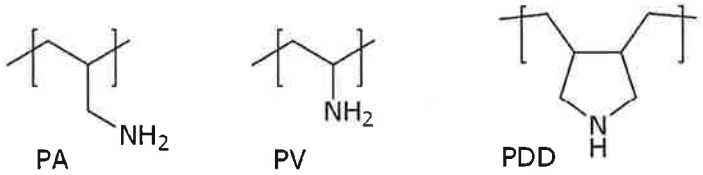
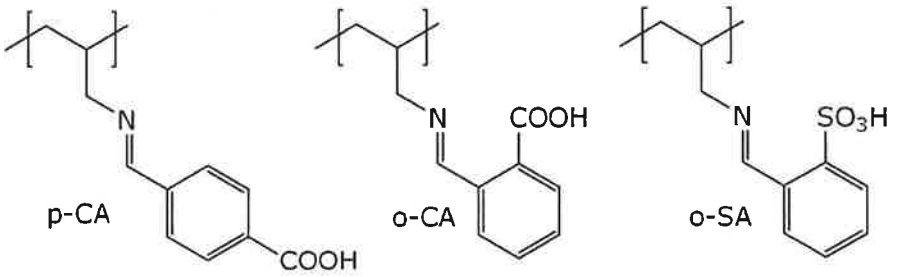
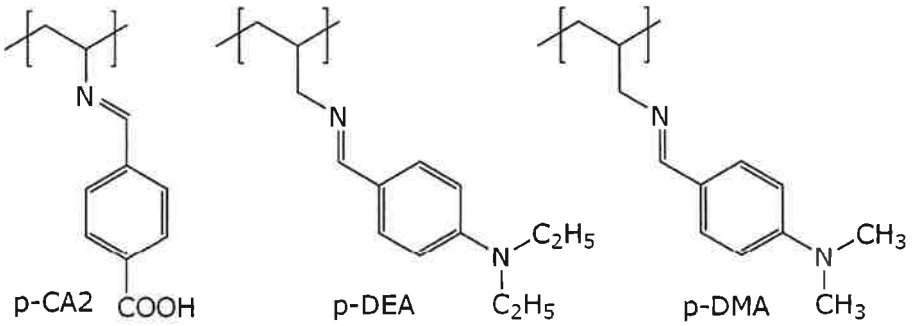
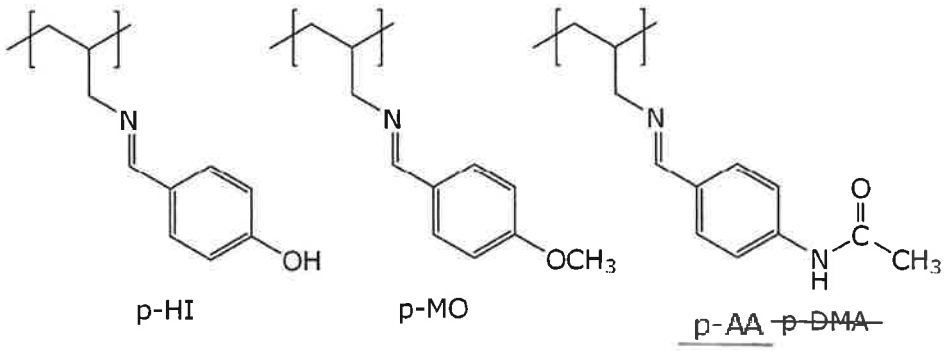
[0100] In the table, symbols of repeating units are as follows:









[0101] Examples and Comparative Examples

Compositions for forming superfine patterns were formulated using prepared polymers and the characteristics thereof were evaluated as follows:

[0102] Evaluation on dimension reduction

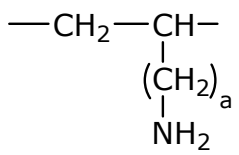
CLAIMS

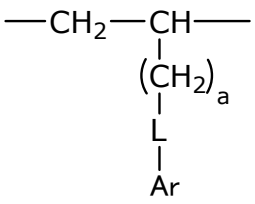
[1] A composition for forming a superfine pattern, comprising pure water and a water-soluble resin represented by the following formula (1):

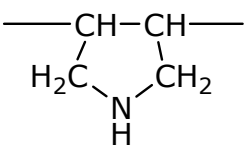
$$-X_p-Y_q-Z_r- \qquad (1)$$

wherein

X, Y and Z are repeating units of

X = 

Y = 

Z= 

,

respectively;

p, q and r are numbers of polymerization ratios of said repeating units X, Y and Z, respectively, provided that they satisfy the conditions of $0.60 \leq p+r \leq 0.95$ and $0.05 \leq q \leq 0.40$ and that each repeating unit may combine with each other either randomly or to form a block;

a in said repeating unit X or Y is an integer of 0 or 1;

L in said repeating unit Y is a divalent linking group selected from the group consisting of

-N=CH-,

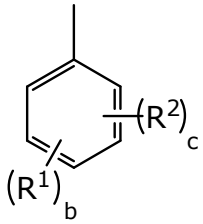
-NH-CHR^0-,

-NH-CH$_2$-CHR^0- and

-NH-CHR^0-CH$_2$-

where R^0 is selected from the group consisting of -H, -CH$_3$, -COOH, -CH$_2$COOH, –CH(CH$_3$)$_2$ and –COOC$_2$H$_5$;

Ar in said repeating unit Y is a group represented by the following formula:



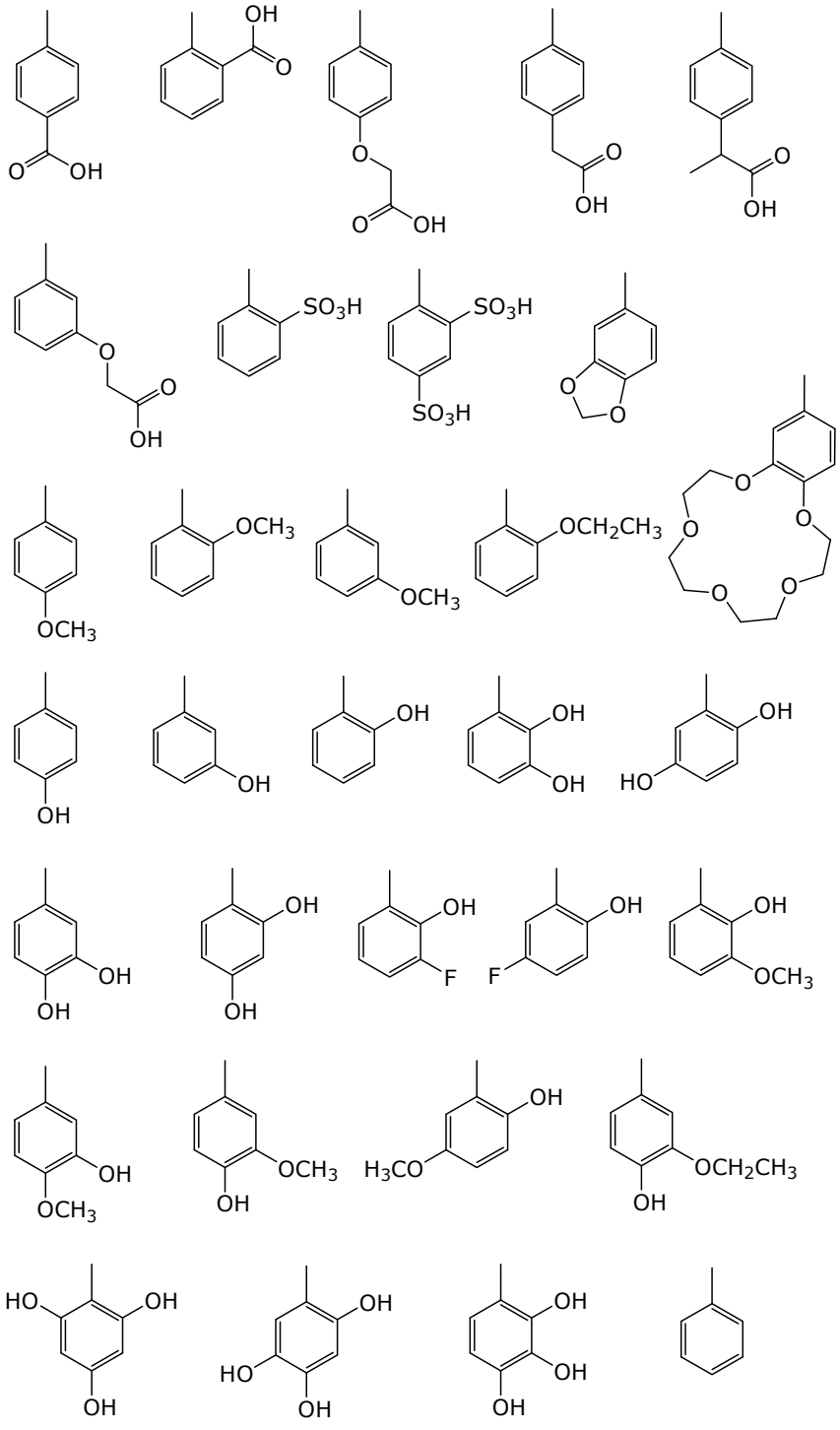
where b is an integer of 0 to 5; c is an integer of 0 to 5-b;

R^1 is an organic group comprising elements selected from the group consisting of carbon, nitrogen, oxygen and fluorine; in the case where b is 2 or more, two R^1s may combine with each other to form a ring structure; and R^2 is an acid group selected from the group consisting of –COOH, $-CH_2COOH$, $-CH(CH_3)COOH$, $-OCH_2COOH$~~,~~ and $-SO_3H$ ~~and –OH~~;

said repeating unit Y contains at least one acid group; and each of said repeating units X and Y may be a combination of repeating units having different structures, respectively.

[2] The composition for forming a superfine pattern according to claim 1, wherein R^1 is selected from the group consisting of alkyl, alkoxy, hydroxy alkyl, substituted amino, non-substituted amino, alkylether, alkylester, alkylamido, fluorine atom and fluorinated alkoxy.

