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(54) **RECORDING MEDIUM, CARD, AND BOOKLET**

(57) To provide a recording medium capable of suppressing coloration of a background.

The recording medium includes: a recording layer that includes a coloring compound with electron-donating properties, a color developer with electron acceptability, an amine compound, at least one compound selected from an epoxy compound and a carbodiimide compound, and a polycarbonate resin. The color developer includes at least one compound represented by the following formulae (1A) and (1B).

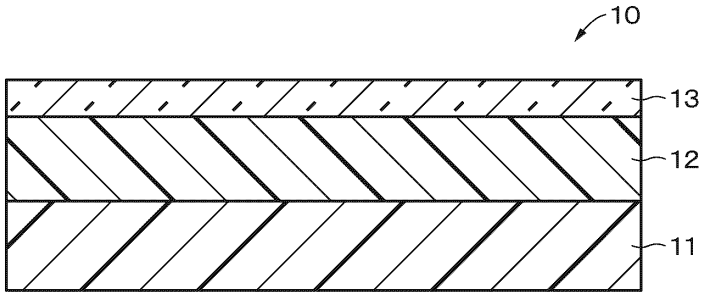

FIG.1

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Description

Technical Field

[0001] The present disclosure relates to a recording medium, a card including the same, and a booklet.

Background Art

[0002] In recent years, as a recording medium to replace a printed matter, a recording medium including a coloring compound with electron-donating properties and a color developer with electron acceptability has been developed. Patent Literature 1 describes using a bis(hydroxybenzoic acid) compound (bisurea compound) represented by a specific formula as a color developer.

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Patent Application Laid-open No. 1996-244355

Disclosure of Invention

Technical Problem

[0004] However, when a bis(hydroxybenzoic acid) compound is used as a color developer, an unrecorded area (hereinafter, referred to as a "background" in some cases.) is colored in some cases.

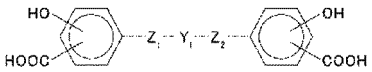
[0005] It is an object of the present disclosure to provide a recording medium capable of suppressing coloration of a background, a card including the same, and a booklet.

Solution to Problem

[0006] In order to achieve the above-mentioned object, a first disclosure is a recording medium including:

a recording layer that includes a coloring compound with electron-donating properties, a color developer with electron acceptability, an amine compound, at least one compound selected from an epoxy compound and a carbodiimide compound, and a polycarbonate resin,
the color developer containing at least one compound represented by the following formulae (1A) and (1B) .

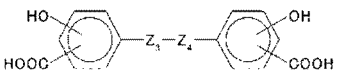
(Chem. 1)



...(1A)

(wherein, in the formula (1A), Z_1 and Z_2 independently represent a hydrogen-bonding bonding group. Y_1 represents a divalent group.)

(Chem. 2)



...(1B)

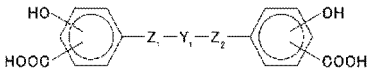
(wherein, in the formula (1B), Z_3 and Z_4 independently represents a hydrogen-bonding bonding group.)

[0007] A second disclosure is a recording medium including:

a recording layer that includes a coloring compound with electron-donating properties, a color developer with electron acceptability, an amine compound, at least one compound selected from an epoxy compound and a carbodiimide

compound, and a matrix resin,
the color developer containing at least one compound represented by the following formulae (1A) and (1B) .

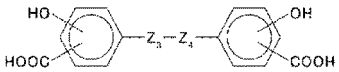
(Chem. 3)



...(1A)

(wherein, in the formula (1A), Z_1 and Z_2 independently represent a hydrogen-bonding bonding group. Y_1 represents a divalent group.)

(Chem. 4)



...(1B)

(wherein, in the formula (1B), Z_3 and Z_4 independently represents a hydrogen-bonding bonding group.)

[0008] A third disclosure is a card that includes the recording medium according to the first or second disclosure.
[0009] A fourth disclosure is a booklet that includes the recording medium according to the first or second disclosure.

Brief Description of Drawings

[0010]

[Fig. 1] Fig. 1 is a cross-sectional view showing an example of a configuration of a recording medium according to a first embodiment.
[Fig. 2] Fig. 2 is a cross-sectional view showing an example of a configuration of a recording medium according to a second embodiment.
[Fig. 3] Fig. 3 is a cross-sectional view showing an example of a configuration of a recording medium according to a third embodiment.
[Fig. 4] Part A of Fig. 4 is a plan view showing an example of the appearance of an application example 1. Part B of Fig. 4 is a cross-sectional view taken along the line IVB-IVB in Part A of Fig. 4.
[Fig. 5] Fig. 5 is a perspective view showing an example of the appearance of an application example 2.
[Fig. 6] Part A of Fig. 6 is a plan view showing an example of the appearance (front surface side) of an application example 3. Part B of Fig. 6 is a plan view showing an example of the appearance (back surface side) of the application example 3.
[Fig. 7] Part A of Fig. 7 is a plan view showing an example of the appearance (front surface side) of an application example 4. Part B of Fig. 7 is a plan view showing an example of the appearance (back surface side) of the application example 4.
[Fig. 8] Part A of Fig. 8 is a perspective view showing an example of the appearance (front surface side) of an application example 5. Part B of Fig. 8 is a perspective view showing an example of the appearance (back surface side) of the application example 5.
[Fig. 9] Part A of Fig. 9 is a plan view showing an example of the appearance (first surface side) of an application example 6. Part B of Fig. 9 is a plan view showing an example of the appearance (second surface side) of the application example 6.
[Fig. 10] Part A of Fig. 10 is a plan view showing an example of the appearance (top surface side) of an application example 7. Part B of Fig. 10 is a plan view showing an example of the appearance (side surface side) of the application example 7.
[Fig. 11] Fig. 11 is a plan view showing an example of the appearance of an application example 8.
[Fig. 12] Fig. 12 is a perspective view showing an example of the appearance of an application example 9.
[Fig. 13] Part A of Fig. 13 is a plan view showing an example of the appearance of an application example 10. Part B of Fig. 13 is a cross-sectional view taken along the line XIIIB-XIIIB in Part A of Fig. 13.

Mode(s) for Carrying Out the Invention

[0011] Embodiments of the present disclosure will be described in the following order. Note that in all the drawings of the following embodiments, the same or corresponding portions will be denoted by the same reference symbols.

<1 First embodiment>

[1.1 Configuration of recording medium]

[0012] Hereinafter, an example of a configuration of a recording medium 10 according to a first embodiment will be described with reference to Fig. 1. The recording medium 10 is configured such that its coloring state can be changed by irradiation of laser light (external stimulation). By using the change in coloring state, an image or the like can be drawn on the recording medium 10. Here, the image includes not only an image such as a design, a color pattern, and a photograph, but also a text such as a character and a symbol.

[0013] The laser light is favorably near-infrared laser light. The change in coloring state may be a reversible change or an irreversible change. That is, the recording medium 10 may be rewritable, in which an image or the like can be rewritten, or write-once, in which an image or the like can be written only once. From the viewpoint of anti-counterfeiting properties, the change in coloring state is favorably an irreversible change.

[0014] The recording medium 10 includes a base material 11 and a recording layer 12 provided on the base material 11. The recording medium 10 may further include a protective layer 13 provided on the recording layer 12. Hereinafter, the base material 11, the recording layer 12, and the protective layer 13 will be described in order.

(Base material)

[0015] The base material 11 is a support for supporting the recording layer 12. The base material 11 is favorably formed of a material having excellent heat resistance and excellent dimension stability in the planar direction. The base material 11 may have either optical transparency or non-optical transparency. The base material 11 may have a predetermined color such as white. The base material 11 has, for example, a plate shape or a film shape. In the present disclosure, the film is defined to include a sheet.

[0016] The base material 11 may have, for example, rigidity or flexibility. In the case where the base material 11 having flexibility is used, it is possible to realize a flexible recording medium 10. Examples of the base material 11 having rigidity include a wafer and a glass substrate. Examples of the base material 11 having flexibility include flexible glass, a film, and paper.

[0017] Examples of the constituent material of the base material 11 include an inorganic material, a metal material, and a polymer material. The inorganic material includes, for example, at least one selected from the group consisting

of silicon (Si), silicon oxide (SiO_X), silicon nitride (SiN_X), and aluminum oxide (AlO_X). The silicon oxide includes, for example, at least one selected from the group consisting of glass and spin-on glass (SOG). The metal material includes, for example, at least one selected from the group consisting of aluminum (Al), nickel (Ni), and stainless steel. The polymer material includes, for example, at least one selected from the group consisting of polycarbonate (PC), polyethylene terephthalate (PET), polyethylene naphthalate (PEN), polyetheletherketone (PEEK), and polyvinyl chloride (PVC).

[0018] Note that a reflective layer (not shown) may be provided on at least one main surface of the base material 11, or the base material 11 itself may have a function as a reflective layer. When the base material 11 has such a configuration, clearer color display is possible.

(Recording layer)

[0019] The recording layer 12 in an unrecorded state (initial state) is in a decolored state. The state of the recording layer 12 can be changed from the decolored state to a colored state by irradiation of laser light. The recording layer 12 is capable of exhibiting a predetermined color in the colored state. Examples of the predetermined color include, but not limited to, black, cyan, magenta, yellow, red, green, and blue.

[0020] The thickness of the recording layer 12 is favorably 1 um or more and 20 um or less, more favorably 2 um or more and 15 um or less. When the thickness of the recording layer 12 is 1 um or more, it is possible to achieve sufficient color density. Meanwhile, in the case where the thickness of the recording layer 12 is 20 um or less, it is possible to prevent the heat utilization amount of the recording layer 12 from becoming too large. Therefore, it is possible to prevent the color development from deteriorating.

[0021] The recording layer 12 includes a coloring compound with electron-donating properties, a color developer with electron acceptability, an amine compound, at least one compound selected from an epoxy compound and a carbodiimide compound, a photothermal conversion agent, and a matrix resin. The recording layer 12 may include, as necessary, at least one additive selected from the group consisting of a sensitizer and an ultraviolet absorber, in addition to the above materials.

(Coloring compound)

[0022] The coloring compound is capable of developing color by reacting with a color developer. The coloring compound is, for example, a leuco dye. When a lactone ring included in the molecule of the leuco dye reacts with an acid, the lactone ring opens to develop color. Further, when the opened lactone ring in the leuco dye reacts with a base, it is closed and loses its color. The leuco dye may be, for example, an existing dye for thermal paper.

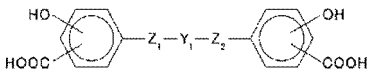
[0023] The leuco dye is not particularly limited and can be appropriately selected in accordance with the purpose. Specific examples of the leuco dye include a fluorane compound, a triphenylmethanephthalide compound, an azaphthalide compound, a phenothiazine compound, a leuco auramine compound, and an indolinophthalide compound. In addition, examples thereof include 2-anilino-3-methyl-6-diethylaminofluorane, 2-anilino-3-methyl-6-di(n-butylamino)fluorane, 2-anilino-3-methyl-6-(N-n-propyl-N-methylamino)fluorane, 2-anilino-3-methyl-6-(N-isopropyl-N-methylamino)fluorane, 2-anilino-3-methyl-6-(N-isobutyl-N-methylamino)fluorane, 2-anilino-3-methyl-6-(N-n-amyl-N-methylamino)fluorane, 2-anilino-3-methyl-6-(N-sec-butyl-N-methylamino)fluorane, 2-anilino-3-methyl-6-(N-n-amyl-N-ethylamino)fluorane, 2-anilino-3-methyl-6-(N-iso-amyl-N-ethylamino)fluorane, 2-anilino-3-methyl-6-(N-n-propyl-N-isopropylamino)fluorane, 2-anilino-3-methyl-6-(N-cyclohexyl-N-methylamino)fluorane, 2-anilino-3-methyl-6-(N-ethyl-p-toluidino)fluorane, 2-anilino-3-methyl-6-(N-methyl-p-toluidino)fluorane, 2-(m-trichloromethylanilino)-3-methyl-6-diethylaminofluorane, 2-(m-trifluoromethylanilino)-3-methyl-6-diethylaminofluorane, 2-(m-trichloromethylanilino)-3-methyl-6-(N-cyclohexyl-N-methylamino)fluorane, 2-(2,4-dimethylanilino)-3-methyl-6-diethylaminofluorane, 2-(N-ethyl-p-toluidino)-3-methyl-6-(N-ethylanilino)fluorane, 2-(N-ethyl-p-toluidino)-3-methyl-6-(N-propyl-p-toluidino)fluorane, 2-anilino-6-(N-n-hexyl-N-ethylamino)fluorane, 2-(o-chloroanilino)-6-diethylaminofluorane, 2-(o-chloroanilino)-6-dibutylaminofluorane, 2-(m-trifluoromethylanilino)-6-diethylaminofluorane, 2,3-dimethyl-6-dimethylaminofluorane, 3-methyl-6-(N-ethyl-p-toluidino)fluorane, 2-chloro-6-diethylaminofluorane, 2-bromo-6-diethylaminofluorane, 2-chloro-6-dipropylaminofluorane, 3-chloro-6-cyclohexylaminofluorane, 3-bromo-6-cyclohexylaminofluorane, 2-chloro-6-(N-ethyl-N-isoamylamino)fluorane, 2-chloro-3-methyl-6-diethylaminofluorane, 2-anilino-3-chloro-6-diethylaminofluorane, 2-(o-chloroanilino)-3-chloro-6-cyclohexylaminofluorane, 2-(m-trifluoromethylanilino)-3-chloro-6-diethylaminofluorane, 2-(2,3-dichloroanilino)-3-chloro-6-diethylaminofluorane, 1,2-benzo-6-diethylaminofluorane, 3-diethylamino-6-(m-trifluoromethylanilino)fluorane, 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-di-

ethylaminophenyl)-4-azaphthalide, 3,3-bis(2-ethoxy-4-diethylaminophenyl)-7-azaphthalide, 2-(p-acetylanilino)-6-(N-n-amyl-N-n-butylamino)fluorane, 2-benzylamino-6-(N-ethyl-p-toluidino)fluorane, 2-benzylamino-6-(N-methyl-2,4-dimethylanilino)fluorane, 2-benzylamino-6-(N-ethyl-2,4-dimethylanilino)fluorane, 2-benzylamino-6-(N-methyl-p-toluidino)fluorane, 2-benzylamino-6-(N-ethyl-p-toluidino)fluorane, 2-(di-p-methylbenzylamino)-6-(N-ethyl-p-toluidino)fluorane, 2-(α-phenylethylamino)-6-(N-ethyl-p-toluidino)fluorane, 2-methylamino-6-(N-methylanilino)fluorane, 2-methylamino-6-(N-ethylanilino)fluorane, 2-methylamino-6-(N-propylanilino)fluorane, 2-ethylamino-6-(N-methyl-p-toluidino)fluorane, 2-methylamino-6-(N-methyl-2,4-dimethylanilino)fluorane, 2-ethylamino-6-(N-ethyl-2,4-dimethylanilino)fluorane, 2-dimethylamino-6-(N-methylanilino)fluorane, 2-dimethylamino-6-(N-ethylanilino)fluorane, 2-diethylamino-6-(N-methyl-p-toluidino)fluorane, 2-diethylamino-6-(N-ethyl-p-toluidino)fluorane, 2-dipropylamino-6-(N-methylanilino)fluorane, 2-dipropylamino-6-(N-ethylanilino)fluorane, 2-amino-6-(N-methylanilino)fluorane, 2-amino-6-(N-ethylanilino)fluorane, 2-amino-6-(N-propylanilino)fluorane, 2-amino-6-(N-methyl-p-toluidino)fluorane, 2-amino-6-(N-ethyl-p-toluidino)fluorane, 2-amino-6-(N-propyl-p-toluidino)fluorane, 2-amino-6-(N-methyl-p-ethylanilino)fluorane, 2-amino-6-(N-ethyl-p-ethylanilino)fluorane, 2-amino-6-(N-propyl-p-ethylanilino)fluorane, 2-amino-6-(N-methyl-2,4-dimethylanilino)fluorane, 2-amino-6-(N-ethyl-2,4-dimethylanilino)fluorane, 2-amino-6-(N-propyl-2,4-dimethylanilino)fluorane, 2-amino-6-(N-methyl-p-chloroanilino)fluorane, 2-amino-6-(N-ethyl-p-chloroanilino)fluorane, 2-amino-6-(N-propyl-p-chloroanilino)fluorane, 1,2-benzo-6-(N-ethyl-N-isoamylamino)fluorane, 1,2-benzo-6-dibutylaminofluorane, 1,2-benzo-6-(N-methyl-N-cyclohexylamino)fluorane, and 1,2-benzo-6-(N-ethyl-N-toluidino)fluorane. The recording layer 12 may contain one of the above leuco dyes alone or two or more of them.

