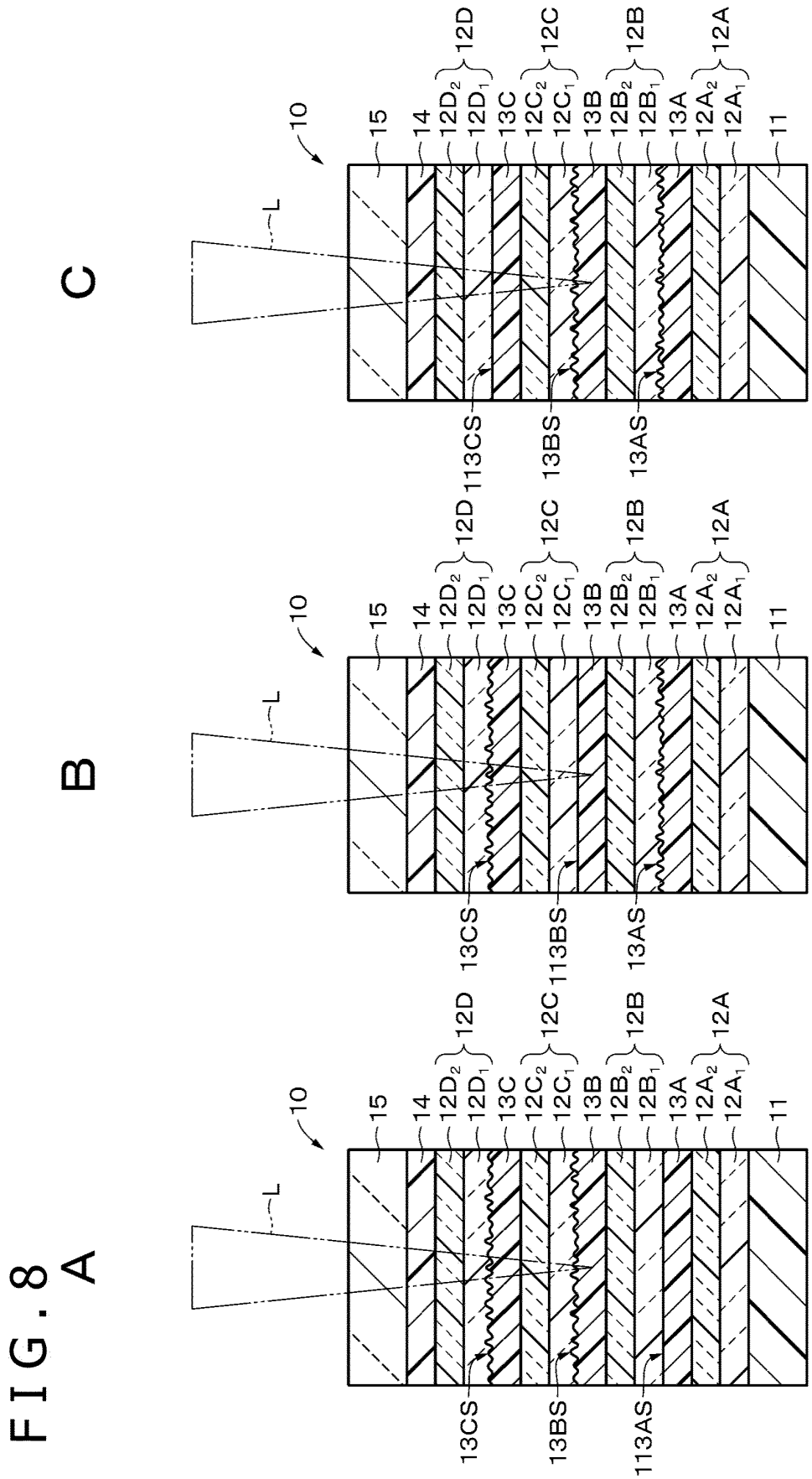
FIG. 8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C
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11
12A
12A1
12A2
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12B1
12B2
12C
12C1
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13CS
113AS
113BS
113CS
14
15

