WHAT IS CLAIMED IS:

1. An electrodeposition composition comprising:

a source of copper ions;

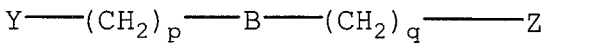
an acid;

a suppressor;

a leveler, wherein the leveler comprises a quaternized dipyridyl compound or a quaternized poly(epihalohydrin); and

an accelerator.

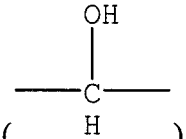
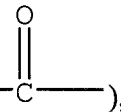
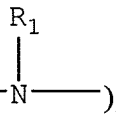
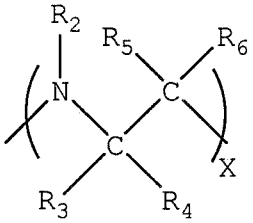
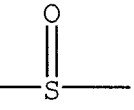
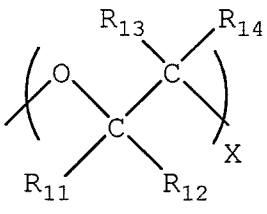
2. The electrodeposition composition as set forth in claim 1, wherein the leveler comprises a quaternized dipyridyl compound, the quaternized dipyridyl compound comprising the reaction product of dipyridyl and an alkylating agent comprising the following structure (IIIb):



Structure (IIIb)

wherein

B is selected from among:

a single bond, an oxygen atom (), a methenyl hydroxide (), a carbonyl (), an amino (), an imino (), a sulfur atom (), a sulfoxide (), and a glycol (); and

p and q may be the same or different, are integers between 0 and 6, wherein at least one of p and q is at least 1;

X is an integer from one to about four;

Y and Z are leaving groups selected from among chloride, bromide, iodide, tosyl, triflate, sulfonate, mesylate, methosulfate, fluorosulfonate, methyl tosylate, brosylate, or nosylate; and

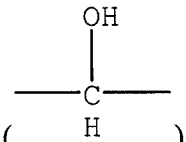
R_1 through R_{14} are each independently hydrogen, substituted or unsubstituted alkyl having from one to six carbon atoms, substituted or unsubstituted alkylene having from one to six carbon atoms, or substituted or unsubstituted aryl.

3. The composition of claim 2, wherein:

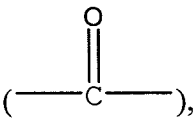
p and q are both one or are both two; and

B is selected from among:

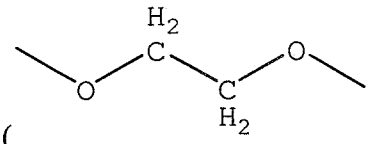
an oxygen atom (——O——),



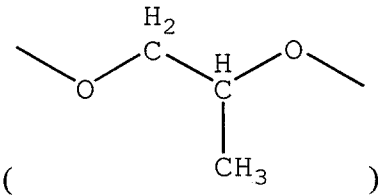
a methenyl hydroxide ( ),



a carbonyl (——C——),



an ethylene glycol group ( ), and



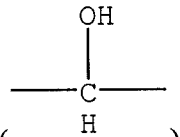
a propylene glycol group ( ).

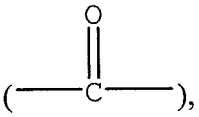
4. The composition of claim 3, wherein:

p and q are both one or are both two; and

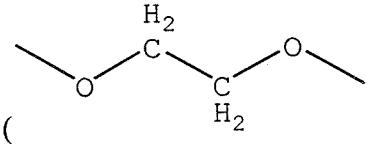
B is selected from among:

an oxygen atom (——O——),

a methenyl hydroxide (),

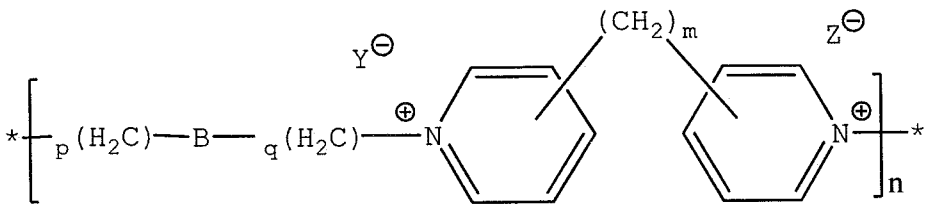
a carbonyl (),

and

an ethylene glycol group ().