(Color developer)

[0024] The color developer is for, for example, developing color from a colorless coloring compound. The color developer includes a bis(hydroxybenzoic acid) compound including a group having electron acceptability in the molecule. The bis(hydroxybenzoic acid) compound includes at least one compound represented by the following formulae (1A) and (1B). Since the acidic group (hydroxybenzoic acid) of the bis(hydroxybenzoic acid) compound reacts with the lactone ring of the coloring compound (e.g., leuco dye) and the lactone ring opens, the coloring compound develops color.

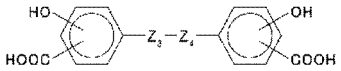
(Chem. 5)



···(1A)

(wherein, in the formula (1A), Z_1 and Z_2 independently represent a hydrogen-bonding bonding group. Y_1 represents a divalent group.)

(Chem. 6)



···(1B)

(wherein, in the formula (1B), Z_3 and Z_4 independently represents a hydrogen-bonding bonding group.)

[0025] In the formulae (1A) and (1B), the bonding sites of the hydroxy group (-OH) and the carboxyl group (-COOH) to benzene are not limited. That is, the bonding sites of the hydroxy group and the carboxyl group to benzene may be any of an ortho position, meta position, and para position. In the formulae (1A) and (1B), the bonding sites of the hydroxy group and the carboxyl group to one benzene and the bonding sites of the hydroxy group and the carboxyl group to the other benzene may be the same as or different from each other.

[0026] Z_1 and Z_2 in the formula (1A) independently represent, for example, a urea bond (-NHCONH-), an amide bond (-NHCO-, -OCHN-), or a hydrazide bond (-NHCOCONH-). In the case where Z_1 represents an amide bond, nitrogen contained in the amide bond may be bonded to benzene or carbon contained in the amide bond may be bonded to benzene. In the case where Z_2 represents an amide bond, nitrogen contained in the amide bond may be bonded to benzene or carbon contained in the amide bond may be bonded to benzene.

[0027] Z_3 and Z_4 in the formula (1B) independently represent, for example, a urea bond (-NHCONH-), an amide bond (-NHCO-, -OCHN-), or a hydrazide bond (-NHCOCONH-). In the case where Z_3 represents an amide bond, nitrogen contained in the amide bond may be bonded to benzene or carbon contained in the amide bond may be bonded to benzene. In the case where Z_4 represents an amide bond, nitrogen contained in the amide bond may be bonded to benzene or carbon contained in the amide bond may be bonded to benzene.

[0028] Y1 only needs to represent a divalent group and is not particularly limited. Examples thereof include a hydrocarbon group, which may have a substituent group. Some of the carbons of the hydrocarbon group (e.g., some of the carbons contained in the main chain of the hydrocarbon group) may be substituted with an element such as oxygen. The hydrocarbon group is a general term for a group including carbon (C) and hydrogen (H), and may be a saturated hydrocarbon group or an unsaturated hydrocarbon group. Here, the saturated hydrocarbon group is an aliphatic hydrocarbon group having no carbon-carbon multiple bond and the unsaturated hydrocarbon group is an aliphatic hydrocarbon group having a carbon-carbon multiple bond (a carbon-carbon double bond or a carbon-carbon triple bond). Further, the hydrocarbon group may be a chain one or include one or two or more rings, but is favorably a chain one. The chain may be linear or branched having one or two or more side chains or the like. When the hydrocarbon group is a chain one, the melting point of the color developer can be reduced. Thus, the color developer melts by irradiation of laser light, making it easier for the coloring compound to develop color. From the viewpoint of reducing the melting point of the color developer, a normal alkyl chain, of the chain hydrocarbon groups, is particularly favorable.

[0029] The number of carbons in the hydrocarbon group is, for example, 1 or more and 15 or less, 1 or more and 13 or less, 1 or more and 12 or less, 1 or more and 10 or less, 1 or more 6 or less, or 1 or more and 3 or less.

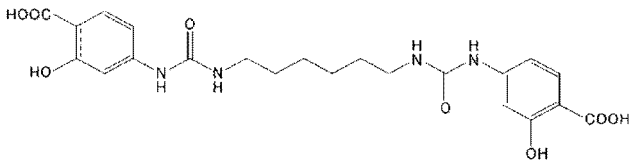
[0030] In the case where Y_1 represents a normal alkyl group, the number of carbons in the normal alkyl group is favorably 8 or less, more favorably 6 or less, still more favorably 5 or less, and particularly favorably 3 or less from the viewpoint of the high-temperature preservation stability. When the number of carbons in the normal alkyl group is 8 or less, since the length of the normal alkyl group is short, it is considerable that thermal disturbances are less likely to occur in the color developer during high-temperature preservation and the sites that have interacted with the coloring compound such as a leuco dye during color development become difficult to remove. Therefore, since the coloring compound such as a leuco dye becomes difficult to lose its color during high-temperature preservation, the high-temperature preservation stability is improved.

[0031] Further, in the case where Y_1 represents a normal alkyl group, taking into consideration the different behavior depending on whether the number of carbons is even or odd (parity of the number of carbons), the melting point of the color developer in which the number of carbons in the normal alkyl group is odd is generally likely to be lower than the melting point of the color developer in which the number of carbons in the normal alkyl group is even. Therefore, in order to improve the color development, the number of carbons in the normal alkyl group is favorably odd. From the viewpoint of improving both the high-temperature preservation properties and the color development, the number of carbons in the normal alkyl group is favorably an odd number of 7 or less, more favorably an odd number of 5 or less, and still more favorably an odd number of 3 or less.

[0032] Examples of the substituent group that the hydrocarbon group may have include a halogen group (e.g., fluorine group) and an alkyl group having a halogen group (e.g., fluorine group).

[0033] More specifically, the bis(hydroxybenzoic acid) color developer may include at least one selected from the group consisting of compounds represented by the following formulae (1-1) to (1-19).

(Chem. 7)



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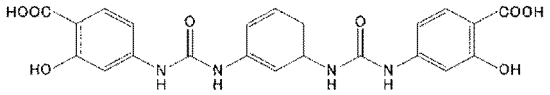

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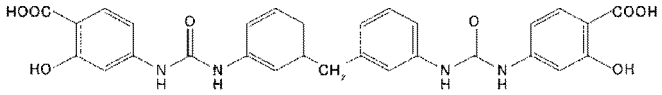

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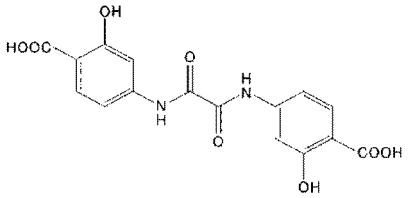
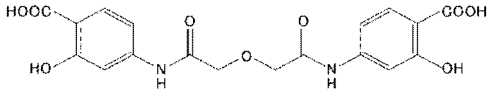


...(1-4)



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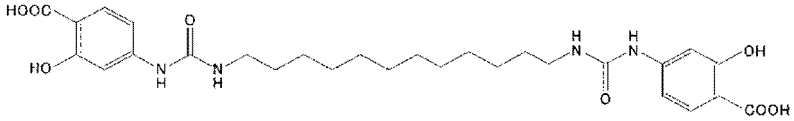

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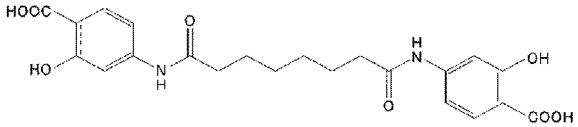

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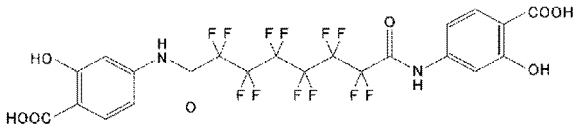

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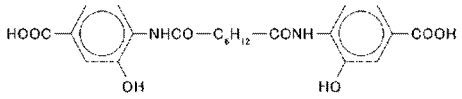
(Chem. 8)



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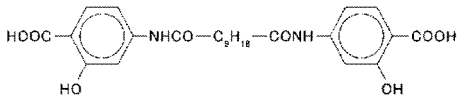

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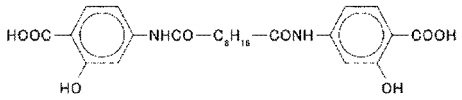

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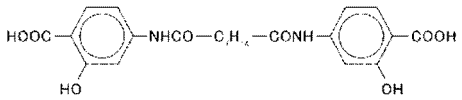

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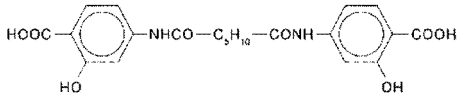

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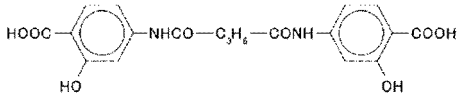

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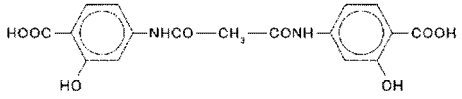

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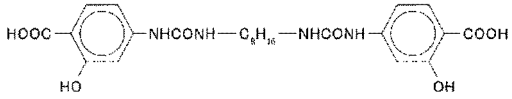

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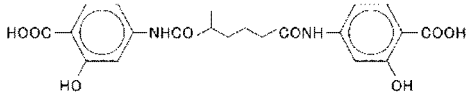

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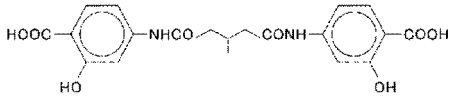

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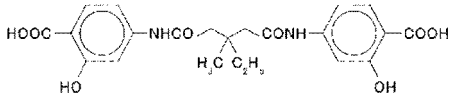


···(1-19)

(Amine compound)

[0034] When the recording layer 12 includes an amine compound, the amine compound caps the acidic group (hydroxybenzoic acid) of the color developer (bis(hydroxybenzoic acid) compound). This prevents the acidic group of the color developer from reacting with the coloring compound (e.g., lactone ring of the leuco dye), and it is possible to suppress coloration of a background. Therefore, it is possible to improve the color expression of the recording medium 10. For example, in the case where the base material 11 has a white color, it is possible to improve the white expression of the recording medium 10.

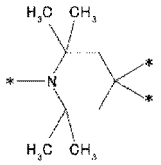
[0035] The amine compound is a compound containing at least one amine in one molecule. In the case where the amine compound contains two or more amines in one molecule, the two or more amines may be of the same type of different types. The amine functions as an adsorption group. The amine is, for example, a primary amine ($-NH_2$), a secondary amine (-NHR), or a tertiary amine (-NRR'). The amine may have a salt structure.

[0036] The amine compound favorably has a branched structure. When the amine compound has a branched structure, the steric hindrance effect of the amine compound can be enhanced when the amine compound caps the acidic group (hydroxybenzoic acid) of the color developer (bis(hydroxybenzoic acid) compound). Therefore, since the acidic group of the color developer is prevented from reacting with the coloring compound (e.g., lactone ring of the leuco dye), the coloration of a background is further suppressed.

[0037] The branched structure is, for example, a comb-shaped molecular structure, a star-shaped molecular structure, or a dendritic molecular structure. The amine compound may be a comb-shaped molecule having an amino group, a star-shaped molecule having an amino group, or a dendritic molecule having an amino group. The recording layer 12 may include two or more types of amine compounds having different branched structures. The amine compound having a branched structure may be an amine dispersant. The amine compound may be an amine polymer. In the present specification, the polymer refers to one having a number average molecular weight (Mn) of 1000 or more.

[0038] The amine compound may be a hindered amine compound. The hindered amine compound is represented by, for example, the following formula (2).

(Chem. 9)



...(2)

Wherein, in the formula (2), it is bonded to an atom such as a hydrogen atom or another structure at the position represented by *. The hindered amine compound may be a polymer including the above structure in one or both of the main chain and the side chain.

[0039] The higher the content of the amine compound in the recording layer 12, the more the color development of the background tends to be suppressed. Meanwhile, as the content of the amine compound in the recording layer 12 increases, the reliability of the colored portion during high-temperature and high-humidity preservation tends to decrease. From the viewpoint of both suppressing the coloration of a background and suppressing the decrease in reliability of the colored portion during high-temperature and high-humidity preservation, the content of the amine compound in the recording layer 12 is favorably 3 parts by mass or more and 25 parts by mass or less with respect to 100 parts by mass of the color developer, more favorably 5 parts by mass or more and 20 parts by mass or less with respect to 100 parts by mass of the color developer, still more favorably 8 parts by mass or more and 15 parts by mass or less with respect to 100 parts by mass of the color developer, and most favorably approximately 10 parts by mass with respect to 100 parts by mass of the color developer.

[0040] The content of the amine compound in the recording layer 12 is measured as follows. First, the recording medium 10 is disassembled to expose the recording layer 12. Next, the exposed recording layer 12 is immersed in an organic solvent to extract the materials forming the recording layer 12. As the organic solvent, methanol is particularly favorable. However, in the case where methanol is insufficient to extract the materials, an organic solvent such as acetone, methyl ethyl ketone, dimethylsulfoxide, dimethylformamide, tetrahydrofuran, chloroform, and acetonitrile can also be used.

[0041] Next, the extract is analyzed by LC/MS (liquid chromatography mass spectrometry) to identify the component contained in the extract and obtain the content of the components. In the case where it is difficult to identify the components and obtain the content of the components using LC/MS alone, an organic analysis method such as infrared spectroscopy, pyrolysis GC/MS (gas chromatography-mass spectrometry), and NMR (nuclear magnetic resonance) may be used in combination therewith. Methanol or acetonitrile is particularly favorable as the mobile phase for LC/MS analysis, an organic solvent such as 2-propanol, ethanol, and acetone can also be used.

(Epoxy compound and carbodiimide compound)

[0042] When the recording layer 12 includes an amine compound, there is a possibility that the reliability of the colored portion during high-temperature and high-humidity preservation decreases. The reason for this decrease in reliability is presumably due to the progress of the neutralization reaction when the amine compound acts on the color developer bonded to the coloring compound and the progress of dissociation between the coloring compound and the color developer.

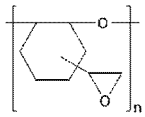
[0043] When the recording layer 12 includes at least one compound selected from an epoxy compound and a carbodiimide compound as well as an amine compound, it is possible to suppress the decrease in reliability of the colored

portion during high-temperature and high-humidity preservation. The following four effects are presumed to be responsible for the expression of this suppression effect.

(1) Water that has entered the recording layer 12 and the above compound react with each other, thereby suppressing decolorization due to water.
(2) The above compound reacts with the coloring compound or color developer to form a cross-linked structure, thereby inhibiting mass transfer in the recording layer 12 and suppressing dissociation between the color developer and the coloring compound.
(3) The above compound reacts with the coloring compound that has developed color, thereby stabilizing the color development structure.
(4) Since the acidic group of the color developer acts as a catalyst in decoloring the coloring compound, the above compound reacts with the acid site of the color developer to deactivate it, thereby suppressing decolorization.

[0044] The epoxy compound is a compound having at least one epoxy group in one molecule. The epoxy compound may be an epoxy resin. The epoxy compound is, for example, an alicyclic epoxy compound. The alicyclic epoxy compound is a compound having at least one epoxy group bonded to an alicyclic ring in one molecule. The alicyclic epoxy compound is, for example, a compound having a structure represented by the following formula (3) (wherein, in the formula (3), n represents the number of repeating units.).

