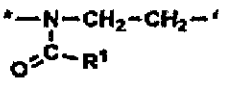
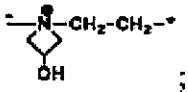
CLAIMS

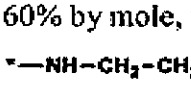
1. A poly(2-oxazoline-co-ethyleneimine)-epichlorohydrin copolymer, comprising:

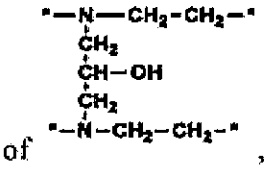
(1) N-acyl-iminoethylene monomeric units in an amount designated as M1 of from 2% to 95% by mole, wherein the N-acyl-iminoethylene monomeric units have a formula of  in which R^1 is

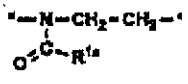
(a) a monovalent radical R^{1a} which is hydrogen, methyl, ethyl, propyl, isopropyl, N-pyrrolidonyl-C_1-C_4 alkyl, or a monovalent radical of –alk–$(OC_2H_4)_{m3}$–OR'' in which alk is C_1-C_6 alkyl diradical, R" is C_1-C_4 alkyl, and m3 is an integer from 1 to 10, or

(b) a monovalent radical R^{1b} which is C_4-C_{18} alkyl, C_1-C_4 alkyl-substituted phenyl, C_1-C_4-alkoxy-substituted phenyl, or C_6-C_{19} aryl radical;

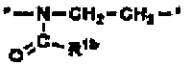
(2) azetidinium monomeric units in an amount designated as M2 of from 0.5% to 95% by mole, wherein the azetidinium monomeric units have a formula of ;

(3) ethyleneimine monomeric units in an amount designated as M3 of from 0 to 60% by mole, wherein the ethyleneimine monomeric units have a formula of ; and

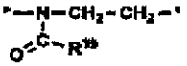
(4) crosslink units in an amount designated as M4 of from 0 to 5% by mole, wherein the crosslink units have a formula of , provided that (M1+M2+M3+M4) is 100%.

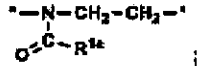
2. The poly(2-oxazoline-co-ethyleneimine)-epichlorohydrin copolymer of claim 1, wherein the poly(2-oxazoline-co-ethyleneimine)-epichlorohydrin copolymer comprises hydrophilic N-acyl-iminoethylene monomeric units of formula  in which R^{1a} is hydrogen, methyl, ethyl, propyl, isopropyl, N-

pyrrolidonyl-C_1-C_4 alkyl, or a monovalent radical of –alk–$(OC_2H_4)_{m3}$–OR" in which alk is C_1-C_6 alkyl diradical, R" is C_1-C_4 alkyl, and m3 is an integer from 1 to 10.

3. The poly(2-oxazoline-co-ethyleneimine)-epichlorohydrin copolymer of claim 1, wherein the poly(2-oxazoline-co-ethyleneimine)-epichlorohydrin copolymer comprises hydrophobic N-acyl-iminoethylene monomeric units of formula  in which R^{1b} is C_6-C_{18} alkyl, C_1-C_4 alkyl-substituted phenyl, C_1-C_4-alkoxy-substituted phenyl, or C_6-C_{18} aryl radical.

4. The poly(2-oxazoline-co-ethyleneimine)-epichlorohydrin copolymer of claim 1, wherein the poly(2-oxazoline-co-ethyleneimine)-epichlorohydrin copolymer comprises:

hydrophobic N-acyl-iminoethylene monomeric units of formula  in which R^{1b} is C_6-C_{18} alkyl, C_1-C_4 alkyl-substituted phenyl, C_1-C_4-alkoxy-substituted phenyl, or C_6-C_{18} aryl radical; and

hydrophilic N-acyl-iminoethylene monomeric units of formula  in which R^{1a} is hydrogen, methyl, ethyl, propyl, isopropyl, N-pyrrolidonyl-C_1-C_4 alkyl, or a monovalent radical of –alk–$(OC_2H_4)_{m3}$–OR" in which alk is C_1-C_6 alkyl diradical, R" is C_1-C_4 alkyl, and m3 is an integer from 1 to 10.

