polarity developer and the low exposure region is dissolved with an organic solvent-containing developer, whereby the region of medium exposure dose is allowed to remain without being dissolved at the development and a line-and-space pattern having a pitch half the pitch of the exposure mask is formed.

Summary of Invention

An object of the present disclosure~~invention~~ is to solve the above-described problems and provide a pattern forming method capable of forming a pattern favored with wide focus latitude (DOF), small line width variation (LWR) and excellent pattern profile and reduced in the bridge defect, an actinic ray-sensitive or radiation-sensitive resin composition (preferably a chemical amplification resist composition, more preferably a chemical amplification negative resist composition), and a resist film.

The present disclosure~~invention~~ includes the following configurations, and the object above can be attained by these configurations.

[1] A pattern forming method comprising:

(i) a step of forming a film from an actinic ray-sensitive or radiation-sensitive resin composition,

(ii) a step of exposing the film, and

(iii) a step of developing the exposed film by using an organic solvent-containing developer,

wherein the actinic ray-sensitive or radiation-sensitive resin composition comprises:

(A) a resin capable of decreasing the solubility for an organic solvent-containing developer by the action of an acid,

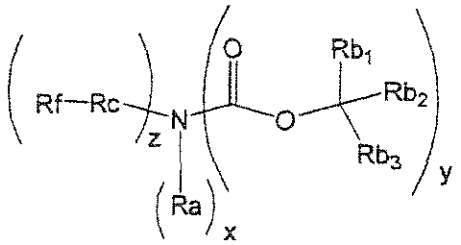
(B) a compound capable of generating an acid upon irradiation with an actinic ray or radiation,

(D) a solvent, and

(G) a compound having at least either one of a fluorine atom and a silicon atom and having basicity or being capable of increasing the basicity by the action of an acid.

[2] The pattern forming method according to the above [1], wherein the resin (A) contains a first repeating unit having a group capable of decomposing by the action of an acid to produce an alcoholic hydroxy group.

[3] The pattern forming method according to the above [1] or [2], wherein the compound (G) is a nitrogen-containing compound.



(1)

wherein, each of Ra, Rb_1, Rb_2 and Rb_3 independently represents a hydrogen atom, an alkyl group, a cycloalkyl group, an aryl group or an aralkyl group, and two members out of Rb_1 to Rb_3 may combine with each other to form a ring, provided that all of Rb_1 to Rb_3 are not a hydrogen atom at the same time,

Rc represents a single bond or a divalent linking group,

Rf represents an organic group,

x represents 0 or 1, y represents 1 or 2, z represents 1 or 2, and x+y+z=3,

when x=z=1, Ra and Rc may combine with each other to form a nitrogen-containing heterocyclic ring,

when z=1, the organic group as Rf contains a fluorine atom or a silicon atom,

when z=2, at least either one of two Rf's contains a fluorine atom or a silicon atom,

when z=2, two Rc's may be the same or different, two Rf's may be the same or different, and two Rc's may combine with each other to form a ring,

when y=2, two Rb_1's may be the same or different, two Rb_2's may be the same or different, and two Rb_3's may be the same or different.

[23] A resin (G) having at least either one of a fluorine atom and a silicon atom, and having a basic group or a group capable of increasing the basicity by the action of an acid.

In the present disclosure~~invention~~, the following embodiments are also preferred.

[24] The pattern forming method according to any one of the above [2] to [12], wherein said first repeating unit is represented by at least one formula selected from the group consisting of the following formulae (I-1) to (I-10):

[42] The actinic ray-sensitive or radiation-sensitive resin composition according to any one of the above [13] to [20], [34] to [41], wherein the resin (A) further contains a repeating unit having a cyano group.

[43] The actinic ray-sensitive or radiation-sensitive resin composition according to any one of the above [13] to [20], [34] to [42], wherein the resin (A) further contains a repeating unit having a group capable of decomposing by the action of an acid to produce a carboxy group.

[43a] In one aspect, there is provided a pattern forming method comprising:

(i) a step of forming a film from a chemical amplification-type resist composition,

(ii) a step of exposing the film, and

(iii) a step of developing the exposed film by using an organic solvent-containing developer,

wherein the resist composition comprises:

(A) a resin capable of decreasing the solubility for an organic solvent-containing developer by the action of an acid,

(B) a compound capable of generating an acid upon irradiation with an actinic ray or radiation,

(D) a solvent, and

(G) a compound having at least either one of a fluorine atom and a silicon atom and having basicity or being capable of increasing the basicity by the action of an acid.

