What is Claimed is:

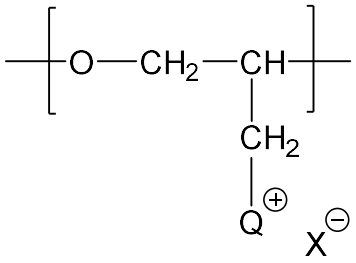
1. A composition for use in electrodeposition of copper for electrodeposition of copper on a dielectric or semiconductor base structure, the composition comprising:

Cu^{++} ions;

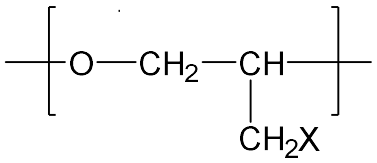
an acid selected from the group consisting of sulfuric acid and an alkylsulfonic acid;

a suppressor;

a polar organic solvent characterized by a boiling point (neat) of at least 120°C; and a quaternized poly(epihalohydrin) comprising n repeating units corresponding to Structure 1N and p repeating units corresponding to Structure 1P:



(1N)



(1P)

wherein Q has a structure obtained by reacting a pendent methylene halide group of poly(epihalohydrin) with a tertiary amine selected from the group consisting of:

(i) $NR^1R^2R^3$

wherein each of R^1, R^2 and R^3 is independently selected from the group consisting of substituted or unsubstituted alkyl, substituted or unsubstituted alkenyl, substituted or unsubstituted alkynyl, substituted or unsubstituted alicyclic, substituted or unsubstituted aralkyl, substituted or unsubstituted aryl, substituted or unsubstituted heterocyclic, and wherein at least one of R^1, R^2 and R^3 is not a lower alkyl having between 1 and 3 carbon atoms; (ii) an N-substituted and

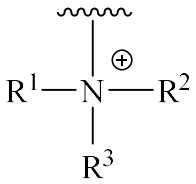
optionally further substituted heteroalicyclic amine wherein the N-substituent is selected from the group consisting of substituted or unsubstituted alkyl, substituted or unsubstituted alkenyl, substituted or unsubstituted alkynyl, substituted or unsubstituted alicyclic, substituted or unsubstituted aralkyl, aryl, and substituted or unsubstituted heterocyclic; and (iii) a substituted or unsubstituted nitrogen-containing heteroaryl compound;

n is an integer between 3 and 35, p is an integer between 0 and 25;

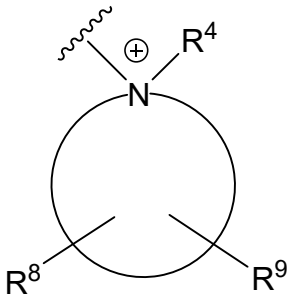
X is a halo substituent; and

X^- is a monovalent anion.

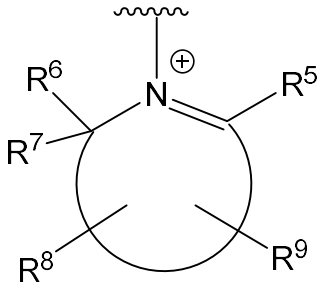
2. A composition as set forth in claim 1, wherein Q is selected from the group consisting of:



(IIA)



(IIB) and



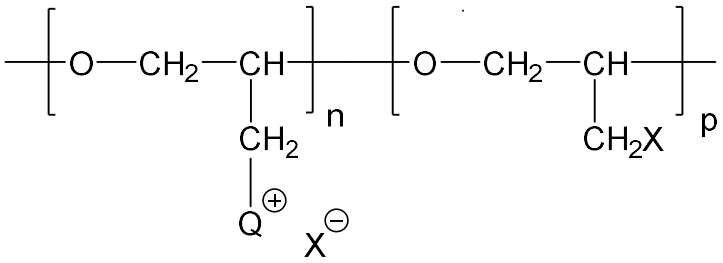
(IIC)