(Chem. 10)



···(3)

[0045] Specific examples of the compound having the structure represented by the formula (3) include a 1,2-epoxy-4-(2-oxiranyl)cyclohexane adduct of 2,2-bis(hydroxymethyl)-1-butanol (EHPE3150 manufactured by Daicel Corporation).
[0046] The carbodiimide compound is a compound having at least one carbodiimide group (-N=C=N-) in one molecule. The carbodiimide compound may be a polymer.
[0047] The lower limit value of the content of at least one compound selected from an epoxy compound and a carbodiimide compound in the recording layer 12 is favorably10 parts by mass or more with respect to 100 parts by mass of the color developer, more favorably 50 parts by mass or more with respect to 100 parts by mass of the color developer, from the viewpoint of suppressing the decrease in reliability of the colored portion during high-temperature and high-humidity preservation. The upper limit value of the content of at least one compound selected from an epoxy compound and a carbodiimide compound in the recording layer 12 is favorably 150 parts by mass or less, more favorably 110 parts by mass or less, and still more favorably 100 parts by mass or less, from the viewpoint of ensuring uniformity of the coating film when applying a paint for forming a recording layer.
[0048] The content of at least one compound selected from an epoxy compound and a carbodiimide compound in the recording layer 12 is measured in a way similar to that for the above content of the amine compound in the recording layer 12.

(Photothermal conversion agent)

[0049] The photothermal conversion agent absorbs light in a predetermined wavelength range such as a near-infrared region, and generates heat. As the photothermal conversion agent, for example, it is favorable to use a near-infrared absorbing dye that has an absorption peak in the wavelength range of 700 nm or more and 2000 nm or less and has substantially no absorption in the visible region. Specific examples thereof include at least one selected from the group consisting of a compound having a phthalocyanine skeleton (phthalocyanine dye), a compound having a squarylium skeleton (squarylium dye), and an inorganic compound.
[0050] Examples of the inorganic compound include at least one selected from the group consisting of a metal complex such as a dithio complex, a diimonium salt, an aminium salt, graphite, carbon black, metal powder particles, tricobalt tetroxide, iron oxide, chromium oxide, copper oxide, titanium black, a metal oxide such as ITO (Indium Tin Oxide), a metal nitride such as niobium nitride, a metal carbide such as tantalum carbide, a metal sulfide, and various magnetic powders. In addition, a compound having a cyanine skeleton, which has excellent light resistance and heat resistance, (cyanine dye) may be used. Note that here, the excellent light resistance means that it is not decomposed under the

environment of use by irradiation of light such as light from a fluorescent light. The excellent heat resistance means that, for example, the maximum absorption peak value of the absorption spectrum does not change by 20% or more when it is deposited with a polymer material and preserved at 150°C for 30 minutes, for example. Examples of such a compound having a cyanine skeleton include those having at least one 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 having a 5-membered ring or a 6-membered ring in the molecule. Note that in the first embodiment, although the compound having a cyanine skeleton used for the recording medium 10 favorably has both any of the above counter ions and a cyclic structure such as a 5-membered ring and a 6-membered ring in a methine chain, sufficient light resistance and heat resistance are ensured when the compound has at least one of them.

(Matrix resin)

[0051] The matrix resin favorably has a function as a binder. The matrix resin is favorably one in which the coloring compound, the color developer, the amine compound, the epoxy compound, the carbodiimide compound, and the photothermal conversion agent are easily and homogenously dispersed. The matrix resin includes, for example, at least one selected from the group consisting of a thermosetting resin and a thermoplastic resin. The matrix resin favorably includes a polycarbonate resin. Here, the polycarbonate resin is a resin having, as a structural unit, a carbonate group (-O-(C=O)-O-) at least in the main chain. Therefore, the main chain may have another structural unit in addition to the carbonate group.

[0052] The matrix resin may include, instead of or in addition to the polycarbonate resin, at least one selected from the group consisting of polyvinyl chloride, polyvinyl acetate, a vinyl chloride-vinyl acetate copolymer, ethylcellulose, polystyrene, a styrene copolymer, a phenoxy resin, a polyester, an aromatic polyester, polyurethane, polyacrylic acid ester, polymethacrylic acid ester, an acrylic acid copolymer, a maleic acid polymer, polyvinylalcohol, modified polyvinylalcohol, hydroxyethyl cellulose, carboxymethyl cellulose, and starch.

(Protective layer)

[0053] The protective layer 13 is for protecting the front surface of the recording layer 12. The protective layer 13 includes, for example, at least one cured product selected from the group consisting of a UV curable resin and a thermosetting resin. The protective layer 13 may include fine particles. The thickness of the protective layer 13 is, for example, 0.1 um or more and 20 um or less.

[1.2 Recording method of recording medium]

[0054] An example of a recording method of a recording medium according to the first embodiment will be described below.

[0055] For example, when laser light is applied to a predetermined position of the recording layer 12 by a semiconductor laser, the photothermal conversion agent contained in the laser light irradiated portion of the recording layer 12 absorbs light and generates heat. The color developer melts due to this heat generation, and a coloring reaction (color development reaction) occurs between the color developer and the coloring compound. Specifically, the bis(hydroxybenzoic acid) compound as a color developer melts, the hydroxybenzoic acid of the bis(hydroxybenzoic acid) compound reacts with a lactone ring of the coloring compound (e.g., leuco dye) , the lactone ring opens, and thus, the coloring compound develops color. As a result, the laser light irradiated portion develops color and a desired image is drawn on the recording layer 12. As the laser light, it is favorable to use near-infrared laser light.

[1.3 Method of producing recording medium]

[0056] An example of the method of producing the recording medium 10 according to the first embodiment will be described below. Here, an example of producing the recording medium 10 using an application method will be described.

[0057] First, the matrix resin is dissolved in a solvent (e.g., methyl ethyl ketone). Next, a coloring compound in a decolored state, a color developer, at least one compound selected from an epoxy compound and a carbodiimide compound, and a photothermal conversion agent are added to this solution and dispersed. As a result, a paint for forming a recording layer is obtained. Subsequently, this paint for forming a recording layer is applied onto the base material 11 and dried to form the recording layer 12. Next, the base material 11 and the recording layer 12 may be integrated by heat pressing as necessary. Next, a paint for forming a protective layer is applied onto the recording layer 12 and cured as necessary. The paint for forming a protective layer includes, for example, at least one selected from the group consisting of a UV curable resin and a thermosetting resin. In this way, the recording medium 10 shown in Fig. 1 is obtained.

[1.4 Operation and effect]

[0058] The recording medium 10 according to the first embodiment includes the recording layer 12 that includes a coloring compound with electron-donating properties, a color developer with electron acceptability, an amine compound, at least one compound selected from an epoxy compound and a carbodiimide compound, and a matrix resin.

[0059] Since the recording layer 12 includes an amine compound, the amine compound caps the acidic group (hydroxybenzoic acid) of the color developer (bis(hydroxybenzoic acid) compound). This makes it possible to prevent the acidic group of the color developer from reacting with the coloring compound (e.g., lactone ring of the leuco dye), and thus, it is possible to suppress coloration of a background. Therefore, it is possible to improve the color expression of the recording medium 10.

[0060] When the recording layer 12 includes an amine compound, there is a possibility that the reliability of the colored portion during high-temperature and high-humidity preservation decreases. However, when the recording layer 12 includes at least one compound selected from an epoxy compound and a carbodiimide compound as well as an amine compound, it is possible to suppress the decrease in reliability of the colored portion due to the amine compound during high-temperature and high-humidity preservation.

[0061] The color developer includes at least one compound represented by the above formula (1A) and formula (1B). Since the above compound is a compound having strong acidity, it is difficult to separate once it reacts with the coloring compound. Further, since the above compounds tend to solidify to some extent via a hydrogen bond, it is possible to improve the stability of the color developer in the recording layer 12. Therefore, it is possible to improve the preservation stability of the recording medium 10. Further, since the energy required to cause the color developer in the recording layer 12 to melt increases, the recording medium 10 is capable of withstanding high-temperature pressing (e.g., high-temperature pressing at 150°C). Here, "capable of withstanding high-temperature pressing" means that the color change (transmittance change) due to high-temperature pressing can be suppressed.

[0062] In the case where the matrix resin includes a polycarbonate resin, the polycarbonate resin is less likely to generate acid due to photolysis, and thus, it is possible to prevent the acid generated from the matrix resin from reacting with the coloring compound. Therefore, it is possible to suppress the color development of the background (unrecorded area) of the recording medium 10. Therefore, it is possible to improve the light resistance of the background of the recording medium 10.

[0063] Since the compounds represented by the above formula (1A) and formula (1B) have an alkyl chain and a benzene ring in addition to a hydrogen-bonding group in the molecule, they have high compatibility with a polycarbonate resin. For this reason, the compounds represented by the above formula (1A) and formula (1B) can easily be made into a particle size of 1 um or less during dispersion, and are difficult to visually recognize in a polycarbonate resin having transparency. Therefore, it is possible to improve the transparency of the recording layer 12.

<2 Second embodiment>

[0064] Although an example in which a recording medium includes one recording layer has been described in the above first embodiment, an example in which a recording medium includes three recording layers having different color development hue in the colored state will be described in a second embodiment.

[2.1 Configuration of recording medium]

[0065] An example of a configuration of a recording medium 10A according to the second embodiment will be described below with reference to Fig. 2. The recording medium 10A includes the base material 11, three recording layers 12A, 12B, and 12C, and two intermediate layers 14A and 14B. the three recording layers 12A, 12B, and 12C and the two intermediate layers 14A and 14B are stacked in the order of the recording layer 12A, the intermediate layer 14A, the recording layer 12B, the intermediate layer 14B, and the recording layer 12C. The recording medium 10A may further include the protective layer 13 on the recording layer 12C.

(Recording layer)

[0066] The recording layers 12A, 12B, and 12C in the unrecorded state (initial state) are in the decolored state. The state of each of the recording layers 12A, 12B, and 12C can be changed from the decolored state to the colored state by irradiation of laser light. The recording layers 12A, 12B, and 12C are capable of exhibiting different hues in the colored state. Specifically, the recording layer 12A is capable of exhibiting a magenta color in the colored state. The recording layer 12B is capable of exhibiting a cyan color in the colored state. The recording layer 12C is capable of exhibiting a yellow color in the colored state. The magenta color, the cyan color, and the yellow color are respectively examples of a first color, a second color, and a third color. The first color, the second color, and the third color may be colors other

than the magenta color, the cyan color, and the yellow color. The laser light capable of changing the state of the recording layer 12A to the colored state, the laser light capable of changing the state of the recording layer 12B to the colored state, and the laser light capable of changing the state of the recording layer 12C to the colored state have different peak wavelengths.

[0067] The thickness of each of the recording layers 12A, 12B, and 12C is favorably 1 um or more and 20 um or less, more favorably 2 um or more and 15 um or less. When the thickness of each of the recording layers 12A, 12B, and 12C is 1 um or more, it is possible to improve the color density. Meanwhile, the thickness of each of the recording layers 12A, 12B, and 12C is 20 um or less, it is possible to suppress the increase in heat utilization amount of the recording layers 12A, 12B, and 12C and suppress deterioration of the color development.

[0068] The recording layer 12A includes a first coloring compound having electron-donating properties, a first color developer having electron acceptability, a first amine compound, at least one compound selected from a first epoxy compound and a first carbodiimide compound, a first photothermal conversion agent, and a first matrix resin.

[0069] The recording layer 12B includes a second coloring compound having electron-donating properties, a second color developer having electron acceptability, a second amine compound, at least one compound selected from a second epoxy compound and a second carbodiimide compound, a second photothermal conversion agent, and a second matrix resin.

[0070] The recording layer 12C includes a third coloring compound having electron-donating properties, a third color developer having electron acceptability, a third amine compound, at least one compound selected from a third epoxy compound and a third carbodiimide compound, a third photothermal conversion agent, and a third matrix resin.

[0071] Each of the recording layers 12A, 12B, and 12C may include, in addition to the above materials, at least one additive selected from the group consisting of a sensitizer and an ultraviolet absorber, similarly to the above recording layer 12.

(First, second, and third coloring compounds)

[0072] The first, second, and third coloring compounds are capable of exhibiting different hues in the colored state. Specifically, the first coloring compound is capable of exhibiting a magenta color in the colored state. The second coloring compound is capable of exhibiting a cyan color in the colored state. The third coloring compound is capable of exhibiting a yellow color in the colored state. The magenta color, the cyan color, and the yellow color are respectively examples of the first color, the second color, and the third color. The first color, the second color, and the third color may be colors other than the magenta color, the cyan color, and the yellow color.

(First, second, and third color developers)

[0073] The first color developer is for causing the first coloring compound in the decolored state to develop color. The second color developer is for causing the second coloring compound in the decolored state to develop color. The third color developer is for causing the third coloring compound in the decolored state to develop color. Examples of the first, second, and third color developers include those similar to the color developer included in the recording layer 12 according to the first embodiment. The types of first, second, and third color developers may be the same, or the types of first, second, and third color developers may be different from each other.

(First, second, and third amine compounds)

[0074] The first, second, and third amine compounds are similar to the matrix resin included in the recording layer 12 according to the first embodiment. The types of first, second, and third amine compounds may be the same, or the types of first, second, and third amine compounds may be different from each other.

(First, second, and third epoxy compounds)

[0075] The first, second, and third epoxy compounds are similar to the epoxy compound included in the recording layer 12 according to the first embodiment. The types of first, second, and third epoxy compounds may be the same, or the types of first, second, and third epoxy compounds may be different from each other.

(First, second, and third carbodiimide compounds)

[0076] The first, second, and third carbodiimide compounds are similar to the carbodiimide compound included in the recording layer 12 according to the first embodiment. The types of first, second, and third carbodiimide compounds may be the same, or the types of first, second, and third carbodiimide compounds may be different from each other.

(First, second, and third photothermal conversion agents)

[0077] The first, second, and third photothermal conversion agents absorb light in a predetermined wavelength range such as a near-infrared region, and generate heat. The first, second, and third photothermal conversion agents have 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 different from each other. The absorption wavelength peak is favorably in a near-infrared region. The near-infrared region is, for example, a wavelength range of 700 nm or more and 2000 nm or less. Since the first, second, and third photothermal conversion agents have different absorption wavelength peaks as described above, it is possible to selectively causing a desired layer of the recording layers 12A, 12B, and 12C to develop color by irradiation of laser light. Examples of the first, second, and third photothermal conversion agents include those similar to the photothermal conversion agent included in the recording layer 12 according to the first embodiment.

(First, second, and third matrix resins)

[0078] The first, second, and third matrix resins are similar to the matrix resin included in the recording layer 12 according to the first embodiment. The types of first, second, and third matrix resins may be the same, or the types of first, second, and third matrix resins may be different from each other.

(Intermediate layer)

[0079] The intermediate layer 14A is provided between the recording layer 12A and the recording layer 12B. The intermediate layer 14A is a thermal insulation layer capable of providing heat insulation between the recording layer 12A and the recording layer 12B. The intermediate layer 14B is provided between the recording layer 12B and the recording layer 12C. The intermediate layer 14B is a thermal insulation layer capable of providing heat insulation between the recording layer 12B and the recording layer 12C.

[0080] The intermediate layers 14A and 14B are each formed of, for example, a general polymer material having transparency. Specific examples of the material include at least one selected from the group consisting of polyvinyl chloride, polyvinyl acetate, a vinyl chloride-vinyl acetate copolymer, ethylcellulose, polystyrene, a styrene copolymer, a phenoxy resin, a polyester, an aromatic polyester, polyurethane, polycarbonate, polyacrylic acid ester, polymethacrylic acid ester, an acrylic acid copolymer, a maleic acid polymer, polyvinylalcohol, modified polyvinylalcohol, hydroxyethyl cellulose, carboxymethyl cellulose, and starch. Note that the intermediate layers 14A and 14B may each include, for example, various additives such as an ultraviolet absorber.

[0081] Further, the intermediate layers 14A and 14B may each be formed of an inorganic material having transparency. For example, it is favorable to use porous silica, alumina, titania, carbon, or a composite thereof, because the thermal conductivity is low and the heat insulation effect is high. The intermediate layers 14A and 14B can be formed of, for example, a sol-gel method.

[0082] The thickness of each of the intermediate layers 14A and 14B is favorably 3 or more and 100 um or less, more favorably 5 um or more and 50 um or less. When the thickness of each of the intermediate layers 14A and 14B is too small, there is a possibility that a sufficient heat insulation effect cannot be achieved. Meanwhile, when the thickness of each of the intermediate layers 14A and 14B is too large, there is a possibility that the transparency decreases. Further, there is also a possibility that the bending resistance of the recording medium 10B decreases and defects such as cracking easily occur.

