using a light-shielding material, and there is a need for the development thereof.

DISCLOSURE OF INVENTION

Summary

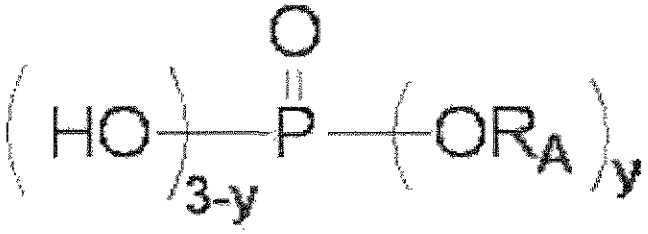
[0013a] In an aspect, there is provided a black curable composition for a wafer level lens, comprising:

(A) an inorganic pigment;

(B-1) a dispersion resin having a phosphoric acid group in a molecule thereof and represented by the following Formula (I);

(C) a polymerization initiator; and

(D) a polymerizable compound:



Formula (I)

wherein, in Formula (I), R_A represents a molecular chain which has a number average molecular weight of from 500 to 30,000 and which is selected from a polyether or a polyester; and y represents 1 or 2.

[0013b] In another aspect, there is provided a black curable composition for wafer level lens, comprising:

(A) an inorganic pigment which is titanium black;

(B-2) a dispersion resin which is a copolymer of a monomer (b-1) having a phosphoric acid group or a sulfonic acid group with a macromonomer (b-2) having a weight average molecular weight of from 1,000 to 30,000;

(C) a polymerization initiator; and

(D) a polymerizable compound.

[0013c] In another aspect, there is provided a wafer level lens, comprising, at a peripheral portion of a lens that is present on a substrate, a light-shielding section obtained using the black curable composition for a wafer level lens as defined above.

Detailed Description

[0014] The present invention has been made in view of the above, and addresses the following objectives.

According to a first aspect of the invention, a black curable composition for a wafer level lens is provided which exhibits excellent developability during formation of a pattern and also imparts excellent adhesion with a lens to a light-shielding film formed therefrom.

According to the first aspect of the invention, a wafer level lens is also provided which allows the amount of light to be appropriately adjusted by the presence of a light-shielding film and which can be simply manufactured.

[0015] According to a second aspect of the invention, a black curable composition for formation of a light-shielding film is provided, which is capable of forming a light-shielding film having an excellent infrared light-shielding ability, which enables reduction of residue generated in an unexposed region during formation of the light-shielding film and has excellent adhesion to a silicon substrate.

According to the second aspect of the invention, a light-shielding film having an excellent infrared light-shielding ability and excellent adhesion to a silicon substrate is provided, and a method for manufacturing a light-shielding film is provided, with which the obtained light-shielding film has an excellent infrared light-shielding ability, in which residue generated in an unexposed region thereof during formation of the light-shielding film is reduced, and which also has improved adhesion to a silicon substrate.

According to the second aspect of the invention, a solid-state imaging device is provided, which exhibits reduction in noise caused by infrared light and reduction in noise caused by residue, and also has a uniform film thickness.

[0016] According to a third aspect of the invention, a black curable composition is provided, which is capable of forming a light-shielding film which has favorable light-shielding properties with respect to light in a broad wavelength range from the visible light region to the infrared light region and good adhesion to a substrate, which also has a high curing sensitivity, and can form a high-precision pattern.

According to the third aspect of the invention, a light-shielding color filter for a solid-state imaging device is provided, which exhibits improved image quality with fine precision and prevents noise generation by using the black curable composition according to the present invention; a wafer level lens is provided, which allows the amount of light to be appropriately adjusted and can be simply manufactured; and a light-shielding film for a solid-

CLAIMS

1. A black curable composition for a wafer level lens, comprising:

(A1) an inorganic pigment;

(B1) a dispersion resin having a phosphoric acid group or a sulfonic acid group in a molecule thereof;

(C1) a polymerization initiator; and

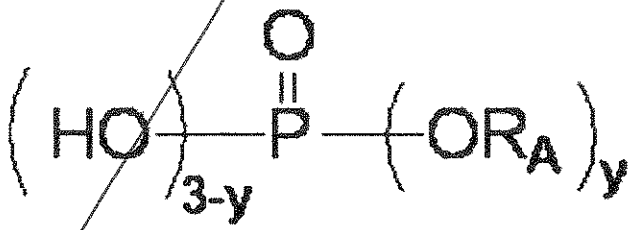
(D1) a polymerizable compound.

