

Method for Making Embedded Hydrogel Contact Lenses

The present invention generally relates to a method for producing embedded hydrogel contact lenses. In addition, the present invention provides embedded hydrogel contact lenses produced according to a method of the invention.

BACKGROUND

Hydrogel contact lenses are widely used for correcting many different types of vision deficiencies due to their softness for wearing comfort. They are made of a hydrated, crosslinked polymeric material that contains from about 20% to about 75% by weight of water within the lens polymer matrix at equilibrium. Hydrogel contact lenses generally are produced according to the conventional full cast-molding process. Such a conventional manufacturing process comprises at least the following steps: lens molding (i.e., curing a polymerizable composition in molds), demolding (i.e., removing lenses from molds), extracting lenses with an extraction medium, hydrating lenses, packaging and sterilizing the hydrated lenses. During hydration, the hydrogel contact lenses will absorb water and typically can swell significantly in size.

In recent years, it has been proposed that various inserts can be incorporated in hydrogel contact lenses for various purposes, e.g., for corneal health, vision correction, diagnosis, etc. See, for example, U.S. Pat. Nos. 4268132, 4401371, 5098546, 5156726, 6851805, 7104648, 7490936, 7883207, 7931832, 8154804, 8215770, 8348424, 8874182, 8922898, 9155614, 9176332, 9296158, 9618773, 9731437, 9889615, 9977260, 10203521, and 10209534; and U.S. Pat. Appl. Pub. Nos. 2004/0141150, 2009/0091818, 2010/0076553, 2011/0157544, and 2012/0140167.

Inserts are typically made of a non-hydrogel material that cannot absorb water and is a non-water-swellaable material. One special type of inserts are rigid inserts made of a rigid material (i.e., a highly-crosslinked polymeric material) as rigid center optics for masking astigmatism like a rigid gas permeable (RGP) contact lens. For such inserts, it is expected that there are huge difference in mechanical properties and especially in water-swelling degree between insert material and silicone hydrogel lens material embedding the insert. Due to such huge differences, embedded silicone hydrogel contact lenses are susceptible to lens distortion or especially delamination during the hydration of the hydrogel contact lenses with inserts embedded therein and during the handling and wearing of the embedded silicone hydrogel contact lens. It would be desirable to have embedded silicone hydrogel contact lenses that have rigid hydrophobic inserts therein and not susceptible to delamination.

U.S. Pat. Appl. Pub. No. 2018/0169905 A1 discloses attempts for reducing distortion

during hydration of an embedded contact lens comprising a hydrogel lens body and a non-expandable object embedded therein by selecting the surface energy of the non-expandable object and the modulus of the hydrogel lens body.

U.S. Pat. No. 10139521 discloses that a silicone elastomer-hydrogel hybrid contact lens that includes a silicone elastomer layer and a hydrogel layer adhered to the silicone elastomer layer by a delamination-resistant bond that is formed by an elastomer-swellaable monomer that is included in the polymerizable composition used to form the hydrogel layer.

U.S. Pat. Appl. Pub. No. 2021/0292558 A1 discloses that when a polysiloxane vinylic crosslinker comprising hydrophilized siloxane units each having one methyl substituent and one organic radical including at least one H-bond donor can be added in a polymerizable composition in cast molding of embedded silicone hydrogel contact lenses each having a rigid insert made of a hydrophobic crosslinked polymeric material, the resultant embedded silicone hydrogel contact lenses are less susceptible to delamination.

SUMMARY OF THE INVENTION

In one aspect, the invention provides a method for producing embedded hydrogel contact lenses, the method of invention comprising the steps of: (1) obtaining an insert mold, wherein the insert mold comprises a male insert mold half having a first molding surface and a female insert mold half having a second molding surface are configured to receive each other such that an insert-molding cavity is formed between the first and second molding surfaces when the female insert mold half is closed with the male insert mold half; (2) dispensing an insert-forming composition in the female insert mold half, wherein the insert-forming composition comprises (i) at least one polymerizable material, (ii) at least one first free-radical initiator, and (iii) at least one iniferter; (3) closing the female insert mold half with the male insert mold half to form a first molding assembly comprising the insert-forming composition within the insert-molding cavity of the insert mold; (4) curing thermally or actinically the insert-forming composition in the insert-molding cavity of the first molding assembly to form a molded insert that is made of a first crosslinked polymeric material comprising iniferter moieties covalently attached thereto; (5) obtaining a lens mold and a lens-forming composition, wherein the lens mold comprises a male lens mold half having a third molding surface and a female lens mold half having a fourth molding surface are configured to receive each other such that a lens-molding cavity is formed between the third and fourth molding surfaces when the female lens mold half is closed with the male lens mold half, wherein the lens-forming composition comprises at least one second polymerizable material and a second free-radical initiator; (6) in no particular order, placing the insert obtained in step (4) in the female lens mold half at a desired position and dispensing the lens-forming composition in the female lens mold half, wherein the insert is

immersed in the lens-forming composition; (7) closing the female lens mold half with the male lens mold half to form a second molding assembly comprising the lens-forming composition and the insert immersed therein in the lens-molding cavity of the lens mold; (8) curing thermally or actinically the lens-forming composition while simultaneously initiating iniferter-induced polymerization of the lens-forming composition at and near the surface of the insert in the lens-molding cavity of the second molding assembly to form an embedded hydrogel lens precursor that comprise a bulk hydrogel material formed from the lens-forming composition and the insert embedded in the bulk material, wherein the bulk hydrogel material is a second crosslinked polymeric material that is covalently linked to the first crosslinked polymeric material at iniferter moieties located at and near the surface of the insert; (9) separating the lens mold obtained in step (8) into the male and female lens mold halves, with the embedded hydrogel lens precursor adhered onto a lens-adhered lens mold half which is one of the male and female lens mold halves; (10) removing the embedded hydrogel lens precursor from the lens-adhered lens mold half (preferably before the embedded hydrogel lens precursor is contact with water or any liquid); and (11) subjecting the embedded hydrogel lens precursor to post-molding processes including a hydration process and one or more other processes selected from the group consisting of extraction, surface treatment, packaging, sterilization, and combinations thereof to form the embedded hydrogel contact lens.

In another aspect, the invention provides an embedded hydrogel contact lens obtained according to a method of the invention.

These and other aspects of the invention will become apparent from the following description of the presently preferred embodiments. The detailed description is merely illustrative of the invention and does not limit the scope of the invention, which is defined by the appended claims and equivalents thereof. As would be obvious to one skilled in the art, many variations and modifications of the invention may be effected without departing from the spirit and scope of the novel concepts of the disclosure.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. Generally, the nomenclature used herein and the laboratory procedures are well known and commonly employed in the art. Conventional methods are used for these procedures, such as those provided in the art and various general references. Where a term is provided in the singular, the inventors also contemplate the plural of that term. The nomenclature used herein and the laboratory procedures described below are those well-known and commonly employed in the art.

"About" as used herein in this application means that a number, which is referred to as "about", comprises the recited number plus or minus 1-10% of that recited number.

"Contact Lens" refers to a structure that can be placed on or within a wearer's eye. A contact lens can correct, improve, or alter a user's eyesight, but that need not be the case. A contact lens can be of any appropriate material known in the art or later developed, and can be a soft lens, a hard lens, or an embedded lens.

A "hydrogel contact lens" refers to a contact lens comprising a hydrogel bulk (core) material. A hydrogel bulk material can be a non-silicone hydrogel material or preferably a silicone hydrogel material.

A "hydrogel" or "hydrogel material" refers to a crosslinked polymeric material which has three-dimensional polymer networks (i.e., polymer matrix), is insoluble in water, but can hold at least 10% by weight of water in its polymer matrix when it is fully hydrated (or equilibrated).

A siloxane, which often also described as a silicone, refers to a molecule having at least one moiety of -Si-O-Si- where each Si atom carries two organic groups as substituents.

A "silicone hydrogel" or "SiHy" refers to a silicone-containing hydrogel obtained by copolymerization of a polymerizable composition comprising at least one silicone-containing monomer or at least one silicone-containing macromer or at least one crosslinkable silicone-containing prepolymer.

As used in this application, the term "non-silicone hydrogel" or "non-silicone hydrogel material" interchangeably refers to a hydrogel that is theoretically free of silicon.

A "male mold half" or "base curve mold half" interchangeably refers to a mold half having (1) a molding surface that is a substantially convex surface and that defines the posterior (back) surface of a contact lens (or an insert) and (2) a central axis that is the normal line at the center of the molding surface.

A "female mold half" or "front curve mold half" interchangeably refers to a mold half having (1) a molding surface that is a substantially concave surface and that defines the anterior (front) surface of a contact lens (or an insert) and (2) a central axis that is the normal line at the center of the molding surface.

The term "anterior surface", "front surface", "front curve surface" or "FC surface" in reference to a contact lens or an insert, as used in this application, interchangeably means a surface of the contact lens or insert that faces away from the eye during wear. The anterior surface (front surface) is typically substantially convex.

The "posterior surface", "back surface", "base curve surface" or "BC surface" in reference to a contact lens or insert, as used in this application, interchangeably means a surface of the contact lens or insert that faces towards the eye during wear. The posterior

surface (back surface) is typically substantially concave.

An “embedded hydrogel contact lens” refers a hydrogel contact lens comprising at least one insert which is embedded fully or partially within the bulk hydrogel material of the embedded hydrogel contact lens.

In this application, an “insert” refers to any preformed article which has a diameter of up to 13 mm, a front (anterior) surface, an opposite back (posterior) surface, a central axis, and a thickness less than any thickness of an embedded hydrogel contact lens in the region where the insert is embedded. It is understood that the insert must be smaller than the embedded hydrogel contact lens in dimension, so as to be embedded in the bulk material of the embedded hydrogel contact lens. The insert can be made of a polymeric material that can be a non-hydrogel material or a hydrogel material. Examples of preferred inserts include without limitation thin rigid inserts for providing rigid center optics for masking astigmatism like a rigid gas permeable (RGP) contact lens, multifocal lens inserts, photochromic inserts, cosmetic inserts having color patterns printed thereon, etc.

In this application, a central axis of an insert (or contact lens) refers to an imaginary line passing through both the centers of the anterior (front) and posterior (back) surface of the insert (or contact lens).

In accordance with the invention, a non-hydrogel material can be any material that can absorb less than 5% (preferably about 4% or less, more preferably about 3% or less, even more preferably about 2% or less) by weight of water when being fully hydrated.

“Hydrophilic,” as used herein, describes a material or portion thereof that will more readily associate with water than with lipids.

“Hydrophobic” in reference to an insert material or insert that has an equilibrium water content (i.e., water content in fully hydrated state) of less than 5% (preferably about 4% or less, more preferably about 3% or less, even more preferably about 2% or less).

The term “room temperature” refers to a temperature of about 22°C to about 26°C.

The term “soluble”, in reference to a compound or material in a solvent, means that the compound or material can be dissolved in the solvent to give a solution with a concentration of at least about 0.5% by weight at room temperature (i.e., a temperature of about 22°C to about 26°C).

The term “insoluble”, in reference to a compound or material in a solvent, means that the compound or material can be dissolved in the solvent to give a solution with a concentration of less than 0.01% by weight at room temperature (as defined above).

A “vinyl monomer” refers to a compound that has one sole ethylenically unsaturated group, is soluble in a solvent, and can be polymerized actinically or thermally.

A “polymerizable material” refers to a compound, a polymer (soluble in a solvent), or a mixture thereof that comprises at least one ethyleneically unsaturated group and can be

polymerized actinically or thermally.

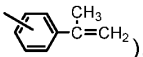
As used in this application, the term “ethylenically unsaturated group” is employed herein in a broad sense and is intended to encompass any groups containing at least one $>C=CH_2$ group. Exemplary ethylenically unsaturated groups include without limitation

(meth)acryloyl ($\begin{smallmatrix} \text{O} & \text{CH}_3 \\ \parallel & | \\ -\text{C} & -\text{C}=\text{CH}_2 \end{smallmatrix}$ and/or $\begin{smallmatrix} \text{O} \\ \parallel \\ -\text{C}-\text{CH}=\text{CH}_2 \end{smallmatrix}$), vinyloxycarbonylamino

($-\text{NR}^0-\begin{smallmatrix} \text{O} \\ \parallel \\ \text{C} \end{smallmatrix}-\text{O}-\text{CH}=\text{CH}_2$ in which R^0 is H or C_1 - C_4 alkyl), vinyloxycarbonyloxy

($-\text{O}-\begin{smallmatrix} \text{O} \\ \parallel \\ \text{C} \end{smallmatrix}-\text{O}-\text{CH}=\text{CH}_2$), vinylaminocarbonylamino ($-\text{NR}^0-\begin{smallmatrix} \text{O} \\ \parallel \\ \text{C} \end{smallmatrix}-\text{NH}-\text{CH}=\text{CH}_2$ in which R^0 is H or C_1 -

C_4 alkyl), vinylaminocarbonyloxy ($-\text{O}-\begin{smallmatrix} \text{O} \\ \parallel \\ \text{C} \end{smallmatrix}-\text{NH}-\text{CH}=\text{CH}_2$), allyl, vinyl, styrenyl (- $\text{CH}=\text{CH}_2$ or

, or other $\text{C}=\text{C}$ containing groups.

An “acrylic monomer” refers to a vinylic monomer having one sole (meth)acryloyl group. Examples of acrylic monomers includes (meth)acryloxy [or (meth)acryloyloxy] monomers and (meth)acrylamido monomers.

An “(meth)acryloxy monomer” or “(meth)acryloyloxy monomer” refers to a vinylic monomer having one sole group of $-\text{O}-\begin{smallmatrix} \text{O} & \text{CH}_3 \\ \parallel & | \\ \text{C} & -\text{C}=\text{CH}_2 \end{smallmatrix}$ or $-\text{O}-\begin{smallmatrix} \text{O} \\ \parallel \\ \text{C} \end{smallmatrix}-\text{CH}=\text{CH}_2$.

An “(meth)acrylamido monomer” or “(meth)acryloylamino monomer” refers to a vinylic monomer having one sole group of $-\text{NR}^0-\begin{smallmatrix} \text{O} & \text{CH}_3 \\ \parallel & | \\ \text{C} & -\text{C}=\text{CH}_2 \end{smallmatrix}$ or $-\text{NR}^0-\begin{smallmatrix} \text{O} \\ \parallel \\ \text{C} \end{smallmatrix}-\text{CH}=\text{CH}_2$ in which R^0 is H or C_1 - C_4 alkyl.

The term “aryl acrylic monomer” refers to an acrylic monomer having at least one aromatic ring.

The term “(meth)acrylamide” refers to methacrylamide and/or acrylamide.

The term “(meth)acrylate” refers to methacrylate and/or acrylate.

An “N-vinyl amide monomer” refers to an amide compound having a vinyl group ($-\text{CH}=\text{CH}_2$) that is directly attached to the nitrogen atom of the amide group.

An “ene monomer” refers to a vinylic monomer having one sole ene group.

The term “ene group” refers to a monovalent radical of $\text{CH}_2=\text{CH}-$ or $\text{CH}_2=\text{CCH}_3-$ that is not covalently attached to an oxygen or nitrogen atom or a carbonyl group.

A “vinyloxycarbonyloxy monomer” refers to a vinylic monomer having one sole vinyloxycarbonyloxy group.

A “vinyloxycarbonylamino monomer” refers to a vinylic monomer having one sole vinyloxycarbonylamino group.

A “vinylaminocarbonyloxy monomer” refers to a vinylic monomer having one sole vinylaminocarbonyloxy group.

A “vinylaminocarbonylamino monomer” refers to a vinylic monomer having one sole vinylaminocarbonylamino group.

A “hydrophilic vinylic monomer” refers to a vinylic monomer which typically yields a homopolymer that is water-soluble or can absorb at least 10 percent by weight of water.

A “hydrophobic vinylic monomer” refers to a vinylic monomer which typically yields a homopolymer that is insoluble in water and can absorb less than 10% by weight of water.

As used in this application, the term “vinylic crosslinker” refers to an organic compound having at least two ethylenically unsaturated groups. A “vinylic crosslinking agent” refers to a vinylic crosslinker having a molecular weight of 700 Daltons or less.

An “acrylic crosslinker” refers to a vinylic crosslinker having at least two (meth)acryloyl groups.

The term “acrylic repeating units” refers to repeating units of a polymeric material, each of which is derived from an acrylic monomer or crosslinker in a free-radical polymerization to form the polymeric material.

The term “terminal (meth)acryloyl group” refers to one (meth)acryloyl group at one of the two ends of the main chain (or backbone) of an organic compound as known to a person skilled in the art.

As used herein, “actinically” in reference to curing, crosslinking or polymerizing of a polymerizable composition, a prepolymer or a material means that the curing (e.g., crosslinked and/or polymerized) is performed by actinic irradiation, such as, for example, UV/visible irradiation, ionizing radiation (e.g. gamma ray or X-ray irradiation), microwave irradiation, and the like. Thermal curing or actinic curing methods are well-known to a person skilled in the art.

As used in this application, the term “polymer” means a material formed by polymerizing/crosslinking one or more monomers or macromers or prepolymers or combinations thereof.

A “macromer” or “prepolymer” refers to a compound or polymer that contains ethylenically unsaturated groups and has a number average molecular weight of greater than 700 Daltons.

As used in this application, the term “molecular weight” of a polymeric material (including monomeric or macromeric materials) refers to the number-average molecular weight unless otherwise specifically noted or unless testing conditions indicate otherwise. A skilled person knows how to determine the molecular weight of a polymer according to known methods, e.g., GPC (gel permeation chromatography) with one or more of a refractive index detector, a low-angle laser light scattering detector, a multi-angle laser light scattering detector, a differential viscometry detector, a UV detector, and an infrared (IR) detector; MALDI-TOF MS (matrix-assisted laser desorption/ionization time-of-flight mass

spectroscopy); ^1H NMR (Proton nuclear magnetic resonance) spectroscopy, etc.

A “polysiloxane segment” or “polydiorganosiloxane segment” interchangeably refers

to a polymer chain segment (i.e., a divalent radical) of $\left[\begin{array}{c} \text{R}_{\text{S}1} \\ | \\ \text{—Si—O—} \\ | \\ \text{R}_{\text{S}2} \end{array} \right]_{\text{SN}} \begin{array}{c} \text{R}_{\text{S}1} \\ | \\ \text{—Si—} \\ | \\ \text{R}_{\text{S}2} \end{array}$ in which SN is an integer of 3 or larger and each of $\text{R}_{\text{S}1}$ and $\text{R}_{\text{S}2}$ independent of one another are selected from the group consisting of: $\text{C}_1\text{--C}_{10}$ alkyl; phenyl; $\text{C}_1\text{--C}_4$ -alkyl-substituted phenyl; $\text{C}_1\text{--C}_4$ -alkoxy-substituted phenyl; phenyl- $\text{C}_1\text{--C}_6$ -alkyl; $\text{C}_1\text{--C}_{10}$ fluoroalkyl; $\text{C}_1\text{--C}_{10}$ fluoroether; aryl; aryl $\text{C}_1\text{--C}_{18}$ alkyl; $\text{—alk—(OC}_2\text{H}_4\text{)}_{\gamma 1}\text{—OR}^0$ (in which alk is $\text{C}_1\text{--C}_6$ alkylene diradical, R^0 is H or $\text{C}_1\text{--C}_4$ alkyl and $\gamma 1$ is an integer from 1 to 10); a $\text{C}_2\text{--C}_{40}$ organic radical having at least one functional group selected from the group consisting of hydroxyl group (—OH), carboxyl group (—COOH), amino group ($\text{—NR}_{\text{N}1}\text{R}_{\text{N}1}'$), amino linkages of $\text{—NR}_{\text{N}1}\text{—}$, amide linkages of $\text{—CONR}_{\text{N}1}\text{—}$, amide of $\text{—CONR}_{\text{N}1}\text{R}_{\text{N}1}'$, urethane linkages of —OCONH— , and $\text{C}_1\text{--C}_4$ alkoxy group, or a linear hydrophilic polymer chain, in which $\text{R}_{\text{N}1}$ and $\text{R}_{\text{N}1}'$ independent of each other are hydrogen or a $\text{C}_1\text{--C}_{15}$ alkyl; and a photochromic organic radical having a photochromic group.

A “polysiloxane vinylic monomer” or a “polysiloxane vinylic monomer” interchangeably refers to a compound comprising at least one polysiloxane segment and one sole ethylenically-unsaturated group.

A “polydiorganosiloxane vinylic crosslinker” or “polysiloxane vinylic crosslinker” interchangeably refers to a compound comprising at least one polysiloxane segment and at least two ethylenically-unsaturated groups.

A “linear polydiorganosiloxane vinylic crosslinker” or “linear polysiloxane vinylic crosslinker” interchangeably refers to a compound comprising a main chain which includes at least one polysiloxane segment and is terminated with one ethylenically-unsaturated group at each of the two ends of the main chain.

A “chain-extended polydiorganosiloxane vinylic crosslinker” or “chain-extended polysiloxane vinylic crosslinker” interchangeably refers to a compound comprising at least two ethylenically-unsaturated groups and at least two polysiloxane segments each pair of which are linked by one divalent radical.

The term “fluid” as used herein indicates that a material is capable of flowing like a liquid.

As used in this application, the term “clear” in reference to a polymerizable composition means that the polymerizable composition is a transparent solution or liquid mixture (i.e., having a light transmissibility of 85% or greater, preferably 90% or greater in the range between 400 to 700 nm).

