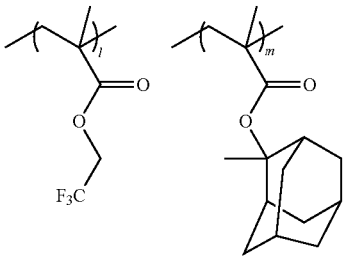
[Chemical Formula 72]

(F-1)



[0733] <Formation of Resist Pattern>

[0734] Each of the resist compositions of examples and comparative examples was applied to an 8-inch silicon substrate which had been treated with hexamethyldisilazane (HMDS) using a spinner, and was then prebaked (PAB) on a hot plate at 110° C. for 60 seconds and dried, thereby forming a resist film having a film thickness of 90 nm.

[0735] Subsequently, the resist film was selectively irradiated with an ArF excimer laser (193 nm) through a mask pattern with a predetermined target (hole diameter: 67 nm, pitch: 130 nm), using an ArF exposure apparatus S610C (NA=1.20; Annular, 0.90/0.70).

[0736] Then, a post exposure bake (PEB) treatment was conducted at 80° C. for 60 seconds.

[0737] Next, a solvent development was conducted at 23° C. for 30 seconds using butyl acetate, followed by a rinse treatment.

[0738] As a result, a contact hole pattern (CH) having a hole diameter of 73 nm and a pitch of 130 nm was formed.

[0739] [Evaluation of Optimum Exposure Dose (Eop)]

[0740] The optimum exposure dose Eop (mJ/cm^2) with which a CH pattern having a target size was formed in the above "Formation of resist pattern" was determined. The results are indicated under "Eop (mJ/cm^2)" in Table 2.

[0741] [Evaluation of in-Plane Uniformity (CDU) of Pattern Size]

[0742] With respect to each CH pattern obtained in the "Formation of resist pattern", 100 holes in the CH pattern were observed from the upper side thereof using a measuring scanning electron microscope (SEM) (product name: S-9380, manufactured by Hitachi High-Technologies Corporation; acceleration voltage: 300V), and the hole diameter (nm) of each hole was measured. From the results, the value of 3 times the standard deviation (σ) (3σ) was determined. The results are indicated under "CDU (nm)" in Table 2.

[0743] The smaller the thus determined 3σ value is, the higher the level of the dimension uniformity (CD uniformity) of the holes formed in the resist film.

[0744] [Evaluation of Circularity]

[0745] With respect to each CH pattern obtained above "Method of forming resist pattern", 25 holes in the CH pattern were observed from the upper side thereof using a length measuring scanning electron microscope (SEM) (product name: S-9380, manufactured by Hitachi High-Technologies Corporation; acceleration voltage: 300V), and the distance from the center of each hole to the outer periphery of the hole was measured in 24 directions. From the results, the value of 3 times the standard deviation (σ) (3σ) was determined. The results are indicated under "Circularity (nm)" in Table 2.

[0746] The smaller this 3σ value is, the higher the level of circularity of the holes.

TABLE 2

	PAB (° C.)	PEB (° C.)	Eop (mJ/cm^2)	CDU (nm)	Circularity (nm)
Example 1	110	80	14.4	4.4	2.7
Comparative Example 1	110	80	20.9	5.2	3.1
Comparative Example 2	110	80	17.3	4.9	2.9
Comparative Example 3	110	80	21.2	5.5	2.7
Comparative Example 4	110	80	16.5	5.7	2.4

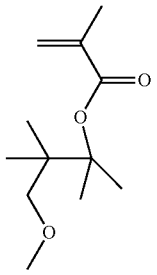
[0747] From the results shown in Table 2, as compared to the resist compositions of Comparative Examples 1 to 4, the resist composition of Example 1 could improve sensitivity and lithography properties, and a resist pattern having a good shape could be formed.

[0748] <Production Example of Monomer (a02)>

[0749] Using 2,3,3-trimethyl-4-methoxy-2-butanol obtained by reacting 3,3-dimethyl-4-methoxy-2-butanone with methylmagnesium bromide, an objective monomer (a02), namely, 2,3,3-trimethyl-4-methoxybutan-2-yl methacrylate having the following NMR properties was obtained with reference to the synthesis example described at paragraph 0090 of WO2013/042694.

[Chemical Formula 73]

(a02)



[0750] The obtained monomer (a02) was analyzed by NMR, and the structure thereof was identified by the following results.

[0751] ^{1}H-NMR ($CDCl_3$) δ(ppm)=6.01 (m, 1H), 5.50 (m, 1H), 3.11 (s, 3H), 3.08 (s, 2H), 1.94 (t, 3H), 1.78 (s, 6H), 1.12 (s, 6H).

[0752] <Production Example of Copolymer (A1'-1-1)>

[0753] To a 300 mL-flask were added 11.3 g of monomer (a01), 15.9 g of p-ethoxyethoxystryene (EESt), 1.1 g of dimethyl 2,2'-azobis(isobutyrate) (V-601) as a polymerization initiator and 65 g of methyl ethyl ketone (MEK) as a solvent, followed by conducting a polymerization reaction at 85° C. for 5 hours.

[0754] Then, to the obtained polymer liquid was added 17.3 g of acetic acid and 246 g of methanol, followed by conducting a deprotection reaction at 30° C.° C. for 8 hours. After the reaction finished, 400 g of heptane was added to the obtained reaction liquid and stirred, and the reaction liquid was allowed to stand, followed by removing the upper