5. The poly(2-oxazoline-co-ethyleneimine)-epichlorohydrin copolymer of any one of claims 1 to 4, wherein the poly(2-oxazoline-co-ethyleneimine)-epichlorohydrin copolymer comprises: (1) from 10% to 85% by mole of N-acyl-iminoethylene monomeric units; (2) from 2.5% to 75% by mole of azetidinium monomeric units; (3) from 0% to 60%, by mole of ethyleneimine monomeric units; and (4) from 0 to 5% by mole of crosslink units.

6. The poly(2-oxazoline-co-ethyleneimine)-epichlorohydrin copolymer of any one of claims 1 to 5, having a weight average molecular weight Mw of at least 500 Daltons.

7. A water-soluble and thermally crosslinkable hydrophilic polymeric material, comprising: azetidinium groups; from 5% to 95% by weight of first polymer chains derived from a poly(2-oxazoline-co-ethyleneimine)-epichlorohydrin copolymer of any one of claims 1 to 6; and from 5% to 95%by weight of moieties or second polymer chains derived from at least one hydrophilicity-enhancing agent having at least one reactive functional group selected from the group consisting of primary amino group, secondary amino group, carboxyl group, thiol group, and combination thereof.

8. The water-soluble and thermally crosslinkable hydrophilic polymeric material of claim 7, wherein the hydrophilicity-enhancing agent is a hydrophilic polymers having one or more amino, carboxyl and/or thiol groups, wherein the content of the amino, carboxyl and/or thiol groups in the hydrophilic polymer as the agent is less than 40% by weight based on the total weight of the hydrophilic polymer.

9. The water-soluble and thermally crosslinkable hydrophilic polymeric material of claim 8, wherein the hydrophilicity-enhancing agent is: PEG-NH_2; PEG-SH; PEG-COOH; H_2N-PEG-NH_2; HOOC-PEG-COOH; HS-PEG-SH; H_2N-PEG-COOH; HOOC-PEG-SH; H_2N-PEG-SH; multi-arm PEG with one or more amino, carboxyl or thiol groups; PEG dendrimers with one or more amino, carboxyl or thiol groups; a diamino-, dicarboxyl-, monoamino- or monocarboxyl-terminated homo- or co-polymer of a non-reactive hydrophilic vinylic monomer; a copolymer which is a polymerization product of a composition comprising (1) 60% by weight or less by weight of at least one reactive vinylic monomer that is a vinylic monomer having at least one reactive functional group selected from the group consisting of carboxyl group, primary amino group, and secondary amino group and (2) at least one non-reactive hydrophilic vinylic monomer that is a vinylic monomer free of carboxyl group, primary amino group, secondary amino group, epoxide group, isocyanate group, azlactone group, or aziridine group; or combinations thereof, wherein PEG is a polyethylene glycol segment

