CLAIMS

1. A method for producing silicone hydrogel contact lenses each having a crosslinked hydrophilic coating thereon, comprising the steps of:
   a) obtaining a silicone hydrogel contact lens including a polymer which is a polymerization product of a polymerizable composition comprising
      (i) at least one siloxane-containing vinylic monomer,
      (ii) a polysiloxane vinylic crosslinker, and
      (iii) at least about 25% by weight of one or more hydrophilic vinylic monomers relative to the total amount of polymerizable components, wherein said one or more hydrophilic vinylic monomers are selected from the group consisting of N,N-dimethylacrylamide, N,N-dimethylmethacrylamide, 2-acrylamidoglycolic acid, N-hydroxypropylacrylamide, N-hydroxyethyl acrylamide, N-[tris(hydroxymethyl)methyl]-acrylamide, N-vinylpyrrolidone, N-vinyl formamide, N-vinyl acetamide, N-vinyl isopropylamide, N-vinyl-N-methyl acetamide, N-methyl-3-methylene-2-pyrrolidone, 1-methyl-5-methylene-2-pyrrolidone, 5-methyl-3-methylene-2-pyrrolidone, and a combination thereof;
   b) contacting the silicone hydrogel contact lens with an organic solvent-based solution of polymethacrylic acid for a time period of from about 30 seconds to about 120 seconds to form a polymethacrylic acid base coating that has a concentration of carboxyl groups of about 20 nanomoles per lens or less, wherein the polymethacrylic acid has a weight average molecular weight M_w of at least about 50,000 Daltons, wherein the organic solvent-based solution comprises from about 0.002% to about 0.75% by weight of the polymethacrylic acid;
   c) forming a polyamidoamine-epichlorohydrin-doped polymethacrylic acid base coating on the silicone hydrogel contact lens by contacting the silicone hydrogel contact lens obtained in step (b) with a polyamidoamine-epichlorohydrin solution having a pH of from about 2.0 to about 3.5 for a time period of from about 30 seconds to about 300 seconds, wherein the polyamidoamine-epichlorohydrin solution comprises from about 0.001% to about 5% by weight of a polyamidoamine-epichlorohydrin dissolved in a mixture of water and an organic solvent relative to the total weight of the polyamidoamine-epichlorohydrin solution, wherein the polyamidoamine-epichlorohydrin intermingles with PMAA in the polyamidoamine-epichlorohydrin-doped polymethacrylic acid base coating;
   d) heating the silicone hydrogel contact lens with the polyamidoamine-epichlorohydrin-doped polymethacrylic acid base coating thereon, which is obtained in step (c), in an aqueous solution which comprises a water-soluble and thermally-crosslinkable hydrophilic polymeric material having azetidinium groups and optionally amino or carboxyl groups, to and at a temperature of from about 60°C. to about 140°C. for a time period

sufficient long to crosslink the polymethacrylic acid, the polyamidoamine epichlorohydrin and the hydrophilic polymeric material, thereby forming a hydrogel coating on the silicone hydrogel contact lens, wherein the hydrogel coating on the silicone hydrogel contact lens has a durability as characterized by having a lubricity better than the control coating on a control lens after being subjected to 30 cycle of digital rubbing tests, wherein the control lens is the silicone hydrogel contact lens and the control coating on the control lens is obtained according to a process in which only step (c) listed above is eliminated whereas other steps and conditions listed above are unchanged.

2. The method of claim 1, wherein said one or more hydrophilic vinylic monomers are selected from the group consisting of N,N-dimethylacrylamide, N,N-dimethylmethacrylamide, N-vinylpyrrolidone, N-vinyl-N-methyl acetamide, N-methyl-3-methylene-2-pyrrolidone, 1-methyl-5-methylene-2-pyrrolidone, 5-methyl-3-methylene-2-pyrrolidone, and a combination thereof.
3. The method of claim 2, wherein the polymethacrylic acid has a weight average molecular weight M_w of from about 100,000 Daltons to about 1,000,000 Daltons; wherein the concentration of polymethacrylic acid is from 0.003% to about 0.1% by weight relative to the total weight of the organic-based solution; wherein the organic solvent-based solution of polymethacrylic acid comprises at least about 60% by weight of an organic solvent.
4. The method of claim 3, wherein the amount of carboxyl groups in the polymethacrylic acid base coating is about 15 nanomoles or less per lens.
5. The method of claim 3, wherein the step of heating is carried out directly in a sealed lens package containing a packaging solution including the water-soluble and thermally-crosslinkable hydrophilic polymeric material during sterilization by autoclave at a temperature from about 115°C. to about 125°C. for at least about 20 minutes under pressure; wherein the packaging solution comprises from about 0.01% to about 2% by weight of the water-soluble and thermally-crosslinkable hydrophilic polymeric material; wherein the packaging solution comprises 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 8 centipoises, at 25°C.
6. The method of claim 5, wherein the water-soluble and thermally crosslinkable hydrophilic polymeric material comprises:
   (i) from about 20% to about 95% by weight of first polymer chains derived from a polyamidoamine-epichlorohydrin or a poly(2-oxazoline-co-ethyleneimine)-epichlorohydrin;
   (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 polyamidoamine-epichlorohydrin or the poly(2-oxazoline-co-ethyleneimine)-epichlorohydrin and one amino, carboxyl or thiol group of the hydrophilicity-enhancing agent.

