Aspect 3: The aqueous alkali solution according to Aspect 1 or 2, wherein R^1, R^2, and R^3 in Formula (1) are methyl groups, and R^4 in Formula (1) is an alkyl group having carbon number from 2 to 16.

Aspect 4: The aqueous alkali solution according to any one of Aspects 1 to 3, wherein the halide ion (B) is a chloride ion or a bromide ion.

Aspect 5. The aqueous alkali solution according to any one of Aspects 1 to 4, wherein a part by mass of the halide ion is 0.0000001 to 0.01 parts by mass when a mass of the hydroxide ion in the aqueous alkali solution is 1 part by mass.

Aspect 6: The aqueous alkali solution according to any one of Aspects 1 to 5, wherein an LD50 value converted assuming that a hydroxide of the quaternary ammonium ion is taken as 100 mass%, in a toxicity test using a rat based on an acute oral toxicity test in accordance with OECD Test Guideline 420, is more than 50 mg/kg.

Aspect 7: The aqueous alkali solution according to any one of Aspects 1 to 6, wherein an EC50 value converted assuming that a hydroxide of the quaternary ammonium ion is taken as 100 mass%, in aDaphnia sp. acute immobilisation test in accordance with OECD Test Guideline 202, is more than 3 mg/L.

Aspect 8: The aqueous alkali solution according to any one of Aspects 1 to 7, further containing one or more compounds selected from the group consisting of an alcohol and an amine.

Aspect 9: The aqueous alkali solution according to any one of Aspects 1 to 8, further containing a surfactant, wherein a concentration of the surfactant in the aqueous alkali solution is less than 100 mass ppm.

Aspect 10: The aqueous alkali solution according to any one of Aspects 1 to 9, wherein the corrosion inhibitor (E) is one or more selected from the group consisting of an azole, an alkyne compound, and an aromatic hydroxy compound.

Aspect 11: A method for using the aqueous alkali solution according to any one of Aspects 1 to 10 as a low toxic aqueous alkali solution for semiconductors.

Aspect 12: A method for producing the aqueous alkali solution according to any one of Aspects 1 to 10, the method including an electrolysis step of electrolyzing an aqueous quaternary ammonium halide solution containing the following (A), (B), and (D), and a step of adding (E) a corrosion inhibitor to the aqueous solution obtained in the electrolysis step:

(A) a quaternary ammonium ion represented by Formula (1) below;

(B) a halide ion; and

(D) water

[Chem. 2]

Data were collected for the 50% effective concentration (EC50) in the Daphnia sp. acute immobilisation test. The aqueous quaternary ammonium hydroxide solutions for which no data was disclosed were subjected to a toxicity test based on the Daphnia sp. acute immobilisation test in accordance with OECD Test Guideline 202 to yield data.

The obtained 50% effective concentration was converted to 100 mass% of the aqueous quaternary ammonium hydroxide solution, and evaluation was performed based on the following criteria. In a case where two or more types of aqueous quaternary ammonium hydroxide solutions were mixed, the median lethal dose of each aqueous quaternary ammonium hydroxide solution was multiplied by the mixing ratio, and the sum of the resulting values was determined. The results are shown in Table 1.

A: 50% effective concentration of more than 10 mg/L

B: 50% effective concentration of more than 3 mg/L to 10 mg/L or less

C: 50% effective concentration of 3 mg/L or less

The aqueous alkali solution evaluated as A or B can be said to be a low toxic aqueous alkali solution, and is preferably evaluated as A.

In addition, even when the ecotoxicity is evaluated as C, if the acute oral toxicity is evaluated as A to B, the aqueous solution can be evaluated as low toxicity.

[0050]

5) Development Test

4-inch silicon wafers were prepared, and the surfaces thereof were washed with sulfuric acid-hydrogen peroxide (volume ratio: 4 : 1). The silicon wafers were baked on a hot plate at 200°C for 60 seconds. Then, a positive photoresist (novolac resin) was applied to the silicon wafers using a spinner to yield positive photoresist films each having a thickness of 3.5 μm. Next, these photoresist films were irradiated with g-, h-, and i-rays having a wavelength of 300 to 500 nm through a mask pattern, and then various aqueous alkali solutions were dropped thereon. The development time was set to 8 minutes or 12 minutes, and the photoresist films were left to stand at 23°C, then washed with ultrapure water, and dried to yield a 20 μm contact hole pattern.

The presence or absence of scum and the shape of the obtained resist pattern were confirmed by SEM, and evaluation was performed based on the following criteria. The results are shown in Table 1.

A: No scum is generated in both cases of the development time of 8 minutes and 12 minutes, and the side wall of the recessed portion of the pattern is upright

B: Scum is observed in a part of the recessed portion in the case of the development time of 8 minutes, but no scum is generated in the case of the development time of 12 minutes, and the side wall of the recessed portion of the pattern is upright

C: Scum is generated in both the cases of the development time of 8 minutes and 12 minutes, and/or the side wall of the recessed portion of the pattern is not upright

R^4 is a C2-16 alkyl group.)