(see, for example, Patent Literature 3).

[0008]

There is also disclosed technology in which a polyimide resin film is used as an ion implantation mask for the purpose of providing a method for producing a semiconductor device, which enables ion implantation performed by accelerating ions with high energy at high temperature, and is capable of easily implanting impurities into a semiconductor substrate, particularly a SiC semiconductor substrate, in a region selective manner, to a sufficient depth (see, for example, Patent Literature 4).

[Citation List]

[Patent Literature]

[0009]

[Patent Literature 1]

Japanese Unexamined Patent Publication (Kokai) No. 2006-324585 (Paragraph 0011)

[Patent Literature 2]

Japanese Unexamined Patent Publication (Kokai) No. 2008-108869

[Patent Literature 3]

Japanese Unexamined Patent Publication (Kokai) No. 2007-42803

[Patent Literature 4]

PCT International Publication No. WO 2004/97914

[Summary ~~of Invention~~]

ion implantation mask performance, thus enabling application to a low-cost high-temperature ion implantation process.

[Solution to Problem]

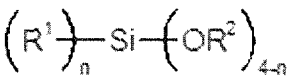
[0015]

In a first aspect, there is provided a photosensitive resin composition which exhibits positive or negative photosensitivity and is used as a mask in an ion implantation step, the photosensitive resin composition comprising, as a resin, (A) a polysiloxane, wherein the polysiloxane (A) further includes an organosilane unit having an acidic group selected from a carboxy group, an acid anhydride group, a sulfonic acid group and a hydroxyimide group, the photosensitive resin composition comprising (C) inorganic particles selected from silica particles, lithium fluoride particles, lithium chloride particles, lithium bromide particles, lithium oxide particles, lithium carbonate particles, lithium sulfate particles, lithium nitrate particles, lithium metasilicate particles, lithium hydroxide particles, sodium fluoride particles, sodium chloride particles, sodium bromide particles, sodium carbonate particles, sodium hydrogen carbonate particles, sodium sulfate particles, sodium nitrate particles, sodium metasilicate particles, sodium hydroxide particles, magnesium fluoride particles, magnesium chloride particles, magnesium bromide particles, magnesium oxide particles, magnesium carbonate particles, magnesium sulfate particles, magnesium nitrate particles, magnesium hydroxide particles, potassium

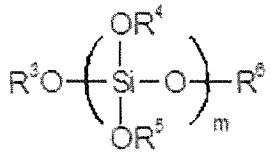
fluoride particles, potassium chloride particles, potassium bromide particles, potassium carbonate particles, potassium sulfate particles, potassium nitrate particles, calcium fluoride particles, calcium chloride particles, calcium bromide particles, calcium oxide particles, calcium carbonate particles, calcium sulfate particles, calcium nitrate particles, calcium hydroxide particles, strontium fluoride particles, barium fluoride particles, lanthanum fluoride particles, and the content of the inorganic particles (C) is 15% by weight or more based on the whole solid content excluding a solvent in the photosensitive resin composition..

~~In a second aspect, t~~There is also provided a photosensitive resin composition comprising (A) a polysiloxane, (C) inorganic particles, and (D) a naphthoquinone diazide compound, wherein the polysiloxane (A) is a polysiloxane obtained by hydrolyzing one or more organosilane(s) selected from an organosilane represented by the general formula (1) and an organosilane represented by the general formula (2), and an organosilane having an acidic group, followed by dehydration condensation, and the content of the inorganic particles (C) is 15% by weight or more based on the whole solid content excluding a solvent in the photosensitive resin composition

[Chemical Formula 2]



(1)



(2)

wherein R^1 in the organosilane represented by the general formula (1) represents a group selected from hydrogen, an alkyl group having 1 to 10 carbon atoms, a cycloalkyl group having 1 to 10 carbon atoms, an alkenyl group having 2 to 10 carbon atoms and an aryl group having 6 to 15 carbon atoms, and a plurality of R^1(s) may be respectively the same or different; R^2 represents a group selected from hydrogen, an alkyl group having 1 to 6 carbon atoms, an acyl group having 2 to 6 carbon atoms and an aryl group having 6 to 15 carbon atoms, and a plurality of R^2(s) may be respectively the same or different; these alkyl groups, acyl groups, and aryl group may be either a non-substitution product or a substitution product; and n represents an integer of 1 to 3; and

wherein R^3 to R^6, in the organosilane represented by the general formula (2), each independently represents a group selected from hydrogen, an alkyl group having 1 to 6 carbon atoms, an acyl group having 2 to 6 carbon atoms and an aryl group having 6 to 15 carbon atoms; these alkyl groups, acyl groups and aryl groups may be either a non-substitution product or a substitution product; and m represents an integer of 1 to 8.