[3] The composition for forming a superfine pattern according to claim 1, wherein Ar is a group selected from the following groups:


OH
O
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OH
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OH
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OH
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OH
O
O
OH
SO3H
SO3H
SO3H
O
O
O
OCH3
OCH3
OCH3
OCH2CH3
O
O
O
O
O
OCH3
OH
OH
OH
OH
OH
HO
OH
OH
OH
OH
OH
F
F
OH
OCH3
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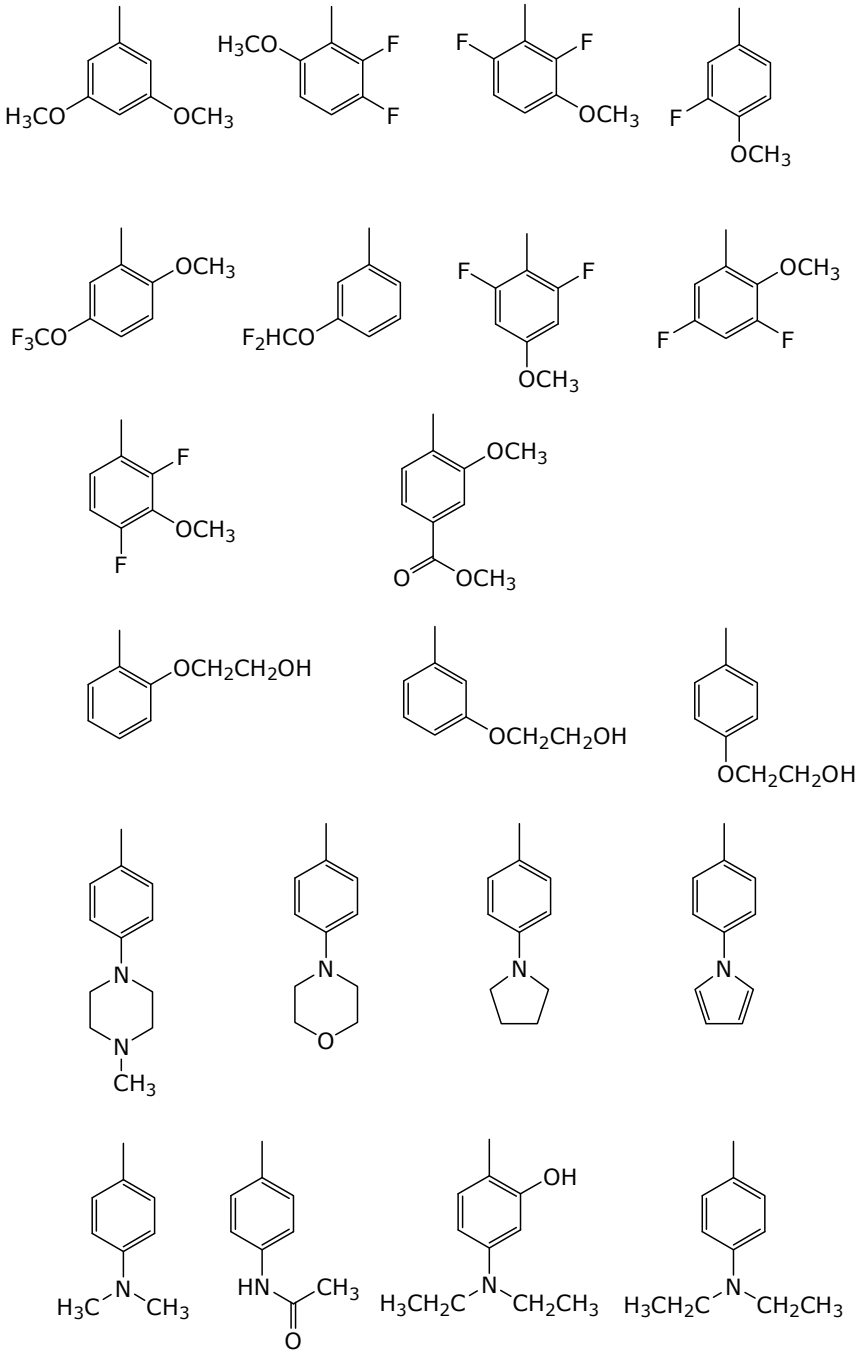
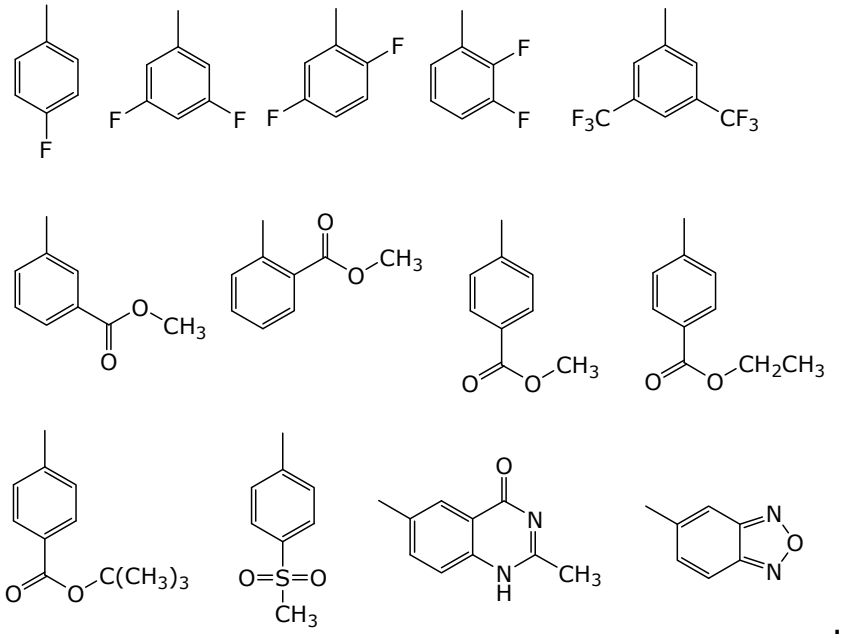
OH
HO
OH
OH
OH
OH