10. The water-soluble and thermally crosslinkable hydrophilic polymeric material of claim 9, wherein the reactive vinylic monomer is selected from the group consisting of amino–C_1-C_6 alkyl (meth)acrylate, C_1-C_6 alkylamino–C_1-C_6 alkyl (meth)acrylate, allylamine, vinylamine, amino–C_1-C_6 alkyl (meth)acrylamide, C_1-C_6 alkylamino–C_1-C_6 alkyl (meth)acrylamide, acrylic acid, C_1-C_4 alkylacrylic acid, N,N-2-acrylamidoglycolic acid, beta-methyl-acrylic acid, alpha-phenyl acrylic acid, beta-acryloxy propionic acid, sorbic acid, angelic acid, cinnamic acid, 1-carobxy-4-phenyl butadiene-1,3, itaconic acid, citraconic acid, mesaconic acid, glutaconic acid, aconitic acid, maleic acid, fumaric acid, tricarboxy ethylene, and combinations thereof,
wherein the non-reactive vinylic monomer is selected from the group consisting of acrylamide, methacrylamide, N,N-dimethylacrylamide, N,N-dimethylmethacrylamide, N-vinylpyrrolidone, N,N,-dimethylaminoethylmethacrylate, N,N-dimethylaminoethylacrylate, N,N-dimethylaminopropylmethacrylamide, N,N-dimethylaminopropylacrylamide, glycerol methacrylate, 3-acryloylamino-1-propanol, N-hydroxyethyl acrylamide, *N*-[tris(hydroxymethyl)methyl]-acrylamide, N-methyl-3-methylene-2-pyrrolidone, 1-ethyl-3-methylene-2-pyrrolidone, 1-methyl-5-methylene-2-pyrrolidone, 1-ethyl-5-methylene-2-pyrrolidone, 5-methyl-3-methylene-2-pyrrolidone, 5-ethyl-3-methylene-2-pyrrolidone, 2-hydroxyethyl (meth)acrylate, hydroxypropyl (meth)acrylate, a phosphorylcholine-containing vinylic monomer, C_1-C_4-alkoxy polyethylene glycol (meth)acrylate having a weight average molecular weight of up to 1500 Daltons, N-vinyl formamide, N-vinyl acetamide, N-vinyl isopropylamide, N-vinyl-N-methyl acetamide, allyl alcohol, vinyl alcohol (hydrolyzed form of vinyl acetate in the copolymer), and combinations thereof.

11. The water-soluble and thermally crosslinkable hydrophilic polymeric material of claim 8, wherein the hydrophilicity-enhancing agent is: PEG-NH_2; PEG-SH; PEG-COOH; H_2N-PEG-NH_2; HOOC-PEG-COOH; HS-PEG-SH; H_2N-PEG-COOH; HOOC-PEG-SH; H_2N-PEG-SH; multi-arm PEG with one or more amino, carboxyl or thiol groups; PEG dendrimers with one or more amino, carboxyl or thiol groups; a monoamino-, monocarboxyl-, diamino- or dicarboxyl-terminated homo- or copolymer of a non-reactive hydrophilic vinylic monomer selected from the group consisting of

acryamide, N,N-dimethylacrylamide, N-vinylpyrrolidone, N-vinyl-N-methyl acetamide, glycerol (meth)acrylate, hydroxyethyl (meth)acrylate, N-hydroxyethyl (meth)acrylamide, (meth)acryloyloxyethyl phosphorylcholine, C_1-C_4-alkoxy polyethylene glycol (meth)acrylate having a weight average molecular weight of up to 400 Daltons, vinyl alcohol, N-methyl-3-methylene-2-pyrrolidone, 1-methyl-5-methylene-2-pyrrolidone, 5-methyl-3-methylene-2-pyrrolidone, N,N-dimethylaminoethyl (meth)acrylate, N,N-dimethylaminopropyl (metha)crylamide, and combination thereof; a copolymer which is a polymerization product of a composition comprising (1) from 0.1% to 30%, by weight of (meth)acrylic acid, allylamine and/or amino-C_1-C_4 alkyl (meth)acrylate, and (2) at least one non-reactive hydrophilic vinylic monomer selected from the group consisting of acryamide, N,N-dimethylacrylamide, N-vinylpyrrolidone, N-vinyl-N-methyl acetamide, glycerol (meth)acrylate, hydroxyethyl (meth)acrylate, N-hydroxyethyl (meth)acrylamide, (meth)acryloyloxyethyl phosphorylcholine, C_1-C_4-alkoxy polyethylene glycol (meth)acrylate having a weight average molecular weight of up to 400 Daltons, vinyl alcohol, and combination thereof.

12. The water-soluble and thermally crosslinkable hydrophilic polymeric material of claim 8, wherein the hydrophilicity-enhancing agent is an amino- or carboxyl-containing polysaccharide, hyaluronic acid, chondroitin sulfate, and combinations thereof.