[43b] In another aspect, there is provided a chemical amplification-type resist composition comprising:

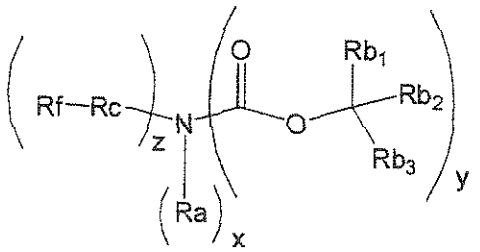
(A) a resin capable of decreasing the solubility for an organic solvent-containing developer by the action of an acid,

(B) a compound capable of generating an acid upon irradiation with an actinic ray or radiation,

(D) a solvent, and

(G) a compound having at least either one of a fluorine atom and a silicon atom and having basicity or being capable of increasing the basicity by the action of an acid,

wherein the compound (G) is a compound represented by the following formula (1):



(1)

wherein, in formula (1),

each of Ra, Rb_1, Rb_2 and Rb_3 independently represents a hydrogen atom, an alkyl group, a cycloalkyl group, an aryl group or an aralkyl group, and two members out of Rb_1 to Rb_3 may combine with each other to form a ring, provided that all of Rb_1 to Rb_3 are not a hydrogen atom at the same time,

Rc represents a single bond or a divalent linking group,

Rf represents an organic group,

x represents 0 or 1, y represents 1 or 2, z represents 1 or 2, and x+y+z=3,

when x=z=1, Ra and Rc may combine with each other to form a nitrogen-containing heterocyclic ring,

when z=1, the organic group as Rf contains a fluorine atom or a silicon atom,

when z=2, at least either one of two Rf's contains a fluorine atom or a silicon atom,

when z=2, two Rc's may be the same or different, two Rf's may be the same or different, and two Rc's may combine with each other to form a ring,

when y=2, two Rb_1's may be the same or different, two Rb_2's may be the same or different, and two Rb_3's may be the same or different.

[43c] In another aspect, there is provided a chemical amplification-type resist composition comprising:

(A) a resin capable of decreasing the solubility for an organic solvent-containing developer by the action of an acid,

(B) a compound capable of generating an acid upon irradiation with an actinic ray or radiation,

(D) a solvent, and

(G) a compound having at least either one of a fluorine atom and a silicon atom and having basicity or being capable of increasing the basicity by the action of an acid,

a hydrophobic resin having a fluorine atom, not corresponding to the compound (G).

[43d] In another aspect, there is provided a chemical amplification-type resist composition comprising:

(A) a resin capable of decreasing the solubility for an organic solvent-containing developer by the action of an acid,

(B) a compound capable of generating an acid upon irradiation with an actinic ray or radiation,

(D) a solvent, and

(G-2) a compound having at least either one of a fluorine atom and a silicon atom and being capable of increasing the basicity by the action of an acid,

wherein the compound (G-2) is a resin.

[43e] In another aspect, there is provided a resist film formed by the chemical amplification-type resist composition as defined above.

According to the present disclosure~~invention~~, a pattern forming method capable of forming a pattern favored with wide focus latitude (DOF), small line width variation (LWR) and excellent pattern profile and reduced in the bridge defect, and an actinic ray-sensitive or radiation-sensitive negative resin composition, can be provided.

Description of Embodiments

An emdobiment for carrying out the present invention is described below.

In the present invention, when a group (atomic group) is denoted without specifying whether substituted or unsubstituted, the group includes both a group having no substituent and a group having a substituent. For example, "an alkyl group" includes not only an alkyl group having no substituent (unsubstituted alkyl group) but also an alkyl group having a substituent (substituted alkyl group).

In the present invention, the term "actinic ray" or "radiation" indicates, for example, a bright line spectrum of mercury lamp, a far ultraviolet ray typified by excimer laser, an extreme-ultraviolet ray (EUV light), an X-ray or an electron beam. Also, in the present invention, the "light" means an actinic ray or radiation. In the present invention, unless otherwise indicated, the "exposure" includes not only exposure to a mercury lamp, a far ultraviolet ray typified by excimer laser, an X-ray, EUV light or the like but also lithography with a particle beam such as electron beam and ion beam.

The pattern formation process necessary for practicing the present invention includes the following steps. A pattern forming method comprising:

(i) a step of forming a film from an actinic ray-sensitive or radiation-sensitive resin composition (preferably a chemical amplification resist composition, more preferably a chemical amplification negative resist composition) (hereinafter also referred to as "composition"),

(ii) a step of exposing the film, and

(iii) a step of developing the exposed film by using an organic solvent-