H3CO
OCH3
H3CO
F
F
F
F
OCH3
F
OCH3
OCH3
F3CO
F2HCO
F
F
OCH3
OCH3
F
F
F
OCH3
OCH3
O
OCH3
OCH2CH2OH
OCH2CH2OH
OCH2CH2OH
N
N
CH3
N
O
N
N
H3C
N
CH3
HN
CH3
O
OH
H3CH2C
N
CH2CH3
H3CH2C
N
CH2CH3

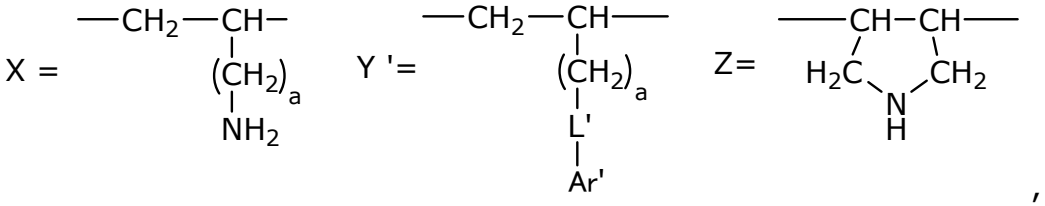


[4] A composition for forming a superfine pattern, comprising pure water, an acid and a water-soluble resin represented by the following formula (1'):

$$-X_p-Y'_q-Z_r- \qquad (1')$$

wherein

X, Y' and Z are repeating units of



respectively;

p, q and r are numbers of polymerization ratios of said repeating units X, Y' and Z, respectively, provided that they satisfy the conditions of $0.60 \leq p+r \leq 0.95$ and $0.05 \leq q \leq 0.40$ and that each repeating unit may combine with each other either randomly or to form a block;

a in said repeating unit X or Y' is an integer of 0 or 1;

L' in said repeating unit Y' is a divalent linking group selected from the group consisting of

-N=CH-,

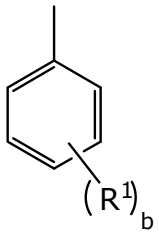
-NH-CHR$^{0'}$-,

-NH-CH_2-CHR$^{0'}$- and

-NH-CHR$^{0'}$-CH_2-

where R$^{0'}$ is selected from the group consisting of -H, -CH_3, –$CH(CH_3)_2$ and –$COOC_2H_5$;

Ar' in said repeating unit Y' is a group represented by the following formula:



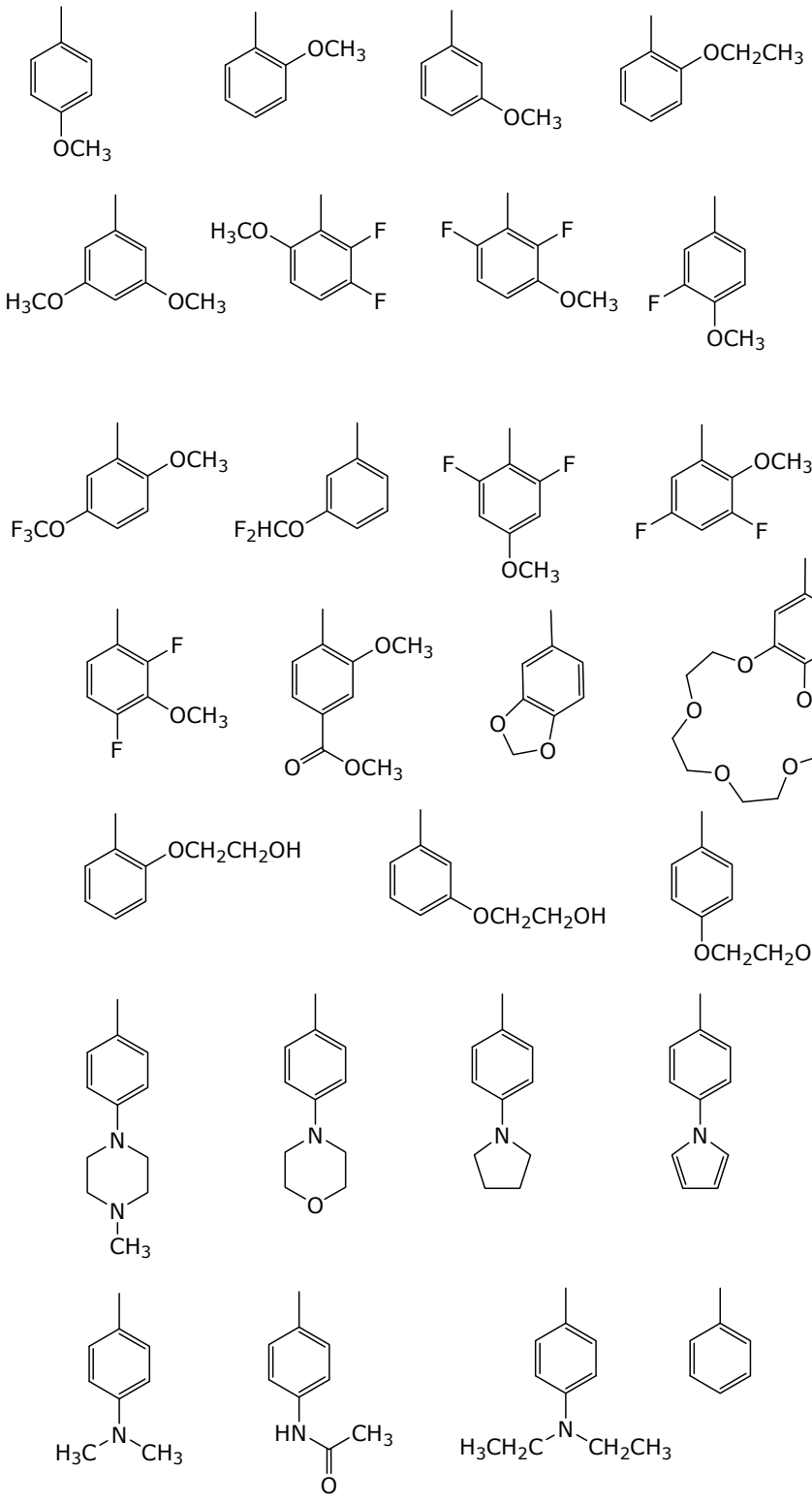
where b is an integer of 0 to 5; R^1 is an organic group comprising elements selected from the group consisting of carbon, nitrogen, oxygen and fluorine; and in the case where b is 2 or more, two R^1s may combine with each other to form a ring structure;

