SUMMARY ~~OF INVENTION~~

[0009] The present ~~invention~~ disclosure is made in view of above-mentioned ~~aspects~~description, and is directed to approach the objects as described below.

That is, ~~an aspect of~~ the ~~invention~~ present disclosure ~~is to~~ provides a black polymerizable composition that has alkali developer resistance, and accordingly, has an excellent light-shielding property.

~~It is another aspect of t~~The present disclosure ~~invention to~~also provides a black polymerizable composition capable of being spray-coated.

In one aspect of the present disclosure, there is provided a black polymerizable composition which is capable of being spray-coated, comprising:

(A) a black material;

(B) a polymerization initiator;

(C) a polymerizable compound; and

(D) an alkali-soluble binder polymer having a weight average molecular weight of at least 30,000 and having a polymerizable group at a side chain thereof,

wherein a total solid content in the black polymerization composition is from 21% by mass to 33% by mass.

~~It is still another aspect of t~~The present disclosure ~~invention to~~further provides a method for producing a black layer, which is useful for a light-shielding region of a wafer level lens, using the black polymerizable composition.

In another aspect of the present disclosure, there is provided a method for producing a black layer, the method comprising:

applying, by spray coating, the black polymerizable composition disclosed herein onto a surface of a solid to form a black polymerizable composition layer; and

applying energy to the formed black polymerizable composition layer to cure the formed black polymerizable composition layer.

[0010] Generally, a resin containing a carboxylic acid as an alkali-soluble group is used in a curable composition. However, in a case in which development is carried out under relatively severe conditions so as to remove the residue of an unexposed portion, there have been problems such as peeling of an image portion.

Meanwhile, in a case of using the curable composition for an aperture of a lens, a light-shielding property widely ranging from a visible region to an infrared region is required.

In a case in which a light-shielding film is formed using a black polymerizable composition, image-wise exposure is carried out generally with a light source of from 250 nm to 500 nm, followed by development using an alkali developer. However, since the curable composition includes a black material capable of shielding light at a wavelength region of from 250 nm to 500 nm, the light transmittance of the exposure light source is insufficient, and thus, a deep portion of the formed film may not be sufficiently cured in some cases. Therefore, in a case in which development is carried out under relatively severe conditions in order to prevent reduction of the residual film, a strongly acidic carboxylic acid may cause penetration of the developer into the image portion, and thus, there has been a concern that reduction of the strength of the image portion may lead to peeling of the light-shielding film (black film).

Furthermore, in a case in which the black polymerizable composition (or the curable composition) is used for an aperture or the like of a wafer level lens, a method in which a black polymerizable composition is coated on a glass wafer and then a lens is formed thereon, a method in which a lens is formed on a glass wafer and then a black polymerizable composition is coated thereto, or the like may be employed. However, particularly in the case in which a black polymerizable composition is coated after a lens has been formed, it is effective to apply the black polymerizable composition on the structure substrate by spray

coating.

In other words, the inventors of the present ~~invention~~ disclosure have extensively studied various black polymerizable compositions, and as a result, have found a black polymerizable composition having alkali developer resistance, and accordingly, having an excellent light-shielding property. The inventors have also found a black polymerizable composition capable of being spray-coated. In addition, the inventors have found a method for producing a black layer, which is useful in a light-shielding region of a wafer level lens, using the black polymerizable composition.

Specific exemplary embodiments of the present disclosure ~~invention~~ are as follows.

<1> A black polymerizable composition, including:

(A) a black material;

(B) a polymerization initiator;

(C) a polymerizable compound; and

(D) an alkali-soluble binder polymer having a weight average molecular weight of at least 30,000 and having a polymerizable group at a side chain thereof.

<2> The black polymerizable composition according to <1>, wherein the (A) black material is titanium black.

<3> The black polymerizable composition according to <1> or <2>, wherein the (D) alkali-soluble binder polymer is an alkali-soluble binder polymer having a weight average molecular weight of from 50,000 to 100,000 and having a polymerizable group at a side chain thereof.

<4> The black polymerizable composition according to any one of <1> to <3>, which is used for forming a light-shielding region of a wafer level lens.

<5> The black polymerizable composition according to any one of <1> to <4>, which is capable of being spray-coated.

<6> The black polymerizable composition according to any one of <1> to <5>, wherein the total solid content in the black polymerizable composition is from 20% by mass to 35% by mass.

<7> The black polymerizable composition according to any one of <1> to <6>, wherein the polymerizable group included in the (D) alkali-soluble binder polymer is an acryl group, a methacryl group, a styryl group, an allyl group, an acrylamide group, a methacrylamide group, a vinyl group or a vinyl ether group.

<8> The black polymerizable composition according to any one of <1> to <7>, wherein a content of the (D) alkali-soluble binder polymer is from 5% by mass to 75% by mass with respect to the total solid content of the black polymerizable composition.

<9> A method for producing a black layer, the method including:

applying, by spray coating, the black polymerizable composition according to any one of <1> to <8> onto a surface of a solid to form a black polymerizable composition layer; and

applying energy to the formed black polymerizable composition layer to cure the formed black polymerizable composition layer.

<10> The method for producing a black layer according to <9>, wherein the surface of the solid is a surface of a peripheral portion of a wafer level lens, and the black layer is a light-shielding region formed in the peripheral portion of a wafer level lens.