2. The black curable composition according to claim 1, wherein the (A1) inorganic pigment comprises titanium black.

3. The black curable composition according to claim 1 or 2, further comprising (E) an organic pigment.

4. The black curable composition according to any one of claims 1 to 3, wherein the (B1) dispersion resin comprises a copolymer of a monomer (b1-1) having a phosphoric acid group or a sulfonic acid group with a macromonomer (b1-2) having a weight average molecular weight of from 1,000 to 30,000.

5. The black curable composition according to any one of claims 1 to 3, wherein the (B1) dispersion resin comprises a resin represented by the following Formula (I):



Formula (I)

wherein, in Formula (I), R_A represents a molecular chain which has a number average molecular weight of from 500 to 30,000 and which is selected from a polyether or a polyester; and y represents 1 or 2.

6. A wafer level lens, comprising, at a peripheral portion of a lens that is present on a substrate, a light-shielding section obtained using the black curable composition for a wafer level lens according to any one of claims 1 to 5.

7. A black curable composition for formation of a light-shielding film, comprising:

(A2) an inorganic pigment;

(B2) a dispersion resin which has at least one of a phosphoric acid group or a sulfonic acid group in a molecule thereof and has an acid value of from 10 mgKOH/g to 100 mgKOH/g;

(C2) a polymerization initiator; and

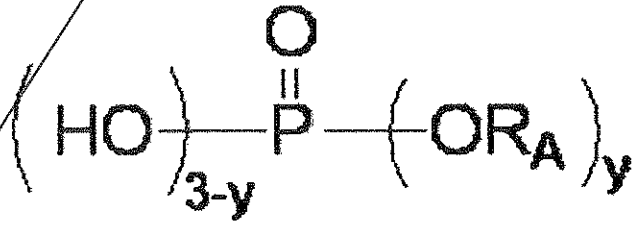
(D2) a polymerizable compound,

wherein the light-shielding film blocks infrared light and is provided on one surface of a silicon substrate having an imaging device section on an opposite surface thereof.

8. The black curable composition according to claim 7, wherein the (A2) inorganic pigment comprises titanium black.

9. The black curable composition according to claim 7 or 8, wherein the (B2) dispersion resin comprises a copolymer of a monomer (b2-1) having at least one of a phosphoric acid group or a sulfonic acid group with a macromonomer (b2-2) having a weight average molecular weight of from 1,000 to 30,000.

10. The black curable composition according to any one of claims 7 to 9, wherein the (B2) dispersion resin comprises a resin represented by the following Formula (I):



Formula (I)

wherein, in Formula (I), R_A represents a molecular chain which has a number average molecular weight of from 500 to 30,000 and which is selected from a polyether or a polyester; and y represents 1 or 2.

11. The black curable composition according to any one of claims 7 to 10, wherein the (B2) dispersion resin has an acid value of from 20 mgKOH/g to 70 mgKOH/g.

12. The black curable composition according to any one of claims 7 to 11, wherein the (C2) polymerization initiator is an oxime ester compound or a hexaarylbiimidazole compound.

13. The black curable composition according to claim 8, wherein the titanium black as the (A2) inorganic pigment has an average primary particle diameter of from 30 nm to 65 nm.

14. The black curable composition according to any one of claims 7 to 13, wherein the content of the (B2) dispersion resin in terms of mass ratio is from 0.20 to 0.40 relative to the (A2) inorganic pigment.

15. A light-shielding film, which is formed using the black curable composition according to any one of claims 7 to 14 on one surface of a silicon substrate having an imaging device section on an opposite surface thereof.

16. A method for manufacturing a light-shielding film, comprising:

applying the black curable composition according to any one of claims 7 to 14 on one surface of a silicon substrate having an imaging device section on an opposite surface thereof to form a black curable composition layer;

subjecting the black curable composition layer to pattern exposure; and

developing the black curable composition layer after exposure to form a pattern.

17. A solid-state imaging device, comprising the light-shielding film according to claim 15 on one surface of a silicon substrate having an imaging device section on an opposite surface thereof.

18. The solid-state imaging device according to claim 17, comprising:

a silicon substrate having an imaging device section on one surface thereof;

a metal electrode provided on an opposite surface of the silicon substrate and electrically connected with the imaging device section; and

the light-shielding film according to claim 15, which is provided on the surface of the silicon substrate having the metal electrode provided thereon, and which is patterned so that at least a part of the metal electrode is exposed.

19. The solid-state imaging device according to claim 18, wherein a solder resist is provided between the metal electrode and the light-shielding film.

20. A black curable composition, comprising:

(A3) an inorganic pigment;

(B3) a chain resin comprising a solvent-compatible moiety and a pigment-adsorbing moiety having an acid group or a basic group;

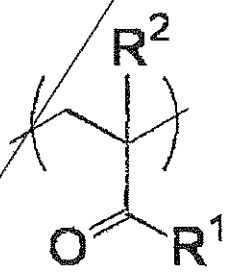
(C3) a polymerization initiator; and

(D3) a polymerizable compound.

