WHAT IS CLAIMED IS:

1. An electrodeposition composition comprising:

(a) a source of copper ions;

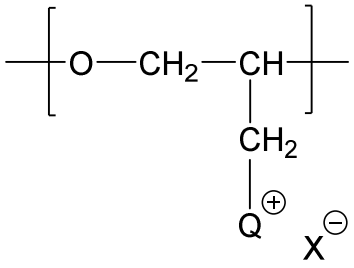
(b) an acid;

(c) a suppressor;

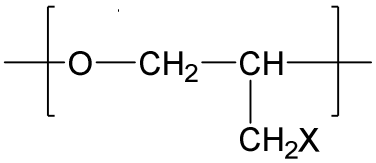
(d) a leveler, wherein the leveler comprises

i) a quaternized dipyridyl compound, wherein the quaternized dipyridyl compound comprises a compound having a structure of a reaction product of N,N'-tetraalkylthiourea with an intermediate produced by a reaction of a dipyridyl with a difunctional alkylating agent; or

ii) a quaternized poly(epihalohydrin) wherein the quaternized poly(epihalohydrin) compound comprises 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~~ pendant 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; and wherein n is an integer between 3

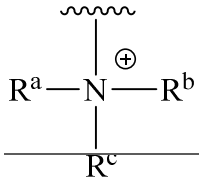
and 35, p is an integer ~~between~~ greater than 0 and up to 25; X is a halo substituent; and X^- is a monovalent anion; and

e) an accelerator.

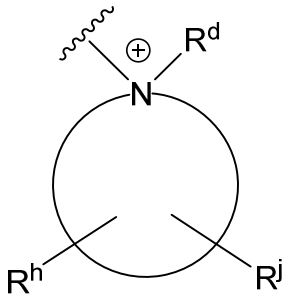
2. The composition of claim 1, wherein the difunctional alkylating agent is selected from the group consisting of 1-chloro-2-(2-chloroethoxy)ethane, 1,2-bis(2-chloroethoxy)ethane, 1,3-dichloropropan-2-one, 1,3-dichloropropan-2-ol, 1,2-dichloroethane, 1,3-dichloropropane, 1,4-dichlorobutane, 1,5-dichloropentane,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

3. The composition of claim 1, wherein the value of n is between 10 and 15.

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

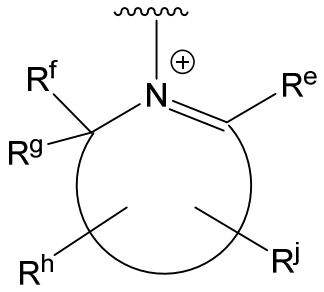


~~(2A)~~



(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.

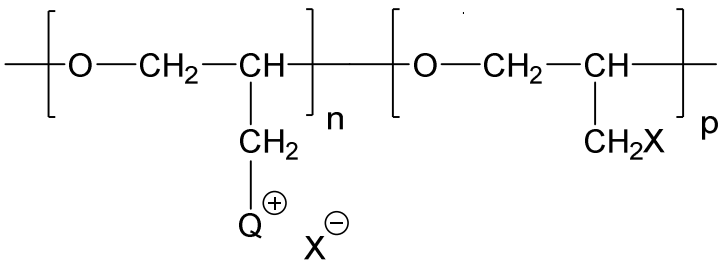
5. The composition as set forth in claim ~~1~~4, wherein the quaternized poly(epihalohydrin) comprises additional repeating units comprising residues of at least one alkylene oxide, or

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.

6. The composition as set forth in claim 5, 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.

7. The composition as set forth in claim 1, wherein repeating units of said poly(epihalohydrin) consist essentially of residues of epihalohydrin and residues of quaternized epihalohydrin



(I)

8. The composition as set forth in claim 1, 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.

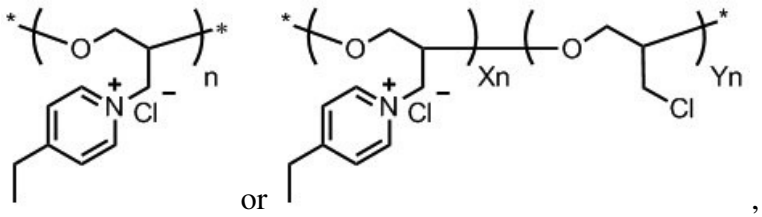
~~9. The composition as set forth in claim 1, wherein Q corresponds to the structure that may be obtained in reacting a pendent methylene halide group of poly(epihalohydrin) with a tertiary amine that comprises $NR^aR^bR^e$; wherein one of R^a, R^b and R^e is selected from the group consisting of unsubstituted 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^e is independently selected from lower alkyl having between 1 and 3 carbon atoms.~~

~~11.~~9. The composition as set forth in claim 1, 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~~ 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,~~ benzyldimethylamine, 4-hydroxybenzyldimethylamine, 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.

~~12.~~10. The composition as set forth in claim 1, wherein the quaternized poly(epihalohydrin) comprises:

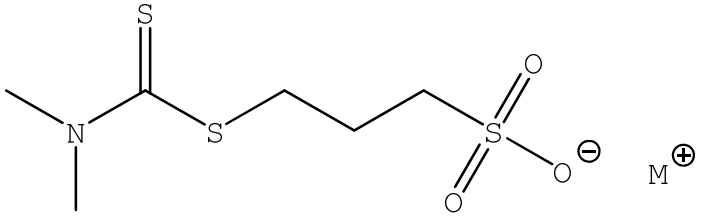


or ,

wherein X is between 0.3 and 0.7.

~~13.~~11. The composition as set forth in claim 1, wherein the aqueous electrodeposition composition further comprises an accelerator

~~14.~~12. The composition as set forth in claim ~~12~~11, wherein the accelerator comprises an organic sulfur compound, having the following general structure (5):



Structure (5) ,

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

~~15.~~13. 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.

~~16.~~14. The composition as set forth in claim 13, wherein the suppressor is a polyether compound and the PO repeat units and EO repeat units are present in a PO:EO ratio between 2:3 and 2:1.

~~17.~~15. The composition as set forth in claim 13, 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.

~~18.~~16. The composition as set forth in claim 1, wherein the ratio of n/n+p is at least 0.4 and less than 1.0.

~~19.~~17. The composition as set forth in claim ~~17~~16, wherein the ratio of n/n+p is between 0.40 and 0.60 or between 0.70 and 0.95.