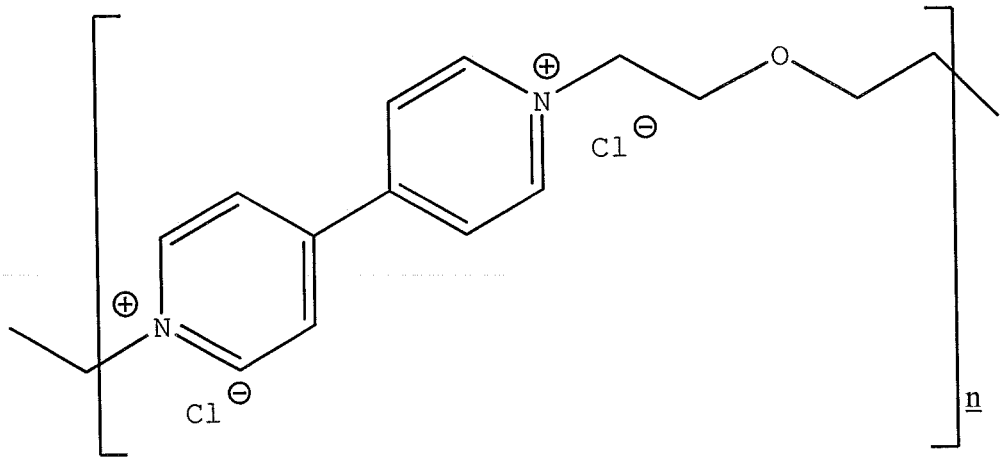
5. The composition of claim 4, wherein the difunctional alkylating agent is selected from the group consisting of 1-chloro-2-(2-chloroethoxy)ethane, 1,2-bis(2-chloroethoxy)ethane, 1,3-dichloropropan-2-one, 1,3-dichloropropan-2-ol, 1,2-dichloroethane, 1,3-dichloropropane, 1,4-dichlorobutane, 1,5-dichloropentane, 1,6-dichlorohexane, 1,7-dichloroheptane, 1,8-dichlorooctane, 1,2-di(2-chloroethyl)ether.

6. The composition of claim 2, wherein the reaction product of the dipyridyl compound and the difunctional alkylating agent polymerizes, wherein the leveler is a polymer selected from the group consisting of the following general structures (IV), (VI), (VII), (VIII), (X), (XI), and (XXX):



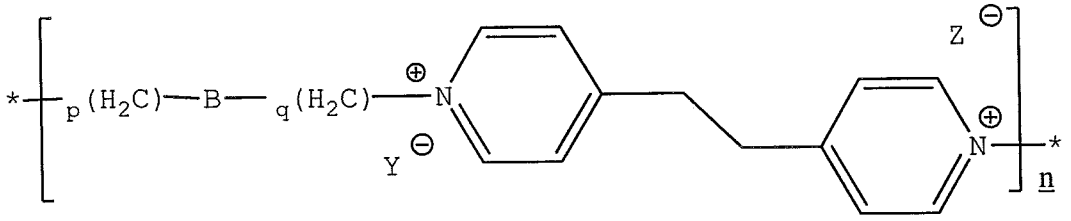
Structure (IV)

wherein B, p, q, Y, and Z are as defined with regard to (IIIb); m is an integer between one and six; and n is an integer that is at least 2;