[2.2 Recording method of recording medium]

[0083] An example of a recording method of the recording medium 10A according to the second embodiment will be described.

[0084] The recording layer 12A develops a magenta color as follows. When a predetermined position of the recording layer 12A is irradiated with near-infrared laser light having the peak wavelength λ_1, the photothermal conversion agent contained in the laser light irradiated portion absorbs the near-infrared laser light and generates heat. The color developer melts due to this heat generation, a coloring reaction (color development reaction) occurs between the color developer and the coloring compound, and the laser light irradiated portion develops a magenta color.

[0085] The recording layer 12B develops a cyan color as follows. When a predetermined position of the recording layer 12B is irradiated with near-infrared laser light having the peak wavelength λ_2, the laser light irradiated portion develops a cyan color by a reaction similar to that of the above recording layer 12A.

[0086] The recording layer 12C develops a yellow color as follows. When a predetermined position of the recording

layer 12B is irradiated with near-infrared laser light having the peak wavelength λ_3, the laser light irradiated portion develops a yellow color by a reaction similar to that of the above recording layer 12A.

[0087] When the predetermined portions of the recording layers 12A, 12B, and 12C respectively develop a magenta color, a cyan color, and a yellow color as described above, a desired full-color image is drawn on the recording medium 10A.

[2.3 Operation and effect]

[0088] In the recording medium 10A according to the second embodiment, it is possible to achieve the operation and effect similar to those in the recording medium 10 according to the first embodiment.

[0089] Further, in the recording medium 10A according to the second embodiment, the recording layers 12A, 12B, and 12C are capable of respectively exhibiting a magenta color, a cyan color, and a yellow color in the colored state. Therefore, it is possible to draw a desired image in full color.

<3 Third embodiment>

[0090] Although an example in which a recording medium includes three recording layers and a full-color image can be drawn has been described in the above second embodiment, an example in which a recording medium includes a recording layer including three types of microcapsules and a full-color image can be drawn will be described in a third embodiment.

[3.1 Configuration of recording medium]

[0091] An example of a configuration of a recording medium 10B according to a third embodiment will be described below with reference to Fig. 3. The recording medium 10B includes the base material 11 and a recording layer 15 provided on the base material 11. The recording medium 10B may further include the protective layer 13 provided on the recording layer 15. Note that in the third embodiment, portions similar to those in the first embodiment will be denoted by the same reference symbols and description thereof will be omitted.

(Recording layer)

[0092] The recording layer 15 includes three types of microcapsules 15A, 15B, and 15C and a matrix resin. The coloring state of each of the microcapsules 15A, 15B, and 15C can be changed by irradiation of laser light. The microcapsules 15A, 15B, and 15C are capable of exhibiting different hues in the colored state. Specifically, the microcapsule 15A is capable of exhibiting a magenta color in the colored state. The microcapsule 15B is capable of exhibiting a cyan color in the colored state. The microcapsule 15C is capable of exhibiting a yellow color in the colored state. The magenta color, the cyan color, and the yellow color are respectively examples of the first color, the second color, and the third color. The first color, the second color, and the third color may be colors other than the magenta color, the cyan color, and the yellow color. The laser light capable of changing the state of the microcapsule 15A to the colored state, the laser light capable of changing the state of the microcapsule 15B to the colored state, and the laser light capable of changing the state of the microcapsule 15C to the colored state have different peak wavelengths.

[0093] The microcapsule 15A includes a first microcapsule wall, a first coloring compound having electron-donating properties, a first color developer having electron acceptability, a first amine compound, at least one compound selected from a first epoxy compound and a first carbodiimide compound, a first photothermal conversion agent, and a first matrix resin. The first microcapsule wall encapsulates the above various materials.

[0094] The microcapsule 15B includes a second microcapsule wall, a second coloring compound having electron-donating properties, a second color developer having electron acceptability, a second amine compound, at least one compound selected from a second epoxy compound and a second carbodiimide compound, a second photothermal conversion agent, and a second matrix resin. The second microcapsule wall encapsulates the above various materials.

[0095] The microcapsule 15C includes a third microcapsule wall, a third coloring compound having electron-donating properties, a third color developer having electron acceptability, a third amine compound, at least one compound selected from a third epoxy compound and a third carbodiimide compound, a third photothermal conversion agent, and a third matrix resin. The third microcapsule wall encapsulates the above various materials.

(Microcapsule wall)

[0096] The first, second, and third microcapsule walls are each formed of, for example, a polymer material having transparency. Specific examples of the microcapsule wall include at least one selected from the group consisting of

polyvinyl chloride, polyvinyl acetate, a vinyl chloride-vinyl acetate copolymer, ethylcellulose, polystyrene, a styrene copolymer, a phenoxy resin, a polyester, an aromatic polyester, polyurethane, polycarbonate, polyacrylic acid ester, polymethacrylic acid ester, an acrylic acid copolymer, a maleic acid polymer, polyvinylalcohol, modified polyvinylalcohol, hydroxyethyl cellulose, carboxymethyl cellulose, and starch. The materials of the first, second, and third microcapsule walls may be the same, or the materials of the first, second, and third microcapsule walls may be different from each other.

(First, second, and third dyes with electron-donating properties)

[0097] The first, second, and third dyes with electron-donating properties are similar to those in the second embodiment.

(First, second, and third color developers)

[0098] The first, second, and third color developers are similar to those in the second embodiment.

(First, second, and third amine compounds)

[0099] The first, second, and third amine compounds are similar to those in the second embodiment.

(First, second, and third epoxy compounds)

[0100] The first, second, and third epoxy compounds are similar to those in the second embodiment.

(First, second, and third carbodiimide compounds)

[0101] The first, second, and third carbodiimide compounds are similar to those in the second embodiment.

(First, second, and third photothermal conversion agents)

[0102] The first, second, and third photothermal conversion agents are similar to those in the second embodiment.

(First, second, and third matrix resins)

[0103] The first, second, and third matrix resins are similar to those in the second embodiment.

[3.2 Recording method of recording medium]

[0104] An example of the recording method of the recording medium 10B according to the third embodiment will be described below.

[0105] The recording layer 15 develops a magenta color as follows. A predetermined position of the recording layer 15 is irradiated with near-infrared laser light having the peak wavelength λ_1. The microcapsule 15A contained in the laser light irradiated portion develops a magenta color. As a result, the laser light irradiated portion develops a magenta color.

[0106] The recording layer 15 develops a cyan color as follows. A predetermined position of the recording layer 15 is irradiated with near-infrared laser light having the peak wavelength λ_2. The microcapsule 15B contained in the laser light irradiated portion develops a cyan color. As a result, the laser light irradiated portion develops a cyan color.

[0107] The recording layer 15 develops a yellow color as follows. A predetermined position of the recording layer 15 is irradiated with near-infrared laser light having the peak wavelength λ_3. The microcapsule 15C contained in the laser light irradiated portion develops a yellow color. As a result, the laser light irradiated portion develops a yellow color.

[0108] When the predetermined positions of the recording layer 15 develop a magenta color, a cyan color, and a yellow color as described above, a desired full-color image is drawn on the recording medium 10B.

[3.3 Operation and effect]

[0109] In the recording medium 10B according to the third embodiment, it is possible to achieve the operation and effect similar to those in the recording medium 10 according to the first embodiment.

[0110] Further, in the recording medium 10B according to the third embodiment, the recording layer 15 includes three types of microcapsules 15A, 15B, and 15C. The microcapsules 15A, 15B, and 15C are capable of respectively exhibiting a magenta color, a cyan color, and a yellow color in the colored state. Therefore, it is possible to draw a desired image

in full color.

<4 Modified examples>

(Modified example 1)

[0111] Although an example in which the intermediate layers 14A and 14B are each a thermal insulation layer has been described in the second embodiment, the intermediate layers 14A and 14B may each be a stacked body including a thermal insulation layer and a bonding layer provided on one surface of the thermal insulation layer, or a stacked body including a thermal insulation layer and bonding layers provided on both surfaces of the thermal insulation layer. The bonding layer is, for example, an adhesive layer or an adhesive layer.

(Modified example 2)

[0112] Although an example in which the recording medium 10A includes the three recording layers 12A, 12B, and 12C and the two intermediate layers 14A and 14B has been described in the second embodiment, the recording medium 10A may include a plurality of (other than three) recording layers 12 and a plurality of (other than two) intermediate layers 14. The plurality of recording layers 12 and the plurality of intermediate layers 14 may be stacked such that the recording layer 12 and the intermediate layer 14 are alternately located. The plurality of recording layers 12 may be capable of exhibiting different hues in the colored state. That is, the coloring compounds included in the plurality of recording layers 12 may be capable of exhibiting different hues in the colored state. The photothermal conversion agents included in the plurality of recording layers 12 may have different absorption wavelength peaks.

(Modified example 3)

[0113] Although an example in which the recording layer 15 includes three types of microcapsules 15A, 15B, and 15C has been described in the third embodiment, a plurality of (other than three) types of microcapsules may be included. The plurality of types of microcapsule may be capable of exhibiting different hues in the colored state. That is, the coloring compounds included in the plurality of types of microcapsules may be capable of exhibiting different hues in the colored state. The photothermal conversion agent included in the plurality of types of microcapsules may have different absorption wavelength peaks.

(Modified example 4)

[0114] Although an example in which the microcapsules 15A, 15B, and 15C respectively include a first matrix resin, a second matrix resin, and a third matrix resin has been described in the third embodiment, the microcapsules 15A, 15B, and 15C do not necessarily need to include a matrix resin.

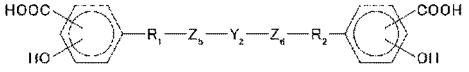
(Modified example 5)

[0115] An example in which the recording media 10, 10A, and 10B each include the base material 11 has been described in the first to third embodiments, the recording media 10, 10A, and 10B do not necessarily need to include the base material 11.

(Modified example 6)

[0116] Although an example in which the bis(hydroxybenzoic acid) color developer includes at least one compound represented by the above formula (1A) and formula (1B) has been described in the above first, second, and third embodiments, the bis(hydroxybenzoic acid) color developer may include at least one compound represented by the following formula (1C) and formula (1D). Alternatively, the bis(hydroxybenzoic acid) color developer may include at least one compound represented by the formula (1A), formula (1B), formula (1C), and formula (1D).

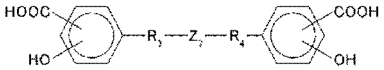
(Chem. 11)



...(1C)

(wherein, in the formula (1C), Z_5 and Z_6 independently represent a hydrogen-bonding bonding group. Y_2 represents a divalent group. R_1 and R_2 independently represent a divalent group.)

(Chem. 12)



...(1D)

(wherein, in the formula (1D), Z_7 represents a hydrogen-bonding bonding group. R_3 and R_4 independently represent a divalent group.)

[0117] Z_5 and Z_6 in the formula (1C) independently represent, for example, a urea bond (-NHCONH-), an amide bond (-NHCO-, -OCHN-), or a hydrazide bond (-NHCOCONH-). In the case where Z_5 represents an amide bond, nitrogen contained in the amide bond may be bonded to R_1 or carbon contained in the amide bond may be bonded to R_1. In the case where Z_6 represents an amide bond, nitrogen contained in the amide bond may be bonded to R_2 or carbon contained in the amide bond may be bonded to R_2.

[0118] Z_7 in the formula (1D) represents, for example, a urea bond (-NHCONH-), an amide bond (-NHCO-, -OCHN-), or a hydrazide bond (-NHCOCONH-).

[0119] Y_2 in the formula (1C) is similar to Y_1 in the formula (1A).

[0120] R_1 and R_2 in the formula (1C) only need to represent a divalent group and are particularly not limited. Examples thereof include a hydrocarbon group, which may have a substituent group. Some of the carbons of the hydrocarbon group (e.g., some of the carbons contained in the main chain of the hydrocarbon group) may be substituted with an element such as oxygen (O), sulfur (S), and nitrogen (N). The hydrocarbon group is a general term for a group including carbon (C) and hydrogen (H), and may be a saturated hydrocarbon group or an unsaturated hydrocarbon group. Here, the saturated hydrocarbon group is an aliphatic hydrocarbon group having no carbon-carbon multiple bond, and the unsaturated hydrocarbon group is an aliphatic hydrocarbon group having a carbon-carbon multiple bond (a carbon-carbon double bond or a carbon-carbon triple bond). Further, the hydrocarbon group may be a chain one or include one or two or more rings. The chain may be linear or branched having one or two or more side chains or the like. Examples of the saturated hydrocarbon group having one ring include a phenylene group.

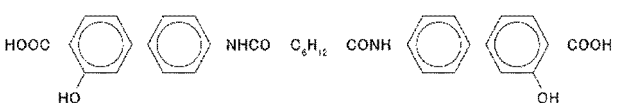
[0121] In the case where R_1 and R_2 have a hydrocarbon group, the number of carbons in the hydrocarbon group is, for example 1 or more and 15 or less, 1 or more and 13 or less, 1 or more and 12 or less, 1 or more and 10 or less, 1 or more and 6 or less, or 1 or more and 3 or less.

[0122] R_3 and R_4 in the formula (1D) only need to represent a divalent group and are not particularly limited. Examples thereof include a hydrocarbon group, which may have a substituent group. Some of the carbons of the hydrocarbon group (e.g., some of the carbons contained in the main chain of the hydrocarbon group) may be substituted with an element such as oxygen (O), sulfur (S), and nitrogen (N). The hydrocarbon group is a general term for a group including carbon (C) and hydrogen (H), and may be a saturated hydrocarbon group or an unsaturated hydrocarbon group. Here, the saturated hydrocarbon group is an aliphatic hydrocarbon group having no carbon-carbon multiple bond, and the unsaturated hydrocarbon group is an aliphatic hydrocarbon group having a carbon-carbon multiple bond (a carbon-carbon double bond or a carbon-carbon triple bond). Further, the hydrocarbon group may be a chain one or include one or two or more rings. The chain may be linear or branched having one or two or more side chains or the like.

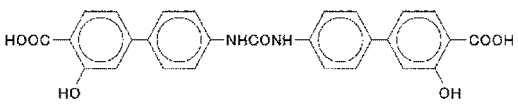
[0123] In the case where R_3 and R_4 have a hydrocarbon group, the number of carbons in the hydrocarbon group is, for example, 1 or more and 15 or less, 1 or more and 13 or less, 1 or more and 12 or less, 1 or more and 10 or less, 1 or more and 6 or less, or 1 or more and 3 or less.

[0124] More specifically, the bis(hydroxybenzoic acid) color developer may include at least one selected from the group consisting of compounds represented by the following formula (1-20) and formula (1-21).

(Chem. 13)



...(1-20)



...(1-21)

(Other modified examples)

[0125] Although embodiments and modified examples of the present disclosure have been specifically described, the present disclosure is not limited to the above embodiments and modified examples, and various modifications can be made on the basis of the technical idea of the present disclosure.

[0126] For example, the configurations, methods, processes, shapes, materials, numerical values, and the like mentioned in the above embodiments and modified examples are merely examples, and configurations, methods, processes, shapes, materials, numerical values, and the like different from these may be used as necessary.

[0127] The configurations, methods, processes, shapes, materials, numerical values, and the like in the above embodiments and modified examples can be combined with each other without departing from the essence of the present disclosure.

[0128] In numerical ranges described in a stepwise manner in the above embodiments and modified examples, the upper limit value or the lower limit value in a numerical range at one stage may be replaced with the upper limit value or the lower limit value in a numerical range at another stage.

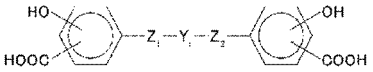
[0129] The materials exemplified in the above embodiments and modified examples can be used alone or two or more of them can be used in combination, unless otherwise specified.

[0130] Further, the present disclosure may also take the following configurations.

(1) A recording medium, including:

a recording layer that includes a coloring compound with electron-donating properties, a color developer with electron acceptability, an amine compound, at least one compound selected from an epoxy compound and a carbodiimide compound, and a polycarbonate resin,
the color developer including at least one compound represented by the following formulae (1A) and (1B) .

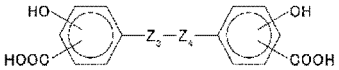
(Chem. 1)



···(1A)

(in which, in the formula (1A), Z_1 and Z_2 independently represent a hydrogen-bonding bonding group. Y_1 represents a divalent group.)