FIG. 9

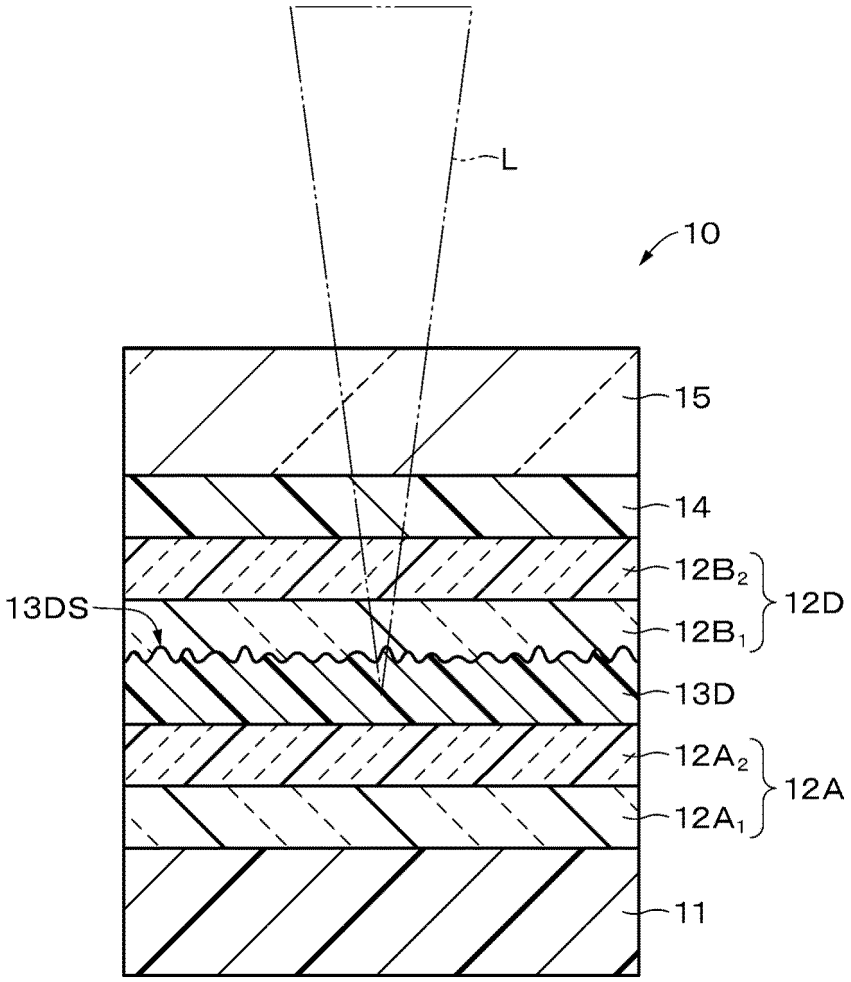
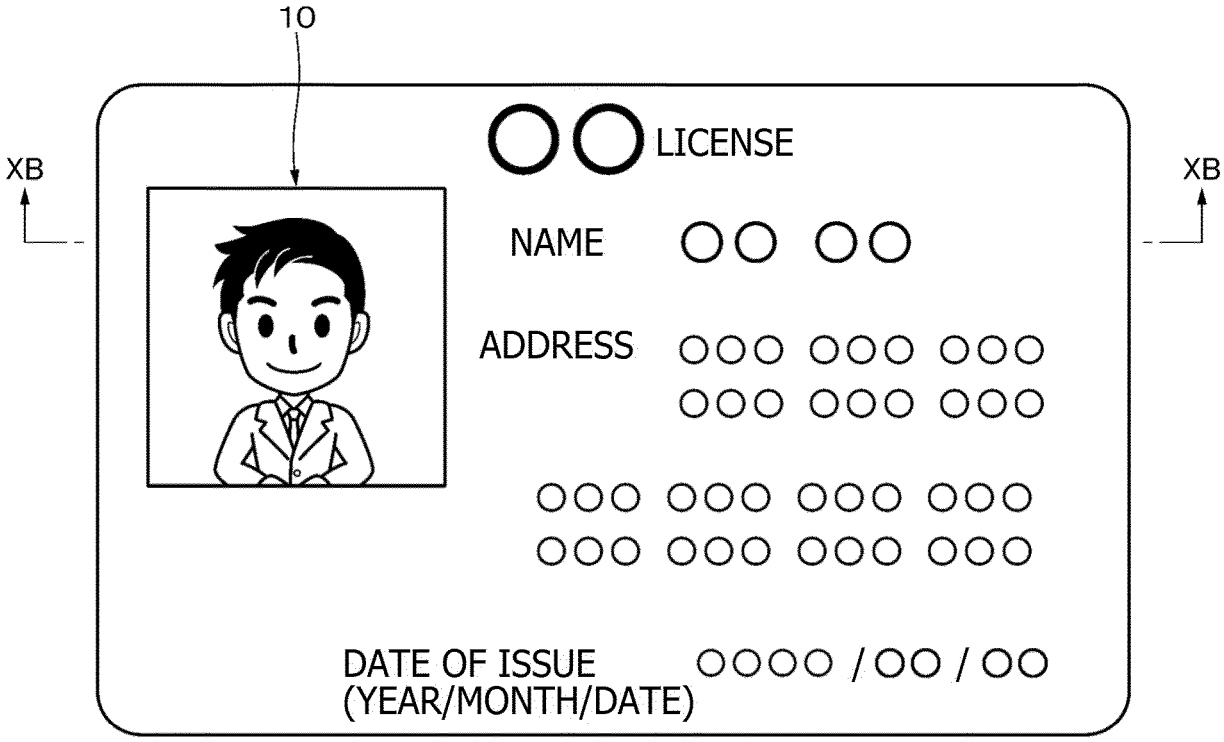


