CLAIMS

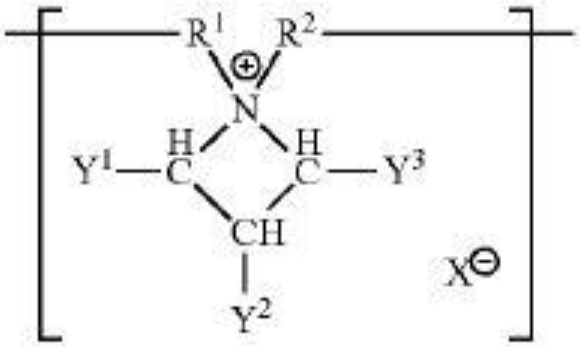
1. A method for producing silicone hydrogel contact lenses with crosslinked hydrophilic coatings thereon, comprising the steps of:

(a) obtaining a silicone hydrogel contact lens having amino groups and/or carboxyl groups on and/or near its surface and a water-soluble and thermally-crosslinkable hydrophilic polymeric material, wherein the silicone hydrogel contact lens comprises amino groups or carboxyl groups or both on and/or near the surface of the contact lens, wherein the hydrophilic polymeric material comprises (i) from about 20% to about 95 by weight of first polymer chains derived from an epichlorohydrin-functionalized polyamine or polyamidoamine, (ii) from about 5% to about 80% by weight of hydrophilic 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 amino group, carboxyl group, thiol group, and combination thereof, and (iii) positively-charged azetidinium groups which are parts of the first polymer chains or pendant or terminal groups covalently attached to the first polymer chains, wherein the hydrophilic moieties or second polymer chains are covalently attached to the first polymer chains through one or more covalent linkages each formed between one azetitdinium group of the epichlorohydrin-functionalized polyamine or polyamidoamine and one amino, carboxyl or thiol group of the hydrophilicity-enhancing agent; and

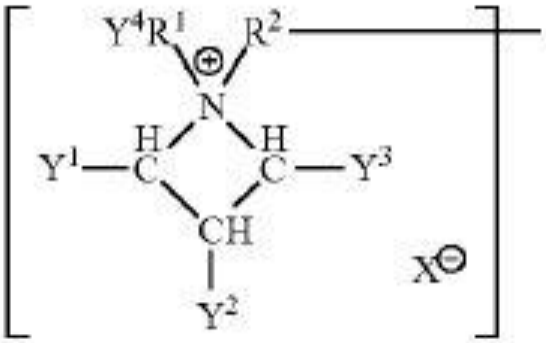
(b) heating the silicone hydrogel contact lens immersed in a packaging solution comprising the hydrophilic polymeric material and at least one buffering agent in an amount sufficient to maintain a pH of from about 6.0 to about 8.5 and has a tonicity of from about 200 to about 450 milliosmol (mOsm) and a viscosity of from about 1 centipoise to about 20 centipoises at 25° C. in a lens package to and at a temperature from about 40° C. to about 140° C. for a period of time sufficient to covalently attach the hydrophilic polymeric material onto the surface of the silicone hydrogel contact lens through second covalent linkages each formed between one azetidinium group of the hydrophilic polymeric material 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 silicone hydrogel contact lens,

(c) adding a polyazetidinium groups-containing component into the package solution with the silicone contact lens of the step (b), wherein the polyazetidinium groups-containing component comprise at least two groups selected from the group consisting of Formula (II), Formula (III) and mixtures thereof:

(II)



(III)



wherein: R^1 and R^2 are independently an alkylene group containing 1 to 6 carbon atoms; X is an anionic counterion; Y^1, Y^2 and Y^3 are each independently selected from the group consisting of hydrogen, hydroxyl, halo, alkoxy, alkyl, amino, carboxy, acetoxy, cyano and sulfhydryl; and Y^4 is a chain-terminating group, selected from the group consisting of hydrogen, alkyl, alkoxy and acyloxy;

(d) sealing the lens package with the contact lens and the package solution of step (c)

(e) reducing the concentration of amino groups and/or carboxyl groups on and/or near the silicone hydrogel contact lens by autoclaving the package with the contact lens and the in-package-coating solution therein of step (d) and inducing reaction between azetidinium groups of the polyazetidinium groups-containing component and residual amino groups and/or carboxyl groups remained on and/or the surface of the silicone hydrogel contact lens immersed in the in-package-coating solution, wherein the reduction of the concentration of carboxyl groups on and/or near the silicone hydrogel contact lens of step (e) is characterized by having an decreased positively charged preservatives uptake in relation to the silicone hydrogel contact lens of step (b) by at least 20%.