wherein: (i) Structure IIB is an N-substituted heterocyclic moiety; (ii) Structure IIC is a heterocyclic moiety; (iii) one or more of R^1, R^2, R^3 and R^4 are independently selected from the group consisting of substituted or unsubstituted alkyl, substituted or unsubstituted alkenyl, substituted or unsubstituted alkynyl, substituted or unsubstituted aralkyl, substituted or unsubstituted alicyclic, substituted or unsubstituted aryl, and substituted or unsubstituted heterocyclic; and (iv) each of R^5, R^6, R^7, R^8 and R^9 is independently selected from the group consisting of hydrogen, substituted or unsubstituted alkyl, substituted or unsubstituted alkenyl, substituted or unsubstituted alkynyl, substituted or unsubstituted aralkyl, substituted or unsubstituted alicyclic, and substituted or unsubstituted aryl, and substituted or unsubstituted heterocyclic.

3. A composition as set forth in claim 1, wherein the quaternized poly(epihalohydrin) comprises additional repeating units comprising residues of at least one alkylene oxide.

4. A composition as set forth in claim 3, wherein the residues of alkylene oxide are selected from the group consisting of ethylene oxide, propylene oxide, butylene oxide, 3,4-epoxy-1-butanol, 2,3-epoxy-1-propanol, glycidol, and combinations of one or more of the foregoing.

5. A composition as set forth in claim 1, wherein the poly(epihalohydrin) consists essentially of repeating units that are residues of epihalohydrin and repeating units that are residues of quaternized epihalohydrin having Structure (I):



(I)

6. A composition as set forth in claim 2, wherein when Q has Structure IIA, one of R^1, R^2 and R^3 is selected from the group consisting of unsubstituted alkyl having at least three carbon atoms, hydroxyalkyl, dihydroxyalkyl, phenyl, hydroxyphenyl, dihydroxyphenyl, benzyl, hydroxyphenylmethyl and dihydroxyphenylmethyl, and each of the others of R^1, R^2 and R^3 is independently selected from lower alkyl having between 1 and 3 carbon atoms.

7. A composition as set forth in claim 2, wherein when Q has Structure IIA, Q is selected from the group consisting of 3-hydroxypropyldimethylamino, n-butyldimethylamino, di(3-hydroxypropyl)methylamino, 2,3-dihydroxypropyldimethylamino, 3-hydroxypropyldiethylamino, 2-hydroxypropyldimethylamino, 4-hydroxybutyldimethylamino, 2-hydroxyethyldimethylamino, n-propyldimethylamino, 2-hydroxyethoxyethyldimethylamino, di(2-

hydroxyethyl)methylamino, benzyldimethylamino, and 4-hydroxybenzyldimethylamino.

8. A composition as set forth in claim 1, wherein the tertiary amine is selected from the group consisting of trimethylamine, triethylamine, N-methylmorpholine, imidazole, 1-benzylimidazole, 2-imidazoline, 3-imidazoline, N,N-dimethylbenzyldimethylamine, 3-dimethylamine-1-propanol, 2-dimethylamino-1-ethanol, 4-ethylpyridine, and 1-methylimidazole.

9. A composition as set forth in claim 1, wherein Q has the structure obtained in reacting a pendent methylene halide group of poly(epihalohydrin) with a tertiary amine that comprises $NR^1R^2R^3$,

wherein one of R^1, R^2 and R^3 is selected from the group consisting of unsubstituted alkyl having at least three carbon atoms, hydroxyalkyl, dihydroxyalkyl, phenyl, hydroxyphenyl, dihydroxyphenyl, benzyl, hydroxyphenylmethyl and dihydroxyphenylmethyl, and each of the others of R^1, R^2 and R^3 is independently selected from lower alkyl having between 1 and 3 carbon atoms.

10. A composition as set forth in claim 1, wherein Q has the structure obtained from reacting a pendent methylene chloride group of poly(epihalohydrin) with a tertiary amine selected from the group consisting of 3-hydroxypropyldimethylamine, n-butyldimethylamine, di(3-hydroxypropyl)methylamine, 2,3-dihydroxypropyldimethylamine, 3-hydroxypropyldiethylamine, 2-hydroxypropyldimethylamine, 4-hydroxybutyldimethylamine, 2-hydroxyethyldimethylamine, n-propyldimethylamine, 2-hydroxyethoxyethyldimethylamine, di(2-hydroxyethyl)methylamine, benzyldimethylamine and 4-hydroxybenzyldimethylamine.