The term “monovalent radical” refers to an organic radical that is obtained by removing a hydrogen atom from an organic compound and that forms one bond with one

other group in an organic compound. Examples include without limitation, alkyl (by removal of a hydrogen atom from an alkane), alkoxy (or alkoxyl) (by removal of one hydrogen atom from the hydroxyl group of an alkyl alcohol), thiyl (by removal of one hydrogen atom from the thiol group of an alkylthiol), cycloalkyl (by removal of a hydrogen atom from a cycloalkane), cycloheteroalkyl (by removal of a hydrogen atom from a cycloheteroalkane), aryl (by removal of a hydrogen atom from an aromatic ring of the aromatic hydrocarbon), heteroaryl (by removal of a hydrogen atom from any ring atom), amino (by removal of one hydrogen atom from an amine), etc.

The term "divalent radical" refers to an organic radical that is obtained by removing two hydrogen atoms from an organic compound and that forms two bonds with other two groups in an organic compound. For example, an alkylene divalent radical (i.e., alkylene) is obtained by removal of two hydrogen atoms from an alkane, a cycloalkylene divalent radical (i.e., cycloalkylene) is obtained by removal of two hydrogen atoms from the cyclic ring.

In this application, the term "substituted" in reference to an alkyl or an alkylene means that the alkyl or the alkylene comprises at least one substituent which replaces one hydrogen atom of the alkyl or the alkylene and is selected from the group consisting of hydroxyl (-OH), carboxyl (-COOH), -NH₂, sulfhydryl (-SH), C₁-C₄ alkyl, C₁-C₄ alkoxy, C₁-C₄ alkylthio (alkyl sulfide), C₁-C₄ acylamino, C₁-C₄ alkylamino, di-C₁-C₄ alkylamino, and combinations thereof.

A free radical initiator can be either a photoinitiator or a thermal initiator. A "photoinitiator" refers to a chemical that initiates free radical crosslinking/polymerizing reaction by the use of light. A "thermal initiator" refers to a chemical that initiates free radical crosslinking/polymerizing reaction by the use of heat energy.

The "oxygen permeability", Dk_i, of a material is the rate at which oxygen will pass through a material and can be measured at about 34-35°C according to the procedures described in Example 1. Oxygen permeability is conventionally expressed in units of barrers, where "barrer" is defined as [(cm³ oxygen)(mm) / (cm²)(sec)(mm Hg)] × 10⁻¹⁰.

The "oxygen transmissibility", Dk/t, of an insert or material is the rate at which oxygen will pass through a specific insert or material with an average thickness of t [in units of mm] over the area being measured. Oxygen transmissibility is conventionally expressed in units of barrers/mm, where "barrers/mm" is defined as [(cm³ oxygen)/(cm²)(sec)(mm Hg)] × 10⁻⁹.

The term "modulus" or "elastic modulus" in reference to a contact lens or a material means the tensile modulus or Young's modulus which is a measure of the stiffness of a contact lens or a material. The modulus can be measured according to the procedures described in Example 1.

An "iniferter" refers to a compound that simultaneously acts as initiator, transfer agent, and terminator in free radical polymerizations. After polymerization, an iniferter will be

incorporated into resultant polymers as the terminal groups of a polymer chain. It is understood that a free-radical initiator can be used in initiating an iniferter-induced polymerization as known to a person skilled in the art.

An "iniferter moiety" refers to a monovalent radical that is obtained by removing a hydrogen atom from of an iniferter.

In general, the invention is directed to a method for producing embedded hydrogel contact lenses, each of which comprises a bulk hydrogel material and an insert that is embedded within the bulk hydrogel material and is made of a crosslinked polymeric material that is covalently linked to the bulk hydrogel material. This invention is partly based on the discovery that an insert, which made of a crosslinked polymeric material comprising iniferter moieties covalently attached thereto, can be prepared by curing of an insert-forming composition comprising a free-radical initiator and an iniferter. The iniferter moieties can be used to induce graft polymerization of polymerizable materials in a lens-forming composition to the polymer matrix of the insert at and near its surface in the absence or preferably in the presence of a free-radical initiator. Such a preformed insert can be reactive in the presence of free-radical. When it is used in cast-molding of an embedded hydrogel contact lens from a lens-forming composition comprising a free-radical initiator, the bulk hydrogel material formed from the lens-forming composition is covalently linked to the insert at iniferter moieties at and near the surface of the insert. Resultant embedded hydrogel contact lenses can have a minimized susceptibility to delamination due to the presence of the covalent linkages between the bulk hydrogel material and the insert embedded therein.

In one aspect, the invention provides a method for producing embedded hydrogel contact lenses, the method of invention comprising the steps of: (1) obtaining an insert mold, wherein the insert mold comprises a male insert mold half having a first molding surface and a female insert mold half having a second molding surface are configured to receive each other such that an insert-molding cavity is formed between the first and second molding surfaces when the female insert mold half is closed with the male insert mold half; (2) dispensing an insert-forming composition in the female insert mold half, wherein the insert-forming composition comprises (i) at least one polymerizable material, (ii) at least one first free-radical initiator, and (iii) at least one iniferter; (3) closing the female insert mold half with the male insert mold half to form a first molding assembly comprising the insert-forming composition within the insert-molding cavity of the insert mold; (4) curing thermally or actinically the insert-forming composition in the insert-molding cavity of the first molding assembly to form a molded insert that is made of a first crosslinked polymeric material comprising iniferter moieties covalently attached thereto; (5) obtaining a lens mold and a lens-forming composition, wherein the lens mold comprises a male lens mold half having a third molding surface and a female lens mold half having a fourth molding surface are

configured to receive each other such that a lens-molding cavity is formed between the third and fourth molding surfaces when the female lens mold half is closed with the male lens mold half, wherein the lens-forming composition comprises at least one second polymerizable material and a second free-radical initiator; (6) in no particular order, placing the insert obtained in step (4) in the female lens mold half at a desired position and dispensing the lens-forming composition in the female lens mold half, wherein the insert is immersed in the lens-forming composition; (7) closing the female lens mold half with the male lens mold half to form a second molding assembly comprising the lens-forming composition and the insert immersed therein in the lens-molding cavity of the lens mold; (8) curing thermally or actinically the lens-forming composition while simultaneously initiating iniferter-induced polymerization of the lens-forming composition at and near the surface of the insert in the lens-molding cavity of the second molding assembly to form an embedded hydrogel lens precursor that comprise a bulk hydrogel material formed from the lens-forming composition and the insert embedded in the bulk material, wherein the bulk hydrogel material is a second crosslinked polymeric material that is covalently linked to the first crosslinked polymeric material at iniferter moieties located at and near the surface of the insert; (9) separating the lens mold obtained in step (8) into the male and female lens mold halves, with the embedded hydrogel lens precursor adhered onto a lens-adhered lens mold half which is one of the male and female lens mold halves; (10) removing the embedded hydrogel lens precursor from the lens-adhered lens mold half (preferably before the embedded hydrogel lens precursor is contact with water or any liquid); and (11) subjecting the embedded hydrogel lens precursor to post-molding processes including a hydration process and one or more other processes selected from the group consisting of extraction, surface treatment, packaging, sterilization, and combinations thereof to form the embedded hydrogel contact lens.

Mold halves for making contact lenses (or inserts) are well known to a person skilled in the art and, for example, are employed in cast molding. In general, a molding assembly comprises at least two mold halves, one male half and one female mold half. The male mold half has a molding (or optical) surface which is in direct contact with a polymerizable composition for cast molding of a contact lens (or an insert) and defines the posterior (back) surface of a molded contact lens (or a molded insert); and the female mold half has a molding (or optical) surface which is in direct contact with the polymerizable composition and defines the anterior (front) surface of the molded contact lens (or molded insert). The male and female mold halves are configured to receive each other such that a lens- or insert-forming cavity is formed between the first molding surface and the second molding surface.

Methods of manufacturing mold halves for cast-molding a contact lens or an insert are generally well known to those of ordinary skill in the art. The process of the present

invention is not limited to any particular method of forming a mold half. In fact, any method of forming a mold half can be used in the present invention. The mold halves can be formed through various techniques, such as injection molding or lathing. Examples of suitable processes for forming the mold halves are disclosed in U.S. Pat. Nos. 4444711; 4460534; 5843346; and 5894002.

Virtually all materials known in the art for making mold halves can be used to make mold halves for making contact lenses or inserts. For example, polymeric materials, such as polyethylene, polypropylene, polystyrene, PMMA, Topas® COC grade 8007-S10 (clear amorphous copolymer of ethylene and norbornene, from Ticona GmbH of Frankfurt, Germany and Summit, New Jersey), or the like can be used.

In accordance with the invention, an insert-forming composition is a polymerizable composition which can be any polymerizable compositions for forming a plastic material, so long as they must comprises an iniferter and a free-radical initiator (a thermal initiator or a photoinitiator).

Any iniferter can be used in the invention. Various iniferters have been disclosed in patents and scientific publication and can be obtained from commercial suppliers or prepared according to procedures described in patents (e.g., US4581429, US5240972, US5449703, US5658986, US5866047, US6255422, US6833276, US7351781, EP507036, EP418118, EP342073, EP338918, WO98/30601, WO96/24620, and WO99/03894) or publications (e.g., Chen et al., Chem. Rev. 2016, 116: 10167-10211; Takayuki Otsu, J. Polym. Sci.: Part A: Polym. Chem. 2000, 38: 2121–2136). Preferably, an iniferter is a

thiocarbonylthio-containing compound (i.e., having a thiocarbonylthio moiety $\text{—}\overset{\text{S}}{\underset{|}{\text{C}}}\text{—S—}$) or an organic nitroxide compound (i.e., having a nitroxide moiety >N—O—).

Thiocarbonylthio-containing compounds are well known to a person skilled in the art. Examples of thiocarbonylthio-containing compounds includes without limitation dithioesters, dithiocarbamates, dithioates, trithiocarbonates, xanthates, thiuram disulfides, xanthate disulfides.

Examples of preferred thiocarbonylthio-containing compounds include without limitation thiuram monosulfide, N,N'-dimethylthiuram monosulfide, N,N,N',N'-tetramethylthiuram monosulfide, N,N'-diethylthiuram monosulfide, N,N,N',N'-tetraethylthiuram monosulfide, thiuram disulfide, N,N-dimethylthiuram disulfide, N,N'-diethylthiuram disulfide, N,N'-diethyl-N,N'-bis(2-hydroxyethyl)thiuram disulfide, N,N'-bis(N-(2-phthalimidoethyl)piperazine-thiuram disulfide, N,N'-dimethylthiuram tetrasulfide, tetramethylthiuram disulfide, tetraethylthiuram disulfide, tetraisopropylthiuram disulfide, N,N'-dimethyl N,N'-di(4-pyridinyl)thiuram disulfide, bis(thio-benzoyl) disulfide, diisopropyl xanthate

disulfide, cyanomethyl benzodithioate, benzyl benzodithioate, 2-phenyl-2-propyl benzodithioate, bis(thiobenzoyl) disulfide, benzyl 1*H*-pyrrole-1-carbodithioate, 2-cyano-2-propyl benzodithioate, bis(carboxymethyl)trithiocarbonate, 4-cyano-4-(thiobenzoylthio)pentanoic acid, ethyl 2-(phenylcarbonothioylthio)-2-phenylacetate, ethyl 2-(phenylcarbonothioylthio)propionate, 1-(methoxycarbonyl)ethyl benzodithioate, 2-cyano-2-propyl 4-cyanobenzodithioate, ethyl 2-(4-methoxyphenylcarbonothioylthio)acetate, ethyl 2-methyl-2-(phenylthiocarbonylthio)propionate, ethyl 2-(phenylcarbonothioylthio)-2-phenylacetate, 2-(4-methoxyphenylcarbonothioylthio)ethanoic acid, 2-nitro-5-(2-propynyloxy)benzyl 4-cyano-4-(phenylcarbonothioylthio)pentanoate, *S,S*-bis(α,α' -dimethyl- α'' -acetic acid) trithiocarbonate, *S*-dodecyl-*S'*-(α,α' -dimethyl- α'' -acetic acid) trithiocarbonate, *S*-ethyl-*S'*-(α,α' -dimethyl- α'' -acetic acid) trithiocarbonate, 4-cyano-4-ethyl-trithiopentanoic acid, *S,S*-dibenzyl trithiocarbonate, bis(carboxymethyl)trithiocarbonate, dimethyl trithiocarbonate, phthalimidomethyl butyl trithiocarbonate, cyanomethyl dodecyl trithiocarbonate, 4-cyano-4-[(dodecylsulfanylthio-carbonyl)sulfanyl]pentanoic acid, 3,5-bis(2-dodecylthiocarbonothioylthio-1-oxopropoxy)benzoic acid, 2-(2-carboxyethylsulfanylthiocarbonylsulfanyl)propionic acid, 2-cyano-2-propyl dodecyl trithiocarbonate, 3-butenyl 2-(dodecylthiocarbonothioylthio)-2-methylpropionate, 2-(dodecylthiocarbonothioylthio)-2-methylpropionic acid, cyanomethyl (3,5-dimethyl-1*H*-pyrazole)-carbodithioate, 2-cyanobutan-2-yl 4-chloro-3,5-dimethyl-1*H*-pyrazole-1-carbodithioate, methyl 2-[methyl(4-pyridinyl)carbamothioylthio]propionate, 2-cyanobutan-2-yl 3,5-dimethyl-1*H*-pyrazole-1-carbodithioate, cyanomethyl methyl(phenyl)carbamodithioate, cyanomethyl methyl(4-pyridyl)carbamodithioate, benzyl 1*H*-pyrrole-1-carbodithioate, cyanomethyl diphenylcarbamodithioate, cyanomethyl methyl(4-pyridyl)carbamodithioate, benzyl-*N,N*-dimethyldithiocarbamate, benzyl-*N,N*-diethyldithiocarbamate, 2-(*N,N*-diethyldithiocarbamyl) isobutyric acid, 2-(*N,N*-diethyldithiocarbamyl) isobutyric acid ethyl ester, (4-cyano-4-diethyldithiocarbamyl) pentanoic acid, 1-(ethoxycarbonyl)prop-1-yl dithiobenzoate, phenacyl morpholine-4-dithiocarbamate, *S*-2-cyano-2-propyl-*O*-ethyl xanthate, 1-phenylethyl phenyldithioacetate, *S*-methacryloyl *O*-ethyl xanthate, 2-(*N,N*-diethyldithiocarbamyl)ethyl methacrylate, acetic acid 2-(*N,N*-diethyldithio-carbamyl)ethyl ether, cyanopentanoic acid dithiobenzoate, 3-benzylsulfanylthiocarbonylsulfanyl propionic acid, 2-(*n*-butyltrithiocarbonate)-propionic acid, *n*-butyl *N,N*-dimethyl-dithiocarbamate, benzyl dithiocarbamate, *p*-xylene-bis(dithiocarbamate), *p*-xylene-bis(*N,N*-dimethyldithio-carbamate), *p*-xylene-bis(*N,N*-diethyldithiocarbamate), 1,2-bis(*N,N*-diethyldithiocarbamyl) ethane, 1,2-bis(*N,N*-dimethyldithiocarbamyl)ethane, 1,2,3-tris(*N,N*-dimethyldithiocarbamyl) propane, 1,2,4,5-tetrakis(*N,N*-diethyldithiocarbamylmethyl)benzene, 1-(*N,N*-diethyldithio-carbamyl)ethyl acetate, and combinations thereof.

Examples of preferred organic nitroxide compounds include without limitation ((2',2',6',6'-tetramethyl-1'-piperidinyloxy)methyl)benzene, 1-phenyl-1-(2',2',6',6'-tetramethyl-1'-piperidinyloxy)ethane, 1-(4'-bromophenyl)-1-(2',2',6',6'-tetramethyl-1'-piperidinyloxy)ethane, 1-naphthyl-1-(2',2',6',6'-tetramethyl-1'-piperidinyloxy)ethane, 1-phenyl-1-(2',2',6',6'-tetramethyl-1'-piperidinyloxy)propane, 1-(benzyloxy)-2-phenyl-2-(2',2',6',6'-tetramethyl-1'-piperidinyloxy)ethane, 1-hydroxy-2-phenyl-2-(2',2',6',6'-tetramethyl-1'-piperidinyloxy)ethane, phenyl 4-cyano-4-(2',2',6',6'-tetramethyl-1'-piperidinyloxy)pentanoate, pentafluorophenyl 4-cyano-4-(2',2',6',6'-tetramethyl-1'-piperidinyloxy)pentanoate, 3-phenyl-1-(2',2',6',6'-tetramethyl-1'-piperidinyloxy)propane, 1-((2',2',6',6'-tetramethyl-1'-piperidinyloxy)methyl)-4-(trifluoromethyl)benzene, methyl 2-((4-benzoylphenyl)((1-methoxy-2-methyl-1-oxopropan-2-yl)oxy)amino)-2-methylpropanoate, 2,2,6,6-tetramethyl-1-piperidinyloxy, 2,2,5-trimethyl-4-phenyl-3-azahexane-3-nitroxide, N-tert-butyl-N-1-phenyl-2-methylpropyl-nitroxide, N-tert-butyl-N-1-(2-naphthyl)-2-methylpropyl nitroxide, N-tert-butyl-N-1-diethylphosphono-2,2-dimethylpropyl nitroxide, N-tert-butyl-N-1-dibenzylphosphono-2,2-dimethylpropyl nitroxide, N-phenyl-N-1-diethylphosphono-2,2-dimethylpropyl nitroxide, N-phenyl-N-1-diethylphosphono-1-methylethyl nitroxide, N-(1-phenyl-2-methylpropyl)-N-1-diethyl-phosphono-1-methylethyl nitroxide, and combinations thereof.

In accordance with the invention, any thermal free-radical initiators can be used in an insert-forming composition of the invention. Suitable thermal free-radical initiators are known to a skilled artisan and include, for example, peroxides, hydroperoxides, azo-bis(alkyl- or cycloalkylnitriles), persulfates, percarbonates, or mixtures thereof. Examples of preferred thermal free-radical initiators include without limitation benzoyl peroxide, t-butyl peroxide, t-amyl peroxybenzoate, 2,2-bis(tert-butylperoxy)butane, 1,1-bis(tert-butylperoxy)cyclohexane, 2,5-Bis(tert-butylperoxy)-2,5-dimethylhexane, 2,5-bis(tert-butylperoxy)-2,5-dimethyl-3-hexyne, bis(1-(tert-butylperoxy)-1-methylethyl)benzene, 1,1-bis(tert-butylperoxy)-3,3,5-trimethylcyclohexane, di-t-butyl-diperoxyphthalate, t-butyl hydroperoxide, t-butyl peracetate, t-butyl peroxybenzoate, t-butylperoxy isopropyl carbonate, acetyl peroxide, lauroyl peroxide, decanoyl peroxide, dicetyl peroxydicarbonate, di(4-t-butylcyclohexyl)peroxy dicarbonate (Perkadox 16S), di(2-ethylhexyl)peroxy dicarbonate, t-butylperoxy pivalate (Lupersol 11); t-butylperoxy-2-ethylhexanoate (Trigonox 21-C50), 2,4-pentanedione peroxide, dicumyl peroxide, peracetic acid, potassium persulfate, sodium persulfate, ammonium persulfate, 2,2'-azobis(4-methoxy-2,4-dimethylvaleronitrile) (VAZO 33), 2,2'-Azobis[2-(2-imidazolin-2-yl)propane]dihydrochloride (VAZO 44), 2,2'-azobis(2-amidinopropane) dihydrochloride (VAZO 50), 2,2'-azobis(2,4-dimethylvaleronitrile) (VAZO 52), 2,2'-azobis(isobutyronitrile) (VAZO 64 or AIBN), 2,2'-azobis-2-methylbutyronitrile (VAZO 67), 1,1-azobis(1-cyclohexanecarbonitrile) (VAZO 88); 2,2'-azobis(2-cyclopropylpropionitrile), 2,2'-azobis(methylisobutyrate), 4,4'-Azobis(4-cyanovaleric acid), and combinations thereof.

Preferably, the thermal initiator is 2,2'-azobis(isobutyronitrile) (AIBN or VAZO 64).

In accordance with the invention, any free-radical photoinitiators known to a person skilled in the art can be used in an insert-forming composition of the invention. Suitable photoinitiators are benzophenone derivatives, α -hydroxyketones, α -aminoketones, acylphosphine oxide derivatives, and an acylgermanium derivatives. Examples of preferred photoinitiators includes without limitation benzoin methyl ether, diethoxyacetophenone, a benzoyl-phosphine oxide, 1-hydroxycyclohexyl phenyl ketone and Darocur and Irgacur types, preferably Darocur 1173® and Darocur 2959®, Germanium-based Norrish Type I photoinitiators (e.g., those described in US7605190). Examples of benzoylphosphine initiators include 2,4,6-trimethylbenzoyldiphenylphosphine oxide; bis-(2,6-dichlorobenzoyl)-4-N-propylphenyl-phosphine oxide; and bis-(2,6-dichlorobenzoyl)-4-N-butylphenylphosphine oxide. Reactive photoinitiators which can be incorporated, e.g., into a macromer or can be used as a special monomer are also suitable. Examples of reactive photoinitiators are those disclosed in EP632329.

In accordance with the invention, an insert-forming composition (i.e., a polymerizable composition) must comprises at least one polymerizable material in addition to the free-radical initiator and iniferter. The polymerizable material can comprises one or more vinylic monomers and one or more vinylic crosslinkers known to a person skilled in the art.

In a preferred embodiment, an insert-forming composition is a polymerizable composition for forming a hard plastics, e.g., any one known to a person skilled in the art (preferably a crosslinked polymethylmethacrylate or polystyrene).

In another preferred embodiment, an insert-forming composition is a polymerizable composition for forming a crosslinked silicone polymer (or a silicone rubber or elastomer as known to a person skilled in the art), e.g., any one known to a person skilled in the art. A crosslinked silicone material has three-dimensional polymer networks (i.e., polymer matrix), is insoluble in water, and has an equilibrium water content of about 5% or less, preferably about 3% or less, more preferably about 2% or less) by weight (i.e., in fully-hydrated state).

