alkaline solution, which is a developer solution, is reduced in an unexposed portion based on the interaction between the phenolic hydroxyl group of the hydroxystyrene resin and the quinonediazide compound. Consequently, the solubility in the alkaline solution is significantly increased in an exposed portion through the light-induced acid generation by the quinonediazide compound. This difference in the solubility in the alkaline solution between the unexposed portion and the exposed portion allows the production of a positive relief pattern.

[0004]

Furthermore, a positive photosensitive resin composition containing a polyhydroxystyrene resin and alkoxymethyl group or methylol group has been proposed, which achieves an increased sensitivity and a lowered stress (Patent Literature 2).

[0005]

On the other hand, a method of reducing the stress generated during the production of a cured film and thereby achieving a lower warpage has been proposed, in which a flexible alkyl group, alkylene-glycol group, and/or siloxane bond is introduced into the repeating unit of an alkali-soluble cyclized polyimide or polybenzoxazole (Patent Literature 3).

Citation List

Patent Literatures

[0006]

Patent Literature 1: JP 2007-156243 A

Patent Literature 2: JP 4692219 B2

Patent Literature 3: JP 2012-234030 A

Patent Literature 4: JP 2008-224984 A

Summary

Technical Problem

[0007]

Cyclized polyimides containing a flexible group achieve a lowered stress, while they exhibit reduced mechanical properties, which have caused a problem of reduced resistance in a reliability test such as an anti-shock test.

[0008]

Moreover, in polybenzoxazoles containing a flexible group synthesized from an aliphatic dicarboxylic acid (Patent Literature 4), dehydrating cyclization during the curing of the polybenzoxazoles leads to an increased stress on a substrate wafer, which easily causes insufficient reduction of stress. Moreover, it has caused a problem of lowered adhesion to metals (such as copper).

[0009]

The present disclosure will solve problems associated with conventional techniques as described above and provide cured films of high elongation, low stress, and high adhesion to metals, particularly to copper, and semiconductor electronic components and semiconductor devices in which those cured films have been arranged.

Solution to Problem

[0010]

In order to achieve the above object, the present disclosure relates to the following.

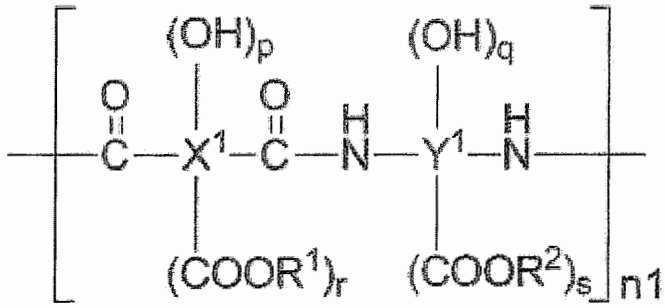
[0011]

That is, the present disclosure relates to a cured film formed by curing a photosensitive resin composition, wherein the photosensitive resin composition comprises a polyhydroxyamide, and wherein the rate of ring-closure of the polyhydroxyamide in the cured film is not more than 10%.

[0011a]

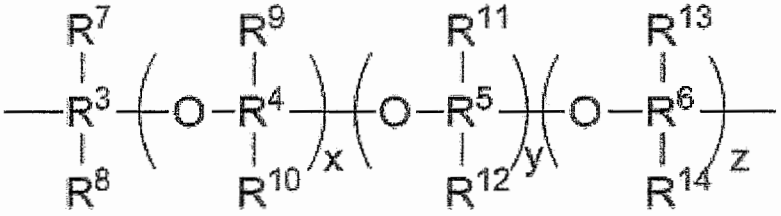
In an aspect, there is provided a cured film formed by curing a photosensitive resin composition, wherein the photosensitive resin composition comprises a polyhydroxyamide, and wherein the rate of ring-closure of the polyhydroxyamide is not more than 10%, and

wherein the polyhydroxyamide has a structural unit (A) represented by the general formula (1):



(1)

wherein X^1 and Y^1 each independently represent an organic group having two to eight valences and containing two or more carbon atoms; R^1 and R^2 each independently represent either a hydrogen atom or a C_1-C_{20} organic group; n1 is an integer number from 2 to 500; p and q are each independently an integer number from 0 to 4; and r and s each independently represent an integer number from 0 to 2, and wherein the polyhydroxyamide has a polyether structural unit represented by the general formula (2):



(2)

wherein R^3 to R^6 each independently represent a C_1-C_6 alkylene group; R^7 to R^{14} each independently represent a hydrogen atom, fluorine atom, or C_1-C_6 alkyl group; and x, y, and z each independently represent an integer number from 0 to 35, and wherein the structure indicated in each parenthesis is different each other.

[0012]

Also, the present disclosure relates to a method of manufacturing the cured

film, the method comprising the steps of: applying the photosensitive resin composition onto a substrate and drying it to form a photosensitive resin film, or forming a photosensitive sheet from the photosensitive resin composition and laminating it onto a substrate to form a photosensitive resin film; exposing the resulting film to light through a mask; dissolving or removing the exposed portion with an alkaline solution; and heat-treating the developed photosensitive resin film.