11. A composition as set forth in claim 1, wherein Q has the structure obtained by reacting a pendent methylene chloride group of poly(epihalohydrin) with a tertiary amine selected from the group consisting of N-methylmorpholine, imidazole, 1-benzylimidazole, 2-imidazoline, 3-imidazoline, 4-ethylpyridine, 2-dimethylamino-1-ethanol, and 1-methylimidazole.

12. A composition as set forth in claim 1, wherein Q has the structure obtained from reacting a pendent methylene halide group of poly(epihalohydrin) with N,N-dimethylalkanolamine.

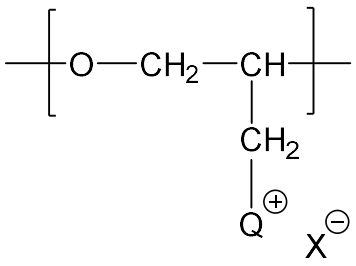
13. A composition as set forth in claim 1, wherein the polar organic solvent is selected from the group consisting of ethylene glycol, propylene glycol, glycerin, ethylene glycol monomethyl ether, ethylene glycol monoethyl ether, ethylene glycol monopropyl ether, ethylene glycol monobutyl ether, and propylene glycol monomethyl ether.

14. A composition as set forth in claim 1, wherein the quaternized poly(halohydrin) is prepared by reaction of polyepihalohydrin with 2-[2-(dimethylamino)ethoxy]ethanol.

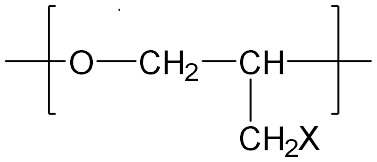
15. A process for formulating an electrodeposition composition for electrodeposition of copper on a dielectric or semiconductor substrate, the process comprising combining in an aqueous medium a source of copper ions, an acid, a suppressor and a solution of a quaternized poly(epihalohydrin),

the solution of poly(epihalohydrin) comprising a polar organic solvent characterized by a boiling point (neat) of at least about 120°C,

the quaternized poly(epihalohydrin) comprising n repeating units corresponding to the Structure 1N and p repeating units corresponding to the Structure 1P:



(1N)



(1P)

wherein Q has a structure obtained by reacting a pendent methylene halide group of poly(epihalohydrin) with a tertiary amine selected from the group consisting of:

(i) $NR^1R^2R^3$

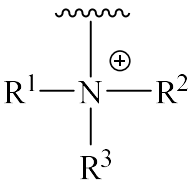
wherein each of R^1, R^2 and R^3 is independently selected from the group consisting of substituted or unsubstituted alkyl, substituted or unsubstituted alkenyl, substituted or unsubstituted alkynyl, substituted or unsubstituted alicyclic, substituted or unsubstituted aralkyl, substituted or unsubstituted aryl, substituted or unsubstituted heterocyclic, and wherein at least one of R^1, R^2 and R^3 is not a lower alkyl having between 1 and 3 carbon atoms; (ii) an N-substituted and optionally further substituted heteroalicyclic amine wherein the N-substituent is selected from the group consisting of substituted or unsubstituted alkyl, substituted or unsubstituted alkenyl, substituted or unsubstituted alkynyl, substituted or unsubstituted alicyclic, substituted or unsubstituted aralkyl, substituted or unsubstituted aryl, and substituted or unsubstituted heterocyclic; and (iii) a substituted or unsubstituted nitrogen-containing heteroaryl compound;

n is an integer between 3 and 35, p is an integer between 0 and 25;

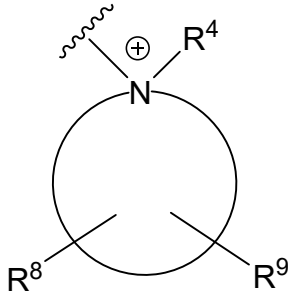
X is a halo substituent; and

X^- is a monovalent anion.