In another preferred embodiment, an insert-forming composition is a polymerizable composition for forming a non-silicone hydrogel material (any one of those described later in this application or known to a person skilled in the art).

In another preferred embodiment, an insert-forming composition is a polymerizable composition for forming a silicone hydrogel material (any one of those described later in this application or known to a person skilled in the art).

In another preferred embodiment, an insert-forming composition is a polymerizable composition for forming a rigid gas permeable material (e.g., a material made from fluorosilicone acrylates or known to a person skilled in the art).

In another preferred embodiment, an insert-forming composition comprises at least

one polymerizable photochromic compound (i.e., at least one photochromic vinylic monomer), at least one UV-absorbing vinylic monomer, at least one UV/HEVL-absorbing vinylic monomer, a fluorescent vinylic monomer, or combinations thereof.

In another preferred embodiment, an insert-forming composition comprises at least one photochromic dye or pigment, at least one color-filtering material for correcting color blindness, a diffractive material, a high refractive-index material, or combinations.

In another preferred embodiment, an insert-forming composition is a polymerizable composition for forming a hydrophobic crosslinked acrylic material that has an equilibrium water content of less than 5% by weight and comprises at least about 55% (preferably at least about 60%, more preferably at least about 65% even more preferably at least about 70%) by mole of one or more acrylic monomers and/or one or more acrylic crosslinker or crosslinking agent and at least about 6% by mole (preferably at least about 8% by mole, more preferably at least about 10% by mole, even more preferably at least about 12% by mole) of at least one vinylic crosslinking agent.

Any hydrophobic acrylic monomers can be used in forming a hydrophobic crosslinked acrylic material of the inventions. Examples of hydrophobic acrylic monomers includes silicone-containing acrylic monomers (any one of those described below in this application), non-silicone hydrophobic acrylic monomers (any one of those described below in this application), fluorine-containing acrylic monomers (any one of those described below in this application), aryl acrylic monomers (any one of those described below in this application), and combinations thereof.

It is also understood that any hydrophobic vinylic monomer can be used as a substitute for a hydrophobic acrylic monomer, so long as it comprises at least one H-bond acceptor such as ester bond, amide bond, carbonate bond, carbamate bond, ether bond, or combinations thereof. Examples of such hydrophobic monomers include vinyl alkanoates (any one of those described above in this application), vinyloxyalkanes (any one of those described above in this application), and combinations thereof.

In accordance with the invention, an insert-forming composition comprises at least one vinylic crosslinker. Any suitable vinyl crosslinkers can be used in the invention. Examples of preferred vinylic crosslinkers include without limitation: acrylic crosslinkers (any one of those described later in this application), allyl methacrylate, allyl acrylate, an aryl crosslinker (e.g., divinylbenzene, 2-methyl-1,4-divinylbenzene, bis(4-vinylphenyl)methane, 1,2-bis(4-vinylphenyl)-ethane, etc.), triallyl isocyanurate, 2,4,6-triallyloxy-1,3,5-triazine, 1,2,4-trivinylcyclohexane, or combinations thereof. It is understood that vinylic crosslinkers are required for imparting the desired rigidity to the crosslinked polymeric material of the rigid hydrophobic insert.

In a preferred embodiment, an insert-forming composition comprises at least one

acrylic crosslinker (any one of those described later in this application).

In another preferred embodiment, an insert-forming composition comprises at least one aryl crosslinker (any one of those described later in this application).

In another preferred embodiment, an insert-forming composition comprises at least one vinyl-functional polysiloxane that comprises at least two vinyl groups each directly attached to one silicon atom and at least 15% by mole of siloxane units each having at least one phenyl substituent.

Examples of such vinyl functional polysiloxanes include without limitation vinyl terminated polyphenylmethysiloxanes (e.g., PMV9925 from Gelest), vinylphenylmethyl terminated phenylmethyl-vinylphenylsiloxane copolymer (e.g., PVV-3522 from Gelest), vinyl terminated diphenylsiloxane-dimethylsiloxane copolymers (e.g., PDV-1625 from Gelest), or combinations thereof. Preferably, the vinyl-functional polysiloxane is vinyl terminated polyphenylmethysiloxanes (e.g., PMV9925 from Gelest), vinylphenylmethyl terminated phenylmethyl-vinylphenylsiloxane copolymer (e.g., PVV-3522 from Gelest), or combinations thereof.

An insert-forming composition can be prepared by mixing all polymerizable materials as described above in the desired proportions, together with one or more free-radical initiators and an iniferter in the presence or in the absence of a non-reactive organic solvent (i.e., a non-reactive diluent) as described later in this application.

Lens-forming compositions (a.k.a., polymerizable compositions) are described in numerous patents and are well known to a person skilled in the art. There are generally two types of lens-forming compositions: the first for forming non-silicone hydrogel contact lenses (i.e., a non-silicone hydrogel bulk material in this application) and the other for forming silicone hydrogel contact lenses (i.e., a silicone hydrogel bulk material in this application).

Typically, a lens-forming composition for forming a non-silicone hydrogel bulk material is either (1) a monomer mixture comprising (a) at least one hydrophilic vinylic monomer (e.g., hydroxyl-containing vinylic monomer, N-vinyl amide monomer, (meth)acrylamido monomer, or combinations thereof), (b) a vinylic crosslinker, and (c) at least one component selected from the group consisting of a hydrophobic vinylic monomer, a free-radical initiator (photoinitiator or thermal initiator), a UV-absorbing vinylic monomer, a high-energy-violet-light ("HEVL") absorbing vinylic monomer, a visibility tinting agent, and combinations thereof; or (2) an aqueous solution comprising one or more water-soluble prepolymers and at least one component selected from the group consisting of hydrophilic vinylic monomer, a vinylic crosslinker, a hydrophobic vinylic monomer, a lubricating agent (or so-called internal wetting agents incorporated in a lens formulation), a free-radical initiator (photoinitiator or thermal initiator), a UV-absorbing vinylic monomer, a HEVL absorbing vinylic monomer, a visibility tinting agent, and combinations thereof.

Examples of water-soluble prepolymers include without limitation: a water-soluble crosslinkable poly(vinyl alcohol) prepolymer described in U.S. Pat. Nos. 5583163 and 6303687; a water-soluble vinyl group-terminated polyurethane prepolymer described in U.S. Pat. No. 6995192; derivatives of a polyvinyl alcohol, polyethyleneimine or polyvinylamine, which are disclosed in U.S. Pat. No. 5849841; a water-soluble crosslinkable polyurea prepolymer described in U.S. Pat. Nos. 6479587 and 7977430; crosslinkable polyacrylamide; crosslinkable statistical copolymers of vinyl lactam, MMA and a comonomer, which are disclosed in U.S. Pat. No. 5712356; crosslinkable copolymers of vinyl lactam, vinyl acetate and vinyl alcohol, which are disclosed in U.S. Pat. No. 5665840; polyether-polyester copolymers with crosslinkable side chains which are disclosed in U.S. Pat. No. 6492478; branched polyalkylene glycol-urethane prepolymers disclosed in U.S. Pat. No. 6165408; polyalkylene glycol-tetra(meth)acrylate prepolymers disclosed in U.S. Pat. No. 6221303; crosslinkable polyallylamine gluconolactone prepolymers disclosed in U.S. Pat. No. 6472489.

Numerous lens-forming compositions for forming non-silicone hydrogel bulk materials (contact lenses) have been described in numerous patents and patent applications published by the filing date of this application and have been used in producing commercial non-silicone hydrogel contact lenses. Examples of commercial non-silicone hydrogel contact lenses include, without limitation, alafilcon A, acofilcon A, deltafilcon A, etafilcon A, focofilcon A, helfilcon A, helfilcon B, hilafilcon B, hioxifilcon A, hioxifilcon B, hioxifilcon D, methafilcon A, methafilcon B, nelfilcon A, nesofilcon A, oculfilcon A, oculfilcon B, oculfilcon C, oculfilcon D, omafilcon A, phemfilcon A, polymacon, samfilcon A, telfilcon A, tetrafilcon A, and vifilcon A. They can be used as a lens-forming composition of the invention.

Preferably, a lens-forming composition for forming a non-silicone hydrogel bulk material comprises at least 50% by mole of at least one hydroxyl-containing vinylic monomer, preferably selected from the group consisting of hydroxyethyl (meth)acrylate, glycerol (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 3-amino-2-hydroxypropyl (meth)acrylate, N-2-hydroxyethyl (meth)acrylamide, N-3-hydroxypropyl (meth)acrylamide, N-2-hydroxypropyl (meth)acrylamide, N-2,3-dihydroxypropyl (meth)acrylamide, N-tris(hydroxymethyl)methyl (meth)acrylamide, vinyl alcohol, allyl alcohol, and combinations thereof, more preferably selected from the group consisting of hydroxyethyl (meth)acrylate, glycerol (meth)acrylate, hydroxyethyl (meth)acrylamide, and vinyl alcohol.

Numerous lens-forming compositions for forming silicone hydrogel contact lenses (bulk materials) have been described in numerous patents and patent applications published by the filing date of this application and have been used in producing commercial SiHy contact lenses. Examples of commercial SiHy contact lenses include, without limitation,

asmocon A, balafilcon A, comfilcon A, delefilcon A, efrofilcon A, enfilcon A, fanfilcon A, galyfilcon A, lotrafilcon A, lotrafilcon B, naracon A, naracon B, senofilcon A, senofilcon B, senofilcon C, smacon A, somofilcon A, and stenfilcon A. They can be used as a lens-forming composition.

In accordance with the invention, a lens-forming composition for forming a silicone hydrogel bulk material comprises (1) at least one polysiloxane vinylic monomer and/or at least one polysiloxane vinylic crosslinker and (2) at least one hydrophilic vinylic monomer.

Any polysiloxane vinylic monomers can be used in the invention. Examples of preferred polysiloxanes vinylic monomers include without limitation: those of formula (M1) which are described later in this application and can be obtained from commercial suppliers (e.g., Shin-Etsu, Gelest, etc.); those prepared according to procedures described in patents, e.g., U.S. Pat. Nos. 5070215, 6166236, 6867245, 8415405, 8475529, 8614261, and 9217813; those prepared by reacting a hydroxyalkyl (meth)acrylate or (meth)acrylamide or a (meth)acryloxypolyethylene glycol with a mono-epoxypropyloxypentyl-terminated polydimethylsiloxane; those prepared by reacting glycidyl (meth)acrylate with a mono-carbinol-terminated polydimethylsiloxane, a mono-aminopropyl-terminated polydimethylsiloxane, or a mono-ethylaminopropyl-terminated polydimethylsiloxane; and those prepared by reacting isocyanatoethyl (meth)acrylate with a mono-carbinol-terminated polydimethylsiloxane according to coupling reactions well known to a person skilled in the art.

Any suitable polysiloxane vinylic crosslinkers can be used in the invention. Examples of preferred polysiloxane vinylic crosslinkers include without limitation: polysiloxane vinylic crosslinkers each comprising hydrophilized siloxane units each having one methyl substituent and one organic radical including at least one H-bond donor (preferably hydroxyl groups); di-(meth)acryloyl-terminated polydimethylsiloxanes; di-vinyl carbonate-terminated polydimethylsiloxanes; di-vinyl carbamate-terminated polydimethylsiloxane; N,N,N',N'-tetrakis(3-methacryloxy-2-hydroxypropyl)-alpha,omega-bis-3-aminopropyl-polydimethylsiloxane; polysiloxane-containing macromer selected from the group consisting of Macromer A, Macromer B, Macromer C, and Macromer D described in US 5,760,100; polysiloxane-containing macromers disclosed in U.S. Pat. Nos. 4136250, 4153641, 4182822, 4189546, 4343927, 4254248, 4355147, 4276402, 4327203, 4341889, 4486577, 4543398, 4605712, 4661575, 4684538, 4703097, 4833218, 4837289, 4954586, 4954587, 5010141, 5034461, 5070170, 5079319, 5039761, 5346946, 5358995, 5387632, 5416132, 5451617, 5486579, 5962548, 5981675, 6039913, and 6762264; polysiloxane-containing macromers disclosed in U.S. Pat. Nos. 4259467, 4260725, and 4261875.

One class of preferred polysiloxane vinylic crosslinkers are di-(meth)acryloyl-terminated polysiloxane vinylic crosslinkers each having dimethylsiloxane units and

hydrophilized siloxane units each having one methyl substituent and one monovalent C₄–C₄₀ organic radical substituent having 2 to 6 hydroxyl groups, more preferably a polysiloxane vinylic crosslinker of formula (G), as described later in this application. They can be prepared according to the procedures disclosed in U.S. Pat. No. 10081697.

Another class of preferred polysiloxane vinylic crosslinkers are vinylic crosslinkers each of which comprises one sole polydiorganosiloxane segment and two terminal (meth)acryloyl groups, which can be obtained from commercial suppliers; prepared by reacting glycidyl (meth)acrylate (meth)acryloyl chloride with a di-amino-terminated polydimethylsiloxane or a di-hydroxyl-terminated polydimethylsiloxane; prepared by reacting isocyanatoethyl (meth)acrylate with di-hydroxyl-terminated polydimethylsiloxanes prepared by reacting an amino-containing acrylic monomer with di-carboxyl-terminated polydimethylsiloxane in the presence of a coupling agent (a carbodiimide); prepared by reacting a carboxyl-containing acrylic monomer with di-amino-terminated polydimethylsiloxane in the presence of a coupling agent (a carbodiimide); or prepared by reacting a hydroxyl-containing acrylic monomer with a di-hydroxy-terminated polydisiloxane in the presence of a diisocyanate or di-epoxy coupling agent.

Other classes of preferred polysiloxane vinylic crosslinkers are chain-extended polysiloxane vinylic crosslinkers each of which has at least two polydiorganosiloxane segments linked by a linker between each pair of polydiorganosiloxane segments and two terminal ethylenically unsaturated groups, which can be prepared according to the procedures described in U.S. Pat. Nos. 5034461, 5416132, 5449729, 5760100, 7423074, 8529057, 8835525, 8993651, 10301451, and 10465047.

Preferably, a lens forming composition for forming a silicone hydrogel bulk material comprises at least one first polysiloxane vinylic crosslinker comprising hydrophilized siloxane units each having one methyl substituent and one organic radical including at least one H-bond donor (preferably hydroxyl groups).

Any hydrophilic vinylic monomers can be used in the invention. Examples of preferred hydrophilic vinylic monomers are alkyl (meth)acrylamides (as described later in this application), hydroxyl-containing acrylic monomers (as described below), amino-containing acrylic monomers (as described later in this application), carboxyl-containing acrylic monomers (as described later in this application), N-vinyl amide monomers (as described later in this application), methylene-containing pyrrolidone monomers (i.e., pyrrolidone derivatives each having a methylene group connected to the pyrrolidone ring at 3- or 5-position) (as described later in this application), acrylic monomers having a C₁–C₄ alkoxyethoxy group (as described later in this application), vinyl ether monomers (as described later in this application), allyl ether monomers (as described later in this application), phosphorylcholine-containing vinylic monomers (as described later in this

application), N-2-hydroxyethyl vinyl carbamate, N-carboxyvinyl- β -alanine (VINYL), N-carboxyvinyl- α -alanine, and combinations thereof.

In accordance with the invention, a lens-forming composition for forming a silicone hydrogel bulk material can further comprise at least one silicone-containing vinylic monomer having a bis(trialkylsilyloxy)-alkylsilyl group or a tris(trialkylsilyloxy)silyl group. Examples of such preferred silicone-containing vinylic monomers include without limitation those of formula (M2), which are described later in this application and can be obtained from commercial suppliers (e.g., Shin-Etsu, Gelest, etc.) or can be prepared according to procedures described in U.S. Pat. Nos. 5070215, 6166236, 7214809, 8475529, 8658748, 9097840, 9103965, and 9475827.

In accordance with the invention, a lens-forming composition for forming a silicone hydrogel bulk material can also comprise one or more hydrophobic non-silicone vinylic monomers. Examples of preferred hydrophobic non-silicone vinylic monomers can be non-silicone hydrophobic acrylic monomers (methyl (meth)acrylate, ethyl (meth)acrylate, propyl (meth)acrylate, isopropyl (meth)acrylate, cyclohexyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, isobornyl (meth)acrylate, (meth)acrylonitrile, etc.), fluorine-containing acrylic monomers (e.g., perfluorohexylethyl-thio-carbonyl-aminoethyl-methacrylate, perfluoro-substituted-C₂-C₁₂ alkyl (meth)acrylates described below, etc.), vinyl alkanoates (e.g., vinyl acetate, vinyl propionate, vinyl butyrate, vinyl valerate, etc.), vinyloxyalkanes (e.g., vinyl ethyl ether, propyl vinyl ether, n-butyl vinyl ether, isopentyl vinyl ether, cyclohexyl vinyl ether, t-butyl vinyl ether, etc.), styrene, vinyl toluene, vinyl chloride, vinylidene chloride, 1-butene, and combinations thereof.

Any suitable perfluoro-substituted-C₂-C₁₂ alkyl (meth)acrylates can be used in the invention. Examples of perfluoro-substituted-C₂-C₁₂ alkyl (meth)acrylates include without limitation 2,2,2-trifluoroethyl (meth)acrylate, tetrafluoropropyl (meth)acrylate, hexafluoro-isopropyl (meth)acrylate, hexafluorobutyl (meth)acrylate, heptafluorobutyl (meth)acrylate, octafluoropentyl (meth)acrylate, heptafluorodecyl (meth)acrylate, pentafluorophenyl (meth)acrylate, and combinations thereof.

In accordance with the invention, a lens-forming composition for forming a silicone hydrogel bulk material can also comprise one or more non-silicone vinylic crosslinkers. Examples of preferred non-silicone vinylic crosslinkers are described later in this application.

In accordance with the invention, a lens-forming composition for forming a silicone hydrogel bulk material can also comprise other polymerizable materials, such as, a UV-absorbing vinylic monomer, a UV/high-energy-violet-light ("HEVL") absorbing vinylic monomer, polymerizable photochromic compound, a polymerizable tinting agent (polymerizable dye), or combinations thereof, as known to a person skilled in the art.

Any suitable UV-absorbing vinylic monomers and UV/HEVL-absorbing vinylic

monomers can be used in a polymerizable composition for preparing a preformed SiHy contact lens of the invention. Examples of preferred UV-absorbing and UV/HEVL-absorbing vinylic monomers include without limitation : 2-(2-hydroxy-5-vinylphenyl)-2H-benzotriazole, 2-(2-hydroxy-5-acryloyloxyphenyl)-2H-benzotriazole, 2-(2-hydroxy-3-methacrylamido methyl-5-tert octylphenyl) benzotriazole, 2-(2'-hydroxy-5'-methacrylamidophenyl)-5-chlorobenzotriazole, 2-(2'-hydroxy-5'-methacrylamidophenyl)-5-methoxybenzotriazole, 2-(2'-hydroxy-5'-methacryloxypropyl-3'-t-butyl-phenyl)-5-chlorobenzotriazole, 2-(2'-hydroxy-5'-methacryloxypropylphenyl) benzotriazole, 2-hydroxy-5-methoxy-3-(5-(trifluoromethyl)-2H-benzo[d][1,2,3]triazol-2-yl)benzyl methacrylate (WL-1), 2-hydroxy-5-methoxy-3-(5-methoxy-2H-benzo[d][1,2,3]triazol-2-yl)benzyl methacrylate (WL-5), 3-(5-fluoro-2H-benzo[d][1,2,3]triazol-2-yl)-2-hydroxy-5-methoxybenzyl methacrylate (WL-2), 3-(2H-benzo[d][1,2,3]triazol-2-yl)-2-hydroxy-5-methoxybenzyl methacrylate (WL-3), 3-(5-chloro-2H-benzo[d][1,2,3]triazol-2-yl)-2-hydroxy-5-methoxybenzyl methacrylate (WL-4), 2-hydroxy-5-methoxy-3-(5-methyl-2H-benzo[d][1,2,3]triazol-2-yl)benzyl methacrylate (WL-6), 2-hydroxy-5-methyl-3-(5-(trifluoromethyl)-2H-benzo[d][1,2,3]triazol-2-yl)benzyl methacrylate (WL-7), 4-allyl-2-(5-chloro-2H-benzo[d][1,2,3]triazol-2-yl)-6-methoxyphenol (WL-8), 2-(2'-Hydroxy-3'-*tert*-5'-(3''-(4''-vinylbenzyloxy)propoxy)phenyl)-5-methoxy-2H-benzotriazole, phenol, 2-(5-chloro-2H-benzotriazol-2-yl)-6-(1,1-dimethylethyl)-4-ethenyl- (UVAM), 2-[2'-hydroxy-5'-(2-methacryloxyethyl)phenyl]-2H-benzotriazole (2-Propenoic acid, 2-methyl-, 2-[3-(2H-benzotriazol-2-yl)-4-hydroxyphenyl]ethyl ester, Norbloc), 2-{2'-Hydroxy-3'-*tert*-butyl-5'-[3'-methacryloyloxypropoxy]phenyl}-2H-benzotriazole, 2-{2'-Hydroxy-3'-*tert*-butyl-5'-[3'-methacryloyloxypropoxy]phenyl}-5-methoxy-2H-benzotriazole (UV13), 2-{2'-Hydroxy-3'-*tert*-butyl-5'-[3'-methacryloyloxypropoxy]phenyl}-5-chloro-2H-benzotriazole (UV28), 2-[2'-Hydroxy-3'-*tert*-butyl-5'-(3'-acryloyloxypropoxy)phenyl]-5-trifluoromethyl-2H-benzotriazole (UV23), 2-(2'-hydroxy-5-methacrylamidophenyl)-5-methoxybenzotriazole (UV6), 2-(3-allyl-2-hydroxy-5-methylphenyl)-2H-benzotriazole (UV9), 2-(2-Hydroxy-3-methallyl-5-methylphenyl)-2H-benzotriazole (UV12), 2-3'-t-butyl-2'-hydroxy-5'-(3''-dimethylvinylsilylpropoxy)-2'-hydroxyphenyl)-5-methoxybenzotriazole (UV15), 2-(2'-hydroxy-5'-methacryloylpropyl-3'-*tert*-butylphenyl)-5-methoxy-2H-benzotriazole (UV16), 2-(2'-hydroxy-5'-acryloylpropyl-3'-*tert*-butylphenyl)-5-methoxy-2H-benzotriazole (UV16A), 2-Methylacrylic acid 3-[3-*tert*-butyl-5-(5-chlorobenzotriazol-2-yl)-4-hydroxyphenyl]-propyl ester (16-100, CAS#96478-15-8), 2-(3-(*tert*-butyl)-4-hydroxy-5-(5-methoxy-2H-benzo[d][1,2,3]triazol-2-yl)phenoxy)ethyl methacrylate (16-102); Phenol, 2-(5-chloro-2H-benzotriazol-2-yl)-6-methoxy-4-(2-propen-1-yl) (CAS#1260141-20-5); 2-[2-Hydroxy-5-[3-(methacryloyloxy)propyl]-3-*tert*-butylphenyl]-5-chloro-2H-benzotriazole; Phenol, 2-(5-ethenyl-2H-benzotriazol-2-yl)-4-methyl-, homopolymer (9CI) (CAS#83063-87-0). In accordance with the invention, the polymerizable composition comprises about 0.1% to about 3.0%, preferably about 0.2% to about 2.5%, more preferably

about 0.3% to about 2.0%, by weight of one or more UV-absorbing vinylic monomers, related to the amount of all polymerizable components in the polymerizable composition.