FIG. 10

A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XB
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NAME ○○ ○○
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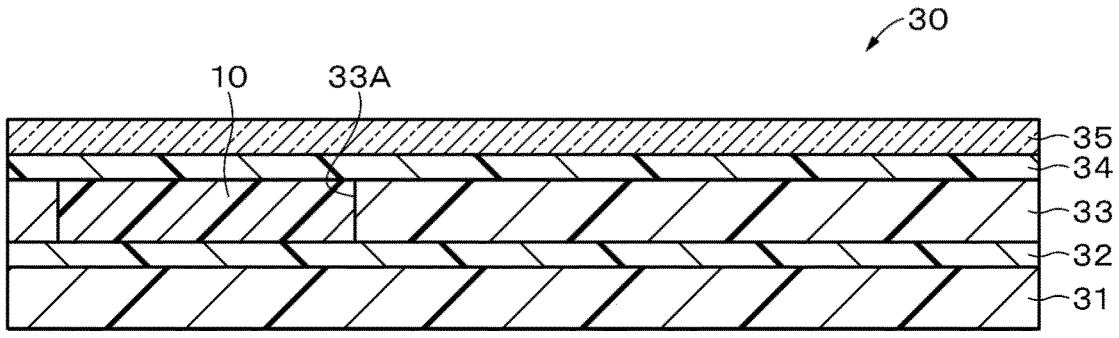
DATE OF ISSUE ○○○○ / ○○ / ○○
(YEAR/MONTH/DATE)