2. The method of claim **1**, wherein the polyazetidinium groups-containing component has a solution viscosity range from 10 to 200 m·Pa·s. at 23% solid.

3. The method of claim **2**, wherein the polyazetidinium groups-containing component has a solution a viscosity range from 30 to 160 m·Pa·s. at 23% solid.

4. The method of claim **3**, wherein the polyazetidinium groups-containing component has a solution a viscosity range from 40 to 130 m·Pa·s. at 23% solid.

5. The method of claim **1**, wherein the in-packaging-coating solution of step (b) comprises from 0.01% to 2% by weight of thermally-crosslinkable hydrophilic polymeric material.

6. The method of claim **1**, wherein the polyazetidinium groups-containing component is added in the in-packaging-coating solution of step (c) in an amount of from about 0.01% to about 5% by weight based on the total amount of the in-packaging-coating solution.

7. The method of claim **1**, wherein the step of heating is perform by heating the silicone hydrogel contact lens immersed in a packaging solution in a sealed lens package at a temperature from about 40° C. to about 140° C. for approximately 20-180 minutes and the step of reducing the concentration of amino groups and/or carboxyl groups on and/or near the silicone hydrogel contact lens by autoclaving the package with the contact lens and the in-package-coating solution at a temperature of from about 118° C. to about 125° C. for approximately 20-90 minutes.

8. The method of claim **7**, wherein the step of heating is perform by heating the silicone hydrogel contact lens immersed in a packaging solution in a sealed lens package at a temperature from about 75° C. to about 95° C. for approximately 20-180 minutes and the step of reducing the concentration of amino groups and/or carboxyl groups on and/or near the silicone hydrogel contact lens by autoclaving the package with the contact lens and the in-package-coating solution at a temperature of from about 118° C. to about 125° C. for approximately about 118° C. to about 125° C. for approximately 20-40 minutes.

9. The method of claim **1**, wherein the hydrophilicity-enhancing agent is a hydrophilic polymers having one or more amino, carboxyl and/or thiol groups, wherein the content of monomeric units having an amino, carboxyl or thiol group in the hydrophilic polymer as the hydrophilicity-enhancing agent is less than about 40% by weight based on the total weight of the hydrophilic polymer.

10. The method of claim **1**, wherein the weight average molecular weight Mw of the hydrophilic polymer having at least one amino, carboxyl or thiol group from about 500 to about 1,000,000 Daltons.

11. The method of claim **1**, wherein the silicone hydrogel contact lens comprises a reactive base coating including amino and/or carboxyl groups.

12. The method of claim **11**, wherein the reactive base coating comprises at least one layer of a reactive polymer having pendant amino groups and/or carboxyl groups and is obtained by contacting the silicone hydrogel 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_{12} alkylacrylic acid; a copolymer of amino-C_2 to C_4 alkyl (meth)acrylamide, amino-C_2 to C_4 alkyl (meth)acrylate, C_1 to C_4 alkylamino-C_2 to C_4 alkyl (meth)acrylamide, C_1 to C_4 alkylamino-C_2 to C_4 alkyl (meth)acrylate, acrylic acid, C_1 to C_{12} alkylacrylic acid, maleic acid, and/or fumaric acid, with at least one non-reactive hydrophilic vinylic monomer; a carboxyl-containing cellulose; hyaluronate; chondroitin sulfate; poly(glutamic acid); poly(aspartic acid); or combinations thereof.

13. The method of claim **12**, wherein the reactive polymer for forming a base coating is polyacrylic acid, polymethacrylic acid, poly(N,N-2-acrylamidoglycolic acid), poly [(meth)acrylic acid-co-acrylamide], poly[(meth)acrylic acid-co-vinylpyrrolidone], hydrolyzed poly[(meth)acrylic acid-co-vinylacetate], polyethyleneimine (PEI), polyallylamine hydrochloride (PAH) homo- or copolymer, polyvinylamine homo- or copolymer, or combinations thereof.

14. The method of claim **13**, wherein the weight average molecular weight Mw of a reactive polymer for forming a reactive base coating is at least about 10,000 Daltons.

15. The method of claim **14**, wherein the weight average molecular weight Mw of a reactive polymer for forming a reactive base coating is from about 10,000 to 1,000,000 Daltons.

16. The method of claim **13**, 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.