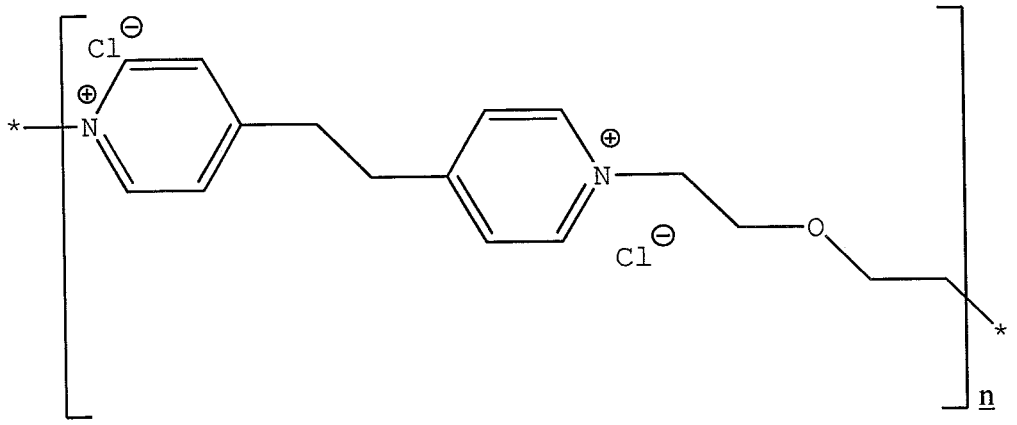
Structure (VI)

wherein n is an integer of at least 2;



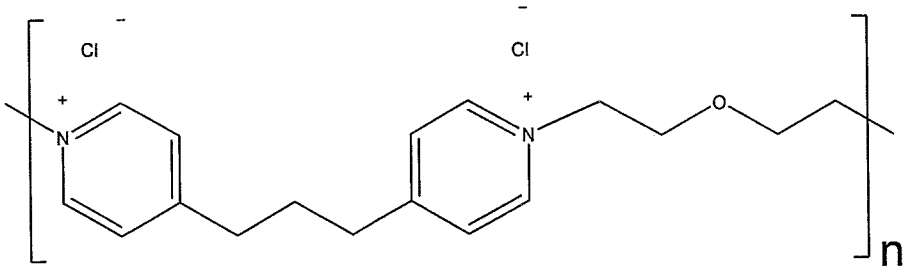
Structure (VII)

wherein B, p, q, Y, and Z are as defined with regard to structure (IIIb) and n is an integer of at least 2;



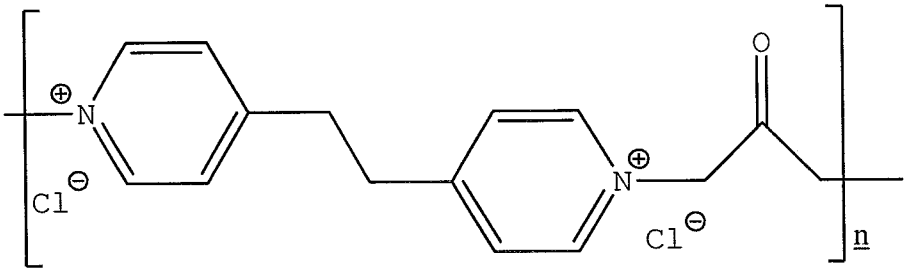
Structure (VIII)

wherein n is an integer of at least 2;



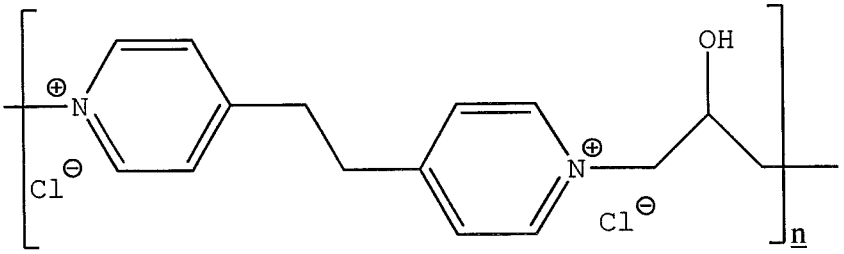
Structure (XXX)

wherein n is an integer of at least 2;



Structure (X)

wherein n is an integer of at least 2; and

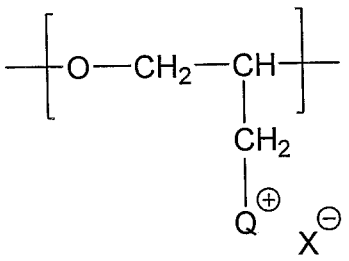


Structure (XI)

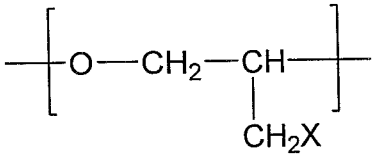
wherein n is an integer of at least 2.