B


30
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33A
35
34
33
32
31

FIG. 11

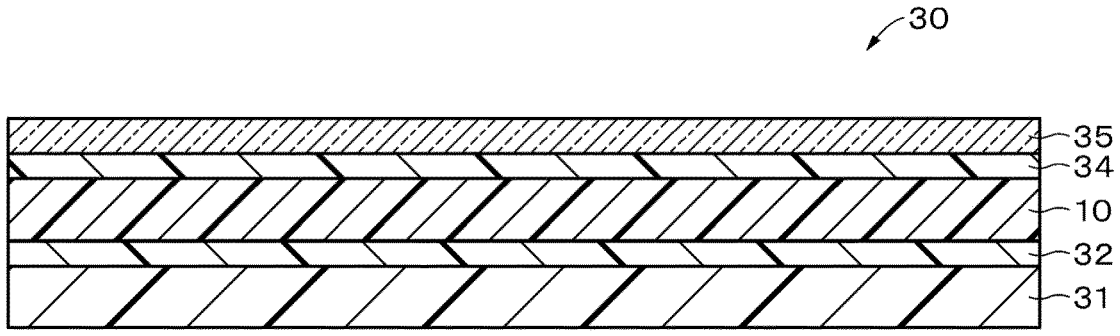


FIG. 12

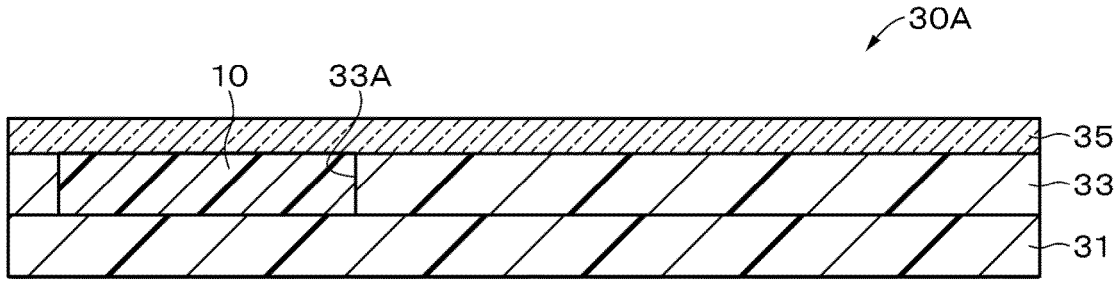


FIG. 13

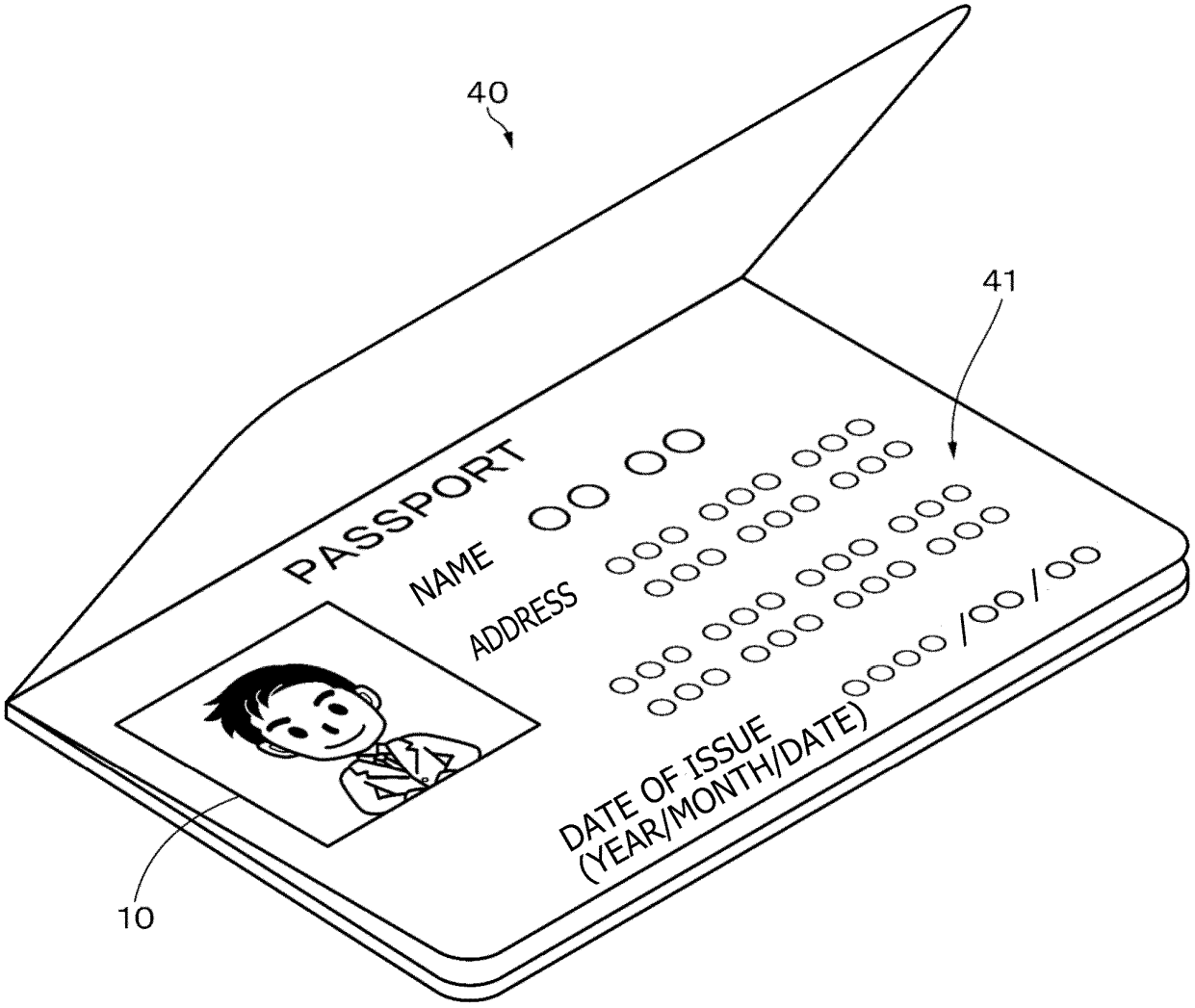

40
41
PASSPORT
NAME OO OO
ADDRESS OOO OOO OOO
OOO OOO OOO
OOO OOO OOO OOO
OOO OOO OOO OOO
OOO OOO OOO OOO
DATE OF ISSUE
(YEAR/MONTH/DATE)
OOOO/OO/OO
10