Examples of preferred photochromic vinylic monomers include polymerizable naphthopyrans, polymerizable benzopyrans, polymerizable indenonaphthopyrans, polymerizable phenanthropyrans, polymerizable spiro(benzindoline)-naphthopyrans, polymerizable spiro(indoline)benzopyrans, polymerizable spiro(indoline)-naphthopyrans, polymerizable spiro(indoline)quinopyrans, polymerizable spiro(indoline)-pyrans, polymerizable naphthoxazines, polymerizable spirobenzopyrans; polymerizable spirobenzopyrans, polymerizable spirobenzothiopyrans, polymerizable naphthacenediones, polymerizable spirooxazines, polymerizable spiro(indoline)naphthoxazines, polymerizable spiro(indoline)pyridobenzoxazines, polymerizable spiro(benzindoline)pyridobenzoxazines, polymerizable spiro(benzindoline)naphthoxazines, polymerizable spiro(indoline)-benzoxazines, polymerizable diarylethenes, and combinations thereof, as disclosed in U.S. Pat. Nos. 4929693, 5166345 6017121, 7556750, 7584630, 7999989, 8158037, 8697770, 8741188, 9052438, 9097916, 9465234, 9904074, 10197707, 6019914, 6113814, 6149841, 6296785, and 6348604.

In accordance with the invention, the formed silicone hydrogel bulk material has an equilibrium water content (i.e., in fully hydrated state or when being fully hydrated) of from about 20% to about 70% (preferably from about 20% to about 65%, more preferably from about 25% to about 65%, even more preferably from about 30% to about 60%) by weight, an oxygen permeability of at least about 40 barrers (preferably at least about 60 barrers, more preferably at least about 80 barrers, more preferably at least about 100 barrers), and a modulus (i.e., Young's modulus) of about 1.5 MPa or less (preferably from about 0.2 MPa to about 1.2 MPa, more preferably from about 0.3 MPa to about 1.1 MPa, even more preferably from about 0.4 MPa to about 1.0 MPa).

In accordance with the invention, a lens-forming composition of the invention must comprise a free-radical initiator, either a thermal free-radical initiator or a free radical photoinitiator. Any one of those described above or known to a person skilled in the art can be used in the invention.

Lens-forming compositions of the invention can be prepared by dissolving or blending all of the desirable components (or materials) in the presence or absence of a non-reactive diluent (solvent) as described later in this application.

A lens-forming composition or an insert-forming composition can be a solventless clear liquid prepared by mixing all polymerizable components (or materials) and other necessary component(or materials) or a solution prepared by dissolving all of the desirable components (or materials) in any suitable solvent, such as, a mixture of water and one or more organic solvents miscible with water, an organic solvent, or a mixture of one or more

organic solvents, as known to a person skilled in the art. The term “solvent” or “non-reactive diluent” refers to a chemical that cannot participate in free-radical polymerization reaction.

A solventless lens SiHy lens formulation (silicone hydrogel lens-forming composition) typically comprises at least one blending vinylic monomer as a reactive solvent for dissolving all other polymerizable components of the solventless SiHy lens formulation. Examples of preferred blending vinylic monomers are described later in this application. Preferably, methyl methacrylate is used as a blending vinylic monomer in preparing a solventless SiHy lens formulation.

Examples of suitable solvents include acetone, methanol, cyclohexane, tetrahydrofuran, tripropylene glycol methyl ether, dipropylene glycol methyl ether, ethylene glycol n-butyl ether, ketones (e.g., acetone, methyl ethyl ketone, etc.), diethylene glycol n-butyl ether, diethylene glycol methyl ether, ethylene glycol phenyl ether, propylene glycol methyl ether, propylene glycol methyl ether acetate, dipropylene glycol methyl ether acetate, propylene glycol n-propyl ether, dipropylene glycol n-propyl ether, tripropylene glycol n-butyl ether, propylene glycol n-butyl ether, dipropylene glycol n-butyl ether, tripropylene glycol n-butyl ether, propylene glycol phenyl ether dipropylene glycol dimethyl ether, polyethylene glycols, polypropylene glycols, ethyl acetate, butyl acetate, amyl acetate, methyl lactate, ethyl lactate, i-propyl lactate, methylene chloride, 2-butanol, 1-propanol, 2-propanol, menthol, cyclohexanol, cyclopentanol and exonorborneol, 2-pentanol, 3-pentanol, 2-hexanol, 3-hexanol, 3-methyl-2-butanol, 2-heptanol, 2-octanol, 2-nonanol, 2-decanol, 3-octanol, norborneol, tert-butanol, tert-amyl alcohol, 2-methyl-2-pentanol, 2,3-dimethyl-2-butanol, 3-methyl-3-pentanol, 1-methylcyclohexanol, 2-methyl-2-hexanol, 3,7-dimethyl-3-octanol, 1-chloro-2-methyl-2-propanol, 2-methyl-2-heptanol, 2-methyl-2-octanol, 2,2-methyl-2-nonanol, 2-methyl-2-decanol, 3-methyl-3-hexanol, 3-methyl-3-heptanol, 4-methyl-4-heptanol, 3-methyl-3-octanol, 4-methyl-4-octanol, 3-methyl-3-nonanol, 4-methyl-4-nonanol, 3-methyl-3-octanol, 3-ethyl-3-hexanol, 3-methyl-3-heptanol, 4-ethyl-4-heptanol, 4-propyl-4-heptanol, 4-isopropyl-4-heptanol, 2,4-dimethyl-2-pentanol, 1-methylcyclopentanol, 1-ethylcyclopentanol, 1-ethylcyclopentanol, 3-hydroxy-3-methyl-1-butene, 4-hydroxy-4-methyl-1-cyclopentanol, 2-phenyl-2-propanol, 2-methoxy-2-methyl-2-propanol, 2,3,4-trimethyl-3-pentanol, 3,7-dimethyl-3-octanol, 2-phenyl-2-butanol, 2-methyl-1-phenyl-2-propanol and 3-ethyl-3-pentanol, 1-ethoxy-2-propanol, 1-methyl-2-propanol, t-amyl alcohol, isopropanol, 1-methyl-2-pyrrolidone, N,N-dimethylpropionamide, dimethyl formamide, dimethyl acetamide, dimethyl propionamide, N-methyl pyrrolidinone, and mixtures thereof. More preferred organic solvents include without limitation methanol, ethanol, 1-propanol, isopropanol, sec-butanol, tert-butyl alcohol, tert-amyl alcohol, acetone, methyl ethyl ketone, methyl isopropyl ketone, methyl propyl ketone, ethyl acetate, heptane, methylhexane (various isomers), methylcyclohexane, dimethylcyclopentane (various isomers), 2,2,4-trimethylpentane, and mixtures thereof.

The insert-forming composition and the lens-forming composition can be introduced into the insert-molding cavity and the lens-molding cavity respectively according any techniques known to a person skilled in the art.

In accordance with a preferred embodiment of the invention, the insert is placed in the female lens mold half in a way to ensure that the central axis of the insert coincides with the central axis of the female lens mold half, according to any techniques known to a person skilled in the art. Examples of preferred systems for insert placement and positioning includes without limitation those described in co-pending U.S. Pat. Appl. Ser. No. 18/070,189 filed 29 November 2022 entitled "SYSTEMS AND METHODS FOR INSERT PLACEMENT TO FABRICATE HYBRID CONTACT LENSES".

When the first molding assembly is closed, any excess insert-forming composition is pressed into overflow area(s) (e.g., grooves) provided on one of the insert mold halves.

When the second molding assembly is closed, any excess lens-forming composition is pressed into overflow area(s) (e.g., grooves) provided on one of the insert mold halves.

The overflow groove surrounds the molding surface defining one of the anterior and posterior surfaces of a contact lens to be molded.

The curing of the insert-forming composition within the insert-molding cavity of the closed first molding assembly is carried out thermally (i.e., by heating) to activate the polymerization initiators, as known to a person skilled in the art.

For example, the thermal curing of the insert-forming composition in an insert mold or the lens-forming composition in a lens mold can be carried out conveniently in an oven at one or more temperatures of from 25 to 120°C and preferably 40 to 100°C, as well known to a person skilled in the art. The reaction time may vary within wide limits, but is conveniently, for example, from 1 to 24 hours or preferably from 2 to 12 hours. It is advantageous to previously degas the insert-forming composition and to carry out said polymerization reaction under an inert atmosphere, e.g., under N₂ or Ar atmosphere.

The curing of the insert-forming composition in an insert mold or the lens-forming composition in a lens mold can be carried out actinically (i.e., by actinic radiation, e.g., UV radiation and/or visible radiation) to activate the polymerization initiators, as known to a person skilled in the art.

After the curing step, the steps of opening a mold (i.e., separating the male insert (lens) mold half from the female insert (lens) mold half with the insert (or lens embedded hydrogel lens precursor) attached onto one of the male and female insert (lens) mold halves and delensing (i.e., removing the insert (embedded hydrogel lens precursor) from the insert-adhered or lens-adhered mold half) are carried out according to any techniques known to a skilled person.

Separating of the first molding assembly can be carried out according to any

techniques known to a person skilled in the art. It is understood that the molded insert is adhered onto the one of the female and male insert mold halves. Many techniques are known in the art. For example, the molding surface of the insert mold half designed to adhere the molded insert can be surface-treated to render the molded insert preferentially adhered to the molding surface of this insert mold half. Alternatively, a compression force can be applied by using a mold-opening device to non-optical surface (opposite to the molding surface) of the insert mold half (not adhering the molded insert) of the first molding assembly at a location about the center area of non-optical molding surface at an angle of less than about 30 degrees, preferably less than about 10 degrees, most preferably less than about 5 degrees (i.e., in a direction substantially normal to center area of non-optical molding surface) relative to the axis of the insert mold to deform the insert mold half, thereby breaking bonds between the molding surface of the insert mold half and the molded insert. Various ways of applying a force to non-optical surface of the insert mold half at a location about the center area of non-optical molding surface along the axis of the insert mold to deform the insert mold half which breaks the bonds between the optical molding surface of the insert mold half and the molded insert. It is understood that the mold-opening device can have any configurations known to a person skilled in the art for performing the function of separating two mold halves from each other.

Similarly, the step of separating the second molding assembly can be carried out according to any techniques known to a person skilled in the art. It is understood that the molded embedded hydrogel lens precursor can be adhered onto either one of the two lens mold halves of the second molding assembly.

After the embedded hydrogel lens precursor is delensed, it typically is extracted with an extraction medium as well known to a person skilled in the art. The extraction liquid medium is any solvent capable of dissolving the diluent(s), unpolymerized polymerizable materials, and oligomers in the embedded silicone hydrogel lens precursor. Water, any organic solvents known to a person skilled in the art, or a mixture thereof can be used in the invention. Preferably, the organic solvents used extraction liquid medium are water, a buffered saline, a C₁-C₃ alkyl alcohol, 1,2-propylene glycol, a polyethyleneglycol having a number average molecular weight of about 400 Daltons or less, a C₁-C₆ alkylalcohol, or combinations thereof.

The extracted embedded hydrogel contact lens can then be hydrated according to any method known to a person skilled in the art.

The hydrated embedded hydrogel contact lens can further subject to further processes, such as, for example, surface treatment, packaging in lens packages with a packaging solution which is well known to a person skilled in the art; sterilization such as autoclave at from 118 to 124°C for at least about 30 minutes; and the like.

Lens packages (or containers) are well known to a person skilled in the art for autoclaving and storing a soft contact lens. Any lens packages can be used in the invention. Preferably, a lens package is a blister package which comprises a base and a cover, wherein the cover is detachably sealed to the base, wherein the base includes a cavity for receiving a sterile packaging solution and the contact lens.

Lenses are packaged in individual packages, sealed, and sterilized (e.g., by autoclave at about 120°C or higher for at least 30 minutes under pressure) prior to dispensing to users. A person skilled in the art will understand well how to seal and sterilize lens packages.

Although various embodiments of the invention have been described using specific terms, devices, and methods, such description is for illustrative purposes only. The words used are words of description rather than of limitation. As would be obvious to one skilled in the art, many variations and modifications of the invention may be made by those skilled in the art without departing from the spirit and scope of the novel concepts of the disclosure. In addition, it should be understood that aspects of the various embodiments of the invention may be interchanged either in whole or in part or can be combined in any manner and/or used together, as illustrated below:

1. A method for producing embedded hydrogel contact lenses, comprising the steps of:
 - (1) obtaining an insert mold, wherein the insert mold comprises a male insert mold half having a first molding surface and a female insert mold half having a second molding surface are configured to receive each other such that an insert-molding cavity is formed between the first and second molding surfaces when the female insert mold half is closed with the male insert mold half;
 - (2) dispensing an insert-forming composition in the female insert mold half, wherein the insert-forming composition comprises (i) at least one polymerizable material, (ii) at least one first free-radical initiator, and (iii) at least one iniferter;
 - (3) closing the female insert mold half with the male insert mold half to form a first molding assembly comprising the insert-forming composition within the insert-molding cavity of the insert mold;
 - (4) curing thermally or actinically the insert-forming composition in the insert-molding cavity of the first molding assembly to form a molded insert that is made of a first crosslinked polymeric material comprising iniferter moieties covalently attached thereto;
 - (5) obtaining a lens mold and a lens-forming composition, wherein the lens mold comprises a male lens mold half having a third molding surface and a female lens mold half having a fourth molding surface are configured to receive each other

such that a lens-molding cavity is formed between the third and fourth molding surfaces when the female lens mold half is closed with the male lens mold half, wherein the lens-forming composition comprises at least one second polymerizable material and a second free-radical initiator;

- (6) in no particular order, placing the insert obtained in step (4) in the female lens mold half at a desired position and dispensing the lens-forming composition in the female lens mold half, wherein the insert is immersed in the lens-forming composition;
 - (7) closing the female lens mold half with the male lens mold half to form a second molding assembly comprising the lens-forming composition and the insert immersed therein in the lens-molding cavity of the lens mold;
 - (8) curing thermally or actinically the lens-forming composition while simultaneously initiating iniferter-induced polymerization of the lens-forming composition at and near the surface of the insert in the lens-molding cavity of the second molding assembly to form an embedded hydrogel lens precursor that comprise a bulk hydrogel material formed from the lens-forming composition and the insert embedded in the bulk material, wherein the bulk hydrogel material is a second crosslinked polymeric material that is covalently linked to the first crosslinked polymeric material at iniferter moieties located at and near the surface of the insert;
 - (9) separating the lens mold obtained in step (8) into the male and female lens mold halves, with the embedded hydrogel lens precursor adhered onto a lens-adhered lens mold half which is one of the male and female lens mold halves;
 - (10) removing the embedded hydrogel lens precursor from the lens-adhered lens mold half (preferably before the embedded hydrogel lens precursor is contact with water or any liquid); and
 - (11) subjecting the embedded hydrogel lens precursor to post-molding processes including a hydration process and one or more other processes selected from the group consisting of extraction, surface treatment, packaging, sterilization, and combinations thereof to form the embedded hydrogel contact lens.
2. The method of embodiment 1, wherein said at least one iniferter comprises a thiocarbonylthio-containing compound (i.e., having a thiocarbonylthio moiety $\overset{\text{S}}{\underset{\text{||}}{\text{C}}}\text{-S-}$).
 3. The method of embodiment 2, wherein said at least one thiocarbonylthio-containing compound is a dithioester, a dithiocarbamate, a dithioate, a trithiocarbonate, a xanthate, a thiuram monosulfide, a thiuram disulfides, a xanthate disulfide, or combinations thereof.
 4. The method of embodiment 1, wherein said at least one iniferter comprises at least one thiocarbonylthio-containing compound selected from the group consisting of thiuram

monosulfide, N,N'-dimethylthiuram monosulfide, N,N,N',N'-tetramethylthiuram monosulfide, N,N'-diethylthiuram monosulfide, N,N,N',N'-tetraethylthiuram monosulfide, thiuram disulfide, N,N-dimethylthiuram disulfide, N,N'-diethylthiuram disulfide, N,N'-diethyl-N,N'-bis(2-hydroxyethyl)thiuram disulfide, N,N'-bis(N-(2-phthalimidoethyl)piperazine-thiuram disulfide, N,N'-dimethylthiuram tetrasulfide, tetramethylthiuram disulfide, tetraethylthiuram disulfide, tetraisopropylthiuram disulfide, N,N'-dimethyl N,N'-di(4-pyridinyl)thiuram disulfide, bis(thiobenzoyl) disulfide, diisopropyl xanthate disulfide, cyanomethyl benzodithioate, benzyl benzodithioate, 2-phenyl-2-propyl benzodithioate, bis(thiobenzoyl) disulfide, benzyl 1H-pyrrole-1-carbodithioate, 2-cyano-2-propyl benzodithioate, bis(carboxymethyl)trithiocarbonate, 4-cyano-4-(thiobenzoylthio)pentanoic acid, ethyl 2-(phenylcarbonothioylthio)-2-phenylacetate, ethyl 2-(phenylcarbonothioylthio)-propionate, 1-(methoxycarbonyl)ethyl benzodithioate, 2-cyano-2-propyl 4-cyanobenzo-dithioate, ethyl 2-(4-methoxyphenylcarbonothioylthio)acetate, ethyl 2-methyl-2-(phenylthiocarbonylthio)propionate, ethyl 2-(phenylcarbonothioylthio)-2-phenylacetate, 2-(4-methoxyphenylcarbonothioylthio)ethanoic acid, 2-nitro-5-(2-propynyloxy)benzyl 4-cyano-4-(phenylcarbonothioylthio)pentanoate, S,S-bis(α,α' -dimethyl- α'' -acetic acid) trithiocarbonate, S-dodecyl-S'-(α,α' -dimethyl- α'' -acetic acid) trithiocarbonate, S-ethyl-S'-(α,α' -dimethyl- α'' -acetic acid) trithiocarbonate, 4-cyano-4-ethyl-trithiopentanoic acid, S,S-dibenzyl trithiocarbonate, bis(carboxymethyl)trithiocarbonate, dimethyl trithiocarbonate, phthalimidomethyl butyl trithiocarbonate, cyanomethyl dodecyl trithiocarbonate, 4-cyano-4-[(dodecylsulfanylthiocarbonyl)sulfanyl]pentanoic acid, 3,5-bis(2-dodecylthiocarbonylthio-1-oxopropoxy)benzoic acid, 2-(2-carboxyethylsulfanylthiocarbonylsulfanyl)-propionic acid, 2-cyano-2-propyl dodecyl trithiocarbonate, 3-butenyl 2-(dodecylthiocarbonothioylthio)-2-methylpropionate, 2-(dodecylthiocarbonothioylthio)-2-methylpropionic acid, cyanomethyl (3,5-dimethyl-1H-pyrazole)-carbodithioate, 2-cyanobutan-2-yl 4-chloro-3,5-dimethyl-1H-pyrazole-1-carbodithioate, methyl 2-[methyl(4-pyridinyl)carbamothioylthio]propionate, 2-cyanobutan-2-yl 3,5-dimethyl-1H-pyrazole-1-carbodithioate, cyanomethyl methyl(phenyl)carbamodithioate, cyanomethyl methyl(4-pyridyl)carbamodithioate, benzyl 1H-pyrrole-1-carbodithioate, cyanomethyl diphenylcarbamodithioate, cyanomethyl methyl(4-pyridyl)carbamodithioate, benzyl-N,N-dimethyldithiocarbamate, benzyl-N,N-diethyldithiocarbamate, 2-(N,N-diethyldithiocarbamyl) isobutyric acid, 2-(N,N-diethyldithiocarbamyl) isobutyric acid ethyl ester, (4-cyano-4-diethyldithiocarbamyl) pentanoic acid, 1-(ethoxycarbonyl)prop-1-yl dithiobenzoate, phenacyl morpholine-4-dithiocarbamate, S-2-cyano-2-propyl-O-ethyl xanthate, 1-phenylethyl phenyldithioacetate, S-methacryloyl O-ethyl xanthate, 2-(N,N-

diethyldithiocarbamyl)ethyl methacrylate, acetic acid 2-(N,N-diethyldithiocarbamyl)ethyl ether, cyanopentanoic acid dithiobenzoate, 3-benzylsulfanylthiocarbonylsulfanyl propionic acid, 2-(n-butyltrithiocarbonate)-propionic acid, n-butyl N,N-dimethyldithiocarbamate, benzyl dithiocarbamate, p-xylene-bis(dithiocarbamate), p-xylene-bis(N,N-dimethyldithiocarbamate), p-xylene-bis(N,N-diethyldithiocarbamate), 1,2-bis(N,N-diethyldithiocarbamyl)ethane, 1,2-bis(N,N-dimethyldithiocarbamyl)ethane, 1,2,3-tris(N,N-dimethyldithiocarbamyl)propane, 1,2,4,5-tetrakis(N,N-diethyldithiocarbamylmethyl)benzene, 1-(N,N-diethyldithiocarbamyl)ethyl acetate, and combinations thereof.