7. The method of claim 6, wherein the hydrophilicity-enhancing agent is a hydrophilic polymer 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 hydrophilicity-enhancing agent is less than about 40% by weight based on the total weight of the hydrophilic polymer.
8. The method of claim 6, wherein the hydrophilic polymer as 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; or combinations thereof, wherein PEG is a polyethylene glycol segment, 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.
9. The method of claim 6, wherein the hydrophilic polymer as the hydrophilicity-enhancing agent is a copolymer which is a polymerization product of a composition comprising (1) about 60% by weight or less by weight of at least one reactive vinylic monomer and (2) at least one non-reactive hydrophilic vinylic monomer, 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.

10. The method of claim 6, wherein the hydrophilic polymer as the hydrophilicity-enhancing agent is an amino- or carboxyl-containing polysaccharide, hyaluronic acid, chondroitin sulfate, and combinations thereof.
11. The method of claim 6, wherein the weight average molecular weight M_w of the hydrophilic polymer as the hydrophilicity-enhancing agent is from about 500 to about 1,000,000 Daltons.
12. The method of claim 6, 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.
13. The method of claim 6, wherein the first polymer chains are derived from the polyamidoamine-epichlorohydrin.
14. The method of claim 6, wherein the first polymer chains are derived from the poly(2-oxazoline-co-ethyleneimine)-epichlorohydrin.
15. The method of claim 1, wherein the polymethacrylic acid has a weight average molecular weight M_w of from about 100,000 Daltons to about 1,000,000 Daltons; wherein the concentration of polymethacrylic acid is from 0.003% to about 0.1% by weight relative to the total weight of the organic-based solution; wherein the organic solvent-based solution of polymethacrylic acid comprises at least about 60% by weight of an organic solvent.
16. The method of claim 15, wherein the step of heating is carried out directly in a sealed lens package containing a packaging solution including the water-soluble and thermally-crosslinkable hydrophilic polymeric material during

sterilization by autoclave at a temperature from about 115°C. to about 125°C. for at least about 20 minutes under pressure; wherein the packaging solution comprises from about 0.01% to about 2% by weight of the water-soluble and thermally-crosslinkable hydrophilic polymeric material; wherein the packaging solution comprises 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 8 centipoises, at 25°C.

17. The method of claim 16, wherein the water-soluble and thermally crosslinkable hydrophilic polymeric material comprises:
    (i) from about 20% to about 95% by weight of first polymer chains derived from a polyamidoamine-epichlorohydrin or a poly(2-oxazoline-co-ethyleneimine)-epichlorohydrin;
    (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 polyamidoamine-epichlorohydrin or the poly(2-oxazoline-co-ethyleneimine)-epichlorohydrin and one amino, carboxyl or thiol group of the hydrophilicity-enhancing agent.
18. The method of claim 17, wherein the hydrophilicity-enhancing agent is a hydrophilic polymer 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 hydrophilicity-enhancing agent is less than about 40% by weight based on the total weight of the hydrophilic polymer.
19. The method of claim 17, wherein the hydrophilic polymer as 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; or combinations thereof, wherein PEG is a polyethylene glycol segment, 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.

20. The method of claim 17, wherein the hydrophilic polymer as the hydrophilicity-enhancing agent is a copolymer which is a polymerization product of a composition comprising (1) about 60% by weight or less by weight of at least one reactive vinylic monomer and (2) at least one non-reactive hydrophilic vinylic monomer, 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.