FIG.14

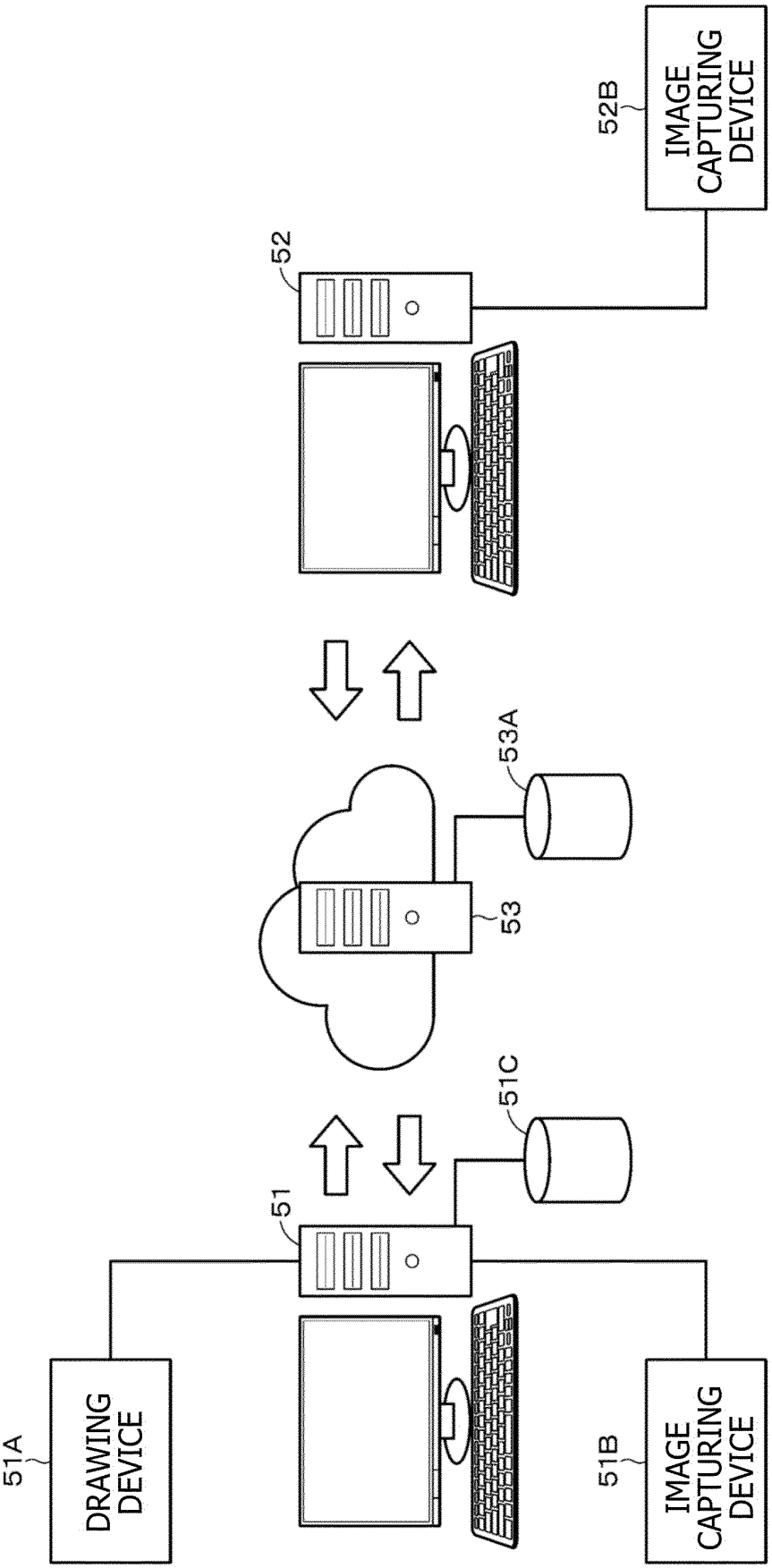

51A
DRAWING DEVICE
51
51B