21. The black curable composition according to claim 20, wherein the (A3) inorganic pigment comprises titanium black.

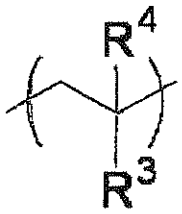
22. The black curable composition according to claim 20 or 21, wherein the solvent-compatible moiety comprises repeating units having an I/O value in a range from 0.05 to 1.50 in an amount of 80% by mass or more.

23. The black curable composition according to any one of claims 20 to 22, wherein the solvent-compatible moiety comprises a repeating unit represented by the following Formula (I-A) or the following Formula (I-B):



(I-A)

wherein, in Formula (I-A), R^1 represents an alkoxy group, a cycloalkoxy group, or an aryloxy group; and R^2 represents a hydrogen atom, a halogen atom, or an alkyl group:



(I-B)

wherein, in Formula (I-B), R^3 represents an aryl group; and R^4 represents a hydrogen atom or an alkyl group.

24. The black curable composition according to any one of claims 20 to 23, wherein the (C3) polymerization initiator is an oxime ester compound or a hexaarylbiimidazole compound.

25. The black curable composition according to any one of claims 20 to 24, further comprising (E3) an alkali-soluble resin that is other than the (B3) chain resin.

26. The black curable composition according to any one of claims 20 to 25, further comprising (F3) an organic pigment.

27. A black curable composition for a solid-state imaging device, comprising the black curable composition according to any one of claims 20 to 26.

28. A light-shielding color filter for a solid-state imaging device, comprising the black curable composition according to claim 27.

29. A solid-state imaging device, comprising the light-shielding color filter for a solid-state imaging device according to claim 28.

30. A black curable composition for a wafer level lens, comprising the black curable composition according to any one of claims 20 to 26.

31. A wafer level lens, comprising, at a peripheral portion of a lens present on a substrate, a light-shielding film obtained using the black curable composition according to claim 30.

32. The black curable composition according to any one of claims 20 to 26, which

is used for formation of an infrared light-shielding film which blocks infrared light and is provided on one surface of a silicon substrate.

33. An infrared light-shielding film, which is formed, using the black curable composition according to claim 32 and on a silicon substrate having an imaging device section, on an opposite surface to a surface on which the imaging device is provided.

34. A method for manufacturing an infrared light-shielding film, comprising:

applying the black curable composition according to claim 32 to a silicon substrate having an imaging device section, on an opposite surface to a surface on which the imaging device is provided, to form a photosensitive layer;

subjecting the photosensitive layer to pattern exposure, and

developing the photosensitive layer after exposure to form a pattern.

35. A solid-state imaging device, comprising the infrared light-shielding film according to claim 33 provided on a silicon substrate having an imaging device section, at an opposite surface to a surface on which the imaging device is provided.

CLAIMS

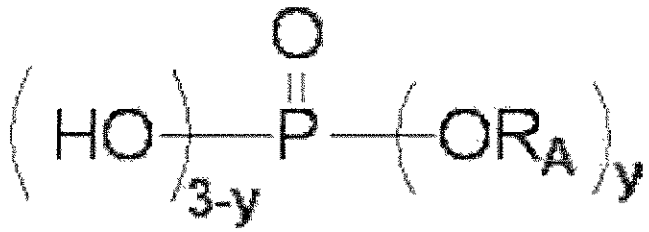
1. A black curable composition for a wafer level lens, comprising:

(A) an inorganic pigment;

(B-1) a dispersion resin having a phosphoric acid group in a molecule thereof and represented by the following Formula (I);

(C) a polymerization initiator; and

(D) a polymerizable compound:



Formula (I)

wherein, in Formula (I), R_A represents a molecular chain which has a number average molecular weight of from 500 to 30,000 and which is selected from a polyether or a polyester; and y represents 1 or 2.

2. A black curable composition for wafer level lens, comprising:

(A) an inorganic pigment which is titanium black;

(B-2) a dispersion resin which is a copolymer of a monomer (b-1) having a phosphoric acid group or a sulfonic acid group with a macromonomer (b-2) having a weight average

molecular weight of from 1,000 to 30,000;

(C) a polymerization initiator; and

(D) a polymerizable compound.

3. The black curable composition according to claim 1, wherein the (A) inorganic pigment comprises titanium black.

4. The black curable composition according to any one of claims 1 to 3, further comprising (E) an organic pigment.

5. A wafer level lens, comprising, at a peripheral portion of a lens that is present on a substrate, a light-shielding section obtained using the black curable composition for a wafer level lens according to any one of claims 1 to 4.