5. The method of embodiment 1, wherein said at least one iniferter comprises at least one organic nitroxide compound (i.e., having a nitroxide moiety >N-O-).
6. The method of embodiment 5, wherein said at least one organic nitroxide compound are selected from the group consisting of ((2',2',6',6'-tetramethyl-1'-piperidinyloxy)methyl)benzene, 1-phenyl-1-(2',2',6',6'-tetramethyl-1'-piperidinyloxy)ethane, 1-(4'-bromophenyl)-1-(2',2',6',6'-tetramethyl-1'-piperidinyloxy)ethane, 1-naphthyl-1-(2',2',6',6'-tetramethyl-1'-piperidinyloxy)-ethane, 1-phenyl-1-(2',2',6',6'-tetramethyl-1'-piperidinyloxy)propane, 1-(benzyloxy)-2-phenyl-2-(2',2',6',6'-tetramethyl-1'-piperidinyloxy)ethane, 1-hydroxy-2-phenyl-2-(2',2',6',6'-tetramethyl-1'-piperidinyloxy)ethane, phenyl 4-cyano-4-(2',2',6',6'-tetramethyl-1'-piperidinyloxy)pentanoate, pentafluorophenyl 4-cyano-4-(2',2',6',6'-tetramethyl-1'-piperidinyloxy)pentanoate, 3-phenyl-1-(2',2',6',6'-tetramethyl-1'-piperidinyloxy)propane, 1-((2',2',6',6'-tetramethyl-1'-piperidinyloxy)methyl)-4-(trifluoromethyl)benzene, methyl 2-((4-benzoylphenyl)((1-methoxy-2-methyl-1-oxopropan-2-yl)oxy)amino)-2-methylpropanoate, 2,2,6,6-tetramethyl-1-piperidinyloxy, 2,2,5-trimethyl-4-phenyl-3-azahexane-3-nitroxide, N-tert-butyl-N-1-phenyl-2-methylpropyl-nitroxide, N-tert-butyl-N-1-(2-naphthyl)-2-methylpropyl nitroxide, N-tert-butyl-N-1-diethylphosphono-2,2-dimethylpropyl nitroxide, N-tert-butyl-N-1-dibenzylphosphono-2,2-dimethylpropyl nitroxide, N-phenyl-N-1-diethylphosphono-2,2-dimethylpropyl nitroxide, N-phenyl-N-1-diethylphosphono-1-methylethyl nitroxide, N-(1-phenyl-2-methylpropyl)-N-1-diethylphosphono-1-methylethyl nitroxide, and combinations thereof.
7. The method of any one of embodiments 1 to 6, wherein said at least one first polymerizable material comprises at least one polymerizable photochromic compound (i.e., photochromic vinylic monomer), at least one UV-absorbing vinylic monomer, at least one UV/HEVL-absorbing vinylic monomer, at least one fluorescent vinylic monomer, or combinations thereof.
8. The method of any one of embodiments 1 to 7, wherein the insert-forming composition

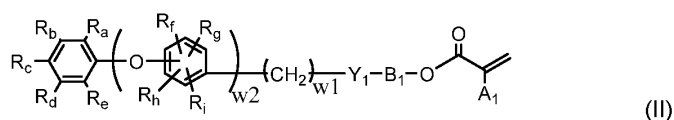
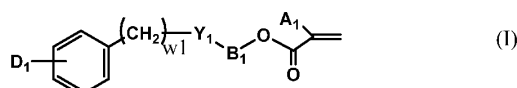
further comprises at least one color-filtering material for correcting color blindness, a diffractive material, a high refractive-index material, or combinations.

9. The method of any one of embodiments 1 to 8, wherein the insert-forming composition is a first polymerizable composition for forming a crosslinked polymethylmethacrylate that comprises repeating units of methyl methacrylate and at least one vinylic crosslinker.
10. The method of any one of embodiments 1 to 8, wherein the insert-forming composition is a second polymerizable composition for forming a crosslinked silicone polymer that has three-dimensional polymer networks, is insoluble in water, and has an equilibrium water content of about 5% or less by weight.
11. The method of embodiment 10, wherein the crosslinked silicone polymer has an equilibrium water content of about 3% or less (preferably about 2% or less) by weight.
12. The method of any one of embodiments 1 to 8, wherein the insert-forming composition is a third polymerizable composition for forming a rigid gas permeable material.
13. The method of any one of embodiments 1 to 8, wherein the insert-forming composition is a fourth polymerizable composition for forming a hydrophobic crosslinked acrylic material that has an equilibrium water content of less than 5% by weight, and comprises at least 55% by mole of one or more acrylic monomers and/or one or more acrylic crosslinker and at least about 6% by mole of at least one acrylic crosslinker and optionally at least one vinylic crosslinker other than acrylic crosslinker, relative to the total amount of said at least one first polymerizable material and other polymerizable materials.
14. The method of embodiment 13, wherein the hydrophobic crosslinked acrylic material has an equilibrium water content of about 4% or less by weight.
15. The method of embodiment 13, wherein the hydrophobic crosslinked acrylic material has an equilibrium water content of about 3% or less by weight.
16. The method of embodiment 13, wherein the hydrophobic crosslinked acrylic material has an equilibrium water content of about 2% or less by weight.
17. The method of any one of embodiments 13 to 16, wherein the insert-forming composition comprises at least about 65% by mole of said one or more acrylic monomers and/or said one or more acrylic crosslinker, relative to the total amount of said at least one first polymerizable material and other polymerizable materials.
18. The method of any one of embodiments 13 to 16, wherein the insert-forming composition comprises at least about 70% by mole of said one or more acrylic monomers and/or said one or more acrylic crosslinker, relative to the total amount of said at least one first polymerizable material and other polymerizable materials.
19. The method of any one of embodiments 13 to 16, wherein the insert-forming

composition comprises at least about 75% by mole of said one or more acrylic monomers and/or said one or more acrylic crosslinker, relative to the total amount of said at least one first polymerizable material and other polymerizable materials.

20. The method of any one of embodiments 13 to 19, wherein the insert-forming composition comprises at least about 20% by mole of said at least one acrylic crosslinker and optionally said at least one vinylic crosslinker other than acrylic crosslinker, relative to the total amount of said at least one first polymerizable material and other polymerizable materials.
21. The method of any one of embodiments 13 to 19, wherein the insert-forming composition comprises at least about 30% by mole of said at least one acrylic crosslinker and optionally said at least one vinylic crosslinker other than acrylic crosslinker.
22. The method of any one of embodiments 13 to 19, wherein the insert-forming composition comprises at least about 35% by mole of said at least one acrylic crosslinker and optionally said at least one vinylic crosslinker other than acrylic crosslinker.
23. The method of any one of embodiments 13 to 22, wherein said at least one acrylic crosslinker is ethylene glycol dimethacrylate; ethylene glycol diacrylate; 1,3-propanediol diacrylate; 1,3-propanediol dimethacrylate; 2,3-propanediol diacrylate; 2,3-propanediol dimethacrylate; 1,4-butanediol dimethacrylate; 1,4-butanediol diacrylate; 1,5-pentanediol dimethacrylate; 1,5-pentanediol diacrylate; 1,6-hexanediol dimethacrylate; 1,6-hexanediol diacrylate; diethylene glycol dimethacrylate; diethylene glycol diacrylate; triethylene glycol dimethacrylate; triethylene glycol diacrylate; tetraethylene glycol dimethacrylate; tetraethylene glycol diacrylate; N,N'-methylene bis(acrylamide); N,N'-methylene bis(methacrylamide); N,N'-ethylene bis(acrylamide); N,N'-ethylene bis(methacrylamide); N,N'-hexamethylene bisacrylamide; N,N'-hexamethylene bismethacrylamide; pentaerythritol triacrylate, pentaerythritol trimethacrylate, trimethyloxypropane triacrylate, trimethyloxypropane trimethacrylate, tris(2-hydroxyethyl)isocyanurate triacrylate, tris(2-hydroxyethyl)isocyanurate trimethacrylate, 1,3,5-triacryloylhexahydro-1,3,5-triazine, 1,3,5-trimethacryloylhexahydro-1,3,5-triazine; pentaerythritol tetraacrylate, pentaerythritol tetramethacrylate, di(trimethyloxypropane) tetraacrylate, di(trimethyloxypropane) tetramethacrylate, or combinations thereof.
24. The method of embodiment 22, wherein said at least one acrylic crosslinker is allyl (meth)acrylate, pentaerythritol tetra(meth)acrylate, Neopentyl glycol di(meth)acrylate, an aryl crosslinking agent, triallyl isocyanurate, 2,4,6-triallyloxy-1,3,5-triazine, 1,2,4-trivinylcyclohexane, or combinations thereof.

25. The method of any one of embodiments 13 to 24, wherein said at least one vinylic crosslinker comprises divinylbenzene, 2-methyl-1,4-divinylbenzene, bis(4-vinylphenyl)methane, 1,2-bis(4-vinylphenyl)ethane, or combinations thereof.
26. The method of any one of embodiments 13 to 25, wherein said at least one first polymerizable material in the fourth polymerizable composition comprises at least one silicone-containing acrylic monomer.
27. The method of any one of embodiments 13 to 26, wherein said at least one first polymerizable material in the fourth polymerizable composition comprises at least one fluorine-containing acrylic monomer.
28. The method of embodiment 27, wherein said at least one fluorine-containing acrylic monomer is perfluorohexylethyl-thio-carbonyl-aminoethyl-methacrylate, 2,2,2-trifluoroethyl (meth)acrylate, tetrafluoropropyl (meth)acrylate, hexafluoro-iso-propyl (meth)acrylate, hexafluorobutyl (meth)acrylate, heptafluorobutyl (meth)acrylate, octafluoropentyl (meth)acrylate, heptadecafluorodecyl (meth)acrylate, pentafluorophenyl (meth)acrylate, or combinations thereof.
29. The method of any one of embodiments 13 to 28, wherein said at least one first polymerizable material in the fourth polymerizable composition comprises at least one polysiloxane vinylic crosslinker.
30. The method of any one of embodiments 13 to 29, wherein said at least one first polymerizable material in the fourth polymerizable composition comprises at least one aryl acrylic monomer of formula (I) or (II)



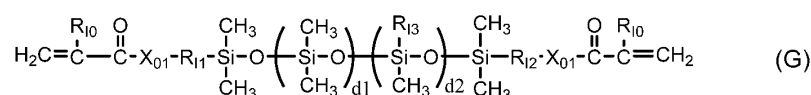
wherein A₁ is H or CH₃ (preferably H); B₁ is (CH₂)_{m1} or [O(CH₂)₂]_{z1} in which m₁ is 2-6 and z₁ is 1-10; Y₁ is a direct bond, O, S, or NR' in which R' is H, CH₃, C_nH_{2n+1} in which n'=1-10, iso-OC₃H₇, C₆H₅, or CH₂C₆H₅; R_a, R_b, R_c, R_d, R_e, R_f, R_g, R_h, and R_i independent of one another are H, C₁-C₁₂ alkyl, or C₁-C₁₂ alkoxy (preferably all are H); w₁ is 0-6, provided that m₁+w₁≤8; w₂ is an integer from 1 to 3; and D₁ is H, Cl, Br, C₁-C₄ alkyl, C₁-C₄ alkoxy, C₆H₅, or CH₂C₆H₅.

31. The method of embodiment 30, wherein said at least one aryl acrylic monomer is selected from the group consisting of 2-ethylphenoxy acrylate; 2-ethylphenoxy methacrylate; phenyl acrylate; phenyl methacrylate; benzyl acrylate; benzyl methacrylate; 2-phenylethyl acrylate; 2-phenylethyl methacrylate; 3-phenylpropyl

acrylate; 3-phenylpropyl methacrylate; 4-phenylbutyl acrylate; 4-phenylbutyl methacrylate; 4-methylphenyl acrylate; 4-methylphenyl methacrylate; 4-methylbenzyl acrylate; 4-methylbenzyl methacrylate; 2-(2-methylphenyl)ethyl acrylate; 2-(2-methylphenyl)ethyl methacrylate; 2-(3-methylphenyl)ethyl acrylate; 2-(3-methylphenyl)ethyl methacrylate; 2-(4-methylphenyl)ethyl acrylate; 2-(4-methylphenyl)ethyl methacrylate; 2-(4-propylphenyl)ethyl acrylate; 2-(4-propylphenyl)ethyl methacrylate; 2-(4-(1-methylethyl)phenyl)ethyl acrylate; 2-(4-(1-methylethyl)phenyl)ethyl methacrylate; 2-(4-methoxyphenyl)ethyl acrylate; 2-(4-methoxyphenyl)ethyl methacrylate; 2-(4-cyclohexylphenyl)ethyl acrylate; 2-(4-cyclohexylphenyl)ethyl methacrylate; 2-(2-chlorophenyl)ethyl acrylate; 2-(2-chlorophenyl)ethyl methacrylate; 2-(3-chlorophenyl)ethyl acrylate; 2-(3-chlorophenyl)ethyl methacrylate; 2-(4-chlorophenyl)ethyl acrylate; 2-(4-chlorophenyl)ethyl methacrylate; 2-(4-bromophenyl)ethyl acrylate; 2-(4-bromophenyl)ethyl methacrylate; 2-(3-phenylphenyl)ethyl acrylate; 2-(3-phenylphenyl)ethyl methacrylate; 2-(4-phenylphenyl)ethyl acrylate; 2-(4-phenylphenyl)ethyl methacrylate; 2-(4-benzylphenyl)ethyl acrylate; 2-(4-benzylphenyl)ethyl methacrylate; 2-(phenylthio)ethyl acrylate; 2-(phenylthio)ethyl methacrylate; 2-benzyloxyethyl acrylate; 3-benzyloxypropyl acrylate; 2-benzyloxyethyl methacrylate; 3-benzyloxypropyl methacrylate; 2-[2-(benzyloxy)ethoxy]ethyl acrylate; 2-[2-(benzyloxy)ethoxy]ethyl methacrylate, and combinations thereof.

32. The method of any one of embodiments 13 to 31, wherein said at least one hydrophobic vinylic monomer selected from the group consisting of a vinyl alkanoate, a vinyloxyalkane, styrene, vinyl toluene, vinyl chloride, vinylidene chloride, 1-butene, and combinations thereof.
33. The method of any one of embodiments 13 to 32, wherein the hydrophobic insert is rigid.
34. The method of any one of embodiments 1 to 33, wherein the lens-forming composition comprises at least 50% by mole of at least one hydroxyl-containing vinylic monomer.
35. The method of embodiment 34, wherein said at least one hydroxyl-containing vinylic monomer is selected from the group consisting of hydroxyethyl (meth)acrylate, glycerol (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 3-amino-2-hydroxypropyl (meth)acrylate, N-2-hydroxyethyl (meth)acrylamide, N-3-hydroxypropyl (meth)acrylamide, N-2-hydroxypropyl (meth)acrylamide, N-2,3-dihydroxypropyl (meth)acrylamide, N-tris(hydroxymethyl)methyl (meth)acrylamide, vinyl alcohol, allyl alcohol, and combinations thereof.
36. The method of any one of embodiments 1 to 33, wherein the lens-forming composition comprises (a) at least one polysiloxane vinylic monomer and/or at least one first

- polysiloxane vinylic crosslinker and (b) at least one hydrophilic vinylic monomer.
37. The method of embodiment 36, wherein the lens-forming composition comprises at least one hydrophilized polysiloxane vinylic crosslinker comprising hydrophilized siloxane units each having one methyl substituent and one organic radical including at least one H-bond donor.
 38. The method of embodiment 37, wherein said at least one hydrophilized polysiloxane vinylic crosslinker comprises hydrophilized siloxane units each having one methyl substituent and one organic radical including at least one hydroxyl groups.
 39. The method of embodiment 37 or 38, wherein said at least one hydrophilized polysiloxane vinylic crosslinker comprises a di-(meth)acryloyloxy-terminated polysiloxane vinylic crosslinker having dimethylsiloxane units and hydrophilized siloxane units each having one methyl substituent and one monovalent C₄–C₄₀ organic radical substituent having 2 to 6 hydroxyl groups.
 40. The method of any one of embodiments 37 to 39, wherein said at least one hydrophilized polysiloxane vinylic crosslinker comprises a vinylic crosslinker of formula (G)



in which:

d₁ is an integer of from 30 to 500 and d₂ is an integer of from 1 to 75, provided that

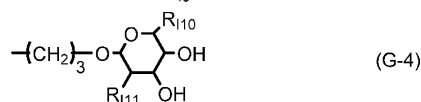
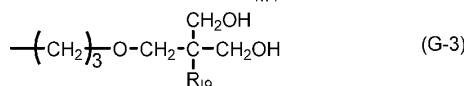
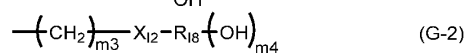
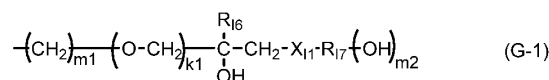
d₂/d₁ is from about 0.035 to about 0.15;

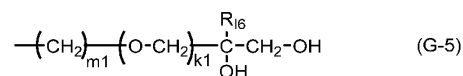
X₀₁ is O or NR_{IN} in which R_{IN} is hydrogen or C₁–C₁₀-alkyl;

R₁₀ is hydrogen or methyl;

R₁₁ and R₁₂ independently of each other are a substituted or unsubstituted C₁–C₁₀ alkylene divalent radical or a divalent radical of –R₁₄–O–R₁₅– in which R₁₄ and R₁₅ independently of each other are a substituted or unsubstituted C₁–C₁₀ alkylene divalent radical;

R₁₃ is a monovalent radical of any one of formula (G-1) to (G-5)





k1 is zero or 1; m1 is an integer of 2 to 4; m2 is an integer of 1 to 5; m3 is an integer of 3 to 6; m4 is an integer of 2 to 5;

R₁₆ is hydrogen or methyl;

R₁₇ is a C₂-C₆ hydrocarbon radical having (m2+1) valencies;

R₁₈ is a C₂-C₆ hydrocarbon radical having (m4+1) valencies;

R₁₉ is ethyl or hydroxymethyl;

R₁₁₀ is methyl or hydromethyl;

R₁₁₁ is hydroxyl or methoxy;

X₁₁ is a sulfur linkage of ---S--- or a tertiary amino linkage of $\text{---NR}_{112}\text{---}$ in which R₁₁₂ is C₁-C₁₀ alkyl, hydroxyethyl, hydroxypropyl, or 2,3-dihydroxypropyl; and

X₁₂ is an amide linkage of $\text{---NR}_{113}\text{---}\overset{\text{O}}{\parallel}\text{C---}$ or $\text{---}\overset{\text{O}}{\parallel}\text{C---NR}_{113}\text{---}$ in which R₁₁₃ is hydrogen or C₁-C₁₀ alkyl.