[0012a]

In another aspect, there is provided a method of manufacturing the cured film as defined above, the method comprising the steps of: applying the photosensitive resin composition onto a substrate and drying it to form a photosensitive resin film, or forming a photosensitive sheet from the photosensitive resin composition and laminating it onto a substrate to form a photosensitive resin film; exposing the photosensitive resin film to light; developing the resulting film; and heat-treating the resulting film.

[0013]

Also, the present disclosure relates to an interlayer insulating film or semiconductor protective film, semiconductor electronic component, and semiconductor device, to which the cured film has been arranged.

[0013a]

In another aspect, there is provided an interlayer insulating film or semiconductor protective film in which the cured film as defined above is arranged.

[0013b]

In another aspect, there is provided a semiconductor electronic component or semiconductor device comprising a relief pattern layer of the cured film as defined above.

[0013c]

In another aspect, there is provided a semiconductor electronic component or

semiconductor device, wherein the cured film as defined above is arranged as an interlayer insulating film between re-wiring layers.

[0013d]

In an aspect, there is provided a semiconductor electronic component or semiconductor device, wherein the cured film as defined above is arranged as an interlayer insulating film between adjacent substrates composed of two or more different kinds of materials.

Advantageous Effects

[0014]

According to the present disclosure, a cured film of high elongation, low stress, and high adhesion to metals, particularly to copper, can be obtained. Moreover, electronic components or semiconductor devices according to the present disclosure have a pattern having a preferable shape, preferable adhesion properties, and excellent heat resistance, which make them highly reliable.

Brief Description of Drawings

[0015]

Fig. 1 depicts an enlarged cross-sectional view of a pad portion of a semiconductor device having a bump.

Fig. 2 depicts a detailed method of producing a semiconductor device having a bump.

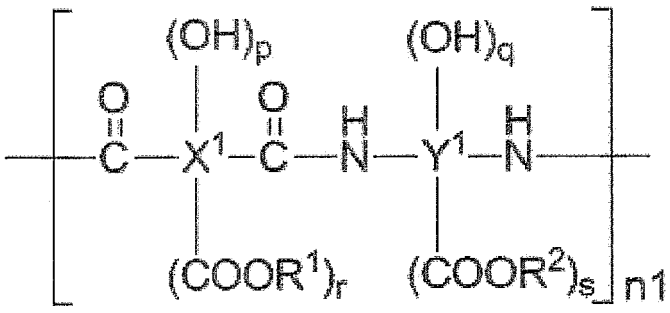
Description of Embodiments

[0016]

The cured film is a cured film formed by curing a photosensitive resin composition, wherein the photosensitive resin composition comprises a polyhydroxyamide, and wherein the rate of ring-closure of the polyhydroxyamide in

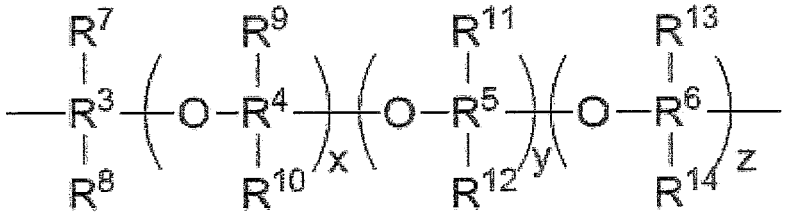
CLAIMS

1. A cured film formed by curing a photosensitive resin composition, wherein the photosensitive resin composition comprises a polyhydroxyamide, and wherein the rate of ring-closure of the polyhydroxyamide is not more than 10%, and wherein the polyhydroxyamide has a structural unit (A) represented by the general formula (1):



(1)

wherein X^1 and Y^1 each independently represent an organic group having two to eight valences and containing two or more carbon atoms; R^1 and R^2 each independently represent either a hydrogen atom or a C_1-C_{20} organic group; n1 is an integer number from 2 to 500; p and q are each independently an integer number from 0 to 4; and r and s each independently represent an integer number from 0 to 2, and wherein the polyhydroxyamide has a polyether structural unit represented by the general formula (2):



(2)

wherein R^3 to R^6 each independently represent a C_1-C_6 alkylene group; R^7 to R^{14} each independently represent a hydrogen atom, fluorine atom, or C_1-C_6 alkyl group; and x, y, and z each independently represent an integer number from 0 to 35, and wherein the structure indicated in each parenthesis is different each other.

2. The cured film according to claim 1, wherein the rate of ring-closure of the polyhydroxyamide in the cured film is not less than 0.1% and not more than 10%.