IMAGE CAPTURING DEVICE
51C
53
53A
52
52B
IMAGE CAPTURING DEVICE

FIG. 15

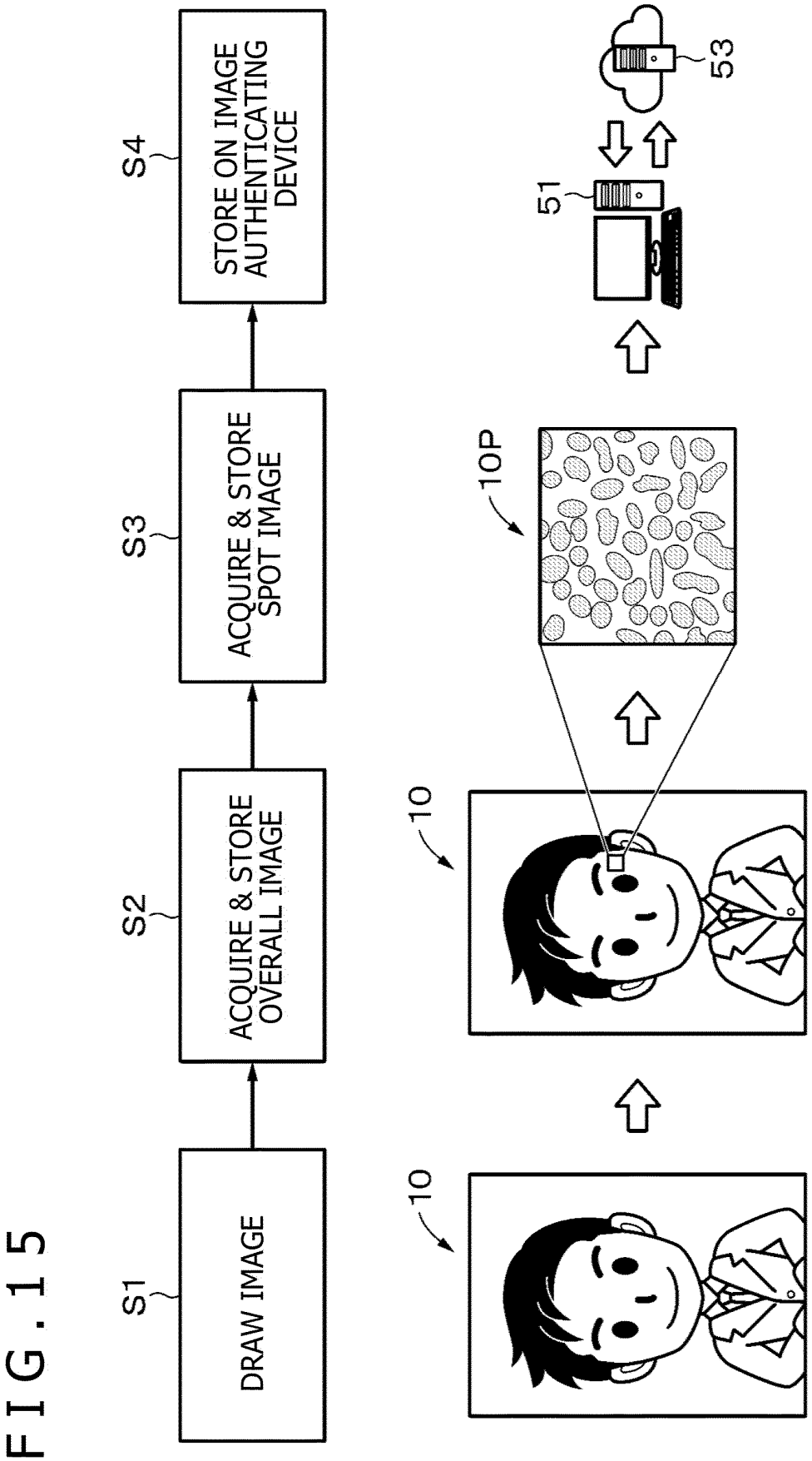
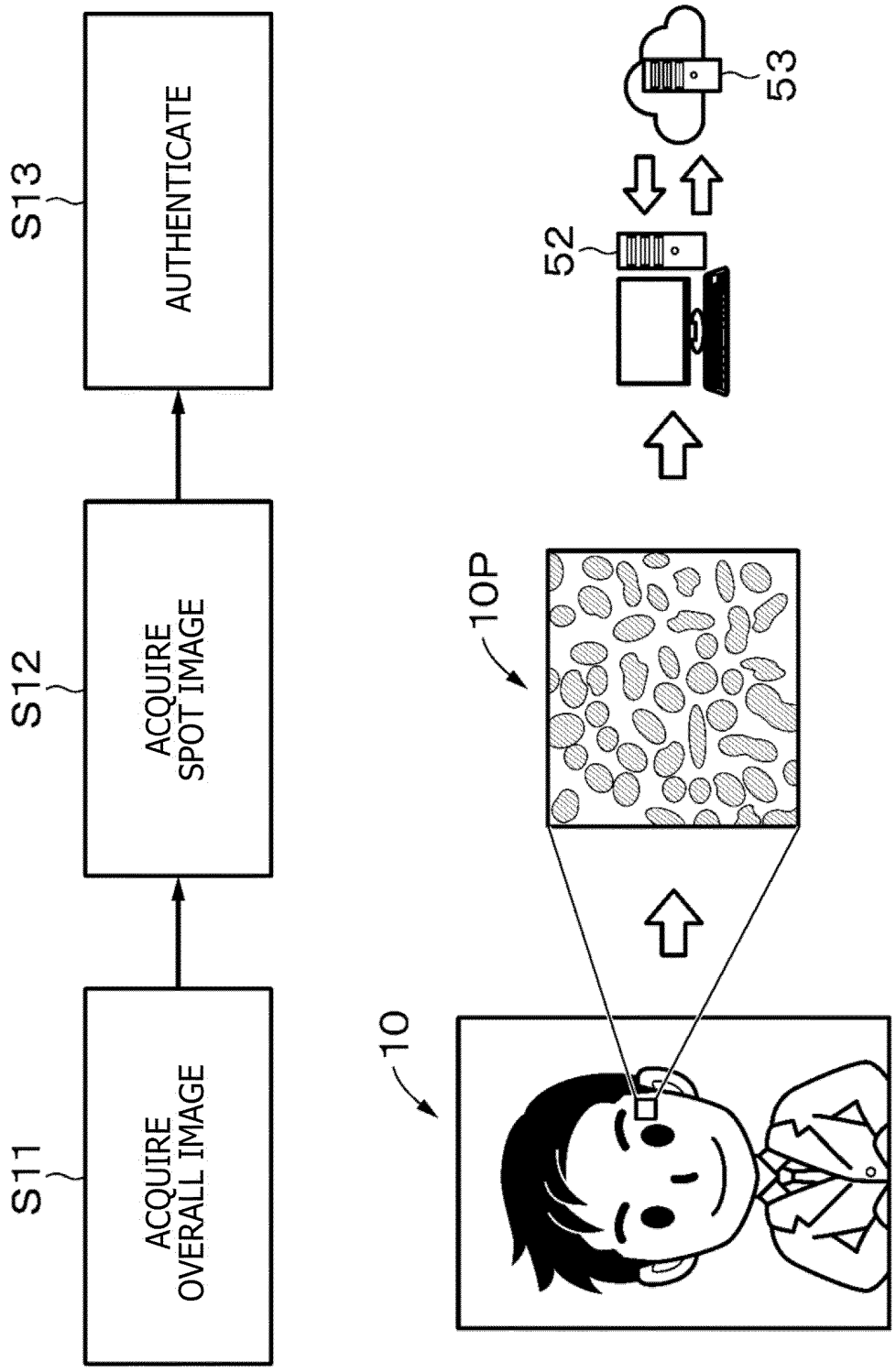