and

each of said repeating units X and Y' may be a combination of repeating units having different structures, respectively.

[5] The composition for forming a superfine pattern according to claim 4, wherein R^1 is selected from the group consisting of alkyl, alkoxy, hydroxy alkyl, substituted amino, non-substituted amino, alkylether, alkylester, alkylamido, fluorine atom and fluorinated alkoxy.

[6] The composition for forming a superfine pattern according to claim 4, wherein Ar' is a group selected from the following groups:


OCH3
OCH3
OCH3
OCH2CH3
OCH3
H3CO
OCH3
H3CO
F
F
F
F
OCH3
F
OCH3
OCH3
F3CO
F2HCO
F
F
OCH3
OCH3
F
F
F
OCH3
OCH3
O
O
F
OCH3
O
OCH3
O
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O
O
OCH2CH2OH
OCH2CH2OH
OCH2CH2OH
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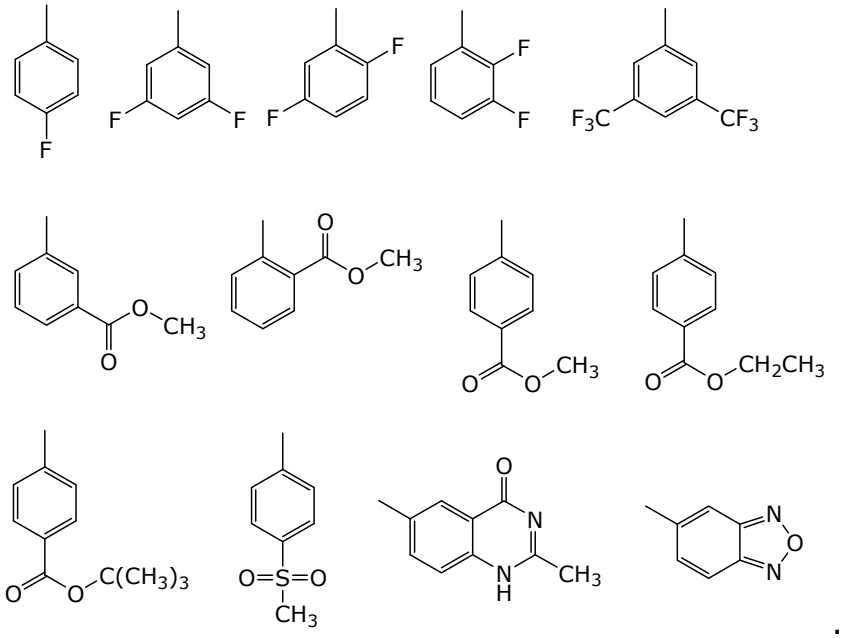
N
CH3
HN
CH3
O
H3CH2C
N
CH2CH3



[7] The composition for forming a superfine pattern according to any one of claims 4 to 6, wherein said acid is selected from the group consisting of nitric acid, sulfuric acid, acetic acid, benzenesulfonic acid, p-toluenesulfonic acid, 2-naphthalenesulfonic acid, 1,3-benzenedisulfonic acid, 1,5-naphthalenedisulfonic acid and 2,7-naphthalenedisulfonic acid.

[8] A composition for forming a superfine pattern, comprising pure water and a water-soluble resin; wherein

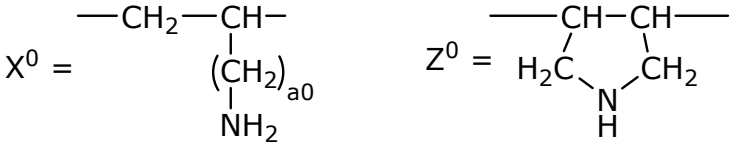
said water-soluble resin is a product of the reaction of

a backbone polymer represented by the following formula (2):

$$-X^0_{p0}-Z^0_{r0}- \qquad (2)$$

in which

X^0 and Z^0 are repeating units of



, respectively;

p0 and r0 are numbers of polymerization ratios of said repeating

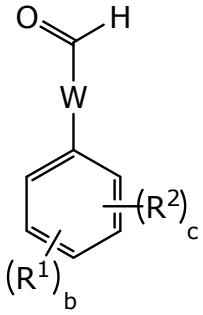
units X^0 and Z^0, respectively, provided that they satisfy the conditions of $0.05 \leq p0 \leq 1$ and $0 \leq r0 \leq 0.95$ and that each repeating unit may combine with each other either randomly or to form a block;

a0 in said repeating unit X^0 is an integer of 0 or 1; and

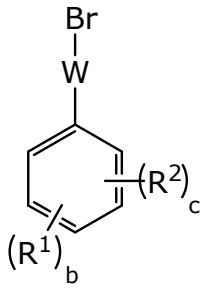
said repeating unit X^0 may be a combination of repeating units having different a0 integers;

with

at least one side-chain forming compound represented by the following formula (3A) or (3B):