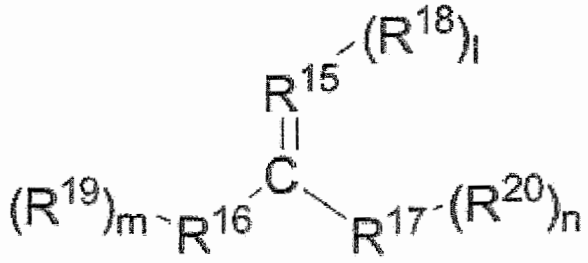
3. The cured film according to claim 1 or 2, wherein the molecular weight of the polyether structural unit represented by the general formula (2) is not less than 150 and not more than 2,000.

4. The cured film according to any one of claims 1 to 3, wherein the content of the polyether structural unit represented by the general formula (2) is 5 to 40% by mole of the total diamine residues.

5. The cured film according to any one of claims 1 to 4, wherein the photosensitive resin composition further comprises a compound (B) that generates an acid upon light exposure, and a heat-crosslinker (C).

6. The cured film according to any one of claims 1 to 5, wherein the polyhydroxyamide is a poly(*o*-hydroxyamide).

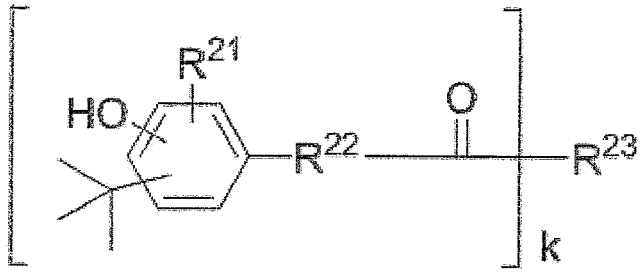
7. The cured film according to any one of claims 1 to 6, wherein the photosensitive resin composition further comprises a compound (D) represented by the general formula (3):



(3)

wherein in the general formula (3), R^{15} to R^{17} represent an O, S, or N atom, provided that at least one of R^{15} to R^{17} represents an S atom; l is 0 or 1; m and n represent an integer number from 0 to 2; and R^{18} to R^{20} each independently represent a hydrogen atom or a C_1-C_{20} organic group.

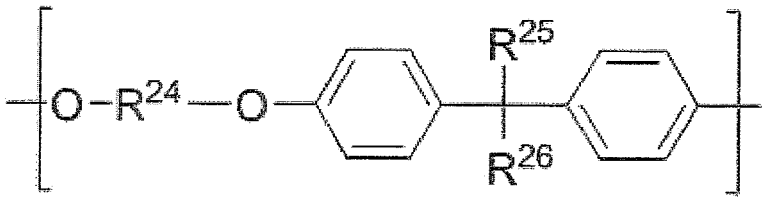
8. The cured film according to any one of claims 1 to 7, further comprising a compound (E) represented by the general formula (4) below:



(4)

wherein in the general formula (4), R^{21} represents a hydrogen atom or an alkyl group containing two or more carbon atoms; R^{22} represents an alkylene group containing two or more carbon atoms; R^{23} represents an organic group having one to four valences and comprising at least any of an alkylene group containing two or more carbon atoms, O atom, and N atom; and k represents an integer number from 1 to 4.

9. The cured film according to any one of claims 1 to 8, further comprising a heat-crosslinker (F) having a structural unit represented by the general formula (5) below:



(5)

wherein in the general formula (5), R^{25} and R^{26} each independently represent a hydrogen atom or methyl group; and R^{24} is a divalent organic group comprising an alkylene group containing two or more carbon atoms, which may be linear, branched, or cyclic.

10. The cured film according to any one of claims 1 to 9, wherein the content of the compound (E) represented by the general formula (4) is in the range of 10 to 50 parts by mass relative to 100 parts by mass of the heat-crosslinker (F) having a structural unit represented by the general formula (5).

11. A method of manufacturing the cured film according to any one of claims 1 to 10, the method comprising the steps of: applying the photosensitive resin

composition onto a substrate and drying it to form a photosensitive resin film, or forming a photosensitive sheet from the photosensitive resin composition and laminating it onto a substrate to form a photosensitive resin film; exposing the photosensitive resin film to light; developing the resulting film; and heat-treating the resulting film.

12. The method of manufacturing the cured film according to claim 11, wherein the step of heat-treating the photosensitive resin film includes the heat-treatment step at a temperature not lower than 170°C and not higher than 250°C.

13. An interlayer insulating film or semiconductor protective film in which the cured film according to any one of claims 1 to 10 is arranged.

14. A semiconductor electronic component or semiconductor device comprising a relief pattern layer of the cured film according to any one of claims 1 to 10.

15. A semiconductor electronic component or semiconductor device, wherein the cured film according to any one of claims 1 to 10 is arranged as an interlayer insulating film between re-wiring layers.

16. The semiconductor electronic component or semiconductor device according to claim 15, wherein a combination of the re-wiring layer and the interlayer insulating film is repeatedly arranged two to ten times.

17. A semiconductor electronic component or semiconductor device, wherein the cured film according to any one of claims 1 to 10 is arranged as an interlayer insulating film between adjacent substrates composed of two or more different kinds of materials.