S1
DRAW IMAGE
S2
ACQUIRE & STORE OVERALL IMAGE
S3
ACQUIRE & STORE SPOT IMAGE
S4
STORE ON IMAGE AUTHENTICATING DEVICE
10
10
10P
51
53

FIG.16


S11
ACQUIRE OVERALL IMAGE
S12
ACQUIRE SPOT IMAGE
S13
AUTHENTICATE
10
10P
52
53

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2022/048603

A. CLASSIFICATION OF SUBJECT MATTER

B41M 5/337(2006.01)i; ***B41M 5/40***(2006.01)i; ***B41M 5/42***(2006.01)i; ***B41M 5/44***(2006.01)i; ***B41M 5/46***(2006.01)i; ***B42D 25/378***(2014.01)i
FI: B41M5/40 210; B41M5/40 213; B41M5/337 212; B41M5/42 210; B41M5/44 210; B41M5/46 210; B42D25/378

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B41M5/00-B41M5/52; B42D25/378

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2023
Registered utility model specifications of Japan 1996-2023
Published registered utility model applications of Japan 1994-2023

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2020/003868 A1 (SONY CORP.) 02 January 2020 (2020-01-02) paragraphs [0014]-[0111], fig. 1-11	1, 3-9, 11-12
A	paragraphs [0014]-[0111], fig. 1-11	2, 10

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09 March 2023	**20 March 2023**
Name and mailing address of the ISA/JP **Japan Patent Office (ISA/JP)** **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2022/048603

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

(Invention 1) Claims 1-12

Document 1 (paragraphs [0014]-[0111] and fig. 4) discloses a recording medium comprising a supporting substrate 11 ("substrate") and recording layers 22, 23 and 24 ("recording layer") containing a coloring compound, a color developer and a polymeric material, and it is considered that the recording layers 22, 23 and 24 have irregularities on the surface thereof.

Therefore, claim 1 lacks novelty in light of document 1 and thus does not have a special technical feature.

However, claim 2 dependent on claim 1 has the special technical feature wherein "the irregularities are formed with Benard cells". Thus, claims 1-2 are classified as invention 1.

Claims 3-12 are dependent on claim 1 and are inventively linked to claim 1, and are thus classified as invention 1.

(Invention 2) Claims 13-16

Claims 13-16 cannot be said to share a same or corresponding special technical feature with claims 1-12 classified as invention 1.

In addition, claims 13-16 are not dependent on claims 1-13. Furthermore, claims 13-16 are not substantially identical to or similarly closely related to any of the claims classified as invention 1.

Accordingly, claims 13-16 cannot be classified as invention 1. Claims 13-16 are classified as invention 2.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☑ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: **Claims 1-12**

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2022/048603

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
WO 2020/003868 A1	02 January 2020	US 2021/0316563 A1 paragraphs [0038]-[0154], fig. 1-11	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2008268380 A **[0004]**