(Chem. 2)



···(1B)

(in which, in the formula (1B), Z_3 and Z_4 independently represents a hydrogen-bonding bonding group.)

(2) The recording medium according to (1), in which
the amine compound has a branched structure.
(3) The recording medium according to (1), in which
the amine compound is a comb-shaped molecule having an amino group.
(4) The recording medium according to any one of (1) to (3), in which
the amine compound is a hindered amine compound.
(5) The recording medium according to any one of (1) to (4), in which
the epoxy compound is an epoxy resin.
(6) The recording medium according to any one of (1) to (5), in which
the content of the amine compound in the recording layer is 3 parts by mass or more and 25 parts by mass or less with respect to 100 parts by mass of the color developer.
(7) The recording medium according to any one of (1) to (6), in which
the content of the at least one compound in the recording layer is 10 parts by mass or more and 150 parts by mass or less with respect to 100 parts by mass of the color developer.
(8) The recording medium according to any one of (1) to (7), in which

the recording layer includes a plurality of recording layers, and
the coloring compound included in each of the plurality of recording layers is capable of exhibiting a different hue in a colored state.

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

each of the plurality of recording layers includes a photothermal conversion agent, and
the photothermal conversion agent included in each of the plurality of recording layers has a different absorption wavelength peak.

(10) The recording medium according to any one of (1) to (7), in which

the recording layer includes a plurality of types of capsules,
the plurality of types of capsules includes the coloring compound, the color developer, the amine compound, the at least one compound, and the polycarbonate resin, and
the coloring compound included in each of the plurality of types of capsules is capable of exhibiting a different hue in a colored state.

(11) The recording medium according to (10), in which

each of the plurality of types of capsules includes a photothermal conversion agent, and
the photothermal conversion agent included in each of the plurality of types of capsules has a different absorption wavelength peak.

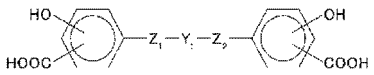
(12) The recording medium according to any one of (1) to (11), further including

a base material,
the recording layer being provided on the base material.

(13) A recording medium, including:

a recording layer that includes a coloring compound with electron-donating properties, a color developer with electron acceptability, an amine compound, at least one compound selected from an epoxy compound and a carbodiimide compound, and a matrix resin,
the color developer including at least one compound represented by the following formulae (1A) and (1B) .

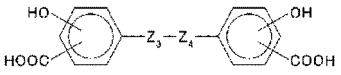
(Chem. 3)



···(1A)

(in which, in the formula (1A), Z_1 and Z_2 independently represent a hydrogen-bonding bonding group. Y_1 represents a divalent group.)

(Chem. 4)



···(1B)

(in which, in the formula (1B), Z_3 and Z_4 independently represents a hydrogen-bonding bonding group.)

(14) A card, including:
the recording medium according to any one of (1) to (13).
(15) A booklet, including:
the recording medium according to any one of (1) to (13).

<5 Application examples>

[0131] Next, an application example of the recording media 10, 10A, and 10B according to the above first, second, ad third embodiments and modified examples will be described. However, the configuration of an electronic apparatus and the like described below is merely an example, and the configuration can be appropriately changed. The above recording media 10, 10A, and 10B are applicable to various electronic apparatuses and some accessories, and the types of electronic apparatuses and accessories are not particularly limited. Specifically, for example, they are applicable to some of accessories such as a watch, a bag, clothes, a hat, glasses, and shoes as a wearable terminal. Further, they are applicable to not only electronic apparatuses and accessories but also, for example, an exterior member of an inner wall or outer wall of a building, and an exterior member of furniture such as a desk.

[0132] Although examples in which the recording medium 10 is applied to an identity card, a card, an electronic apparatus, and the like will be described in the following application examples 1 to 10, any of the recording media 10A and 10B can be applied to an identity card, a card, an electronic apparatus, and the like instead of the recording medium 10, and two or more of the recording media 10, 10A, and 10B can be combined and applied to an identity card, a card, an electronic apparatus, and the like. Further, in the following application examples 1 to 10, an example in which a predetermined image is drawn on the recording medium 10 and a recorded area and an unrecorded area are formed in the recording layer 12 will be described.

(Application example 1)

[0133] Part A of Fig. 4 shows the appearance of a card-type identity card. Part B of Fig. 4 is a cross-sectional view taken along the line IVB-IVB in Part A of Fig. 4. The card-type identity card is an example of a card or an identity card. The card-type identity card includes a base material 21, a bonding layer 22, a recording medium 23, a bonding layer 24, and an overlay layer 25 in this order. Although an example in which the recording medium 23 is provided on one surface of the base material 21 will be described here, the recording medium 23 may be provided on both surfaces of the base material 21.

[0134] The base material 21 is a support base material that supports the recording medium 23. The base material 21 is, for example, a plastic substrate. The recording medium 23 is the recording medium 10. The bonding layer 22 bonds the base material 21 and the recording medium 23 to each other. The bonding layer 24 bonds the recording medium 23 and the overlay layer 25 to each other. The overlay layer 25 protects the recording medium 23. The overlay layer 25 covers one surface of the recording medium 23.

[0135] Specific examples of the card-type identity card include a driver's license, a health insurance card, a basic resident register card, and a personal number card (my number card).

(Application example 2)

[0136] Fig. 5 shows the appearance of a booklet-type identity card. The booklet-type identity card is an example of a booklet. The booklet-type identity card includes a plurality of sheets 31. The plurality of sheets 31 is saddle stitched. The recording medium 10 is provided on at least one surface of the sheet 31. A character, a numerical value, a face photo, and the like are drawn on the recording medium 10. Specific examples of the booklet-type identity card include a passport.

(Application example 3)

[0137] Part A of Fig. 6 and Part B of Fig. 6 show the appearance of an integrated circuit (IC) card with a rewrite function. In this IC card, the front surface of the card is a print surface 110, and a sheet-shaped recording medium 10 is provided on the print surface 110. By providing the recording medium 10 on the print surface 110 of the IC card, it is possible to draw a desired image or the like on the print surface 110 as shown in Part A of Fig. 6 and Part B of Fig. 6.

(Application example 4)

[0138] Part A of Fig. 7 and Part B of Fig. 7 show the appearance of a credit card with an IC chip. The credit card with an IC chip is another example of the IC card. The credit card includes an IC chip 121 on a front surface (first surface) 120B, and a face photo 122 on a back surface (second surface) 120A. By providing the recording medium 10 on the front surface 120B and the back surface120A of the credit card, it is possible to draw on the front surface 120B and the back surface 120A of the credit card as shown in Part A of Fig. 7 and Part B of Fig. 7.

(Application example 5)

[0139] Part A of Fig. 8 shows an external configuration of a front surface of a smartphone. Part B of Fig. 8 shows an external configuration of a back surface of the smartphone shown in Part A of Fig. 8. This smartphone includes, for example, a display portion 210, a non-display portion 220, and a casing 230. For example, the recording medium 10 is provided as an exterior member of the casing 230 on, for example, one surface of the casing 230 on the back surface side. This makes it possible to display various color patterns as shown in Part B of Fig. 8. Note that although a smartphone has been taken as an example here, the present disclosure is not limited thereto and is applicable to, for example, a notebook personal computer (PC), a tablet PC, and the like.

(Application example 6)

[0140] Part A of Fig. 9 and Part B of Fig. 9 show the appearance of a bag. This bag includes, for example, a compartment 310 and a handle 320, and the recording medium 10 is provided in the compartment 310. As a result, it is possible to display various characters, designs, and the like on the compartment 310. Further, by attaching the recording medium 10 to the portion of the handle 320, it is possible to display various color patterns. As shown in the example of Part A of Fig. 9 and Part B of Fig. 9, the design of the compartment 310 can be changed. It is possible to realize an electronic device that is useful also in fashion applications.

(Application example 7)

[0141] Part A of Fig. 10 shows the appearance of a top surface of an automobile, and Part B of Fig. 10 shows the appearance of a side surface of the automobile. By providing the recording medium 10 on, for example, a vehicle body such as a bonnet 411, a bumper 412, a roof 413, a trunk cover 414, a front door 415, a rear door 416, and a rear bumper 417, it is possible to display various types of information and color patterns on the respective portions. Further, by providing the recording medium 10 in the interior of an automobile, such as a steering wheel and a dashboard, it is possible to display various color patterns.

(Application example 8)

[0142] Fig. 11 shows the appearance of a cosmetic container. This cosmetic container includes a housing portion 510 and a lid 520 that covers the housing portion 510, and the recording medium 10 is provided on the lid 520. This recording medium 10 decorates the lid 520 with, for example, a design shown in Fig. 11, a color pattern, or a character. The design of this lid 520, color pattern, character, and the like can be written by a predetermined drawing device. Note that the recording medium 10 can be attached to not only the front surface (lid 520) of the cosmetic container but also the back surface (housing portion 510) or the like.

(Application example 9)

[0143] Fig. 12 shows the appearance of a nail tip. The nail tip is an example of an exterior member. The nail tip includes the recording medium 10 on the front surface. When the nail tip includes the recording medium 10 on the front surface in this way, it is possible to display various color patterns. Note that although a configuration in which a nail tip includes the recording medium 10 on the front surface has been described in the above example, the configuration of the nail tip is not limited thereto and the recording medium 10 itself may be a nail tip. In this case, the base material 11 has a nail shape.

(Application example 10)

[0144] Part A of Fig. 13 shows the appearance of a nail sticker. Part B of Fig. 13 shows the cross section taken along the line XIIIB to XIIIB in Part A of Fig. 13. The nail sticker is an example of an exterior member. The nail sticker includes a recording medium with an adhesive layer 610 and a release sheet 620. The recording medium with an adhesive layer 610 includes the recording medium 10 and an adhesive layer 611. When the recording medium with an adhesive layer 610 includes the recording medium 10 in this way, it is possible to display various color patterns. The adhesive layer 611 is provided on the surface of the recording medium 10 on the side of the base material 11. The recording medium 10 may further include the protective layer 13 on the recording layer 12.

[0145] The recording medium 10 and the like include a plurality of nail sticker portions 612 to be attached to the nails of fingers of both hands. The nail sticker portion 612 is held in a cut or half-cut state relative to the nail sticker and is configured to be peelable on the interface between the adhesive layer 611 and the release sheet 620.

[0146] Although examples in which the present disclosure is applied to a nail tip and a nail sticker have been described

in the application examples 9 and 10, the application example of the present disclosure to nails is not limited thereto. For example, the recording layer 12 may be directly formed on a bare nail (human nail) as a support base material. The recording layer 12 may be formed by applying a paint to the bare nail and curing it, or the recording layer 12 having self-supporting properties may be separately formed and attached to the bare nail.

<6 Examples>

[0147] Although the present disclosure will be specifically described by way of Examples, the present disclosure is not limited to these Examples.

[0148] The content of each of the amine compound, the epoxy compound, and the carbodiimide compound in the recording layer of the completed recording media according to the following embodiments and Comparative Examples is a value obtained by the measurement method described in the first embodiment.

<Study on recording layer including amine compound and epoxy compound or carbodiimide compound>

[Examples 1 to 7]

(Process of preparing paint for forming recording layer)

[0149] First, polycarbonate (PC) was dissolved in methyl ethyl ketone (MEK), a color developer was added thereto, and the solution was dispersed using a rocking mill to obtain a solution. A compound represented by the above formula (1A) was used as the color developer. Next, a leuco dye was added to the solution, and the solution was prepared such that the final ratio (mass ratio) of leuco dye: color developer: polycarbonate = 1:2:4 was obtained. Further, a photothermal conversion agent having a phthalocyanine skeleton was added to the solution. Note that the mixing amount of the photothermal conversion agent was such that the absorbance at the time of coating was 0.2. Further, an amine compound and an epoxy compound were added to the solution to prepare a paint for forming a recording layer.

[0150] The mixing amount of the amine compound was adjusted such that the content of the amine compound in the recording layer of the completed recording medium was 10 parts by mass with respect to 100 parts by mass of the color developer. Further, the content of the epoxy compound was adjusted such that the content of the epoxy compound in the recording layer of the completed recording medium was 100 parts by mass with respect to 100 parts by mass of the color developer.

[0151] As the leuco dye, the amine compound, and the epoxy compound, the following materials were used as shown in Table 1.

(Leuco dye)

[0152] A leuco dye capable of exhibiting a magenta color

(Amine compound)

[0153] An amine compound having a comb-shaped molecular structure: SOLSPERSE 24000GR (Example 1), SOLSPERSE 35000 (Example2), SOLSPERSE 71000 (Example3), SOLSPERSE 72700 (Example4), SOLSPERSE 76700 (Example5), SOLSPERSE M387 (Example6), and SOLSPERSE X300 (Examples 7, 16, and 18) (each of which is manufactured by The Lubrizol Corporation)

(Epoxy compound)

[0154] An epoxy resin: EHPE3150 (1,2-epoxy-4-(2-oxiranyl)cyclohexane adduct of 2,2-bis(hydroxymethyl)-1-butanol) (manufactured by Daicel Corporation, epoxy equivalent of 170 to 190 g/mol)

(Process of forming recording layer)

[0155] Next, a paint for forming a recording layer was coated on a PET film (support base material) having a thickness of 50 um to a thickness of 5 um using a wire bar, and dried at 110°C for 5 minutes to obtain a recording layer. Next, the recording layer was irradiated with laser light to form a colored portion and an uncolored portion (background). The output of the laser light was set such that OD (Optical Density) at the time of color development was 1.1. In this way, a target recording medium was obtained.

[Examples 8 to 12]

[0156] A recording medium was obtained in a way similar to that in Example 1 except that the following amine compound was used as an amine compound.

(Amine compound)

[0157] DISPERBYK-145 (Example 8), DISPERBYK-161 (Example 9), DISPERBYK-166 (Example 10), DISPERBYK-2155 (Example 11), and BYK-9076 (Example 12) (each of which is manufactured by BYK Japan KK)

[Example 13]

[0158] A recording medium was obtained in a way similar to that in Example 1 except that the following amine compound was used as an amine compound.

(Amine compound)

[0159] An amine compound having a comb-shaped molecular structure: Hinoact T9100 (manufactured by Kawaken Fine Chemicals Co.,Ltd.)

[Example 14]

[0160] A recording medium was obtained in a way similar to that in Example 1 except that the following amine compound was used as an amine compound.

(Amine compound)

[0161] Hindered amine compound: Hostavin N 30 (manufactured by Clariant)

[Example 15]

[0162] A recording medium was obtained in a way similar to that in Example 7 except that the following carbodiimide compound was used instead of an epoxy compound. Note that the mixing amount of the carbodiimide compound was adjusted such that the content of the carbodiimide compound in the recording layer of the completed recording medium was 100 parts by mass with respect to 100 parts by mass of the color developer.

(Carbodiimide compound)

[0163] A carbodiimide oligomer (manufactured by Nisshinbo Chemical Inc., CARBODILITE V-09GB, carbodiimide equivalent of 200 g/mol)

[Example 16]

[0164] A recording medium was obtained in a way similar to that in Example 7 except that the following leuco dye was used as a leuco dye.

(Leuco dye)

[0165] A leuco dye capable of exhibiting a cyan color

[Example 17]

[0166] A recording medium was obtained in a way similar to that in Example 16 except that the following carbodiimide compound was used instead of the epoxy compound.

(Carbodiimide compound)

[0167] A carbodiimide oligomer (manufactured by Nisshinbo Chemical Inc., CARBODILITE V-09GB, carbodiimide

equivalent of 200 g/mol)

[Example 18]

[0168] A recording medium was obtained in a way similar to that in Example 7 except that the following leuco dye was used as a leuco dye.

(Leuco dye)

[0169] A leuco dye capable of exhibiting a yellow color

[Example 19]

[0170] A recording medium was obtained in a way similar to that in Example 18 except that the following carbodiimide compound was used instead of the epoxy compound.

(Carbodiimide compound)

[0171] A carbodiimide oligomer (manufactured by Nisshinbo Chemical Inc., CARBODILITE V-09GB, carbodiimide equivalent of 200 g/mol)

[Comparative Example 1]

[0172] A recording medium was obtained in a way similar to that in Example 7 except that a paint for forming a recording layer was prepared without adding an epoxy compound in a process of preparing the paint for forming a recording layer.