41. The method of any one of embodiments 36 to 40, wherein the lens-forming composition comprises: a di-(meth)acryloyl-terminated polydimethylsiloxane, a di-vinyl carbonate-terminated polydimethylsiloxane; a di-vinyl carbamate-terminated polydimethylsiloxane; N,N,N',N'-tetrakis(3-methacryloxy-2-hydroxypropyl)-alpha,omega-bis-3-aminopropyl-polydimethylsiloxane, or a combination thereof.
42. The method of any one of embodiments 36 to 41, wherein the lens-forming composition comprises: (1) a vinylic crosslinker which comprises one sole polydiorganosiloxane segment and two terminal ethylenically-unsaturated groups selected from the group consisting of (meth)acryloyloxy groups, (meth)acryloylamino groups, vinyl carbonate groups, vinylcarbamate groups; and/or (2) a chain-extended polysiloxane vinylic crosslinker which comprises at least two polydiorganosiloxane segment and a covalent linker between each pair of polydiorganosiloxane segments and two two terminal ethylenically-unsaturated groups selected from the group consisting of (meth)acryloyloxy groups, (meth)acryloylamino groups, vinyl carbonate groups, vinylcarbamate groups.
43. The method of any one of embodiments 36 to 41, wherein the lens-forming composition comprises: alpha,omega-bis[3-(meth)acrylamidopropyl]-terminated polydimethylsiloxane, alpha,omega-bis[3-(meth)acryloxypropyl]-terminated polydimethylsiloxane, alpha,omega-bis[3-(meth)acryloxy-2-hydroxypropyloxypropyl]-terminated polydimethylsiloxane, alpha,omega-bis[3-(meth)acryloxyethoxy-2-hydroxypropyloxypropyl]-terminated polydimethylsiloxane, alpha,omega-bis[3-(meth)acryloxypropyloxy-2-hydroxypropyloxypropyl]-terminated polydimethylsiloxane, alpha,omega-bis[3-(meth)acryloxy-

isopropoxy-2-hydroxypropoxypropyl]-terminated polydimethylsiloxane, α,ω -bis[3-(meth)acryloxybutyloxy-2-hydroxypropoxypropyl]-terminated polydimethylsiloxane, α,ω -bis[3-(meth)acrylamidoethoxy-2-hydroxypropoxypropyl]-terminated polydimethylsiloxane, α,ω -bis[3-(meth)acrylamidopropoxy-2-hydroxypropoxypropyl]-terminated polydimethylsiloxane, α,ω -bis[3-(meth)acrylamidoisopropoxy-2-hydroxypropoxypropyl]-terminated polydimethylsiloxane, α,ω -bis[3-(meth)acrylamidobutyloxy-2-hydroxypropoxypropyl]-terminated polydimethylsiloxane, α,ω -bis[3-(meth)acryloxyethylamino-2-hydroxypropoxypropyl]-terminated polydimethylsiloxane, α,ω -bis[3-(meth)acryloxypropylamino-2-hydroxypropoxypropyl]-terminated polydimethylsiloxane, α,ω -bis[3-(meth)acryloxybutylamino-2-hydroxypropoxypropyl]-terminated polydimethylsiloxane, α,ω -bis[(meth)acrylamidoethylamino-2-hydroxypropoxy-propyl]-terminated polydimethylsiloxane, α,ω -bis[3-(meth)acrylamidopropylamino-2-hydroxypropoxypropyl]-terminated polydimethylsiloxane, α,ω -bis[3-(meth)acrylamide-butylamino-2-hydroxypropoxypropyl]-terminated polydimethylsiloxane, α,ω -bis[(meth)acryloxy-2-hydroxypropoxy-ethoxypropyl]-terminated polydimethylsiloxane, α,ω -bis[(meth)acryloxy-2-hydroxypropyl-N-ethylaminopropyl]-terminated polydimethylsiloxane, α,ω -bis[(meth)acryloxy-2-hydroxypropyl-aminopropyl]-terminated polydimethylsiloxane, α,ω -bis[(meth)acryloxy-2-hydroxypropoxy-(polyethylenoxy)propyl]-terminated polydimethylsiloxane, α,ω -bis[(meth)acryloxyethylamino-carbonyloxy-ethoxypropyl]-terminated polydimethylsiloxane, α,ω -bis[(meth)acryloxyethylamino-carbonyloxy-(polyethylenoxy)propyl]-terminated polydimethylsiloxane, or combinations thereof.

44. The method of any one of embodiments 36 to 43, wherein said at least one hydrophilic vinylic monomer comprises: (1) an alkyl (meth)acrylamide selected from the group consisting of (meth)acrylamide, N,N-dimethyl (meth)acrylamide, N-ethyl (meth)acrylamide, N,N-diethyl (meth)acrylamide, N-propyl (meth)acrylamide, N-isopropyl (meth)acrylamide, N-3-methoxypropyl (meth)acrylamide, and combinations thereof; (2) a hydroxyl-containing acrylic monomer selected from the group consisting of N-2-hydroxyethyl (meth)acrylamide, N,N-bis(hydroxyethyl) (meth)acrylamide, N-3-hydroxypropyl (meth)acrylamide, N-2-hydroxypropyl (meth)acrylamide, N-2,3-dihydroxypropyl (meth)acrylamide, *N*-tris(hydroxymethyl)methyl (meth)acrylamide, 2-hydroxyethyl (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, glycerol methacrylate (GMA), di(ethylene glycol) (meth)acrylate, tri(ethylene glycol) (meth)acrylate, tetra(ethylene glycol) (meth)acrylate, poly(ethylene glycol) (meth)acrylate having a number average molecular weight of up to 1500, poly(ethylene glycol)ethyl (meth)acrylamide having a number average molecular

weight of up to 1500, and combinations thereof; (3) a carboxyl-containing acrylic monomer selected from the group consisting of 2-(meth)acrylamidoglycolic acid, (meth)acrylic acid, ethylacrylic acid, 3-(meth)acrylamidopropionic acid, 5-(meth)acrylamidopentanoic acid, 4-(meth)acrylamidobutanoic acid, 3-(meth)acrylamido-2-methylbutanoic acid, 3-(meth)acrylamido-3-methylbutanoic acid, 2-(meth)acrylamido-2-methyl-3,3-dimethyl butanoic acid, 3-(meth)acrylamidohexanoic acid, 4-(meth)acrylamido-3,3-dimethylhexanoic acid, and combinations thereof; (4) an amino-containing acrylic monomer selected from the group consisting of N-2-aminoethyl (meth)acrylamide, N-2-methylaminoethyl (meth)acrylamide, N-2-ethylaminoethyl (meth)acrylamide, N-2-dimethylaminoethyl (meth)acrylamide, N-3-aminopropyl (meth)acrylamide, N-3-methylaminopropyl (meth)acrylamide, N-3-dimethylaminopropyl (meth)acrylamide, 2-aminoethyl (meth)acrylate, 2-methylaminoethyl (meth)acrylate, 2-ethylaminoethyl (meth)acrylate, 3-aminopropyl (meth)acrylate, 3-methylaminopropyl (meth)acrylate, 3-ethylaminopropyl (meth)acrylate, 3-amino-2-hydroxypropyl (meth)acrylate, trimethylammonium 2-hydroxy propyl (meth)acrylate hydrochloride, dimethylaminoethyl (meth)acrylate, and combinations thereof; (5) an N-vinyl amide monomer selected from the group consisting of N-vinylpyrrolidone (*aka*, N-vinyl-2-pyrrolidone), N-vinyl-3-methyl-2-pyrrolidone, N-vinyl-4-methyl-2-pyrrolidone, N-vinyl-5-methyl-2-pyrrolidone, N-vinyl-6-methyl-2-pyrrolidone, N-vinyl-3-ethyl-2-pyrrolidone, N-vinyl-4,5-dimethyl-2-pyrrolidone, N-vinyl-5,5-dimethyl-2-pyrrolidone, N-vinyl-3,3,5-trimethyl-2-pyrrolidone, N-vinyl piperidone (*aka*, N-vinyl-2-piperidone), N-vinyl-3-methyl-2-piperidone, N-vinyl-4-methyl-2-piperidone, N-vinyl-5-methyl-2-piperidone, N-vinyl-6-methyl-2-piperidone, N-vinyl-6-ethyl-2-piperidone, N-vinyl-3,5-dimethyl-2-piperidone, N-vinyl-4,4-dimethyl-2-piperidone, N-vinyl caprolactam (*aka*, N-vinyl-2-caprolactam), N-vinyl-3-methyl-2-caprolactam, N-vinyl-4-methyl-2-caprolactam, N-vinyl-7-methyl-2-caprolactam, N-vinyl-7-ethyl-2-caprolactam, N-vinyl-3,5-dimethyl-2-caprolactam, N-vinyl-4,6-dimethyl-2-caprolactam, N-vinyl-3,5,7-trimethyl-2-caprolactam, N-vinyl-N-methyl acetamide, N-vinyl formamide, N-vinyl acetamide, N-vinyl isopropylamide, N-vinyl-N-ethyl acetamide, N-vinyl-N-ethyl formamide, and mixtures thereof; (6) a methylene-containing pyrrolidone monomer selected from the group consisting of 1-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, and combinations thereof; (7) an acrylic monomer having a

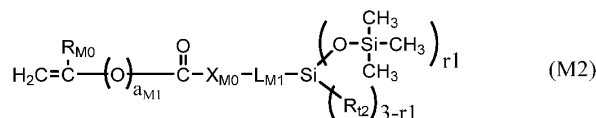
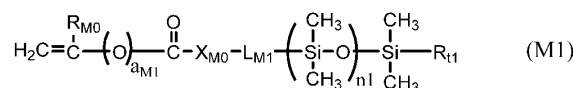
C₁-C₄ alkoxyethoxy group and selected from the group consisting of ethylene glycol methyl ether (meth)acrylate, di(ethylene glycol) methyl ether (meth)acrylate, tri(ethylene glycol) methyl ether (meth)acrylate, tetra(ethylene glycol) methyl ether (meth)acrylate, C₁-C₄-alkoxy poly(ethylene glycol) (meth)acrylate having a number average molecular weight of up to 1500, methoxy-poly(ethylene glycol)ethyl (meth)acrylamide having a number average molecular weight of up to 1500, and combinations thereof; (8) a vinyl ether monomer selected from the group consisting of ethylene glycol monovinyl ether, di(ethylene glycol) monovinyl ether, tri(ethylene glycol) monovinyl ether, tetra(ethylene glycol) monovinyl ether, poly(ethylene glycol) monovinyl ether, ethylene glycol methyl vinyl ether, di(ethylene glycol) methyl vinyl ether, tri(ethylene glycol) methyl vinyl ether, tetra(ethylene glycol) methyl vinyl ether, poly(ethylene glycol) methyl vinyl ether, and combinations thereof; (9) an allyl ether monomer selected from the group consisting of ethylene glycol monoallyl ether, di(ethylene glycol) monoallyl ether, tri(ethylene glycol) monoallyl ether, tetra(ethylene glycol) monoallyl ether, poly(ethylene glycol) monoallyl ether, ethylene glycol methyl allyl ether, di(ethylene glycol) methyl allyl ether, tri(ethylene glycol) methyl allyl ether, tetra(ethylene glycol) methyl allyl ether, poly(ethylene glycol) methyl allyl ether, and combinations thereof; (10) a phosphorylcholine-containing vinylic monomer selected from the group consisting of (meth)acryloyloxyethyl phosphorylcholine, (meth)acryloyloxypropyl phosphorylcholine, 4-((meth)acryloyloxy)butyl-2'-(trimethylammonio)ethylphosphate, 2-[(meth)acryloylamino]ethyl-2'-(trimethylammonio)-ethylphosphate, 3-[(meth)acryloylamino]propyl-2'-(trimethylammonio)ethylphosphate, 4-[(meth)acryloylamino]butyl-2'-(trimethylammonio)ethylphosphate, 5-((meth)acryloyloxy)pentyl-2'-(trimethylammonio)ethyl phosphate, 6-((meth)acryloyloxy)hexyl-2'-(trimethylammonio)-ethylphosphate, 2-((meth)acryloyloxy)ethyl-2'-(triethylammonio)ethylphosphate, 2-((meth)acryloyloxy)ethyl-2'-(tripropylammonio)ethylphosphate, 2-((meth)acryloyloxy)ethyl-2'-(tributylammonio)ethyl phosphate, 2-((meth)acryloyloxy)propyl-2'-(trimethylammonio)-ethylphosphate, 2-((meth)acryloyloxy)butyl-2'-(trimethylammonio)ethylphosphate, 2-((meth)acryloyloxy)pentyl-2'-(trimethylammonio)ethylphosphate, 2-((meth)acryloyloxy)hexyl-2'-(trimethylammonio)ethyl phosphate, 2-(vinylloxy)ethyl-2'-(trimethylammonio)ethylphosphate, 2-(allyloxy)ethyl-2'-(trimethylammonio)ethylphosphate, 2-(vinylloxycarbonyl)ethyl-2'-(trimethylammonio)ethyl phosphate, 2-(allyloxycarbonyl)ethyl-2'-(trimethylammonio)-ethylphosphate, 2-(vinylcarbonylamino)ethyl-2'-(trimethylammonio)ethylphosphate, 2-(allyloxycarbonylamino)ethyl-2'-(trimethylammonio)ethyl phosphate, 2-

- (butenoyloxy)ethyl-2'-(trimethylammonio)ethylphosphate, and combinations thereof;
- (11) allyl alcohol; (12) N-2-hydroxyethyl vinyl carbamate; (13) N-carboxyvinyl- β -alanine (VINYL); (14) N-carboxyvinyl- α -alanine; (15) or combinations thereof.
45. The method of any one of embodiments 36 to 43, wherein said at least one hydrophilic vinylic monomer comprises N-vinylpyrrolidone, N-vinyl-N-methyl acetamide, or combinations thereof.
 46. The method of any one of embodiments 36 to 45, wherein said at least one hydrophilic vinylic monomer comprises at least one (meth)acrylamido monomer selected from the group consisting of (meth)acrylamide, N,N-dimethyl (meth)acrylamide, N-ethyl (meth)acrylamide, N,N-diethyl (meth)acrylamide, N-propyl (meth)acrylamide, N-isopropyl (meth)acrylamide, N-3-methoxypropyl (meth)acrylamide, N-2-hydroxyethyl (meth)acrylamide, N,N-bis(hydroxyethyl) (meth)acrylamide, N-3-hydroxypropyl (meth)acrylamide, N-2-hydroxypropyl (meth)acrylamide, N-2,3-dihydroxypropyl (meth)acrylamide, N-tris(hydroxymethyl)methyl (meth)acrylamide, 2-(meth)acrylamidoglycolic acid, 3-(meth)acrylamidopropionic acid, 5-(meth)acrylamidopentanoic acid, 4-(meth)acrylamidobutanoic acid, 3-(meth)acrylamido-2-methylbutanoic acid, 3-(meth)acrylamido-3-methylbutanoic acid, 2-(meth)acrylamido-2-methyl-3,3-dimethyl butanoic acid, 3-(meth)acrylamidohexanoic acid, 4-(meth)acrylamido-3,3-dimethylhexanoic acid, N-2-aminoethyl (meth)acrylamide, N-2-methylaminoethyl (meth)acrylamide, N-2-ethylaminoethyl (meth)acrylamide, N-2-dimethylaminoethyl (meth)acrylamide, N-3-aminopropyl (meth)acrylamide, N-3-methylaminopropyl (meth)acrylamide, N-3-dimethylaminopropyl (meth)acrylamide, methoxy-poly(ethylene glycol)ethyl (meth)acrylamide having a number average molecular weight of up to 1500, and combinations thereof.
 47. The method of any one of embodiments 36 to 45, wherein said at least one hydrophilic vinylic monomer comprises (meth)acrylamide, N,N-dimethyl (meth)acrylamide, N-ethyl (meth)acrylamide, N,N-diethyl (meth)acrylamide, N-propyl (meth)acrylamide, N-isopropyl (meth)acrylamide, N-3-methoxypropyl (meth)acrylamide, N-2-hydroxyethyl (meth)acrylamide, or combinations thereof.
 48. The method of any one of embodiments 36 to 47, wherein said at least one hydrophilic vinylic monomer comprises 2-hydroxyethyl (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, glycerol methacrylate (GMA), di(ethylene glycol) (meth)acrylate, tri(ethylene glycol) (meth)acrylate, tetra(ethylene glycol) (meth)acrylate, poly(ethylene glycol) (meth)acrylate having a number average molecular weight of up to 1500, or combinations thereof.
 49. The method of any one of embodiments 36 to 48, wherein the lens-forming composition comprises at least one polysiloxane vinylic monomer selected from the

group consisting of α -(meth)acryloxypropyl terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -(meth)acryloxy-2-hydroxypropyloxypropyl terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -(2-hydroxyl-methacryloxypropyloxypropyl)- ω -C₁-C₄-alkyl-decamethylpentasiloxane, α -[3-(meth)acryloxyethoxy-2-hydroxypropyloxypropyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[3-(meth)acryloxy-propyloxy-2-hydroxypropyloxypropyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[3-(meth)acryloxyisopropyloxy-2-hydroxypropyloxypropyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[3-(meth)acryloxybutyloxy-2-hydroxypropyloxypropyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[3-(meth)acryloxyethylamino-2-hydroxypropyloxypropyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[3-(meth)acryloxypropylamino-2-hydroxypropyloxypropyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[3-(meth)acryloxy-butylamino-2-hydroxypropyloxypropyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -(meth)acryloxy(polyethylenoxy)-2-hydroxypropyloxypropyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[(meth)acryloxy-2-hydroxypropyloxy-ethoxypropyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[(meth)acryloxy-2-hydroxypropyl-N-ethylaminopropyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[(meth)acryloxy-2-hydroxypropyl-aminopropyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[(meth)acryloxy-2-hydroxypropyloxy-(polyethylenoxy)propyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -(meth)acryloylamidopropyloxypropyl terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -N-methyl-(meth)acryloylamidopropyloxypropyl terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[3-(meth)acrylamidoethoxy-2-hydroxypropyloxy-propyl]-terminated ω -C₁-C₄-alkyl polydimethylsiloxane, α -[3-(meth)acrylamidopropyloxy-2-hydroxypropyloxypropyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[3-(meth)acrylamidoisopropyloxy-2-hydroxypropyloxypropyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[3-(meth)acrylamidobutyloxy-2-hydroxypropyloxypropyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[3-(meth)acryloylamido-2-hydroxypropyloxypropyl]-terminated ω -C₁-C₄-alkyl polydimethylsiloxane, α -[3-[N-methyl-(meth)acryloylamido]-2-hydroxypropyloxypropyl] terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, N-methyl-N'-(propyltetra(dimethylsiloxy)dimethylbutylsilane) (meth)acrylamide, N-(2,3-dihydroxypropane)-N'-(propyltetra(dimethylsiloxy)dimethylbutylsilane) (meth)acrylamide, (meth)acryloylamidopropyltetra(dimethylsiloxy)dimethylbutylsilane, α -vinyl carbonate-terminated ω -C₁-C₄-alkyl-terminated polydimethylsiloxanes, α -vinyl carbamate-terminated ω -C₁-C₄-alkyl-terminated polydimethylsiloxane, or a mixture

thereof.

50. The method of any one of embodiments 36 to 49, wherein the lens-forming composition comprises at least one silicone-containing vinylic monomer selected from the group consisting of a vinylic monomer having a bis(trialkylsilyloxy)alkylsilyl group, a vinylic monomer having a tris(trialkylsilyloxy)silyl group, a polysiloxane vinylic monomer, 3-methacryloxy propylpentamethyldisiloxane, t-butyl dimethyl-siloxyethyl vinyl carbonate, trimethylsilylethyl vinyl carbonate, and trimethylsilylmethyl vinyl carbonate, and combinations thereof.
51. The method of any one of embodiments 36 to 49, wherein the lens-forming composition comprises at least one silicone-containing vinylic monomer of formula (M1) or (M2)



in which: $a_{\text{M}1}$ is zero or 1; $\text{R}_{\text{M}0}$ is H or methyl; $\text{X}_{\text{M}0}$ is O or $\text{NR}_{\text{M}1}$; $\text{L}_{\text{M}1}$ is a C_2 - C_8 alkylene

divalent radical or a divalent radical of $-\text{L}_{\text{M}1}'-\text{X}_{\text{M}1}-\text{L}_{\text{M}1}''-$, $-(\text{C}_2\text{H}_4\text{O})_{v1}-\text{CONH}-\text{L}_{\text{M}1}''-$, $-(\text{C}_2\text{H}_4\text{O})_{v1}-\text{L}_{\text{M}1}''-$, $-\text{L}_{\text{M}1}'-\text{NHCOO}-(\text{C}_2\text{H}_4\text{O})_{v1}-\text{L}_{\text{M}1}''-$, $-\text{CH}_2\cdot\text{CH}(\text{OH})\cdot\text{CH}_2-\text{X}_{\text{M}1}'-(\text{C}_2\text{H}_4\text{O})_{v2}-\text{L}_{\text{M}1}''-$, $-\text{L}_{\text{M}1}'\cdot\text{X}_{\text{M}1}'-\text{CH}_2\cdot\text{CH}(\text{OH})\cdot\text{CH}_2-\text{O}-\text{L}_{\text{M}1}''-$, or $-(\text{C}_2\text{H}_4\text{O})_{v1}-\text{CH}_2\cdot\text{CH}(\text{OH})\cdot\text{CH}_2-\text{O}-\text{L}_{\text{M}1}''-$; $\text{L}_{\text{M}1}'$ is a C_2 - C_8 alkylene divalent radical which has zero or one hydroxyl group; $\text{L}_{\text{M}1}''$ is C_3 - C_8 alkylene divalent radical which has zero or one hydroxyl group; $\text{X}_{\text{M}1}$ is O, $\text{NR}_{\text{M}1}$, NHCOO , OCONH , $\text{CONR}_{\text{M}1}$, or $\text{NR}_{\text{M}1}\text{CO}$; $\text{R}_{\text{M}1}$ is H or a C_1 - C_4 alkyl having 0 to 2 hydroxyl group; $\text{R}_{\text{t}1}$ and $\text{R}_{\text{t}2}$ independent of each other are a C_1 - C_6 alkyl; $\text{X}_{\text{M}1}'$ is O or $\text{NR}_{\text{M}1}$; $v1$ is an integer of 1 to 30; $v2$ is an integer of 0 to 30; n is an integer of 3 to 40; and $r1$ is an integer of 2 or 3.

