JP2009-263614A discloses a near infrared absorbing compound which has an absorption in the near infrared range and is excellent in invisibility in a wavelength range of 400 to 700 nm without having an absorption in the wavelength range.

SUMMARY OF THE INVENTION

[0006] A sensing technique using near infrared rays is used in various purposes.

Near infrared rays are less likely to be scattered than visible rays due to its long wavelength and can be used in, for example, distance measurement or three-dimensional measurement. By utilizing these characteristics of near infrared rays, near infrared rays can be used in a proximity sensor, a motion sensor, or the like. In addition, near infrared rays are invisible by a person or an animal. Therefore, even when an object is irradiated using a near infrared light source at night, the object cannot recognize near infrared rays. Thus, near infrared rays can be used for imaging a nocturnal wild animal or imaging an object without provoking the object for a security reason.

[0007] However, it cannot be said that color filters which have been known until now have sufficient light shielding properties with respect to visible rays on the long wavelength side. For example, it was found that, when a color filter of the related art is applied to, for example, an optical sensor in which near infrared rays or the like having a wavelength of 900 nm or longer (near infrared rays having a wavelength which is longer than that of visible rays) are used as a light source, noises are generated from visible rays, which causes deterioration in the performance of the sensor.

[0008] Accordingly, embodiments of the present invention provide a coloring composition with which a color filter capable of allowing transmission of near infrared rays in a state where noises generated from visible rays are small can be formed. In addition, embodiments of the present invention provide a film, a color filter, a pattern forming method, a method of manufacturing a color filter, a solid image pickup element, and an infrared sensor in which the coloring composition is used.

[0009] The present inventors performed a thorough investigation and found that the above-described embodiments can be achieved using a coloring composition in which a ratio of a minimum value of an absorbance in a specific wavelength range to a maximum value of an absorbance in another specific wavelength range is a specific value or higher, thereby completing the present invention. Embodiments of the present invention are summarized as follows.

According to a first aspect, there is provided a coloring composition including colorants; and a resin, wherein the colorants include one or more first colorants having an absorption maximum in a wavelength range of 800 to 900 nm and two or more second colorants having an absorption maximum in a wavelength range of 400 to 700 nm, a content of the first

colorants is 10 to 200 parts by mass with respect to 100 parts by mass of the second colorants, a content of the second colorants is 10 to 60 mass% with respect to the total solid content of the coloring composition, a ratio A/B of a minimum value A of an absorbance in a wavelength range of 400 to 830 nm to a maximum value B of an absorbance in a wavelength range of 1000 to 1300 nm is 4.5 or higher, and when a film having a thickness range of 0.5 to 50 μm is formed using the coloring composition, at least one value in the thickness range, a light transmittance in a thickness direction of the film has a maximum value of 20% or lower in a wavelength range of 400 to 830 nm and has a minimum value of 70% or higher in a wavelength range of 1000 to 1300 nm.

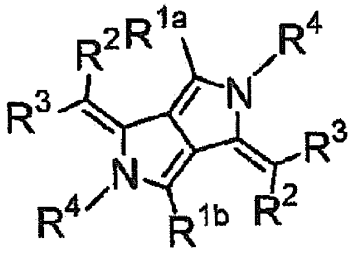
In an embodiment, the colorants include one or more first colorants having an absorption maximum in a wavelength range of 800 to 900 nm and two or more second colorants having an absorption maximum in a wavelength range of 400 to 700 nm.

In an embodiment, a content of the first colorants is 10 to 200 parts by mass with respect 100 parts to by mass of the second colorants.

In an embodiment, the first colorants include a pyrrolopyrrole colorant compound.

In an embodiment, the pyrrolopyrrole colorant compound is a pigment.

In an embodiment, the pyrrolopyrrole colorant compound is represented by the following formula (1),



(1)

in Formula (1), R^{1a} and R^{1b} each independently represent an alkyl group, an aryl group, or a heteroaryl group, R^2 and R^3 each independently represent a hydrogen atom or a substituent, at least one of R^2 or R^3 represents an electron-withdrawing group, R^2 and R^3 may be bonded to each other to form a ring, R^4 represents a hydrogen atom, an alkyl group, an aryl group, a heteroaryl group, a substituted boron atom, or a metal atom and may form a covalent bond or a coordinate bond with at least one selected from the group consisting of R^{1a}, R^{1b}, and R^3.

In an embodiment, the colorants include, as the second colorants, two or more colorants selected from the group consisting of a red colorant, a yellow colorant, a blue colorant, and a violet colorant.

In an embodiment, the coloring composition further comprises a polymerizable compound.

In an embodiment, the coloring composition further comprises a photopolymerization initiator.

In an embodiment, the coloring composition is used for forming a colored layer of a

color filter.

According to a second aspect, there is provided a film including colorants, wherein the colorants include one or more first colorants having an absorption maximum in a wavelength range of 800 to 900 nm and two or more second colorants having an absorption maximum in a wavelength range of 400 to 700 nm, a content of the first colorants is 10 to 200 parts by mass with respect to 100 parts by mass of the second colorants, a content of the second colorants in the film is 10 to 60 mass%, a thickness of the film is 0.1 to 20 μm, and a light transmittance in a thickness direction of the film has a maximum value of 20% or lower in a wavelength range of 400 to 830 nm and has a minimum value of 70% or higher in a wavelength range of 1000 to 1300 nm.