[Comparative Example 2]

[0173] A recording medium was obtained in a way similar to that in Example 7 except that a paint for forming a recording layer was prepared without adding an amine compound in a process of preparing the paint for forming a recording layer.

[Comparative Example 3]

[0174] A recording medium was obtained in a way similar to that in Example 7 except that a paint for forming a recording layer was prepared without adding an amine compound and an epoxy compound in a process of preparing the paint for forming a recording layer.

[Comparative Example 4]

[0175] A recording medium was obtained in a way similar to that in Example 16 except that a paint for forming a recording layer was prepared without adding an amine compound and an epoxy compound in a process of preparing the paint for forming a recording layer.

[Comparative Example 5]

[0176] A recording medium was obtained in a way similar to that in Example 18 except that a paint for forming a recording layer was prepared without adding an amine compound and an epoxy compound in a process of preparing the paint for forming a recording layer.

[Evaluation of uncolored portion]

[0177] The OD of the uncolored portion of each of the recording media obtained as described above was measured. Samples in which the OD of the uncolored portion was 0.25 or less were evaluated as "Good", and samples in which the OD change rate before and after a preservation test exceeded 0.25% were evaluated as "Poor". It is said that when the OD exceeds 0.25, the color development of the coloring dye becomes recognizable to anyone. In this regard, 0.25 was used as the reference value for determining good/poor. The evaluation results of the uncolored portion are shown in Table 1.

[Evaluation of preservation stability]

[0178] First, the OD of the colored portion of each of the recording media obtained as described above was measured. Next, a preservation test was conducted by preserving the recording medium under high-temperature ¬and high-humidity conditions of 80°C and 60% RH for 24 hours. The condition of the temperature of 80°C in the preservation test is the highest temperature in the preservation test for all parts. If a good result is obtained in the preservation test at this temperature, the recording medium is presumably capable of withstanding preservation under various environments. Next, regarding the colored portion, the OD change rate before and after the preservation test was obtained using the following formula.

(OD change rate before and after the preservation test) [%] = 100 - (((OD after the preservation test) / (OD before the preservation test)) $\times$ 100)

[0179] Samples in which the OD change rate before and after the preservation test was 20% or less were evaluated as "Good", and samples in which the OD change rate before and after the preservation test exceeded 20% were evaluated as "Poor". It is said that when the OD change rate before and after the preservation test exceeds 20%, the change from the original color is noticeable to anyone. In this regard, the OD change rate of 20% was used as the reference value for determining good/poor. The evaluation results of preservation stability are shown in Table 1.

[Table 1]

	Coloring compound (leuco dye)	Amine compound (Amine value [mg KOH/gJ)	Epoxy compound	Carbodiimide compound	Evaluation of non-color-production portion		Storage stability of color production portion	
					OD value	Determination	OD change rate[%]	Determination
Example 1	Magenta color	**SOLSPERSE 240006R (42)**	EHPE3150	None	**0.24**	Good	**12**	Good
Example 2		**SOLSPERSE 35000 (32)**			**0.23**	Good	**13**	Good
Example 3		**SOLSPERSE 71000 (77)**			**0.19**	Good	**14**	Good
Example 4		**SOLSPERSE 72700 (8)**			**0.21**	Good	**9**	Good
Example 5		**SOLSPERSE 76700 (12)**			**0.18**	Good	**11**	Good
Example 6		**SOLSPERSE M387 (86)**			**0.19**	Good	**10**	Good
Example 7		**SOLSPERSE X300 (31)**			**0.21**	Good	**11**	Good
Example 8		**DISPERBYK-145 (71)**			**0.16**	Good	**12**	Good
Example 9		**DISPERBYK-161 (11)**			**0.20**	Good	**12**	Good
Example 10		**DISPERBYK-166 (20)**			**0.19**	Good	**10**	Good
Example 11		**DISPERBYK-2155 (48)**			**0.16**	Good	**13**	Good
Example 12		**BYK-9076 (44)**			**0.16**	Good	**12**	Good
Example 13		Hinoact **T9100 (160~200)**			**0.19**	Good	**7**	Good
Example 14		Hostavln N 30			0.24	Good	0	Good
Example 15		**SOLSPERSE X300 (31)**	None	Carbodilite V-09GB	**0.16**	Good	**is**	Good
Example 16	Cyan color	**SOLSPERSE X300 (31)**	EHPE3150	None	**0.18**	Good	**14**	Good
Example 17		**SOLSPERSE X300 (31)**	None	Carbodilite V-09GB	**0.18**	Good	**19**	Good
Example 18	Yellow color	**SOLSPERSE X300 (31)**	EHPE3150	None	**0.21**	Good	**0**	Good
Example 19		**SOLSPERSE X300 (31)**	None	Carbodilite V-09GB	**0.21**	Good	**1**	Good

(continued)

	Coloring compound (leuco dye)	Amine compound (Amine value [mg KOH/gJ)	Epoxy compound	Carbodiimide compound	Evaluation of non-color-production portion		Storage stability of color production portion	
					OD value	Determination	OD change rate[%]	Determination
Comparative Example 1	Magenta color	**SOLSPERSE X300 (31)**	None	None	**0.16**	Good	50 or more	Poor
Comparative Example 2		None	EHPE3150	None	**0.32**	Poor	**0**	Good
Comparative Example 3		None	None	None	**0.34**	Poor	**0**	Good
Comparative Example 4	Cyan color	None	None	None	**0.35**	Poor	**3**	Good
Comparative Example 5	Yellow color	None	None	None	**0.30**	Poor	**0**	Good

[0180] The following can be seen from Table 1.

[0181] When the recording layer includes an amine compound and an epoxy compound or a carbodiimide compound, it is possible to suppress coloration of a background and suppress the decrease in reliability of the colored portion during high-temperature and high-humidity preservation (see Examples 1 to 19).

[0182] In the case where the recording layer includes an amine compound but does not include an epoxy compound or a carbodiimide compound, coloration of a background can be suppressed, but the reliability of the colored portion during high-temperature and high-humidity preservation decreases (see Comparative Example 1).

[0183] In the case where the recording layer does not include an amine compound but includes an epoxy compound, the reliability of the colored portion during high-temperature and high-humidity preservation does not decrease, but the background is colored (see Comparative Example 2).

[0184] In the case where the recording layer does not include an amine compound and an epoxy compound or a carbodiimide compound, the reliability of the colored portion during high-temperature and high-humidity preservation does not decrease or does not substantially decrease, but the background is colored (see Comparative Examples 3 to 5).

<Study on content of amine compound in recording layer>

[Examples 20 to 22]

[0185] As shown in Table 2, a recording medium was obtained in a way similar to that in Example 7 except that the mixing amount of the amine compound was adjusted such that the content of the amine compound in the recording layer of the completed recording medium 5 parts by mass, 20 parts by mass, or 30 parts by mass with respect to 100 parts by mass of the color developer.

[Evaluation of uncolored portion]

[0186] Regarding the recording medium obtained as described above, the uncolored portion was evaluated in a way similar to that of the above evaluation of the uncolored portion. The results are shown in Table 2.

[Evaluation of preservation stability]

[0187] Regarding the recording medium obtained as described above, the preservation stability was evaluated in a way similar that of the above evaluation of the preservation stability. The results are shown in Table 2.

[Table 2]

	Coloring compound (leuco dye)	Amine compound		Epoxy compound	Evaluation of non-color-production portion		Storage stability of color production portion	
		Material	Content [parts by mass)		OD value	Determination	OD change rate[%]	Determination
Example 20	Magenta color	**SOLSPERSE** X300	5	EHPE3150	0.22	Good	4	Good
Example 7			10		0.21	Good	11	Good
Example 21			20		0.20	Good	18	Good
Example 22			30		0.20	Good	is	Poor
Comparative Example 2	Magenta color	SOLSPERSE X300	0	EHPE3150	0.32	Poor	0	Good

[0188] The following can be seen from Table 2.

[0189] The higher the content of the amine compound in the recording layer, the more the coloration of the background tends to be suppressed. Meanwhile, as the content of the amine compound in the recording layer increases, the reliability of the colored portion during high-temperature and high-humidity preservation tends to decrease.

[0190] From the viewpoint of suppressing coloration of the background and suppressing the decrease in reliability of the colored portion during high-temperature and high-humidity preservation, the content of the amine compound in the recording layer is favorably 3 parts by mass or more and 25 parts by mass or less with respect to 100 parts by mass of the color developer, more favorably 5 parts by mass or more and 20 parts by mass or less with respect to 100 parts by mass of the color developer, and still more favorably 8 parts by mass or more and 15 parts by mass or less with respect to 100 parts by mass of the color developer.

<Study on content of epoxy compound in recording layer>

[Examples 23 and 24]

[0191] As shown in Table 3, a recording medium was obtained in a way similar to that in Example 7 except that the mixing amount of the epoxy compound was adjusted such that the content of the epoxy compound in the recording layer of the completed recording medium was 50 parts by mass or 150 parts by mass with respect to 100 parts by mass of the color developer.

[Evaluation of uncolored portion]

[0192] Regarding the recording medium obtained as described above, the uncolored portion was evaluated in a way similar to that of the above evaluation of the uncolored portion. The results are shown in Table 3.

[Evaluation of preservation stability]

[0193] Regarding the recording medium obtained as described above, the preservation stability was evaluated in a way similar that of the above evaluation of the preservation stability. The results are shown in Table 3.

[Table 3]

	Coloring compound (leuco dye)	Amine compound	Epoxy compound		Evaluation of non-color-production portion		Storage stability of color production portion	
			Material	Content [parts by mass]	OD value	Determination	OD change rate[%]	Determination
Example 23	Magenta color	SOLSPERSE X300	EHPE3150	50	0.21	Good	11	Good
Example 7				100	0.21	Good	11	Good
Example 24				150	0.21	Good	12	Good

(continued)

	Coloring compound (leuco dye)	Amine compound	Epoxy compound		Evaluation of non-color-production portion		Storage stability of color production portion	
			Material	Content [parts by mass]	OD value	Determination	OD change rate[%]	Determination
Comparative Example 1	Magenta color	SOLSPERSE X300	EHPE3150	0	0.16	Good	50 or more	Poor

[0194] The following can be seen from Table 3.

[0195] When the recording layer includes an epoxy compound, it is possible to suppress the decrease in reliability of the colored portion during high-temperature and high-humidity preservation.

[0196] From the viewpoint of suppressing the decrease in reliability of the colored portion during high-temperature and high-humidity preservation, the content of the epoxy compound in the recording layer is favorably 10 parts by mass or more with respect to 100 parts by mass of the color developer, more favorably 50 parts by mass or more with respect to 100 parts by mass of the color developer.

Reference Signs List

[0197]

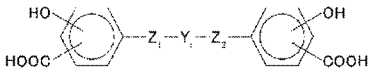
10, 10A, 10B recording medium
11, 21 base material
12, 12A, 12B, 12C, 15 recording layer
13 protective layer
14A, 14B thermal insulation layer
15A, 15B, 15C microcapsule
22, 24 bonding layer
25 overlay layer
31 sheet
110 print surface
120A back surface
120B front surface
121 IC chip
122 face photo
210 display portion
220 non-display portion
230 casing
310 compartment
320 handle
411 bonnet
412 bumper
413 roof
414 trunk cover
415 front door
416 rear door
417 rear bumper
510 housing unit
520 lid
610 recording medium with adhesive layer
620 release sheet
611 adhesive layer
612 nail sticker portion

Claims

1. A recording medium, comprising:

a recording layer that includes a coloring compound with electron-donating properties, a color developer with electron acceptability, an amine compound, at least one compound selected from an epoxy compound and a carbodiimide compound, and a polycarbonate resin,
the color developer including at least one compound represented by the following formulae (1A) and (1B) .

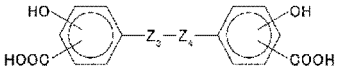
(Chem. 1)



···(1A)

(wherein, in the formula (1A), Z_1 and Z_2 independently represent a hydrogen-bonding bonding group. Y_1 represents a divalent group.)

(Chem. 2)



···(1B)

(wherein, in the formula (1B), Z_3 and Z_4 independently represents a hydrogen-bonding bonding group.)

2. The recording medium according to claim 1, wherein
the amine compound has a branched structure.

3. The recording medium according to claim 1, wherein
the amine compound is a comb-shaped molecule having an amino group.

4. The recording medium according to claim 1, wherein
the amine compound is a hindered amine compound.

5. The recording medium according to claim 1, wherein
the epoxy compound is an epoxy resin.

6. The recording medium according to claim 1, wherein
the content of the amine compound in the recording layer is 3 parts by mass or more and 25 parts by mass or less with respect to 100 parts by mass of the color developer.

7. The recording medium according to claim 1, wherein
the content of the at least one compound in the recording layer is 10 parts by mass or more and 150 parts by mass or less with respect to 100 parts by mass of the color developer.

8. The recording medium according to claim 1, wherein

the recording layer includes a plurality of recording layers, and
the coloring compound included in each of the plurality of recording layers is capable of exhibiting a different hue in a colored state.

9. The recording medium according to claim 8, wherein

each of the plurality of recording layers includes a photothermal conversion agent, and
the photothermal conversion agent included in each of the plurality of recording layers has a different absorption wavelength peak.

10. The recording medium according to claim 1, wherein

the recording layer includes a plurality of types of capsules,
the plurality of types of capsules includes the coloring compound, the color developer, the amine compound, the at least one compound, and the polycarbonate resin, and
the coloring compound included in each of the plurality of types of capsules is capable of exhibiting a different hue in a colored state.

11. The recording medium according to claim 10, wherein

each of the plurality of types of capsules includes a photothermal conversion agent, and
the photothermal conversion agent included in each of the plurality of types of capsules has a different absorption wavelength peak.

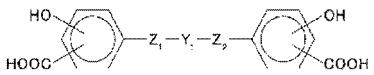
12. The recording medium according to claim 1, further comprising

a base material,
the recording layer being provided on the base material.

13. A recording medium, comprising:

a recording layer that includes a coloring compound with electron-donating properties, a color developer with electron acceptability, an amine compound, at least one compound selected from an epoxy compound and a carbodiimide compound, and a matrix resin,
the color developer including at least one compound represented by the following formulae (1A) and (1B) .

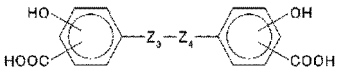
(Chem. 3)



···(1A)

(wherein, in the formula (1A), Z_1 and Z_2 independently represent a hydrogen-bonding bonding group. Y_1 represents a divalent group.)

(Chem. 4)



···(1B)

(wherein, in the formula (1B), Z_3 and Z_4 independently represents a hydrogen-bonding bonding group.)