7. The composition of claim 6, wherein the value of n is between 10 and 15.

8. The composition as set forth in claim 1, wherein the quaternized poly(epihalohydrin) compound comprising n repeating units corresponding to structure 1N and p repeating units corresponding to structure 1P:



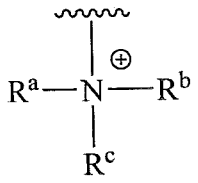
(1N)



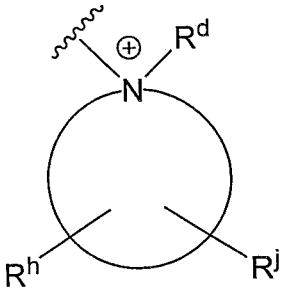
(1P)

wherein Q has a structure corresponding to that which may be obtained by reacting a pendent methylene halide group of poly(epihalohydrin) with a tertiary amine selected from the group consisting of: (i) $NR^aR^bR^c$ wherein each of R^a, R^b and R^c is independently selected from the group consisting of substituted or unsubstituted alkyl, alicyclic, aralkyl, substituted or unsubstituted alkenyl, substituted or unsubstituted alkynyl, aryl and heterocyclic; (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, alicyclic, aralkyl, aryl, and 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, ordinarily a halide ion.

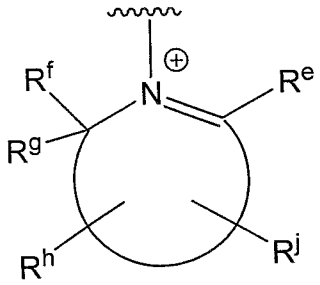
9. The composition as set forth in claim 8, wherein Q is selected from the group consisting of:



(2A)



(2B) or



(2C)

wherein: (i) structure IIB is an N-substituted heterocyclic moiety; (ii) structure IIC is a heterocyclic moiety; (iii) each of R^a, R^b, R^c and R^d 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^e, R^f, R^g, R^h and R^j 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.

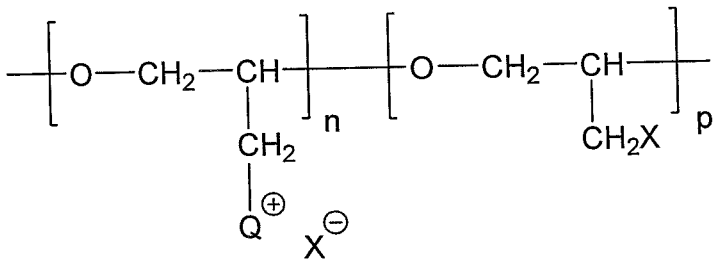
10. The composition as set forth in claim 9, wherein the quaternized poly(epihalohydrin) comprises additional repeating units comprising residues of at least one alkylene oxide, or

wherein the quaternized poly(epihalohydrin) comprises repeating units that are residues of ethylene oxide, or

wherein the quaternized poly(epihalohydrin) comprises repeating units that are residues of propylene oxide.

11. The composition as set forth in claim 8, wherein the total of alkylene oxide repeating units in said quaternized poly(epihalohydrin) is q, and the ratio of q/n+p+q is not greater than about 0.05, or is between about 0.05 and about 0.50.

12. The composition as set forth in claim 8, wherein repeating units of said poly(epihalohydrin) consist essentially of residues of epihalohydrin and residues of quaternized epihalohydrin



(I)

13. The composition as set forth in claim 8, wherein the quaternized poly(epihalohydrin) repeating units and non-quaternized epihalohydrin repeating units in said quaternized poly(epihalohydrin) are arranged in a block, alternating or random configuration.