13. The water-soluble and thermally crosslinkable hydrophilic polymeric material of claim 7, wherein the hydrophilicity-enhancing agent is: amino-, carboxyl- or thiol-containing monosaccharides; amino-, carboxyl- or thiol-containing disaccharides; and amino-, carboxyl- or thiol-containing oligosaccharides.

14. A method for producing coated contact lenses each having a crosslinked hydrophilic coating thereon comprises the steps of:

(a) obtaining a contact lens and a poly(2-oxazoline-co-ethyleneimine)-epichlorohydrin copolymer of any one of claims 1 to 6, wherein the contact lens comprises, on and/or near the surface of the contact lens, reactive

functional groups selected from the group consisting of primary amino groups, secondary amino groups, carboxyl groups, and combinations thereof; and

(b) heating the contact lens in an aqueous solution in the presence of the poly(2-oxazoline-co-ethyleneimine)-epichlorohydrin copolymer to and at a temperature from 40°C to 140°C for a period of time sufficient to covalently attach the poly(2-oxazoline-co-ethyleneimine)-epichlorohydrin copolymer onto the surface of the contact lens through covalent linkages each formed between one azetidinium group of the poly(2-oxazoline-co-ethyleneimine)-epichlorohydrin copolymer and one of the reactive functional groups on and/or near the surface of the contact lens, thereby forming a crosslinked hydrophilic coating on the contact lens.

15. A method for producing coated contact lenses each having a crosslinked hydrophilic coating thereon comprises the steps of:

(a) obtaining a contact lens;

(b) applying a layer of a poly(2-oxazoline-co-ethyleneimine)-epichlorohydrin copolymer of claim 3 or 4 to form an anchoring coating on the contact lens, wherein the poly(2-oxazoline-co-ethyleneimine)-epichlorohydrin copolymer comprises hydrophobic N-acyl-iminoethylene monomeric units; and

(c) heating the contact lens having the anchoring coating thereon in an aqueous solution to and at a temperature from 40°C to 140°C in the presence of a water-soluble hydrophilic polymer having reactive functional groups selected from the group consisting of primary amino groups, secondary amino groups, carboxyl groups, thiol groups, and combinations thereof, for a period of time sufficient to covalently attach the hydrophilic polymer onto the surface of the contact lens through covalent linkages each formed between one azetidinium group of the anchoring coating and one of the reactive functional groups of the hydrophilic polymer, thereby forming a crosslinked hydrophilic coating on the contact lens.

16. A method for producing coated contact lenses each having a crosslinked hydrophilic coating thereon comprises the steps of:

(a) obtaining a contact lens and a water-soluble and thermally-crosslinkable hydrophilic polymeric material of any one of claims 7 to 13, wherein the contact lens comprises, on and/or near the surface of the contact lens, reactive functional groups selected from the group consisting of primary amino groups, secondary amino groups, carboxyl groups, and combinations thereof; and

(b) heating the contact lens in an aqueous solution in the presence of the water-soluble and thermally-crosslinkable hydrophilic polymeric material to and at a temperature from 40°C to 140°C for a period of time sufficient to covalently attach the hydrophilic polymeric material onto the surface of the contact lens through covalent linkages each formed between one azetidinium group of the poly(2-oxazoline-co-ethyleneimine)-epichlorohydrin copolymer and one of the reactive functional groups on and/or near the surface of the contact lens, thereby forming a crosslinked hydrophilic coating on the contact lens.

17. The method according to any one of claims 14 to 16, wherein the contact lens is made by polymerizing a silicone hydrogel lens formulation comprising from about 0.1% to about 10% by weight of at least one reactive vinylic monomer selected from the group consisting of: amino–C_1-C_6 alkyl (meth)acrylate, C_1-C_6 alkylamino–C_1-C_6 alkyl (meth)acrylate, allylamine, amino–C_1-C_6 alkyl (meth)acrylamide, C_1-C_6 alkylamino–C_1-C_6 alkyl (meth)acrylamide, acrylic acid, C_1-C_6 alkylacrylic acid, and combinations thereof.