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

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

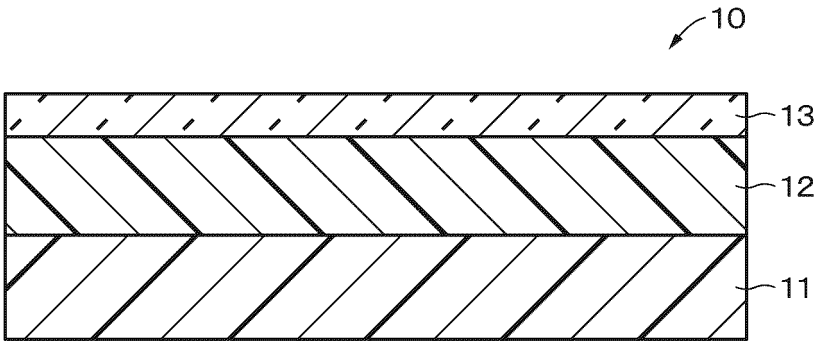


FIG.1

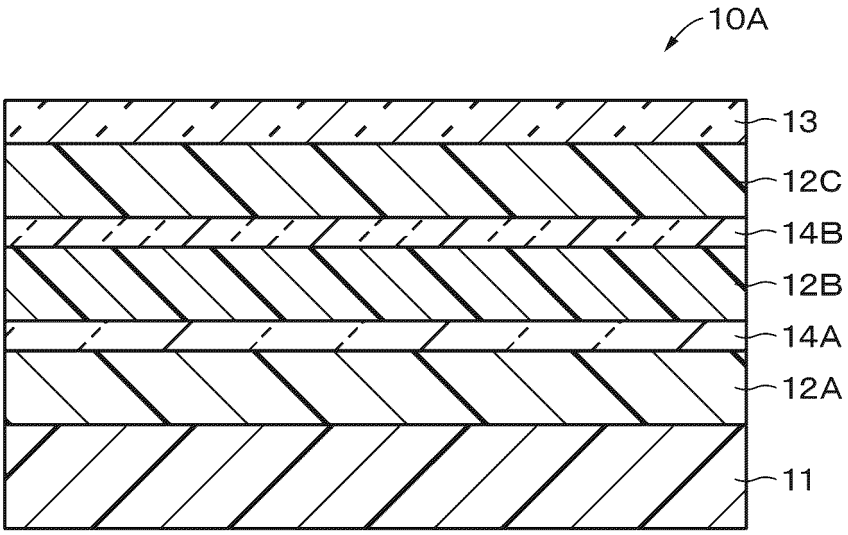


FIG.2

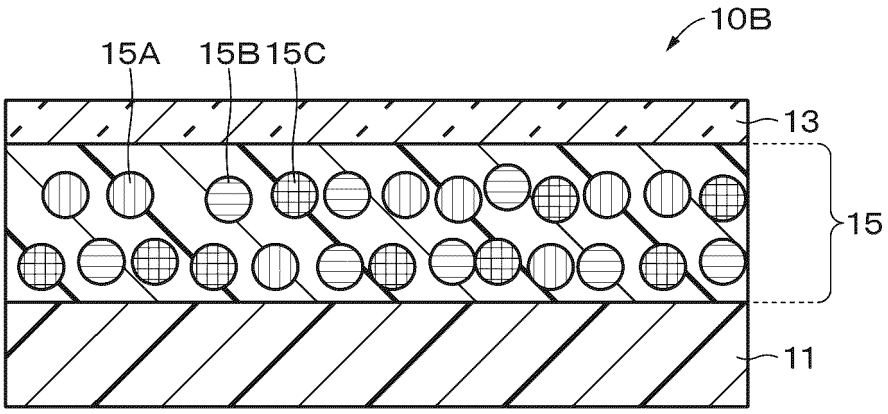
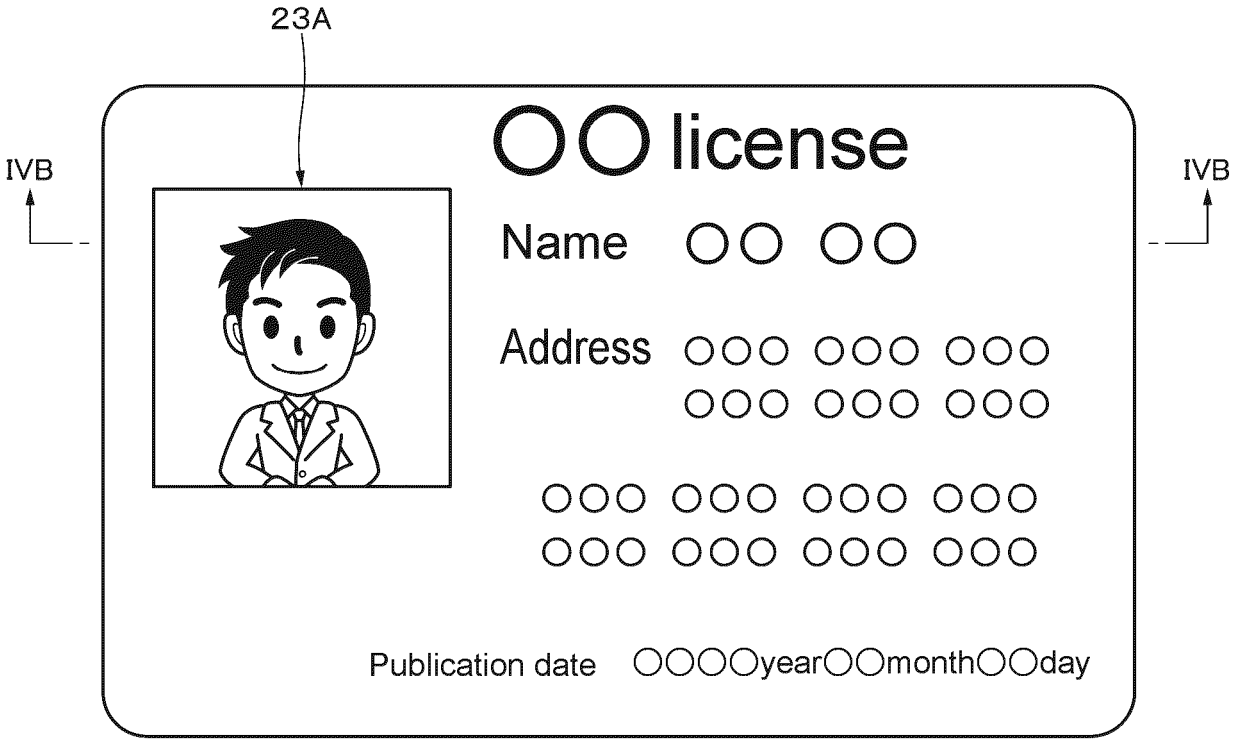


FIG.3

A


23A
IVB
IVB
○○ license
Name ○○ ○○
Address ○○○ ○○○ ○○○
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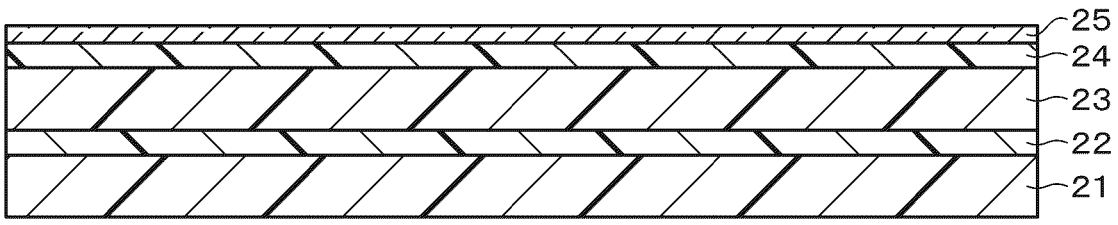
○○○ ○○○ ○○○ ○○○
○○○ ○○○ ○○○ ○○○
Publication date ○○○○year○○month○○day

B


25
24
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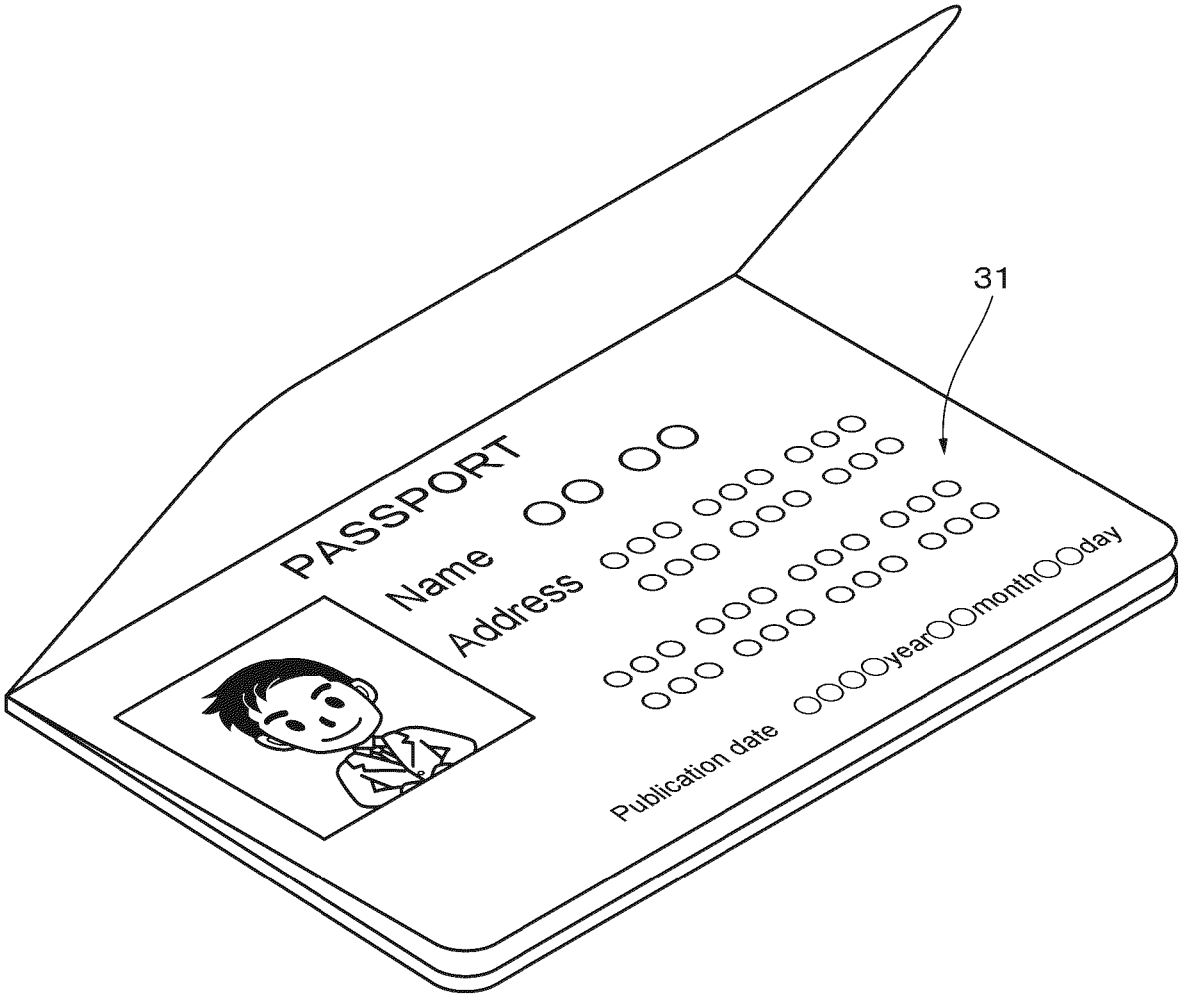
22
21

FIG.4


31
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Name OO OO
Address OOO OOO OOO
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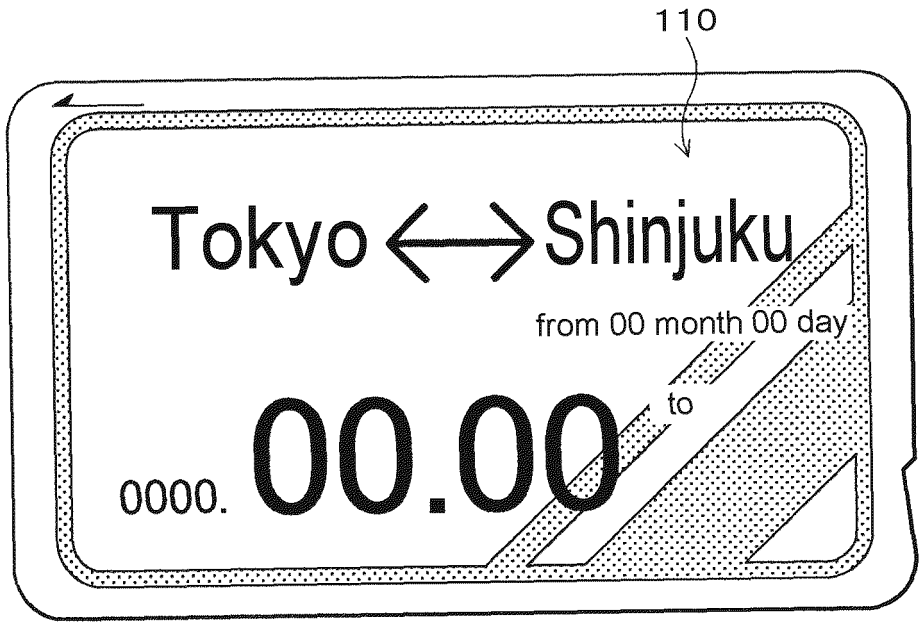
OOO OOO OOO OOO
Publication date OOOOyearOOmonthOOday

FIG.5

A



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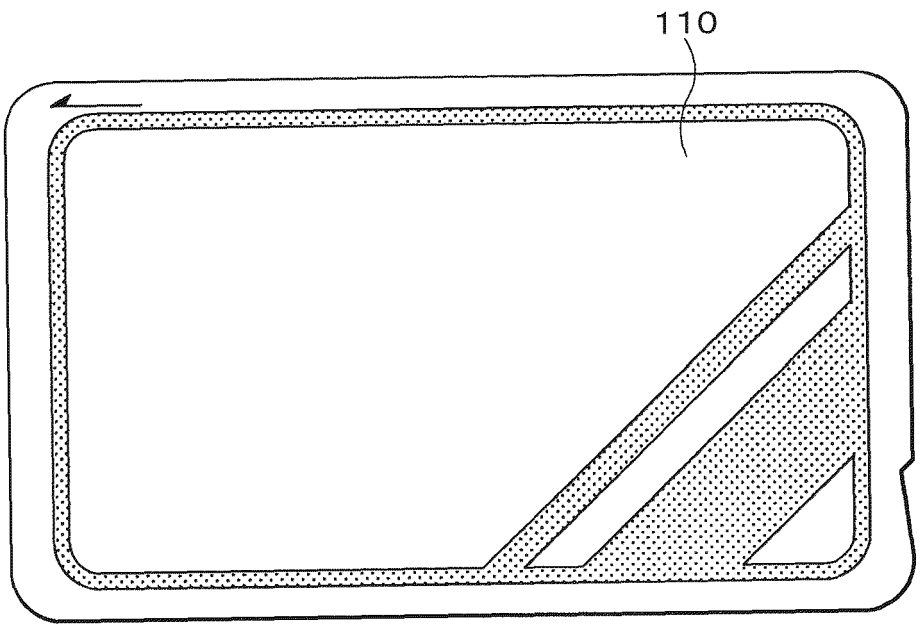
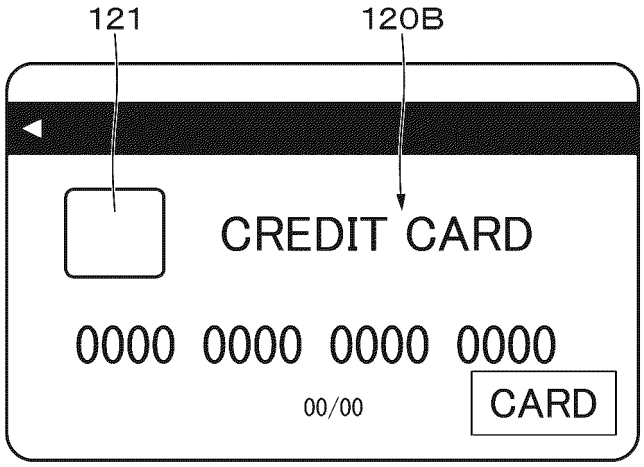


FIG.6

A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120B
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00/00
CARD

B

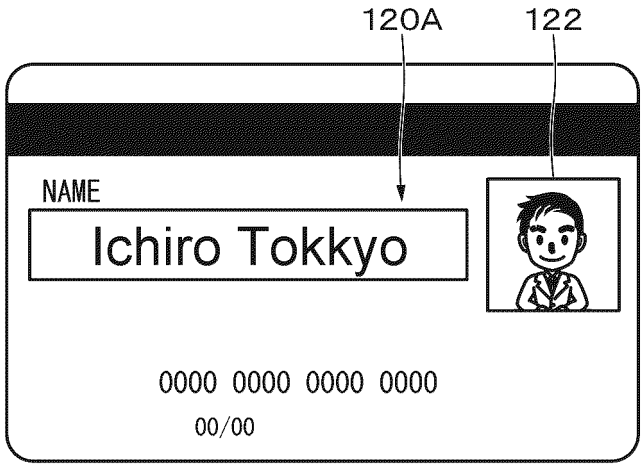
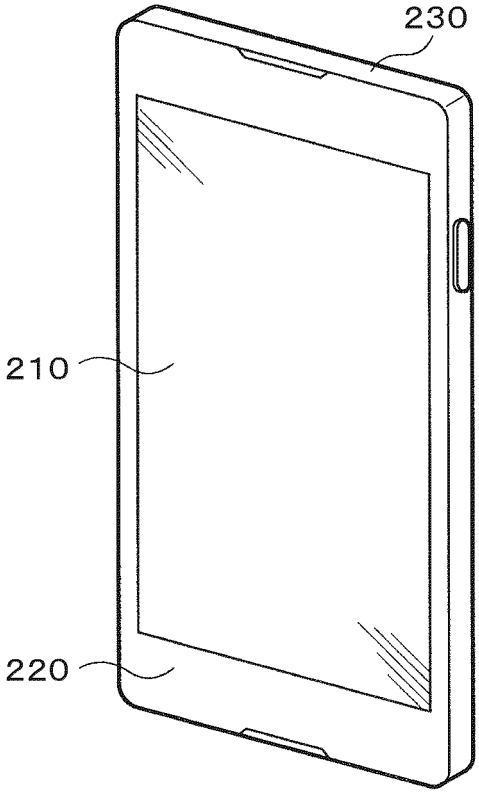