In another ~~third~~ aspect, there is provided a method for

producing a semiconductor device, which comprises steps of forming a pattern of the photosensitive resin composition as disclosed herein on a semiconductor substrate; firing the pattern of the resin composition to obtain a fired pattern; implanting ions into the region of the semiconductor substrate where the fired pattern does not exist, using the fired pattern as an ion implantation mask; and removing the ion implantation mask.

In order to achieve the above object, in the present disclosure, there is applied a photosensitive resin composition which exhibits positive or negative photosensitivity and is used as a mask in an ion implantation step, the photosensitive resin composition including, as a resin, (A) a polysiloxane.

[0016]

Another embodiment of the present disclosure is directed to a photosensitive resin composition including (A) a polysiloxane, (C) inorganic particles, and (D) a naphthoquinone diazide compound, wherein the polysiloxane (A) is a polysiloxane obtained by hydrolyzing one or more organosilane(s) selected from an organosilane represented by the general formula (1) and an organosilane represented by the general formula (2), and an organosilane having an acidic group, followed by dehydration condensation, and the content of the inorganic particles (C) is 15% by weight or more based on the whole solid content excluding a solvent in the photosensitive resin composition:

[0017]

[Chemical Formula 1]

$$\left(R^1\right)_n-Si-\left(OR^2\right)_{4-n} \quad (1)$$

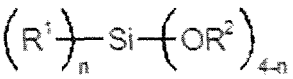
[CLAIMS]

1. A photosensitive resin composition which exhibits positive or negative photosensitivity and is used as a mask in an ion implantation step, the photosensitive resin composition comprising, as a resin, (A) a polysiloxane, wherein the polysiloxane (A) further includes an organosilane unit having an acidic group selected from a carboxy group, an acid anhydride group, a sulfonic acid group and a hydroxyimide group, the photosensitive resin composition comprising (C) inorganic particles selected from silica particles, lithium fluoride particles, lithium chloride particles, lithium bromide particles, lithium oxide particles, lithium carbonate particles, lithium sulfate particles, lithium nitrate particles, lithium metasilicate particles, lithium hydroxide particles, sodium fluoride particles, sodium chloride particles, sodium bromide particles, sodium carbonate particles, sodium hydrogen carbonate particles, sodium sulfate particles, sodium nitrate particles, sodium metasilicate particles, sodium hydroxide particles, magnesium fluoride particles, magnesium chloride particles, magnesium bromide particles, magnesium oxide particles, magnesium carbonate particles, magnesium sulfate particles, magnesium nitrate particles, magnesium hydroxide particles, potassium fluoride particles, potassium chloride particles, potassium bromide particles, potassium carbonate particles, potassium sulfate particles, potassium nitrate particles, calcium fluoride

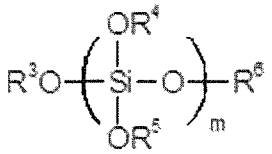
particles, calcium chloride particles, calcium bromide particles, calcium oxide particles, calcium carbonate particles, calcium sulfate particles, calcium nitrate particles, calcium hydroxide particles, strontium fluoride particles, barium fluoride particles, lanthanum fluoride particles, and the content of the inorganic particles (C) is 15% by weight or more based on the whole solid content excluding a solvent in the photosensitive resin composition.

2. The photosensitive resin composition according to claim 1, wherein the polysiloxane (A) is a polysiloxane obtained by hydrolyzing one or more organosilane(s) selected from an organosilane represented by the below-mentioned general formula (1) and an organosilane represented by the below-mentioned general formula (2), followed by condensation:

[Chemical Formula 1]



(1)



(2)

wherein R^1 in the organosilane represented by the general formula (1) represents a group selected from hydrogen, an alkyl group having 1 to 10 carbon atoms, a cycloalkyl group having 1 to 10 carbon atoms, an alkenyl group having 2 to 10 carbon atoms and an aryl group having 6 to 15 carbon atoms, and a plurality of R^1(s) may

be respectively the same or different; R^2 represents a group selected from hydrogen, an alkyl group having 1 to 6 carbon atoms, an acyl group having 2 to 6 carbon atoms and an aryl group having

6 to 15 carbon atoms, and a plurality of R^2(s) may be respectively the same or different; ~~these alkyl groups, acyl groups and aryl groups may be either a non-substitution product or a substitution product;~~ and n represents an integer of 1 to 3; and

wherein R^3 to R^6, in the organosilane represented by the general formula (2), each independently represents a group selected from hydrogen, an alkyl group having 1 to 6 carbon atoms, an acyl group having 2 to 6 carbon atoms and an aryl group having 6 to 15 carbon atoms; ~~these alkyl groups, acyl groups and aryl groups may be either a non-substitution product or a substitution product;~~ and m represents an integer of 1 to 8.