52. The method of any one of embodiments 36 to 51, wherein the lens-forming composition comprises tris(trimethylsilyloxy)silylpropyl (meth)acrylate, [3-(meth)acryloxy-2-hydroxypropyloxy]propylbis(trimethylsilyloxy)methylsilane, [3-(meth)acryloxy-2-hydroxypropyloxy]propylbis(trimethylsilyloxy)butylsilane, 3-(meth)acryloxy-2-(2-hydroxyethoxy)-propyloxy]propylbis(trimethylsilyloxy)methylsilane, 3-(meth)acryloxy-2-hydroxypropyloxy]propyltris(trimethylsilyloxy)silane, N-[tris(trimethylsilyloxy)silylpropyl]-(meth)acrylamide, N-(2-hydroxy-3-(3-(bis(trimethylsilyloxy)methylsilyl)propyloxy)propyl)-2-methyl (meth)acrylamide, N-(2-

hydroxy-3-(3-(bis(trimethylsilyloxy)methylsilyl)propyloxy)-propyl) (meth)acrylamide, N-(2-hydroxy-3-(3-(tris(trimethylsilyloxy)silyl)propyloxy)propyl)-2-methyl acrylamide, N-(2-hydroxy-3-(3-(tris(trimethylsilyloxy)silyl)propyloxy)propyl) (meth)acrylamide, N-[tris(dimethylpropylsiloxy)silylpropyl]-(meth)acrylamide, N-[tris(dimethylphenylsiloxy)-silylpropyl] (meth)acrylamide, N-[tris(dimethylethylsiloxy)-silylpropyl] (meth)acrylamide, N,N-bis[2-hydroxy-3-(3-(bis(trimethylsilyloxy)methylsilyl)-propyloxy)propyl]-2-methyl (meth)acrylamide, N,N-bis[2-hydroxy-3-(3-(bis(trimethylsilyloxy)methylsilyl)propyloxy)-propyl] (meth)acrylamide, N,N-bis[2-hydroxy-3-(3-(tris(trimethylsilyloxy)silyl)propyloxy)-propyl]-2-methyl (meth)acrylamide, N,N-bis[2-hydroxy-3-(3-(tris(trimethylsilyloxy)silyl)-propyloxy)propyl] (meth)acrylamide, N-[2-hydroxy-3-(3-(t-butylidimethylsilyl)propyloxy)-propyl]-2-methyl (meth)acrylamide, N-[2-hydroxy-3-(3-(t-butylidimethylsilyl)propyloxy)-propyl] (meth)acrylamide, N,N-bis[2-hydroxy-3-(3-(t-butylidimethylsilyl)propyloxy)propyl]-2-methyl (meth)acrylamide, N-2-(meth)acryloxyethyl-O-(methyl-bis-trimethylsiloxy-3-propyl)silyl carbamate, 3-(trimethylsilyl)propylvinyl carbonate, 3-(vinylloxycarbonylthio)-propyl-tris(trimethylsiloxy)silane, 3-[tris(trimethylsiloxy)silyl]propylvinyl carbamate, 3-[tris(trimethylsiloxy)silyl] propyl allyl carbamate, 3-[tris(trimethylsiloxy)silyl]propyl vinyl carbonate, or a combination thereof.

53. The method of any one of embodiments 36 to 52, wherein the lens-forming composition comprises at least one non-silicone vinylic crosslinker.
54. The method of embodiment 53, wherein said at least one non-silicone vinylic crosslinker comprises ethyleneglycol di-(meth)acrylate, diethyleneglycol di-(meth)acrylate, triethyleneglycol di-(meth)acrylate, tetraethyleneglycol di-(meth)acrylate, glycerol di-(meth)acrylate, 1,3-propanediol di-(meth)acrylate, 1,3-butanediol di-(meth)acrylate, 1,4-butanediol di-(meth)acrylate, glycerol 1,3-diglycerolate di-(meth)acrylate, ethylenebis[oxy(2-hydroxypropane-1,3-diyl)] di-(meth)acrylate, bis[2-(meth)acryloxyethyl] phosphate, trimethylolpropane di-(meth)acrylate, and 3,4-bis[(meth)acryloyl]tetrahydrofuran, diacrylamide, dimethacrylamide, N,N-di(meth)acryloyl-N-methylamine, N,N-di(meth)acryloyl-N-ethylamine, N,N'-methylene bis(meth)acrylamide, N,N'-ethylene bis(meth)acrylamide, N,N'-dihydroxyethylene bis(meth)acrylamide, N,N'-propylene bis(meth)acrylamide, N,N'-2-hydroxypropylene bis(meth)acrylamide, N,N'-2,3-dihydroxybutylene bis(meth)acrylamide, 1,3-bis(meth)acrylamidepropane-2-yl dihydrogen phosphate, piperazine diacrylamide, tetraethyleneglycol divinyl ether, triethyleneglycol divinyl ether, diethyleneglycol divinyl ether, ethyleneglycol divinyl ether, triallyl isocyanurate, triallyl cyanurate, trimethylpropane trimethacrylate, pentaerythritol tetramethacrylate, bisphenol A dimethacrylate, allylmethacrylate, allylacrylate, N-allyl-methacrylamide, N-

allyl-acrylamide, or combinations thereof.

55. The method of any one of embodiments 36 to 54, wherein the lens-forming composition comprises at least one blending vinylic monomer.
56. The method of embodiment 55, wherein said at least one blending vinylic monomer comprises C₁-C₁₀ alkyl (meth)acrylate, cyclopentylacrylate, cyclohexylmethacrylate, cyclohexylacrylate, isobornyl (meth)acrylate, styrene, 4,6-trimethylstyrene (TMS), t-butyl styrene (TBS), trifluoroethyl (meth)acrylate, hexafluoro-isopropyl (meth)acrylate, hexafluorobutyl (meth)acrylate, or combinations thereof.
57. The method of any one of embodiments 36 to 56, wherein the first and second lens-forming compositions comprise at least one polymerizable material selected from the group consisting of a UV-absorbing vinylic monomer, a UV/HEVL-absorbing vinylic monomer, a photochromic vinylic monomer, a polymerizable dye, and combinations thereof.
58. The method of any one of embodiments 36 to 57, wherein the bulk hydrogel material is a silicone hydrogel material that has an equilibrium water content (i.e., in fully hydrated state or when being fully hydrated) of from about 20% to about 70% by weight, an oxygen permeability of at least about 40 barrers, and a modulus (i.e., Young's modulus) of from about 0.2 MPa to about 1.5 MPa.

The previous disclosure will enable one having ordinary skill in the art to practice the invention. Various modifications, variations, and combinations can be made to the various embodiment described herein. In order to better enable the reader to understand specific embodiments and the advantages thereof, reference to the following examples is suggested. It is intended that the specification and examples be considered as exemplary.

Example 1

Oxygen Permeability Measurements

Unless specified, the oxygen transmissibility (Dk/t), the intrinsic (or edge-corrected) oxygen permeability (Dk_i or Dk_e) of an insert and an insert material are determined according to procedures described in ISO 18369-4.

Equilibrium Water Content

The equilibrium water content (EWC) of contact lenses is determined as follows.

Amount of water (expressed as percent by weight) present in a hydrated hydrogel contact lens, which is fully equilibrated in saline solution, is determined at room temperature. Quickly stack the lenses, and transfer the lens stack to the aluminum pan on the analytical balance after blotting lens in a cloth. The number of lenses for each sample pan is typically five (5). Record the pan plus hydrated weight of the lenses. Cover the pan with aluminum

foil. Place pans in a laboratory oven at $100 \pm 2^\circ\text{C}$ to dry for 16-18 hours. Remove pan plus lenses from the oven and cool in a desiccator for at least 30 minutes. Remove a single pan from the desiccator, and discard the aluminum foil. Weigh the pan plus dried lens sample on an analytical balance. Repeat for all pans. The wet and dry weight of the lens samples can be calculated by subtracting the weight of the empty weigh pan.

Elastic Modulus

The storage modulus (Young's modulus) of inserts is determined using a TA RSA-G2 DMA (Dynamic Mechanical Analyzer). The insert is cut into a 3.08 mm wide strip using Precision Concept dry lens cutter. Five thickness values are measured within 6.5mm gauge length. The strip is mounted on the instrument with metal grips. Oscillation temperature ramp test with a linear ramping rate at $2^\circ\text{C}/\text{minute}$ from $10^\circ\text{C} \sim 50^\circ\text{C}$ is applied on the insert, the material response to increasing temperature is monitored at a constant frequency of 1 Hz, constant amplitude of 0.5% deformation and sampling rate of 10.0 pts/s. Storage modulus (E'), loss modulus (E'') and $\tan \delta$ data are calculated by TRIOS software.

The elastic modulus of a silicone hydrogel material or contact lens is determined using a MTS insight instrument. The contact lens is first cut into a 3.12 mm wide strip using Precision Concept two stage cutter. Five thickness values are measured within 6.5mm gauge length. The strip is mounted on the instrument grips and submerged in PBS (phosphate buffered saline) with the temperature controlled at $21 \pm 2^\circ\text{C}$. Typically 5N Load cell is used for the test. Constant force and speed is applied to the sample until the sample breaks. Force and displacement data are collected by the TestWorks software. The elastic modulus value is calculated by the TestWorks software which is the slope or tangent of the stress vs. strain curve near zero elongation, in the elastic deformation region.

Delamination

Embedded hydrogel contact lenses are examined for possible delamination either using Optimec instrument or Optical Coherence Tomography (OCT).

Regardless of evaluation method, contact lenses are staged for a minimum of 12 hours at room temperature after autoclave run and prior to delamination study.

After meeting required staging time, fully hydrated contact lens is placed in a "V" graticule assembly of Optimec instrument (Model JCF; OPTIMEC England). After the contact lens is settled under the influence of gravity, the front view of the contact lens is inspected carefully for any sign of circular pattern. Delamination displays as circular patterns in Optimec image.

OCT (Spectral Domain Optical Coherence Tomography; Telesto-II; Thorlabs) could also be utilized to study delamination. OCT allows non-invasive imaging of the contact lens to obtain high resolution cross-section image. For this purpose, after meeting the minimum staging requirement, the contact lens is removed from its blister and is soaked into PBS

solution for a minimum of 30 min to come to equilibrium. Then a cuvette with a “V” block feature will be filled approximately $\frac{3}{4}$ with fresh PBS solution and the contact lens will be transferred to the cuvette using Q-tips. The lens will be allowed to freely float to the “V” shape at the bottom of the cuvette and the entire contact lens will be scanned in increment of 10 degree. Delamination appears as air pocket in interval surface of insert and carrier in OCT images.

Chemicals

The following abbreviations are used in the following examples: PEMA represent phenylethyl methacrylate; D6 represents monobutyl-terminated monomethacryloxypropyl-terminated polydimethylsiloxane ($M_n \sim 700\text{-}800$ g/mol from Shin-Etsu); BDDA represents 1,4-butanediol diacrylate; DtBN represents di-tert-butyl nitroxide; VAZO 64 represents 2,2'-azobis(isobutyronitrile); TrisMA represents 3-[tris(trimethylsiloxy)silyl]propyl methacrylate; DMA represents N,N-dimethyl acrylamide; MMA represent methyl methacrylate; Betacon represents a dimethacrylate-terminated chain-extended polydimethylsiloxane ($M_n \sim 5000$ g/mol), which has two polydimethylsiloxane (PDMS) segments separated by one perfluoropolyether (PFPE) via diurethane linkages between PDMS and PFPE segments and two urethane linkages each located between one terminal methacrylate group and one PDMS segment, is prepared according to method similar to what described in Example B-1 of US5,760,100; EGBE represents ethylene glycol butyl ether; PBS represents a phosphate-buffered saline which has a pH of 7.2 ± 0.2 at 25°C and contains about 0.044 wt.% $\text{NaH}_2\text{PO}_4 \cdot \text{H}_2\text{O}$, about 0.388 wt.% $\text{Na}_2\text{HPO}_4 \cdot 2\text{H}_2\text{O}$, and about 0.79 wt.% NaCl and; wt.% represents weight percent.

Example 2

Inserts

Rigid hydrophobic Inserts are prepared by thermal cast-molding of an insert-forming composition shown in Table 1.

Table 1

Insert-forming Composition	PEMA	D6	BDDA	Vazo 64	DtBN
I1-1	62	27	10	1	
I1-2	62	27	10	1	0.5

The insert-forming composition is purged with nitrogen at room temperature for 30 to 35 minutes. An amount of the N_2 -purged insert-forming composition is disposed in the center of the molding surface of a female insert mold half that is made of polypropylene. The female insert mold half with the insert-forming composition therein is closed with a male insert mold half which is made of polypropylene. The oven is configured as follows: a nitrogen supply is

connected to the oven through a higher flow capacity controller which can control the flow rate of nitrogen through the oven; at the exhaust line of the oven, vacuum pumps are connected to control the differential pressure of the oven.

The insert-forming compositions in the insert molds are thermally cured in the oven under the following conditions: ramp from room temperature to 55°C at a ramp rate of about 7°C/minute; holding at 55°C for about 30-40 minutes; ramp from 55°C to 80°C at a ramp rate of about 7°C/minute; holding at 55°C for about 30-40 minutes; ramp from 80°C to 100°C at a ramp rate of about 7°C/minute; and holding at 100°C for about 30-40 minutes. The insert molds are opened and the molded inserts are removed from the insert-adhered mold halves.

The produced inserts have a diameter (from edge to edge of the insert) of about 8.0 mm.

Lens-Forming Compositions

One lens-forming composition (i.e., SiHy lens formulation) is prepared at room temperature in air by blending all the components (materials) to having the following components: Betacon (29 weight unit parts); TrisMA (17 weight unit parts); DMA (28 weight unit parts); EGBE (25 weight unit parts); and Vazo 64 (0.5 weight unit part).

Preparation of Embedded Silicone Hydrogel Contact Lenses

An insert having a diameter of 8.0 mm prepared above is placed precisely in the center of a female lens mold half (having guiding posts) by using an insert precision placement tool (or anyone known to a person skilled in the art). An amount of the lens-forming composition is introduced in the female lens mold half to completely immerse the insert. A male lens mold half is placed on top of the female lens mold half, and then closed to form a molding assembly including the insert immersed in the lens-forming composition. The lens-forming composition in the molding assembly are cured actinically by using a Mercury lamp-based UV box at an intensity of approximately 3 mW/cm² for 5-10 minutes to form an embedded hydrogel lens precursor. The molding assembly is opened and the molded embedded hydrogel lens precursor is removed from the lens molds.

Lens molds each with a molded silicone hydrogel lens precursor therein are mechanically opened. The molded embedded silicone hydrogel lens precursors adhere to the male lens mold halves or female lens mold halves. Molded embedded silicone hydrogel lens precursors adhered to male lens mold halves are delensed using ultrasonic unit; molded embedded silicone hydrogel lens precursors adhered to female lens mold halves are delensed manually from lens-adhered female lens mold halves.

The delensed embedded silicone hydrogel lens precursors can be extracted with a mixture of 50:50 of propylene glycol:water. Preferably, the delensed embedded silicone hydrogel lens precursors are subjected to the following extraction/hydration, coating, autoclave processes as follows. The embedded silicone hydrogel lens precursors are

soaked in a bath containing deionized water or an aqueous solution of Tween 80 (500 PPM), for about 60 minutes, then in a bath containing an aqueous solution of polyacrylic acid (PAA, Mw 450K) at a concentration of ca. 0.1% by weight at 40°C for about 120 minutes; then in a bath containing a PBS solution at room temperature for about 60 minutes; packed/sealed in polypropylene lens packaging shells (or blisters) (one lens per shell) with 0.65 mL of an in-package-coating packaging saline which is prepared according to the procedure described in Example 19 of US8480227; and finally autoclaved for about 45 minutes at 121°C. The resultant embedded SiHy contact lenses each have a hydrogel coating thereon.

The obtained embedded SiHy contact lenses are examined for delamination according to the procedures described in Example 1. When the insert is prepared from insert-forming composition I1-2 which comprises an iniferter (DtBN), no bubble is observed under microscopy at interfaces between the insert (I1-2) and the SiHy bulk material within the embedded silicone hydrogel contact lens, i.e., no delamination. When the insert is prepared from insert-forming composition I1-1 which is free of an iniferter (DtBN), many bubbles are observed under microscopy at interfaces between the insert (I1-1) and the SiHy bulk material within the embedded silicone hydrogel contact lens, i.e., delamination occurred.

All the publications, patents, and patent application publications, which have been cited herein above in this application, are hereby incorporated by reference in their entireties.

What is claimed is:

1. A method for producing embedded hydrogel contact lenses, comprising the steps of:
 - (1) obtaining an insert mold, wherein the insert mold comprises a male insert mold half having a first molding surface and a female insert mold half having a second molding surface are configured to receive each other such that an insert-molding cavity is formed between the first and second molding surfaces when the female insert mold half is closed with the male insert mold half;
 - (2) dispensing an insert-forming composition in the female insert mold half, wherein the insert-forming composition comprises (i) at least one polymerizable material, (ii) at least one first free-radical initiator, and (iii) at least one iniferter;
 - (3) closing the female insert mold half with the male insert mold half to form a first molding assembly comprising the insert-forming composition within the insert-molding cavity of the insert mold;
 - (4) curing thermally or actinically the insert-forming composition in the insert-molding cavity of the first molding assembly to form a molded insert that is made of a first crosslinked polymeric material comprising iniferter moieties covalently attached thereto;
 - (5) obtaining a lens mold and a lens-forming composition, wherein the lens mold comprises a male lens mold half having a third molding surface and a female lens mold half having a fourth molding surface are configured to receive each other such that a lens-molding cavity is formed between the third and fourth molding surfaces when the female lens mold half is closed with the male lens mold half, wherein the lens-forming composition comprises at least one second polymerizable material and a second free-radical initiator;
 - (6) in no particular order, placing the insert obtained in step (4) in the female lens mold half at a desired position and dispensing the lens-forming composition in the female lens mold half, wherein the insert is immersed in the lens-forming composition;
 - (7) closing the female lens mold half with the male lens mold half to form a second molding assembly comprising the lens-forming composition and the insert immersed therein in the lens-molding cavity of the lens mold;
 - (8) curing thermally or actinically the lens-forming composition while simultaneously initiating iniferter-induced polymerization of the lens-forming composition at and near the surface of the insert in the lens-molding cavity of the second molding assembly to form an embedded hydrogel lens precursor that comprise a bulk hydrogel material formed from the lens-forming composition and the insert embedded in the bulk material, wherein the bulk hydrogel material is a second crosslinked polymeric material that is covalently linked to the first crosslinked

- polymeric material at iniferter moieties located at and near the surface of the insert;
- (9) separating the lens mold obtained in step (8) into the male and female lens mold halves, with the embedded hydrogel lens precursor adhered onto a lens-adhered lens mold half which is one of the male and female lens mold halves;
- (10) removing the embedded hydrogel lens precursor from the lens-adhered lens mold half; and
- (11) subjecting the embedded hydrogel lens precursor to post-molding processes including a hydration process and one or more other processes selected from the group consisting of extraction, surface treatment, packaging, sterilization, and combinations thereof to form the embedded hydrogel contact lens.
2. The method of claim 1, wherein said at least one iniferter comprises a thiocarbonylthio-containing compound having a thiocarbonylthio moiety $\text{—}\overset{\text{S}}{\underset{\text{||}}{\text{C}}}\text{—S—}$.
 3. The method of claim 2, wherein said at least one thiocarbonylthio-containing compound is a dithioester, a dithiocarbamate, a dithioate, a trithiocarbonate, a xanthate, a thiuram monosulfide, a thiuram disulfides, a xanthate disulfide, or combinations thereof.
 4. The method of claim 1, wherein said at least one iniferter comprises at least one thiocarbonylthio-containing compound selected from the group consisting of thiuram monosulfide, N,N'-dimethylthiuram monosulfide, N,N,N',N'-tetramethylthiuram monosulfide, N,N'-diethylthiuram monosulfide, N,N,N',N'-tetraethylthiuram monosulfide, thiuram disulfide, N,N-dimethylthiuram disulfide, N,N'-diethylthiuram disulfide, N,N'-diethyl-N,N'-bis(2-hydroxyethyl)thiuram disulfide, N,N'-bis(N-(2-phthalimidoethyl)piperazine-thiuram disulfide, N,N'-dimethylthiuram tetrasulfide, tetramethylthiuram disulfide, tetraethylthiuram disulfide, tetraisopropylthiuram disulfide, N,N'-dimethyl N,N'-di(4-pyridinyl)thiuram disulfide, bis(thiobenzoyl) disulfide, diisopropyl xanthate disulfide, cyanomethyl benzodithioate, benzyl benzodithioate, 2-phenyl-2-propyl benzodithioate, bis(thiobenzoyl) disulfide, benzyl 1H-pyrrole-1-carbodithioate, 2-cyano-2-propyl benzodithioate, bis(carboxymethyl)trithiocarbonate, 4-cyano-4-(thiobenzoylthio)pentanoic acid, ethyl 2-(phenylcarbonothioylthio)-2-phenylacetate, ethyl 2-(phenylcarbonothioylthio)-propionate, 1-(methoxycarbonyl)ethyl benzodithioate, 2-cyano-2-propyl 4-cyanobenzo-dithioate, ethyl 2-(4-methoxyphenylcarbonothioylthio)acetate, ethyl 2-methyl-2-(phenylthio-carbonylthio)propionate, ethyl 2-(phenylcarbonothioylthio)-2-phenylacetate, 2-(4-methoxy-phenylcarbonothioylthio)ethanoic acid, 2-nitro-5-(2-propynyloxy)benzyl 4-cyano-4-(phenyl-carbonothioylthio)pentanoate, S,S-bis(α,α' -dimethyl- α'' -acetic acid) trithiocarbonate, S-dodecyl-S'-(α,α' -dimethyl- α'' -acetic acid) trithiocarbonate, S-ethyl-S'-

(α,α' -dimethyl- α'' -acetic acid) trithiocarbonate, 4-cyano-4-ethyl-trithiopentanoic acid, S,S-dibenzyl trithio-carbonate, bis(carboxymethyl)trithiocarbonate, dimethyl trithiocarbonate, phthalimido-methyl butyl trithiocarbonate, cyanomethyl dodecyl trithiocarbonate, 4-cyano-4-[(dodecyl-sulfanylthiocarbonyl)sulfanyl]pentanoic acid, 3,5-bis(2-dodecylthiocarbonylthio-1-oxopropoxy)benzoic acid, 2-(2-carboxyethylsulfanylthiocarbonylsulfanyl)-propionic acid, 2-cyano-2-propyl dodecyl trithiocarbonate, 3-butenyl 2-(dodecylthiocarbonothioylthio)-2-methylpropionate, 2-(dodecylthiocarbonothioylthio)-2-methylpropionic acid, cyanomethyl (3,5-dimethyl-1H-pyrazole)-carbodithioate, 2-cyanobutan-2-yl 4-chloro-3,5-dimethyl-1H-pyrazole-1-carbodithioate, methyl 2-[methyl(4-pyridinyl)carbamothioylthio]propionate, 2-cyanobutan-2-yl 3,5-dimethyl-1H-pyrazole-1-carbodithioate, cyanomethyl methyl-(phenyl)carbamodithioate, cyanomethyl methyl(4-pyridyl)carbamodithioate, benzyl 1H-pyrrole-1-carbodithioate, cyanomethyl diphenylcarbamodithioate, cyanomethyl methyl(4-pyridyl)carbamodithioate, benzyl-N,N-dimethyldithiocarbamate, benzyl-N,N-diethyldithio-carbamate, 2-(N,N-diethyldithiocarbamyl) isobutyric acid, 2-(N,N-diethyldithiocarbamyl) isobutyric acid ethyl ester, (4-cyano-4-diethyldithiocarbamyl) pentanoic acid, 1-(ethoxy-carbonyl)prop-1-yl dithiobenzoate, phenacyl morpholine-4-dithiocarbamate, S-2-cyano-2-propyl-O-ethyl xanthate, 1-phenylethyl phenyldithioacetate, S-methacryloyl O-ethyl xanthate, 2-(N,N-diethyldithiocarbamyl)ethyl methacrylate, acetic acid 2-(N,N-diethyldithiocarbamyl)ethyl ether, cyanopentanoic acid dithiobenzoate, 3-benzylsulfanylthiocarbonyl-sulfanyl propionic acid, 2-(n-butyltrithiocarbonate)-propionic acid, n-butyl N,N-dimethyl-dithiocarbamate, benzyl dithiocarbamate, p-xylene-bis(dithiocarbamate), p-xylene-bis(N,N-dimethyldithiocarbamate), p-xylene-bis(N,N-diethyldithiocarbamate), 1,2-bis(N,N-diethyldithiocarbamyl)ethane, 1,2-bis(N,N-dimethyldithiocarbamyl)ethane, 1,2,3-tris(N,N-dimethyldithiocarbamyl)propane, 1,2,4,5-tetrakis(N,N-diethyldithiocarbamylmethyl)-benzene, 1-(N,N-diethyldithiocarbamyl)ethyl acetate, and combinations thereof.