120A
122
NAME
Ichiro Tokkyo
0000 0000 0000 0000
00/00

FIG.7

A



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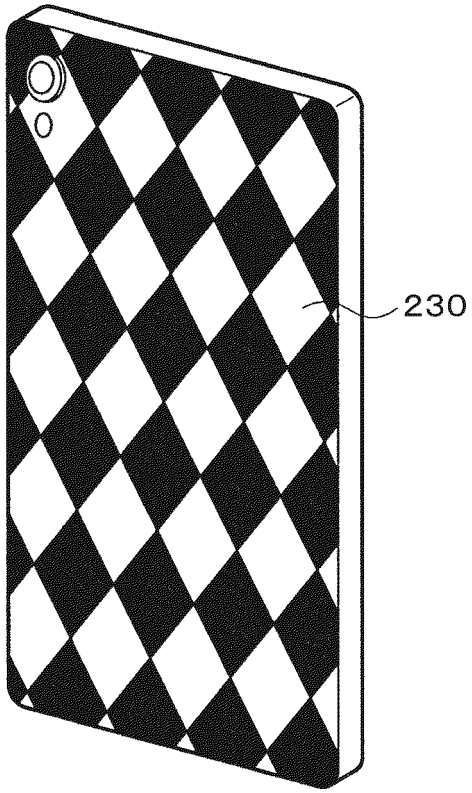
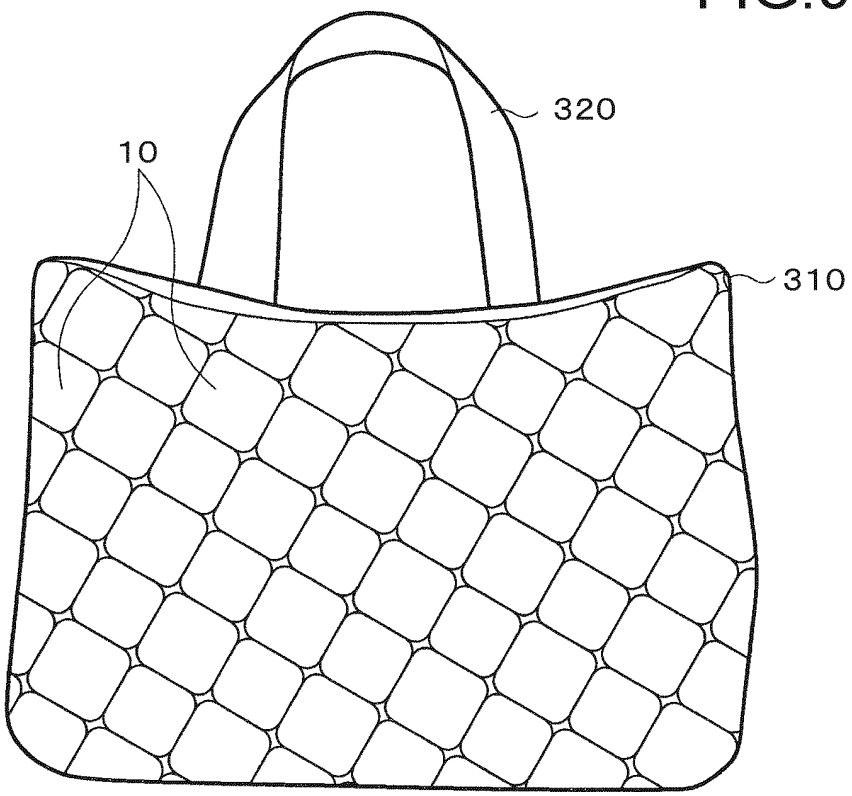


FIG.8

FIG.9

A



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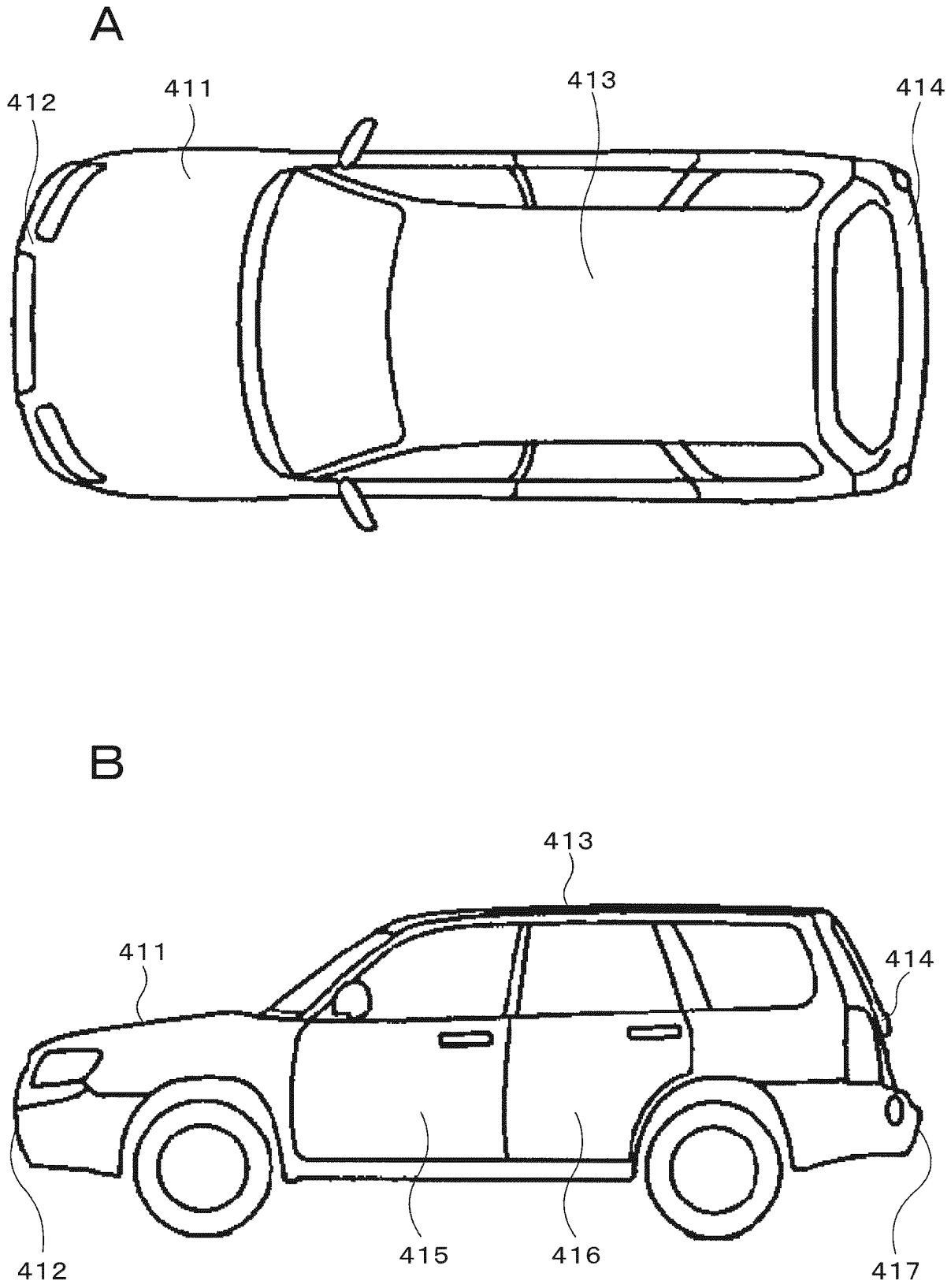


FIG.10

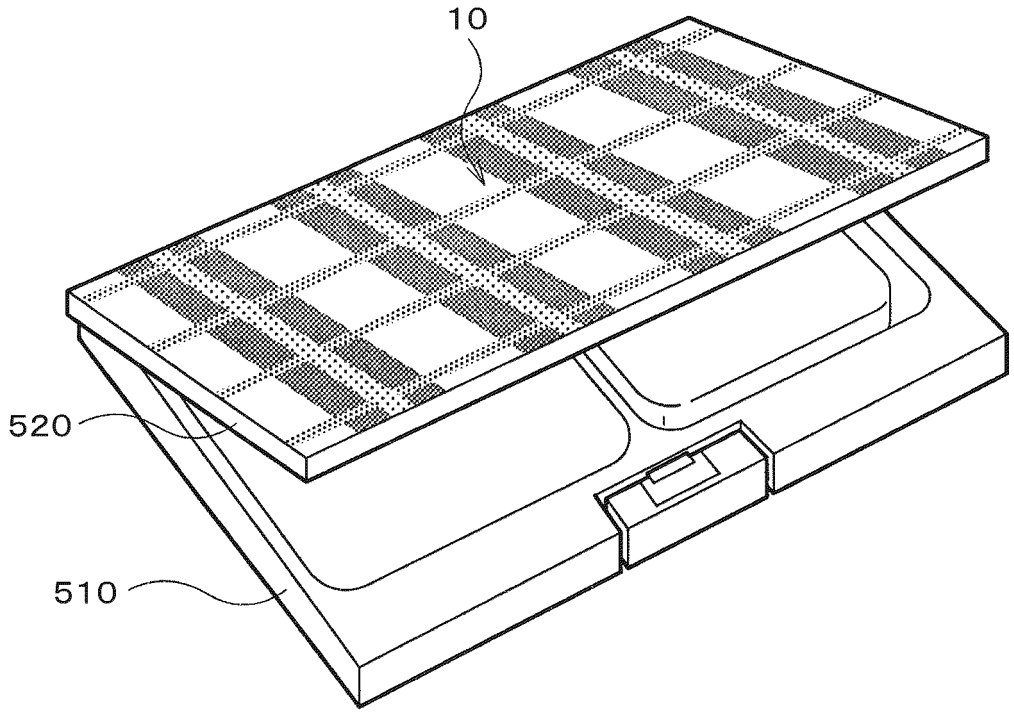


FIG.11

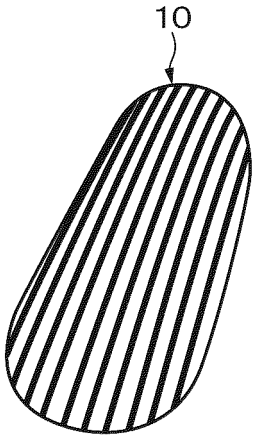
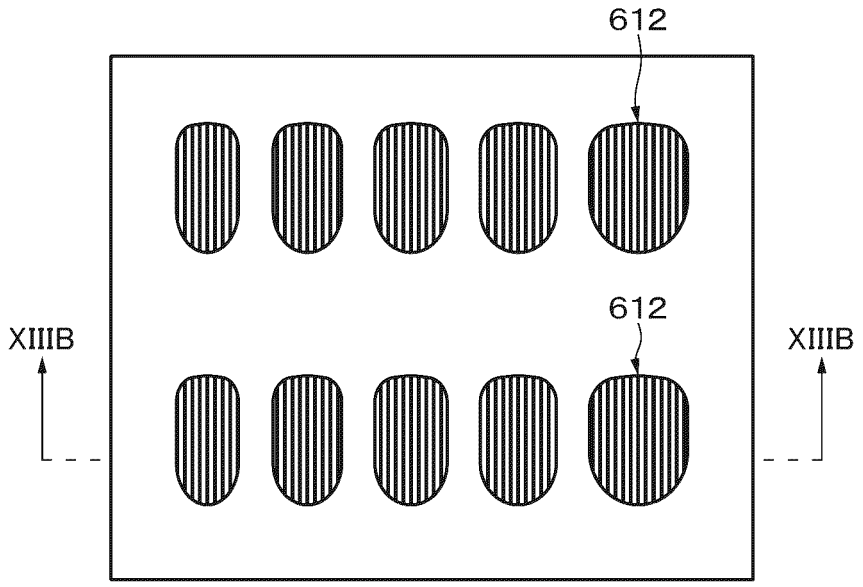


FIG.12

A



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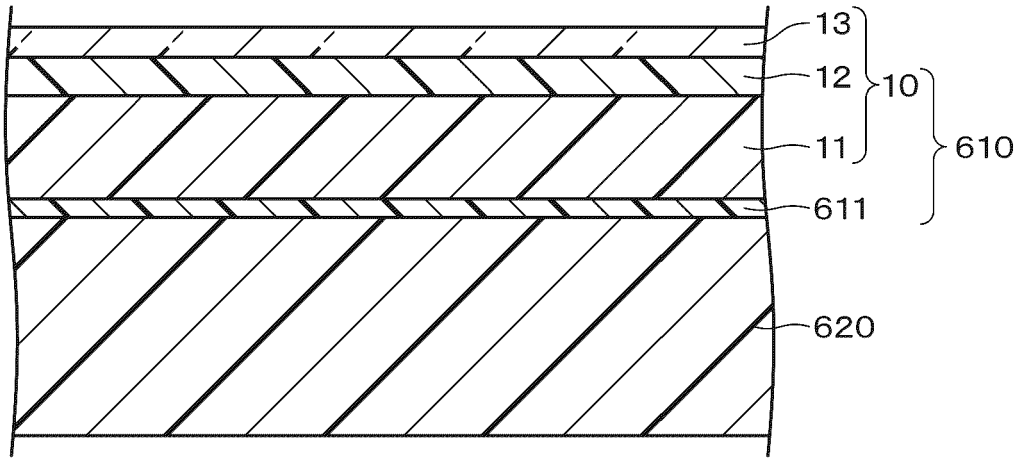

FIG.13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2022/012809

A. CLASSIFICATION OF SUBJECT MATTER

B41M 5/28(2006.01)i; ***B41M 5/333***(2006.01)i; ***B41M 5/337***(2006.01)i; ***B41M 5/40***(2006.01)i; ***B42D 25/23***(2014.01)i; ***B42D 25/24***(2014.01)i
FI: B41M5/333 220; B41M5/337 230; B41M5/40 212; B41M5/28 250; B41M5/337 212; B42D25/24; B42D25/23

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)

B41M5/333; B41M5/337; B41M5/34; B41M5/40; B41M5/42

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 1971-2022
Registered utility model specifications of Japan 1996-2022
Published registered utility model applications of Japan 1994-2022

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.
Y	WO 2020/003868 A1 (SONY CORP) 02 January 2020 (2020-01-02) paragraphs [0014]-[0111]	1-15
Y	JP 8-244355 A (NIPPON PAPER IND CO LTD) 24 September 1996 (1996-09-24) paragraphs [0011]-[0089]	1-15
Y	JP 2-292086 A (KANZAKI PAPER MFG CO LTD) 03 December 1990 (1990-12-03) claim 1, p. 2, upper right column, line 9 to lower left column, line 4	1-15
Y	JP 63-13778 A (FUJI PHOTO FILM CO LTD) 21 January 1988 (1988-01-21) p. 5, lower left column, line 15	1-15
P, A	WO 2021/187385 A1 (SONY GROUP CORP) 23 September 2021 (2021-09-23) paragraphs [0010]-[0138]	1-15

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

* Special categories of cited documents:
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"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
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"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
10 May 2022	**24 May 2022**
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.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2022/012809

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 A paragraphs [0039]-[0154]	
JP 8-244355 A	24 September 1996	(Family: none)	
JP 2-292086 A	03 December 1990	(Family: none)	
JP 63-13778 A	21 January 1988	(Family: none)	
WO 2021/187385 A1	23 September 2021	(Family: none)	

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 8244355 A **[0003]**