~~3. The photosensitive resin composition according to any one of claims 1 to 2, further comprising (C) inorganic particles.~~

~~4~~3. The photosensitive resin composition according to claim ~~3~~1 or 2, wherein the inorganic particles (C) are silica particles.

~~5. The photosensitive resin composition according to any one of claims 3 to 4, wherein the content of the inorganic particles (C) is 15% by weight or more based on the whole solid content excluding a solvent in the photosensitive resin composition.~~

~~6~~4. The photosensitive resin composition according to any one of claims ~~3~~1 to ~~5~~3, wherein the polysiloxane (A) is an inorganic particle-containing polysiloxane obtained by reacting an organosilane with inorganic particles.

~~7. The photosensitive resin composition according to any one of claims 1 to 6, wherein the polysiloxane (A) further includes an~~

~~organosilane unit having an acidic group.~~

~~8~~5. The photosensitive resin composition according to any one of claims 1 to ~~7~~4, further comprising at least any one selected from (B1) a photoacid generator, (B2) a photobase generator, (B3) a thermal acid generator, and (B4) a thermal base generator.

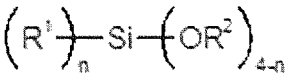
~~9~~6. The photosensitive resin composition according to any one of claims 1 to ~~8~~5, further comprising (D) a naphthoquinone diazide compound.

~~10~~7. The photosensitive resin composition according to any one of claims 1 to ~~8~~6, further comprising a compound selected from (E1) a photopolymerization initiator and (E2) a photosensitizer.

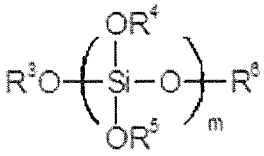
~~11~~8. The photosensitive resin composition according to any one of claims 1 to ~~8~~5 and ~~7~~10, further comprising (F) a photopolymerizable compound.

~~12~~9. ~~A~~ The photosensitive resin composition according to claim 1, comprising (A) a polysiloxane, (C) inorganic particles, and (D) a naphthoquinone diazide compound, wherein the polysiloxane (A) is a polysiloxane obtained by hydrolyzing one or more organosilane(s) selected from an organosilane represented by the general formula (1) and an organosilane represented by the general formula (2), ~~and an organosilane having an acidic group,~~ followed by dehydration condensation, and the content of the inorganic particles (C) is 15% by weight or more based on the whole solid content excluding a solvent in the photosensitive resin composition

[Chemical Formula 2]



(1)



(2)

wherein R^1 in the organosilane represented by the general formula (1) represents a group selected from hydrogen, an alkyl group having 1 to 10 carbon atoms, a cycloalkyl group having 1 to 10 carbon atoms, an alkenyl group having 2 to 10 carbon atoms and an aryl group having 6 to 15 carbon atoms, and a plurality of R^1(s) may be respectively the same or different; R^2 represents a group selected from hydrogen, an alkyl group having 1 to 6 carbon atoms, an acyl group having 2 to 6 carbon atoms and an aryl group having 6 to 15 carbon atoms, and a plurality of R^2(s) may be respectively the same or different; ~~these alkyl groups, acyl groups, and aryl group may be either a non-substitution product or a substitution product;~~ and n represents an integer of 1 to 3; and

wherein R^3 to R^6, in the organosilane represented by the general formula (2), each independently represents a group selected from hydrogen, an alkyl group having 1 to 6 carbon atoms, an acyl group having 2 to 6 carbon atoms and an aryl group having 6 to 15 carbon atoms; ~~these alkyl groups, acyl groups and aryl groups may be either a non-substitution product or a substitution product;~~ and m represents an integer of 1 to 8.

10. The photosensitive resin composition according to any one of claims 1 to 9, wherein the acidic group of the organosilane unit is selected from a carboxy group and an acid anhydride group.

~~13~~11. A method for producing a semiconductor device, which comprises

steps of forming a pattern of the photosensitive resin composition according to any one of claims 1 to ~~12~~ 10 on a semiconductor substrate; firing the pattern of the resin composition to obtain a fired pattern; implanting ions into the region of the semiconductor substrate where the fired pattern does not exist, using the fired pattern as an ion implantation mask; and removing the ion implantation mask.

~~14~~12. The method for producing a semiconductor device according to claim ~~13~~11, wherein the step of implanting ions is performed at 200 to 1,000°C.

~~15~~13. The method for producing a semiconductor device according to claim ~~13~~ 11 or ~~14~~12, wherein the semiconductor substrate is a silicon carbide substrate, a gallium nitride substrate, or a diamond substrate.