14. The composition as set forth in claim 8, wherein Q corresponds to the structure that may be obtained in reacting a pendent methylene halide group of poly(epihalohydrin) with a tertiary amine that comprises $NR^aR^bR^c$.

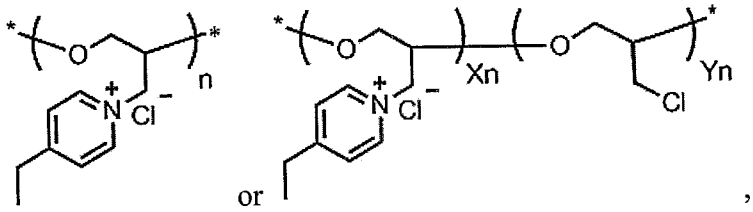
15. The composition as set forth in claim 9, wherein one of R^a, R^b and R^c is selected from the group consisting of unsubstituted alkyl having at least three carbon atoms, hydroxyalkyl, dihydroxyalkyl, phenyl, hydroxyphenyl, dihydroxyphenyl, benzyl, hydroxyphenylmethyl and dihydroxyphenylmethyl, and each of the others of R^a, R^b and R^c is independently selected from lower alkyl having between 1 and 3 carbon atoms.

16. The composition as set forth in claim 8, wherein Q has the structure which may be obtained from reacting a pendent methylene chloride group of poly(epihalohydrin) with:

a) a quaternizing agent 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; or

b) a pendent methylene halide group 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-hydroxybenzyldimethyleamine, 2-methylpyridine, 3-methylpyridine, 4-methylpyridine, 2-ethylpyridine, 3-ethylpyridine, 4-ethylpyridine, 2-propylpyridine, 3-propylpyridine, 4-propylpyridine, 4-tertbutylpyridine, 4-cyanopyridine, 4-isopropylpyridine, 4-methoxypyridine, 3,4-lutidine, 3-methoxypyridine, 3-pyridinemethanol, and 4-pyridinemethanol.

17. The composition as set forth in claim 8, wherein the quaternized poly(epihalohydrin) comprises:

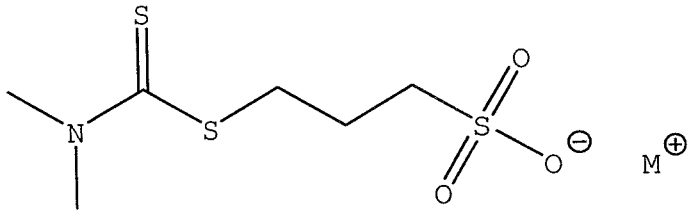


or

,

wherein X is between 0.3 and 0.7.

18. The composition as set forth in claim 8, wherein the aqueous electrodeposition composition further comprises an accelerator preferably wherein the accelerator comprises an organic sulfur compound, more preferably wherein the organic sulfur compound has the following general structure (5):



Structure (5)

,

wherein M is selected from the group consisting of alkali metal ions and charge balancing cations.

19. The composition as set forth in claim 1, wherein the suppressor comprises a compound selected from the group consisting of:

a) an alkoxylated amine;

b) a polyether compound comprising a combination of propylene oxide (PO) repeat units and ethylene oxide (EO) repeat units present in a PO:EO ratio between about 1:9 and about 9:1 and bonded to a nitrogen-containing species; and

c) a polyalkylene glycol having a terminal sulfonic acid moiety and a terminal aromatic moiety formed by condensing a substituted phenol with a terminal hydroxyl of said polyalkylene glycol.

20. The composition as set forth in claim 19, wherein the suppressor is a polyether compound and the PO repeat units and EO repeat units are present in a PO:EO ratio between about 2:3 and about 2:1.

21. The composition as set forth in claim 19, wherein the suppressor is an alkoxylated amine, and the alkoxylated amine is selected from the group consisting of a tetraalkoxylated alkylene diamine, an alkoxylated diethylene triamine, a tetraalkoxylated triethylene tetraamine, and combinations of one or more of the foregoing.