(3A)



(3B)

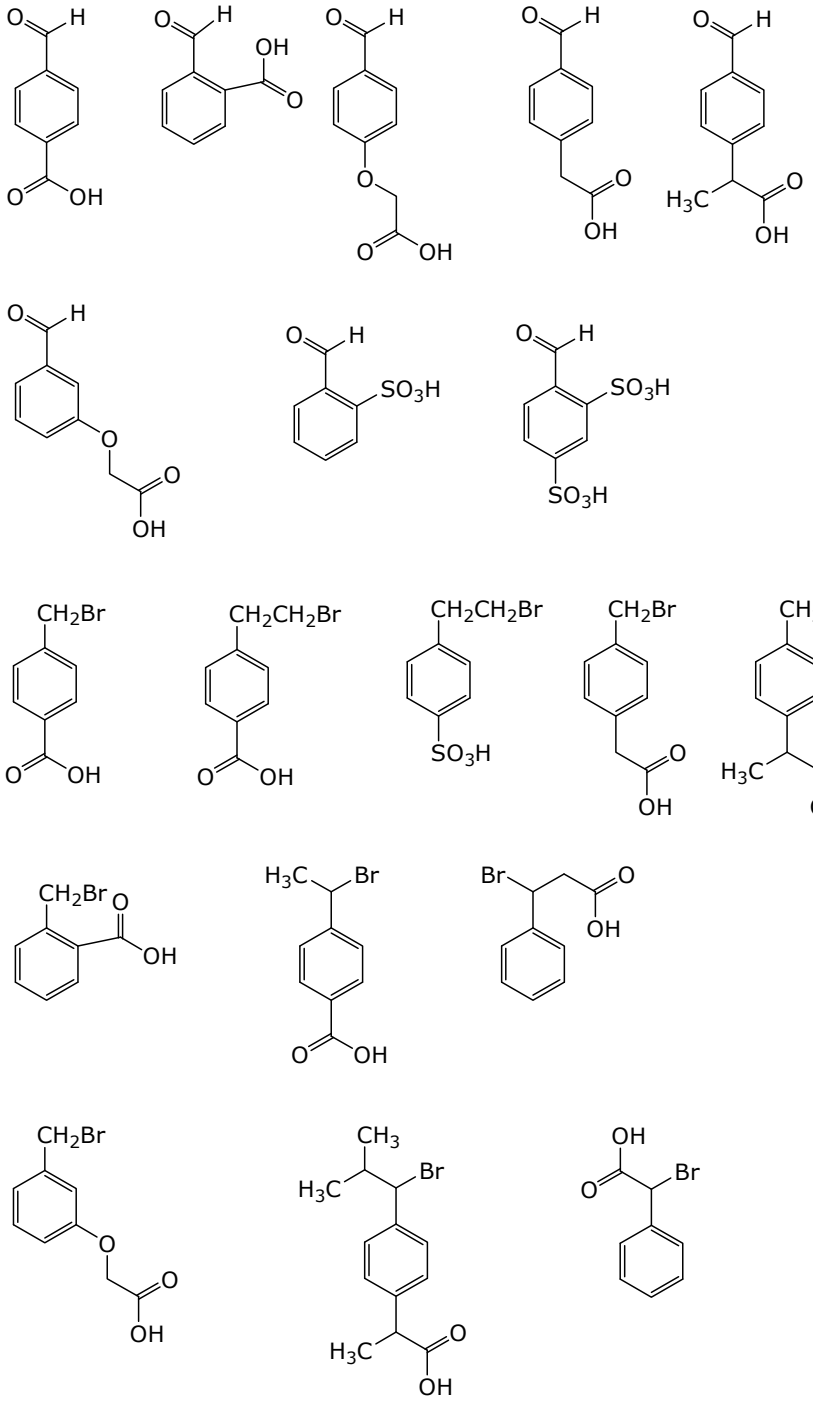
in which b is an integer of 0 to 5; c is an integer of 0 to 5-b; W is a single bond or a divalent linking group selected from the group consisting of $-CHR^0-$ and $-CHR^0-CH_2-$ where R^0 is selected from the group consisting of -H, $-CH_3$, $-CH(CH_3)_2$, -COOH, $-CH_2COOH$ and $-COOC_2H_5$; R^1 is an organic group comprising elements selected from the group consisting of carbon, nitrogen, oxygen and fluorine; in the case where b is 2 or more, two R^1s may combine with each other to form a ring structure; R^2 is an acid group selected from the group consisting of –COOH, $-CH_2COOH$, $-CH(CH_3)COOH$, $-OCH_2COOH$~~,~~ and -SO_3H ~~and –OH~~; and W or R^1 includes at least one acid group;

so that

aromatic group-containing substituents derived from said side-chain forming compound are combined with 5 to 40% of nitrogen atoms in said backbone polymer.

[9] The composition for forming a superfine pattern according

to claim 8, wherein said side-chain forming compound is selected from the group consisting of:



.