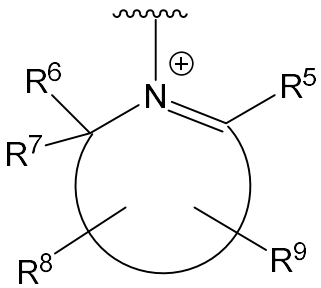
16. A process as set forth in claim 15, wherein Q is selected from the group consisting of:



(IIA)



(IIB) , and



(IIC)

wherein: (i) Structure IIB is an N-substituted heterocyclic moiety; (ii) Structure IIC is a heterocyclic moiety; (iii) one or more of R^1, R^2, R^3 and R^4 is independently selected from the

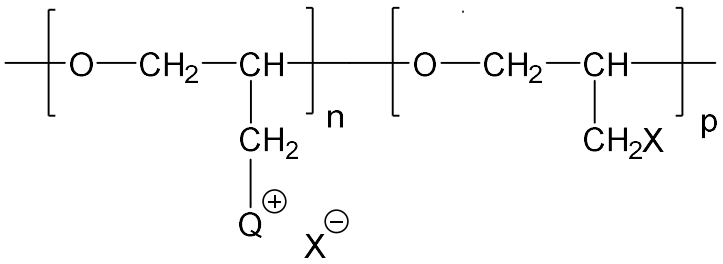
group consisting of substituted or unsubstituted alkyl, substituted or unsubstituted alkenyl, substituted or unsubstituted alkynyl, substituted or unsubstituted aralkyl, substituted or unsubstituted alicyclic, substituted or unsubstituted aryl, and substituted or unsubstituted heterocyclic; and (iv) each of R^5, R^6, R^7, R^8 and R^9 is independently selected from the group consisting of hydrogen, substituted or unsubstituted alkyl, substituted or unsubstituted alkenyl, substituted or unsubstituted alkynyl, substituted or unsubstituted aralkyl, substituted or substituted alicyclic, and substituted or unsubstituted aryl, and substituted or unsubstituted heterocyclic; and

n is an integer between 3 and 35, and p is an integer between 0 and 25.

17. A process as set forth in claim 15, wherein the quaternized poly(epihalohydrin) comprises additional repeating units comprising residues of at least one alkylene oxide.

18. A process as set forth in claim 17, wherein the residues of alkylene oxide are selected from the group consisting of ethylene oxide, propylene oxide, butylene oxide, 3,4-epoxy-1-butanol, 2,3-epoxy-1-propanol, glycidol, and combinations of one or more of the foregoing.

19. A process as set forth in claim 15, wherein the poly(epihalohydrin) consists essentially of repeating units that are residues of epihalohydrin and repeating units that are residues of quaternized epihalohydrin having Structure (I):



(I)

20. A process as set forth in claim 16, wherein when Q has Structure IIA, one of R^1, R^2 and R^3 is selected from the group consisting of unsubstituted alkyl having at least three carbon atoms, hydroxyalkyl, dihydroxyalkyl, phenyl, hydroxyphenyl, dihydroxyphenyl, benzyl, hydroxyphenylmethyl and dihydroxyphenylmethyl, and each of the others of R^1, R^2 and R^3 is independently selected from lower alkyl having between 1 and 3 carbon atoms.

21. A process as set forth in claim 16, wherein when Q has Structure IIA, Q is selected from the group consisting of 3-hydroxypropyldimethylamino, n-butyldimethylamino, di(3-hydroxypropyl)methylamino, 2,3-dihydroxypropyldimethylamino, 3-hydroxypropyldiethylamino, 2-hydroxypropyldimethylamino, 4-hydroxybutyldimethylamino, 2-hydroxyethyldimethylamino, n-propyldimethylamino, 2-hydroxyethoxyethyldimethylamino, di(2-hydroxyethyl)methylamino, benzyldimethylamino, and 4-hydroxybenzyldimethylamino.

22. A process as set forth in claim 15, wherein the solution of quaternized poly(epihalohydrin) comprising a polar organic solvent is prepared by a process comprising reacting poly(epihalohydrin) in said polar organic solvent with a tertiary amine.

23. A process as set forth in claim 15, wherein the electrodeposition composition further comprises an accelerator.