about 1 part by weight of tetramethylammonium hydroxide was used as the basic additive.

Example 6

A chemically amplified resist composition was manufactured in the same manner as in the Example 3, except that about 1 part by weight of tetramethylammonium hydroxide was used as the basic additive.

Example 7

A chemically amplified resist composition was manufactured in the same manner as in the Example 4, except that about 1 part by weight of tetramethylammonium hydroxide was used as the basic additive.

Example 8

A chemically amplified resist composition was manufactured in the same manner as in the Example 2, except that about 1.25 parts by weight of tetramethylammonium hydroxide was used as the basic additive.

Example 9

A chemically amplified resist composition was manufactured in the same manner as in the Example 3, except that about 1.25 parts by weight of tetramethylammonium hydroxide was used as the basic additive.

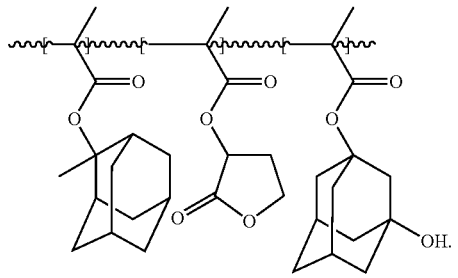
Example 10

A chemically amplified resist composition was manufactured in the same manner as in the Example 4, except that about 1.25 parts by weight of tetramethylammonium hydroxide was used as the basic additive.

Comparative Example 1

A chemically amplified resist composition was manufactured in the same manner as in the Example 1, except that about 100 parts by weight of a methacrylate copolymer represented as Chemical formula 22 below was used instead of using about 100 parts by weight of the copolymer obtained in the synthesis example 15.

[Chemical formula 22]



Comparative Example 2

A chemically amplified resist composition was manufactured in the same manner as in the Comparative Example 1, except that about 1 parts by weight of tetramethylammonium hydroxide was used as the basic additive.

Comparative Example 3

A chemically amplified resist composition was manufactured in the same manner as in the Comparative Example 1, except that about 1.25 parts by weight of tetramethylammonium hydroxide was used as the basic additive.

2. Estimating Characteristics of Chemically Amplified Resist Composition

The chemically amplified resist compositions respectively manufactured through Examples 1 to 10, and the Comparative Examples 1 to 3 were coated on a substrate using a spinner, and dried for about 90 seconds at about 110° C. to form a resist layer having a thickness of about 0.2 μm. Next, the formed resist layer was exposed using an ArF excimer laser stepper (lens numerical aperture: about 0.75), and subjected to a heat treatment at about 120° C. for about 90 seconds. Next, the resist layer was developed for about 40 seconds using about 2.38 wt % of a tetramethylammonium hydroxide aqueous solution, and then washed and dried to form a resist pattern. In this regard, sensitivity, resolution, and characteristics of line edge roughness were measured, and the results are shown in Table 1 below. Here, the sensitivity may denote an optimal exposure amount enabling a Line and Space (L/S) pattern of about 0.12 μm formed after developing to be formed to have a line width of 1:1. Also, the resolution may denote a minimal pattern numerical value formed in the sensitivity. Also, the line edge roughness was measured using a critical-dimension-measurement scanning electron microscope (CD-SEM), and a degree of the line edge roughness was classified into five levels, which were 1 (significantly bad), 2 (bad), 3 (moderate), 4 (good), and 5 (significantly good).

TABLE 1

	Sensitivity (mJ/cm^2)	Resolution (nm)	Line edge roughness
Example 1	10	100	5
Example 2	15	90	4
Example 3	14	100	3
Example 4	16	100	5
Example 5	11	110	4
Example 6	11	100	4
Example 7	13	120	5
Example 8	10	110	3
Example 9	10	120	4
Example 10	11	120	5
Comparative Example 1	16	90	3
Comparative Example 2	15	100	4
Comparative Example 3	17	100	2

Referring to Table 1, the resolutions in the Examples and Comparative Examples were similar, however, the sensitivity and characteristics of line edge roughness were relatively excellent in the Examples than in the Comparative Examples. Particularly, the sensitivity was significantly excellent in Examples 1, 8, and 9, and the characteristics of line edge roughness was significantly excellent in Examples 1, 4, 7, and 10.

As described above, according to the exemplary embodiments, the PAG is connected with a main chain of the copolymer, whereby the PAG may be equally dispersed within the resist layer. As a result, characteristics of line edge roughness