[10] A composition for forming a superfine pattern, comprising pure water, an acid and a water-soluble resin; wherein

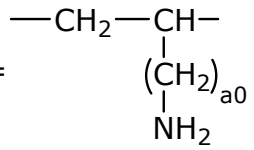
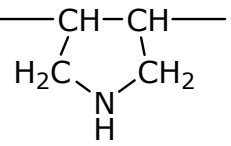
said water-soluble resin is a product of the reaction of

a backbone polymer represented by the following formula (2):

$$-X^0{}_{p0}-Z^0{}_{r0}- \qquad (2)$$

in which

X^0 and Z^0 are repeating units of

X^0 =  Z^0 = , respectively;

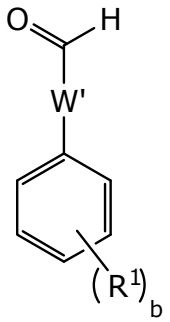
p0 and r0 are numbers of polymerization ratios of said repeating units X^0 and Z^0, respectively, provided that they satisfy the conditions of $0.05 \leq p0 \leq 1$ and $0 \leq r0 \leq 0.95$ and that each repeating unit may combine with each other either randomly or to form a block;

a0 in said repeating unit X^0 is an integer of 0 or 1; and

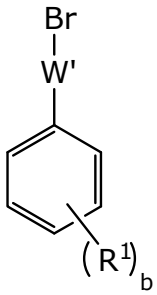
said repeating unit X^0 may be a combination of repeating units having different a0 integers;

with

at least one side-chain forming compound represented by the following formula (3A') or (3B'):



(3A')



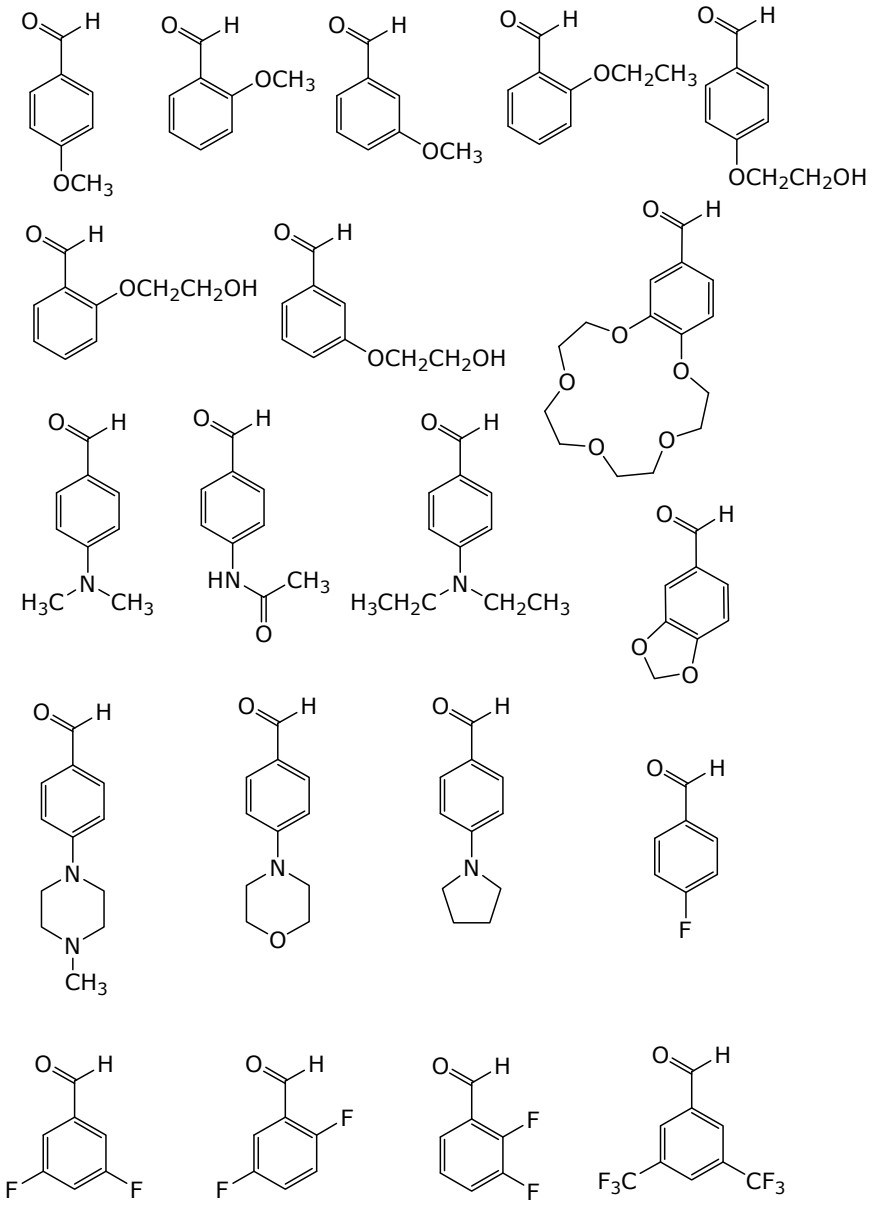
(3B')