In an embodiment, the film is formed by curing the above coloring composition.

According to a third aspect, there is provided a color filter including the film of the first aspect or the film formed by curing the above coloring composition.

According to a fourth aspect, there is provided a pattern forming method including a step of applying the above coloring composition to a support to form a coloring composition layer; a step of exposing the coloring composition layer in a pattern shape; and a step of forming a colored pattern by removing a non-exposed portion by development.

According to a fifth aspect, there is provided a method of manufacturing a color filter including the above pattern forming method.

According to a sixth aspect, there is provided a solid image pickup element including the above color filter or a color filter which is obtained using the above method of manufacturing a color filter.

According to a seventh aspect, there is provided an infrared sensor including the above color filter or a color filter which is obtained using the above method of manufacturing a color filter.

[0010] According to embodiments of the present invention a coloring composition can be provided with which a color filter capable of allowing transmission of near infrared rays in a state where noises generated from visible rays are small can be formed. In addition, a film, a color filter, a pattern forming method, a method of manufacturing a color filter, a solid image pickup element, and an infrared sensor in which the coloring composition is used can be provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Fig. 1 is a schematic cross-sectional view showing a configuration of an infrared sensor according to an embodiment of the present invention.

Fig. 2 is a functional block diagram showing an imaging apparatus to which the infrared sensor is applied.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0012] In this specification, a total solid content denotes the total mass of components of a total composition of a coloring composition excluding a solvent. In addition, a solid content

CLAIMS:

1. A coloring composition comprising:

colorants; and

a resin,

wherein the colorants include one or more first colorants having an absorption maximum in a wavelength range of 800 to 900 nm and two or more second colorants having an absorption maximum in a wavelength range of 400 to 700 nm,

a content of the first colorants is 10 to 200 parts by mass with respect to 100 parts by mass of the second colorants,

a content of the second colorants is 10 to 60 mass% with respect to the total solid content of the coloring composition,a ratio A/B of a minimum value A of an absorbance in a wavelength range of 400 to 830 nm to a maximum value B of an absorbance in a wavelength range of 1000 to 1300 nm is 4.5 or higher, and

when a film having a thickness range of 0.5 to 50 μm is formed using the coloring composition, at least one value in the thickness range, a light transmittance in a thickness direction of the film has a maximum value of 20% or lower in a wavelength range of 400 to 830 nm and has a minimum value of 70% or higher in a wavelength range of 1000 to 1300 nm.

2. The coloring composition according to claim 1,

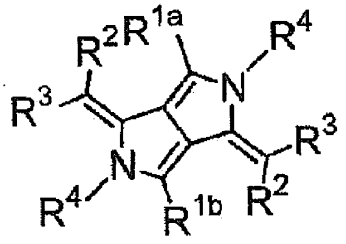
wherein the first colorants include a pyrrolopyrrole colorant compound.

3. The coloring composition according to claim 2,

wherein the pyrrolopyrrole colorant compound is a pigment.

4. The coloring composition according to claim 2 or 3,

wherein the pyrrolopyrrole colorant compound is represented by the following Formula (1),



(1)

in Formula (1), R^{1a} and R^{1b} each independently represent an alkyl group, an aryl group, or a heteroaryl group,

R^2 and R^3 each independently represent a hydrogen atom or a

substituent,

at least one of R^2 or R^3 represents an electron-withdrawing group,

R^2 and R^3 may be bonded to each other to form a ring, and

R^4 represents a hydrogen atom, an alkyl group, an aryl group, a heteroaryl group, a substituted boron atom, or a metal atom and may form a covalent bond or a coordinate bond with one or more selected from the group consisting of R^{1a}, R^{1b}, and R^3.

5. The coloring composition according to any one of claims 1 to 4,

wherein the colorants include, as the second colorants, two or more colorants selected from the group consisting of a red colorant, a yellow colorant, a blue colorant, and a violet colorant.

6. The coloring composition according to any one of claims 1 to 5, further comprising:

a polymerizable compound.

7. The coloring composition according to claim 6, further comprising:

a photopolymerization initiator.

8. The coloring composition according to any one of claims 1 to 7 which is used for forming a colored layer of a color filter.

9. The coloring composition according to any one of claims 1 to 5, further comprising:

an alkali-soluble resin,

a polymerizable compound, and

a photopolymerization initiator,

wherein a content of the alkali-soluble resin is 1 to 15 mass% with respect to the total solid content of the coloring composition,

a content of the polymerizable compound is 2 to 30 mass% with respect to the total solid content of the coloring composition, and

a content of the photopolymerization initiator is 0.1 to 20 mass% with respect to the total solid content of the coloring composition.

10. The coloring composition according to any one of claims 1 to 9,

wherein the second colorants include a pigment, and

a content of the pigment in the second colorants is 95 mass% or higher.