[0011] According to ~~an aspect of~~ the present disclosure~~invention~~, a black polymerizable composition that has an alkali developer resistance, and accordingly, exhibits an excellent light-shielding property is provided.

Further, ~~according to another aspect of~~ the present disclosure~~invention~~ provides, a black polymerizable composition capable of being spray-coated ~~is provided~~.

In addition, ~~according to still another aspect of~~ the present disclosure~~invention~~ provides, a method for producing a black layer which is useful for a light-shielding region of a wafer level lens, is provided using the black polymerizable composition.

BRIEF DESCRIPTION OF DRAWINGS

[0012] Fig. 1 is a plain view showing an example of a wafer level lens array.

Fig. 2 is a cross-sectional view of the wafer level lens array shown in Fig. 1, which is taken along the line A-A.

Fig. 3 is a view showing the state of supplying a molding material for forming a lens onto a substrate.

Figs. 4A to 4C are views showing the process of forming lenses on a substrate using a mold.

Figs. 5A to 5C are schematic views showing the process of forming a patterned light-shielding film on the substrate having the lenses formed thereon.

Fig. 6 is a view showing an example of a wafer level lens array.

Figs. 7A to 7C are schematic views showing another embodiment of the process of forming a light-shielding film.

Figs. 8A to 8C are schematic views showing the process of forming lenses on a substrate having a patterned light-shielding film.

DESCRIPTION OF EMBODIMENTS

CLAIMS

1. A black polymerizable composition which is capable of being spray-coated, comprising:

(A) a black material;

(B) a polymerization initiator;

(C) a polymerizable compound; and

(D) an alkali-soluble binder polymer having a weight average molecular weight of at least 30,000 and having a polymerizable group at a side chain thereof,

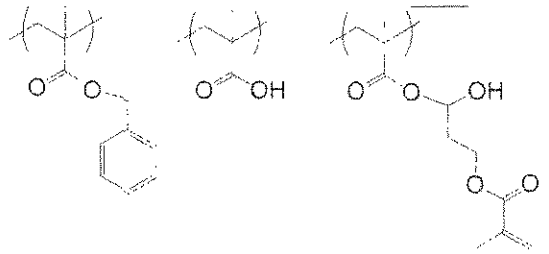
wherein a total solid content in the black polymerization composition is from 21% by mass to 33% by mass.

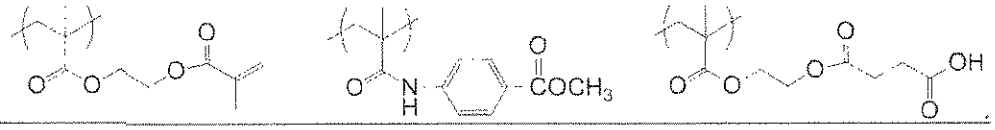
2. The black polymerizable composition according to claim 1, wherein the (A) black material comprises titanium black.

3. The black polymerizable composition according to claim 1 or 2, wherein the (D) alkali-soluble binder polymer comprises an alkali-soluble binder polymer having a weight average molecular weight of from 50,000 to 100,000 and having a polymerizable group at a side chain thereof.

4. The black polymerizable composition according to any one of claims 1 to 3, wherein an amount of the polymerizable group included in the side chain of the (D) alkali-soluble binder polymer is from 30% by mole to 60% by mole with respect to total monomer units each having a polymerizable group in a polymer.

5. The black polymerizable composition according to any one of claims 1 to 4, wherein the (D) alkali-soluble binder polymer is at least one of a polymer comprising repeating units of the following Formula B-1-1 and a polymer comprising repeating units of the following Formula B-2-1:

B-1-1 

B-2-1 

46. The black polymerizable composition according to any one of claims 1 to ~~3~~5, which is used for forming a light-shielding region of a wafer level lens.

~~5. The black polymerizable composition according to any one of claims 1 to 4, which is capable of being spray-coated.~~

~~6. The black polymerizable composition according to any one of claims 1 to 5, wherein the total solid content in the black polymerizable composition is from 20% by mass to 35% by mass.~~

~~7. The black polymerizable composition according to any one of claims 1 to 6, wherein the polymerizable group included in the (D) alkali-soluble binder polymer comprises an acryl group, a methacryl group, a styryl group, an allyl group, an acrylamide group, a methacrylamide group, a vinyl group or a vinyl ether group.~~

~~8. The black polymerizable composition according to any one of claims 1 to 7, wherein a content of the (D) alkali-soluble binder polymer is from 5% by mass to 75% by mass with respect to the total solid content of the black polymerizable composition.~~

97. A method for producing a black layer, the method comprising:

applying, by spray coating, the black polymerizable composition according to any one of claims 1 to ~~8~~ 6 onto a surface of a solid to form a black polymerizable composition layer; and

applying energy to the formed black polymerizable composition layer to cure the formed black polymerizable composition layer.

~~10~~ 8. The method for producing a black layer according to claim 97, wherein the surface of the solid is a surface of a peripheral portion of a wafer level lens, and the black layer is a light-shielding region formed in the peripheral portion of a wafer level lens.

9. The method for producing a black layer according to claim 7 or 8, wherein the surface of the solid is a curved surface.