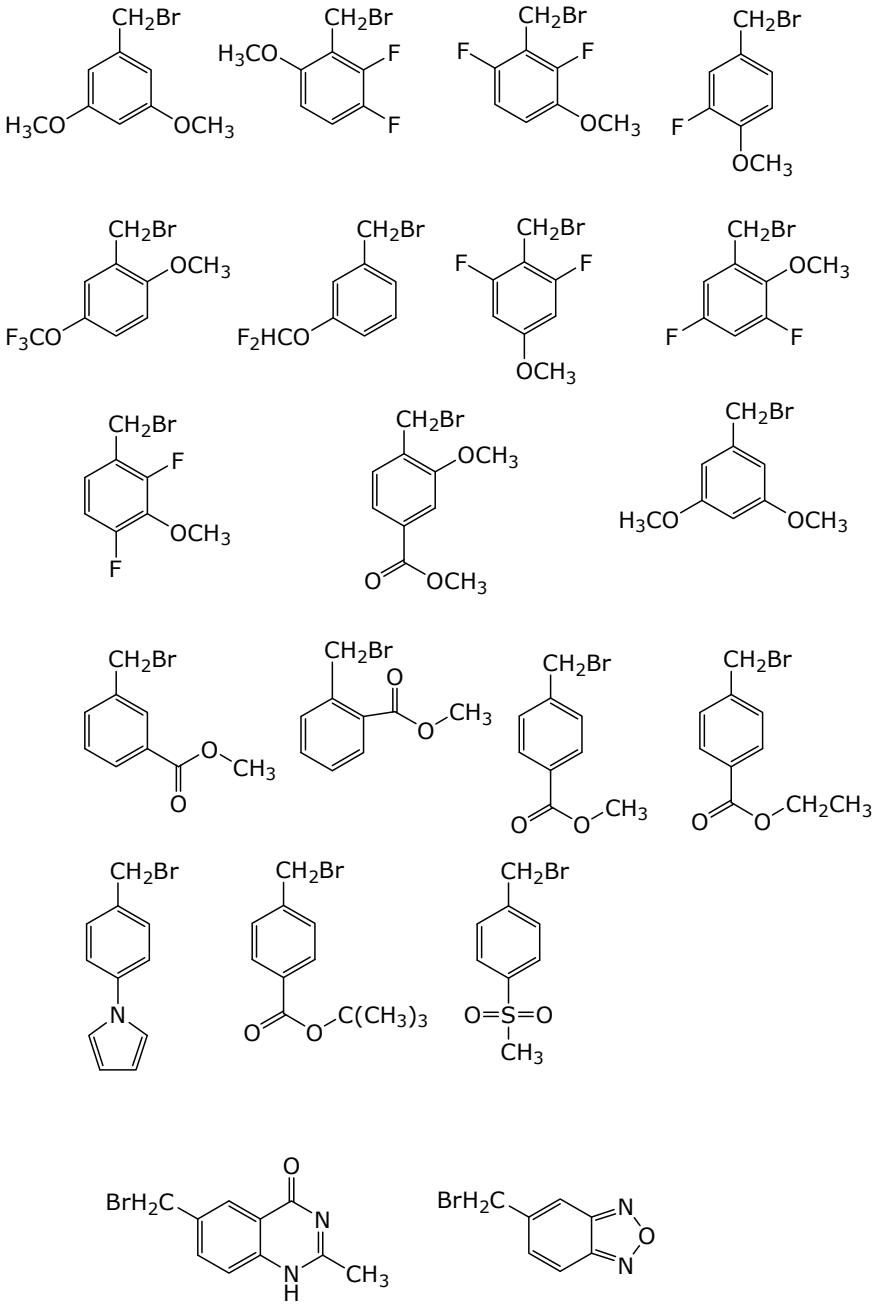
in which b is an integer of 0 to 5; W' is a single bond or a divalent linking group selected from the group consisting of $-CHR^{0'}-$ and $-CHR^{0'}-CH_2-$ where $R^{0'}$ is selected from the group consisting of -H, $-CH_3$ and $-COOC_2H_5$; R^1 is an organic group comprising elements selected from the group consisting of carbon, nitrogen, oxygen and fluorine; and in the case where b is 2 or more, two R^1s may combine with each other to form a ring structure;

so that

aromatic group-containing substituents derived from said side-chain forming compound are combined with 5 to 40% of nitrogen atoms in said backbone polymer.

[11] The composition for forming a superfine pattern according to claim10, wherein said side-chain forming compound is selected from the group consisting of:





.

[12] The composition for forming a superfine pattern according to claim 10 or 11, wherein said acid is selected from the group consisting of nitric acid, sulfuric acid, acetic acid, benzenesulfonic acid, p-toluenesulfonic acid, 2-naphthalenesulfonic acid, 1,3-benzenedisulfonic acid, 1,5-naphthalenedisulfonic acid and 2,7-naphthalenedisulfonic acid.

[13] The composition for forming a superfine pattern according

to any one of claims 1 to 12, wherein said water-soluble resin has a weight average molecular weight of 3000 to 100000.

[14] The composition for forming a superfine pattern according to any one of claims 1 to 13, wherein said water-soluble resin is contained in an amount of 0.1 to 10 wt% based on the total weight of the composition.

[15] A method for forming a superfine resist pattern, comprising the step of

treating a resist pattern after development with the composition for forming a superfine pattern according to any one of claims 1 to 14, so as to reduce the effective size of the resist pattern after the development.

[16] The method for forming a superfine resist pattern according to claim 15, further comprising the step of

washing said resist pattern with pure water immediately before or after the treatment with the composition for forming a superfine pattern.

[17] A fined resist pattern formed by the steps of

developing an imagewise exposed resist substrate with a developer, and then

treating the developed resist substrate with the composition for forming a superfine pattern according to any one of claims 1 to 14.