11. The coloring composition according to any one of claims 1 to 10,

wherein the second colorants include C.I. Pigment Red 254, C.I. Pigment Yellow 139, C.I. Pigment Blue 15:6, or C.I. Pigment Violet 23.

12. The coloring composition according to claim 5,
wherein the second colorants include a red colorant, and
a ratio of the mass of the red colorant to the total mass of the second colorants is 0.1 to 0.4.

13. The coloring composition according to claim 5,
wherein the second colorants include a yellow colorant, and
a ratio of the mass of the yellow colorant to the total mass of the second colorants is 0.1 to 0.4.

14. The coloring composition according to claim 5,
wherein the second colorants include a blue colorant, and
a ratio of the mass of the blue colorant to the total mass of the second colorants is 0.2 to 0.6.

15. The coloring composition according to claim 5,
wherein the second colorants include a violet colorant, and
a ratio of the mass of the violet colorant to the total mass of the second colorants is 0.01 to 0.3.

16. The coloring composition according to any one of claims 1 to 15,
wherein the content of the second colorants is 30 to 50 mass% with respect to the total solid content of the coloring composition.

17. The coloring composition according to any one of claims 1 to 16,
wherein the content of the first colorants is 20 to 150 parts by mass with respect to 100 parts by mass of the second colorants.

18. The coloring composition according to any one of claims 1 to 17,
wherein the content of the first colorants is 30 to 80 parts by mass with respect to 100 parts by mass of the second colorants.

19. The coloring composition according to any one of claims 1 to 18,
wherein the second colorants include at least one colorant selected from the group consisting of a bisbenzofuranone pigment, an azomethine pigment, a perylene pigment, and an azo dye.

20. The coloring composition according to any one of claims 1 to 19,
wherein the second colorants include a bisbenzofuranone pigment.

21. The coloring composition according to any one of claims 1 to 20,
wherein the first colorant is a pigment.

22. The coloring composition according to any one of claims 1 to 21, satisfying at least one of the following spectral characteristics:

(1) when a film having a thickness of 1 μm after drying is formed using the composition, a light transmittance in a thickness direction of the film has a maximum value of 20% or lower in a wavelength range of 400 to 830 nm and has a minimum value of 70% or higher in a wavelength range of 1000 to 1300 nm,

(2) when a film having a thickness of 2 μm after drying is formed using the composition, a light transmittance in a thickness direction of the film has a maximum value of 20% or lower in a wavelength range of 400 to 830 nm and has a minimum value of 70% or higher in a wavelength range of 1000 to 1300 nm,

(3) when a film having a thickness of 3 μm after drying is formed using the composition, a light transmittance in a thickness direction of the film has a maximum value of 20% or lower in a wavelength range of 400 to 830 nm and has a minimum value of 70% or higher in a wavelength range of 1000 to 1300 nm, or

(4) when a film having a thickness of 5 μm after drying is formed using the composition according to the present invention, a light transmittance in a thickness direction of the film has a maximum value of 20% or lower in a wavelength range of 400 to 830 nm and has a minimum value of 70% or higher in a wavelength range of 1000 to 1300 nm.

23. The coloring composition according to claim 22,

wherein the second colorants include a red colorant, a yellow colorant, a blue colorant, and a violet colorant,

a ratio of the mass of the red colorant to the total mass of the second colorants is 0.1 to 0.4,

a ratio of the mass of the yellow colorant to the total mass of the second colorants is 0.1 to 0.4,

a ratio of the mass of the blue colorant to the total mass of the second colorants is 0.2 to 0.6, and

a ratio of the mass of the violet colorant to the total mass of the second colorants is 0.01 to 0.3.

24. A film comprising colorants,

wherein the colorants include one or more first colorants having an absorption maximum in a wavelength range of 800 to 900 nm and two or more second colorants having an absorption maximum in a wavelength range of 400 to 700 nm,

a content of the first colorants is 10 to 200 parts by mass with respect to 100 parts by mass of the second colorants,

a content of the second colorants in the film is 10 to 60 mass%,

a thickness of the film is 0.1 to 20 μm, and

a light transmittance in a thickness direction of the film has a maximum value of 20% or lower in a wavelength range of 400 to 830 nm and has a minimum value of 70% or higher in a wavelength range of 1000 to 1300 nm.

25. The film according to claim 24 which is formed by curing the coloring composition according to any one of claims 1 to 23.

26. A color filter comprising:

the film according to claim 24 or 25.

27. A pattern forming method comprising:

a step of applying the coloring composition according to any one of claims 1 to 23 to a support to form a coloring composition layer;

a step of exposing the coloring composition layer in a pattern shape; and

a step of forming a colored pattern by removing a non-exposed portion by development.

28. A method of manufacturing a color filter comprising:

the pattern forming method according to claim 27.

29. A solid image pickup element comprising:

the color filter according to claim 26 or a color filter which is obtained using the method of manufacturing a color filter according to claim 28.

30. An infrared sensor comprising:

the color filter according to claim 26 or a color filter which is obtained using the method of manufacturing a color filter according to claim 28.