18. The method of claim 14 or 16, wherein the contact lens comprises a reactive base coating which comprises at least one layer of a reactive polymer having pendant amino groups and/or carboxyl groups and is obtained by contacting the contact lens with a solution of the reactive polymer, wherein the reactive polymer is: a homopolymer of

amino-C_1 to C_4 alkyl (meth)acrylamide, amino-C_1 to C_4 alkyl (meth)acrylate, C_1 to C_4 alkylamino-C_1 to C_4 alkyl (meth)acrylamide, C_1 to C_4 alkylamino-C_1 to C_4 alkyl (meth)acrylate, allylamine, or vinylamine; polyethyleneimine; a polyvinylalcohol with pendant amino groups; a linear or branched polyacrylic acid; a homopolymer of C_1 to C_4 alkylacrylic acid; a copolymer of amino-C_1 to C_4 alkyl (meth)acrylamide, amino-C_1 to C_4 alkyl (meth)acrylate, C_1 to C_4 alkylamino-C_1 to C_4 alkyl (meth)acrylamide, C_1 to C_4 alkylamino-C_1 to C_4 alkyl (meth)acrylate, acrylic acid, C_1 to C_4 alkylacrylic acid, maleic acid, and/or fumaric acid, with at least one non-reactive hydrophilic vinylic monomer (preferably selected from the group consisting of acrylamide, N,N-dimethyl (meth)acrylamide, N-vinylpyrrolidone, glycerol methacrylate, N,N-2-acrylamidoglycolic acid, 3-acryloylamino-1-propanol, N-hydroxyethyl acrylamide, *N*-[tris(hydroxymethyl)methyl]-acrylamide, N-methyl-3-methylene-2-pyrrolidone, 1-ethyl-3-methylene-2-pyrrolidone, 1-methyl-5-methylene-2-pyrrolidone, 1-ethyl-5-methylene-2-pyrrolidone, 5-methyl-3-methylene-2-pyrrolidone, 5-ethyl-3-methylene-2-pyrrolidone, 1-n-propyl-3-methylene-2-pyrrolidone, 1-n-propyl-5-methylene-2-pyrrolidone, 1-isopropyl-3-methylene-2-pyrrolidone, 1-isopropyl-5-methylene-2-pyrrolidone, 1-n-butyl-3-methylene-2-pyrrolidone, 1-tert-butyl-3-methylene-2-pyrrolidone, 2-hydroxyethyl (meth)acrylate, hydroxypropyl (meth)acrylate, (meth)acryloyloxyethyl phosphorylcholine, C_1-C_4-alkoxy polyethylene glycol (meth)acrylate having a weight average molecular weight of up to 1500 Daltons, N-vinyl formamide, N-vinyl acetamide, N-vinyl isopropylamide, N-vinyl-N-methyl acetamide, allyl alcohol, vinyl alcohol (hydrolyzed form of vinyl acetate in the copolymer), and combination thereof); a carboxyl-containing cellulose; hyaluronate; chondroitin sulfate; poly(glutamic acid); poly(aspartic acid); or combinations thereof.

19. The method of claim 18, wherein the reactive polymer is dissolved in a mixture of water and one or more organic solvents, an organic solvent, or a mixture of one or more organic solvents.

20. The method according to any one of claims 14 to 19, wherein the step of heating is performed by autoclaving the contact lens immersed in a packaging solution in a

sealed lens package at a temperature of from 118°C to 125°C for 20 to 90 minutes to form the crosslinked hydrophilic coating on the contact lens, wherein the packaging solution comprises at least one buffering agent in an amount sufficient to maintain a pH of from 6.0 to 8.5 and has a tonicity of from 200 to 450 milliosmol (mOsm) and a viscosity of from 1 centipoise to 20 centipoises at 25°C.