5. The method of claim 1, wherein said at least one iniferter comprises at least one organic nitroxide compound.
6. The method of claim 5, wherein said at least one organic nitroxide compound are selected from the group consisting of ((2',2',6',6'-tetramethyl-1'-piperidinyloxy)methyl)benzene, 1-phenyl-1-(2',2',6',6'-tetramethyl-1'-piperidinyloxy)ethane, 1-(4'-bromophenyl)-1-(2'',2'',6'',6''-tetramethyl-1''-piperidinyloxy)ethane, 1-naphthyl-1-(2',2',6',6'-tetramethyl-1'-piperidinyloxy)-ethane, 1-phenyl-1-(2',2',6',6'-tetramethyl-1'-piperidinyloxy)propane, 1-(benzyloxy)-2-phenyl-2-(2',2',6',6'-tetramethyl-1'-piperidinyloxy)ethane, 1-hydroxy-2-phenyl-2-(2',2',6',6'-

tetramethyl-1-piperidinyloxy)ethane, phenyl 4-cyano-4-(2',2',6',6'-tetramethyl-1'-piperidinyloxy)pentanoate, pentafluorophenyl 4-cyano-4-(2',2',6',6'-tetramethyl-1'-piperidinyloxy)pentanoate, 3-phenyl-1-(2',2',6',6'-tetramethyl-1'-piperidinyloxy)propane, 1-((2',2',6',6'-tetramethyl-1'-piperidinyloxy)methyl)-4-(trifluoromethyl)benzene, methyl 2-((4-benzoylphenyl)((1-methoxy-2-methyl-1-oxopropan-2-yl)oxy)amino)-2-methylpropanoate, 2,2,6,6-tetramethyl-1-piperidinyloxy, 2,2,5-trimethyl-4-phenyl-3-azahexane-3-nitroxide, N-tert-butyl-N-1-phenyl-2-methylpropyl-nitroxide, N-tert-butyl-N-1-(2-naphthyl)-2-methyl-propyl nitroxide, N-tert-butyl-N-1-diethylphosphono-2,2-dimethylpropyl nitroxide, N-tert-butyl-N-1-dibenzylphosphono-2,2-dimethylpropyl nitroxide, N-phenyl-N-1-diethyl-phosphono-2,2-dimethylpropyl nitroxide, N-phenyl-N-1-diethylphosphono-1-methylethyl nitroxide, N-(1-phenyl-2-methylpropyl)-N-1-diethyl-phosphono-1-methylethyl nitroxide, and combinations thereof.

7. The method of any one of claims 1 to 6, wherein the insert-forming composition comprises (a) said at least one first polymerizable material that comprises at least one polymerizable photochromic compound (i.e., photochromic vinylic monomer), at least one UV-absorbing vinylic monomer, at least one UV/HEVL-absorbing vinylic monomer, at least one fluorescent vinylic monomer, or combinations thereof and/or (b) at least one color-filtering material for correcting color blindness, a diffractive material, a high refractive-index material, or combinations, wherein the insert-forming composition is: a first polymerizable composition for forming a crosslinked polymethylmethacrylate that comprises repeating units of methyl methacrylate and at least one vinylic crosslinker; a second polymerizable composition for forming a crosslinked silicone polymer that has three-dimensional polymer networks, is insoluble in water, and has an equilibrium water content of about 5% or less by weight; a third polymerizable composition for forming a rigid gas permeable material; or a fourth polymerizable composition for forming a hydrophobic crosslinked acrylic material that has an equilibrium water content of less than 5% by weight, and comprises at least 55% by mole of one or more acrylic monomers and/or one or more acrylic crosslinker and at least about 6% by mole of at least one acrylic crosslinker and optionally at least one vinylic crosslinker other than acrylic crosslinker, relative to the total amount of said at least one first polymerizable material and other polymerizable materials.
8. The method of claim 7, wherein the insert-forming composition is the fourth polymerizable composition, wherein said at least one acrylic crosslinker in the fourth polymerizable composition is ethylene glycol dimethacrylate; ethylene glycol diacrylate; 1,3-propanediol diacrylate; 1,3-propanediol dimethacrylate; 2,3-propanediol diacrylate; 2,3-propanediol dimethacrylate; 1,4-butanediol dimethacrylate; 1,4-butanediol

diacrylate; 1,5-pentanediol dimethacrylate; 1,5-pentanediol diacrylate; 1,6-hexanediol dimethacrylate; 1,6-hexanediol diacrylate; diethylene glycol dimethacrylate; diethylene glycol diacrylate; triethylene glycol dimethacrylate; triethylene glycol diacrylate; tetraethylene glycol dimethacrylate; tetraethylene glycol diacrylate; N,N'-methylene bis(acrylamide); N,N'-methylene bis(methacrylamide); N,N'-ethylene bis(acrylamide); N,N'-ethylene bis(methacrylamide); N,N'-hexamethylene bisacrylamide; N,N'-hexamethylene bismethacrylamide; pentaerythritol triacrylate, pentaerythritol trimethacrylate, trimethyloxypropane triacrylate, trimethyloxypropane trimethacrylate, tris(2-hydroxyethyl)isocyanurate triacrylate, tris(2-hydroxyethyl)isocyanurate trimethacrylate, 1,3,5-triacryloylhexahydro-1,3,5-triazine, 1,3,5-trimethacryloylhexahydro-1,3,5-triazine; pentaerythritol tetraacrylate, pentaerythritol tetramethacrylate, di(trimethyloxypropane) tetraacrylate, di(trimethyloxypropane) tetramethacrylate, or combinations thereof.

9. The method of claim 7 or 8, wherein the insert-forming composition is the fourth polymerizable composition, wherein said at least one vinylic crosslinker in the fourth polymerizable composition comprises divinylbenzene, 2-methyl-1,4-divinylbenzene, bis(4-vinylphenyl)methane, 1,2-bis(4-vinylphenyl)ethane, or combinations thereof.
10. The method of any one of claims 7 to 9, wherein said at least one first polymerizable material in the fourth polymerizable composition comprises: at least one silicone-containing acrylic monomer; at least one fluorine-containing acrylic monomer; at least one polysiloxane vinylic crosslinker; at least one aryl acrylic monomer; at least one hydrophobic vinylic monomer selected from the group consisting of a vinyl alkanoate, a vinyloxyalkane, styrene, vinyl toluene, vinyl chloride, vinylidene chloride, 1-butene, and combinations thereof; or combinations thereof.
11. The method of any one of claims 1 to 10, wherein the lens-forming composition comprises at least 50% by mole of at least one hydroxyl-containing vinylic monomer selected from the group consisting of hydroxyethyl (meth)acrylate, glycerol (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 3-amino-2-hydroxypropyl (meth)acrylate, N-2-hydroxyethyl (meth)acrylamide, N-3-hydroxypropyl (meth)acrylamide, N-2-hydroxypropyl (meth)acrylamide, N-2,3-dihydroxypropyl (meth)acrylamide, N-tris(hydroxymethyl)methyl (meth)acrylamide, vinyl alcohol, allyl alcohol, and combinations thereof.
12. The method of any one of claims 1 to 10, wherein the lens-forming composition comprises (a) at least one polysiloxane vinylic monomer and/or at least one first polysiloxane vinylic crosslinker and (b) at least one hydrophilic vinylic monomer.
13. The method of claim 12, wherein the lens-forming composition comprises at least one hydrophilized polysiloxane vinylic crosslinker comprising hydrophilized siloxane units

each having one methyl substituent and one organic radical including at least one H-bond donor.

14. The method of claim 12 or 13, wherein the lens-forming composition comprises: (1) a vinylic crosslinker which comprises one sole polydiorganosiloxane segment and two terminal ethylenically-unsaturated groups selected from the group consisting of (meth)acryloyloxy groups, (meth)acryloylamino groups, vinyl carbonate groups, vinylcarbamate groups; (2) a chain-extended polysiloxane vinylic crosslinker which comprises at least two polydiorganosiloxane segment and a covalent linker between each pair of polydiorganosiloxane segments and two terminal ethylenically-unsaturated groups selected from the group consisting of (meth)acryloyloxy groups, (meth)acryloylamino groups, vinyl carbonate groups, vinylcarbamate groups; (3) a polysiloxane vinylic crosslinker which is: α,ω -bis[3-(meth)acrylamidopropyl]-terminated polydimethylsiloxane, α,ω -bis[3-(meth)acryloxypropyl]-terminated polydimethylsiloxane, α,ω -bis[3-(meth)acryloxy-2-hydroxypropyloxypropyl]-terminated polydimethylsiloxane, α,ω -bis[3-(meth)acryloxyethoxy-2-hydroxypropyloxypropyl]-terminated polydimethylsiloxane, α,ω -bis[3-(meth)acryloxypropyloxy-2-hydroxypropyloxypropyl]-terminated polydimethylsiloxane, α,ω -bis[3-(meth)acryloxy-isopropyloxy-2-hydroxypropyloxypropyl]-terminated polydimethylsiloxane, α,ω -bis[3-(meth)acryloxybutyloxy-2-hydroxypropyloxypropyl]-terminated polydimethylsiloxane, α,ω -bis[3-(meth)acrylamidoethoxy-2-hydroxypropyloxypropyl]-terminated polydimethylsiloxane, α,ω -bis[3-(meth)acrylamidopropyloxy-2-hydroxypropyloxypropyl]-terminated polydimethylsiloxane, α,ω -bis[3-(meth)acrylamidoisopropyloxy-2-hydroxypropyloxypropyl]-terminated polydimethylsiloxane, α,ω -bis[3-(meth)acrylamidobutyloxy-2-hydroxypropyloxypropyl]-terminated polydimethylsiloxane, α,ω -bis[3-(meth)acryloxyethylamino-2-hydroxypropyloxypropyl]-terminated polydimethylsiloxane, α,ω -bis[3-(meth)acryloxypropylamino-2-hydroxypropyloxypropyl]-terminated polydimethylsiloxane, α,ω -bis[3-(meth)acryloxybutylamino-2-hydroxypropyloxypropyl]-terminated polydimethylsiloxane, α,ω -bis[(meth)acrylamidoethylamino-2-hydroxy-propyloxypropyl]-terminated polydimethylsiloxane, α,ω -bis[3-(meth)acrylamidopropyl-amino-2-hydroxypropyloxypropyl]-terminated polydimethylsiloxane, α,ω -bis[3-(meth)acrylamide-butylamino-2-hydroxypropyloxypropyl]-terminated polydimethylsiloxane, α,ω -bis[(meth)acryloxy-2-hydroxypropyloxy-ethoxypropyl]-terminated polydimethylsiloxane, α,ω -bis[(meth)acryloxy-2-hydroxypropyl-N-ethylaminopropyl]-terminated polydimethylsiloxane, α,ω -bis[(meth)acryloxy-2-hydroxypropyl-aminopropyl]-terminated polydimethylsiloxane, α,ω -bis[(meth)acryloxy-2-hydroxypropyloxy-(polyethylenoxy)propyl]-terminated polydimethylsiloxane, α,ω -

bis[(meth)acryloxyethylamino-carbonyloxy-ethoxypropyl]-terminated polydimethylsiloxane, α, ω -bis[(meth)acryloxyethylamino-carbonyloxy-(polyethylenoxy)propyl]-terminated polydimethylsiloxane, or combinations thereof; (4) at least one polysiloxane vinylic monomer selected from the group consisting of α -(meth)acryloxypropyl terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -(meth)acryloxy-2-hydroxypropyloxypropyl terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -(2-hydroxyl-methacryloxypropyloxypropyl)- ω -C₁-C₄-alkyl-decamethylpentasiloxane, α -[3-(meth)acryloxyethoxy-2-hydroxypropyloxypropyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[3-(meth)acryloxypropyloxy-2-hydroxypropyloxypropyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[3-(meth)acryloxyisopropyloxy-2-hydroxypropyloxypropyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[3-(meth)acryloxybutyloxy-2-hydroxypropyloxypropyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[3-(meth)acryloxyethylamino-2-hydroxypropyloxypropyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[3-(meth)acryloxypropylamino-2-hydroxypropyloxypropyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[3-(meth)acryloxy-butylamino-2-hydroxypropyloxy-propyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -(meth)acryloxy-(polyethylenoxy)-2-hydroxypropyloxypropyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[(meth)acryloxy-2-hydroxypropyloxy-ethoxypropyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[(meth)acryloxy-2-hydroxypropyl-N-ethylaminopropyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[(meth)acryloxy-2-hydroxypropyl-aminopropyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[(meth)acryloxy-2-hydroxypropyloxy-(polyethylenoxy)propyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -(meth)acryloylamido-propyloxypropyl terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -N-methyl-(meth)acryloylamidopropyloxypropyl terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[3-(meth)acrylamidoethoxy-2-hydroxypropyloxy-propyl]-terminated ω -C₁-C₄-alkyl polydimethylsiloxane, α -[3-(meth)acrylamidopropyloxy-2-hydroxypropyloxy-propyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[3-(meth)acrylamido-isopropyloxy-2-hydroxypropyloxypropyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[3-(meth)acrylamidobutyloxy-2-hydroxypropyloxypropyl]-terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, α -[3-(meth)acryloylamido-2-hydroxy-propyloxypropyl] terminated ω -C₁-C₄-alkyl polydimethylsiloxane, α -[3-[N-methyl-(meth)acryloylamido]-2-hydroxypropyloxypropyl] terminated ω -C₁-C₄-alkyl terminated polydimethylsiloxane, N-methyl-N'-(propyltetra(dimethylsiloxy)dimethylbutylsilane) (meth)acrylamide, N-(2,3-

dihydroxypropane)-N'-(propyltetra(dimethylsiloxy)dimethyl-butylsilane) (meth)acrylamide, (meth)acryloylamidopropyltetra(dimethylsiloxy)dimethyl-butylsilane, α -vinyl carbonate-terminated ω -C₁-C₄-alkyl-terminated polydimethylsiloxanes, α -vinyl carbamate-terminated ω -C₁-C₄-alkyl-terminated polydimethylsiloxane, or a mixture thereof; (5) at least one siloxane-containing vinylic monomer selected from the group consisting of a vinylic monomer having a bis(trialkylsilyloxy)alkylsilyl group, a vinylic monomer having a tris(trialkylsilyloxy)silyl group, a polysiloxane vinylic monomer, 3-methacryloxy propylpentamethyldisiloxane, t-butyl dimethyl-siloxyethyl vinyl carbonate, trimethylsilylethyl vinyl carbonate, and trimethylsilylmethyl vinyl carbonate, and combinations thereof; or (6) combinations thereof, wherein said at least one hydrophilic vinylic monomer comprises: (1) an alkyl (meth)acrylamide selected from the group consisting of (meth)acrylamide, N,N-dimethyl (meth)acrylamide, N-ethyl (meth)acrylamide, N,N-diethyl (meth)acrylamide, N-propyl (meth)acrylamide, N-isopropyl (meth)acrylamide, N-3-methoxypropyl (meth)acrylamide, and combinations thereof; (2) a hydroxyl-containing acrylic monomer selected from the group consisting of N-2-hydroxyethyl (meth)acrylamide, N,N-bis(hydroxyethyl) (meth)acrylamide, N-3-hydroxypropyl (meth)acrylamide, N-2-hydroxypropyl (meth)acrylamide, N-2,3-dihydroxypropyl (meth)acrylamide, N-tris(hydroxymethyl)methyl (meth)acrylamide, 2-hydroxyethyl (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, glycerol methacrylate (GMA), di(ethylene glycol) (meth)acrylate, tri(ethylene glycol) (meth)acrylate, tetra(ethylene glycol) (meth)acrylate, poly(ethylene glycol) (meth)acrylate having a number average molecular weight of up to 1500, poly(ethylene glycol)ethyl (meth)acrylamide having a number average molecular weight of up to 1500, and combinations thereof; (3) a carboxyl-containing acrylic monomer selected from the group consisting of 2-(meth)acrylamidoglycolic acid, (meth)acrylic acid, ethylacrylic acid, 3-(meth)acrylamidopropionic acid, 5-(meth)acrylamidopentanoic acid, 4-(meth)acrylamidobutanoic acid, 3-(meth)acrylamido-2-methylbutanoic acid, 3-(meth)acrylamido-3-methylbutanoic acid, 2-(meth)acrylamido-2methyl—3,3-dimethylbutanoic acid, 3-(meth)acrylamidohexanoic acid, 4-(meth)acrylamido-3,3-dimethylhexanoic acid, and combinations thereof; (4) an amino-containing acrylic monomer selected from the group consisting of N-2-aminoethyl (meth)acrylamide, N-2-methylaminoethyl (meth)acrylamide, N-2-ethylaminoethyl (meth)acrylamide, N-2-dimethylaminoethyl (meth)acrylamide, N-3-aminopropyl (meth)acrylamide, N-3-methylaminopropyl (meth)acrylamide, N-3-dimethylaminopropyl (meth)acrylamide, 2-aminoethyl (meth)acrylate, 2-methylaminoethyl (meth)acrylate, 2-ethylaminoethyl (meth)acrylate, 3-aminopropyl (meth)acrylate, 3-methylaminopropyl (meth)acrylate, 3-

ethylaminopropyl (meth)acrylate, 3-amino-2-hydroxypropyl (meth)acrylate, trimethylammonium 2-hydroxy propyl (meth)acrylate hydrochloride, dimethylaminoethyl (meth)acrylate, and combinations thereof; (5) an N-vinyl amide monomer selected from the group consisting of N-vinylpyrrolidone, N-vinyl-3-methyl-2-pyrrolidone, N-vinyl-4-methyl-2-pyrrolidone, N-vinyl-5-methyl-2-pyrrolidone, N-vinyl-6-methyl-2-pyrrolidone, N-vinyl-3-ethyl-2-pyrrolidone, N-vinyl-4,5-dimethyl-2-pyrrolidone, N-vinyl-5,5-dimethyl-2-pyrrolidone, N-vinyl-3,3,5-trimethyl-2-pyrrolidone, N-vinyl piperidone, N-vinyl-3-methyl-2-piperidone, N-vinyl-4-methyl-2-piperidone, N-vinyl-5-methyl-2-piperidone, N-vinyl-6-methyl-2-piperidone, N-vinyl-6-ethyl-2-piperidone, N-vinyl-3,5-dimethyl-2-piperidone, N-vinyl-4,4-dimethyl-2-piperidone, N-vinyl caprolactam, N-vinyl-3-methyl-2-caprolactam, N-vinyl-4-methyl-2-caprolactam, N-vinyl-7-methyl-2-caprolactam, N-vinyl-7-ethyl-2-caprolactam, N-vinyl-3,5-dimethyl-2-caprolactam, N-vinyl-4,6-dimethyl-2-caprolactam, N-vinyl-3,5,7-trimethyl-2-caprolactam, N-vinyl-N-methyl acetamide, N-vinyl formamide, N-vinyl acetamide, N-vinyl isopropylamide, N-vinyl-N-ethyl acetamide, N-vinyl-N-ethyl formamide, and mixtures thereof; (6) a methylene-containing pyrrolidone monomer selected from the group consisting of 1-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, and combinations thereof; (7) an acrylic monomer having a C₁-C₄ alkoxyethoxy group and selected from the group consisting of ethylene glycol methyl ether (meth)acrylate, di(ethylene glycol) methyl ether (meth)acrylate, tri(ethylene glycol) methyl ether (meth)acrylate, tetra(ethylene glycol) methyl ether (meth)acrylate, C₁-C₄-alkoxy poly(ethylene glycol) (meth)acrylate having a number average molecular weight of up to 1500, methoxy-poly(ethylene glycol)ethyl (meth)acrylamide having a number average molecular weight of up to 1500, and combinations thereof; (8) a vinyl ether monomer selected from the group consisting of ethylene glycol monovinyl ether, di(ethylene glycol) monovinyl ether, tri(ethylene glycol) monovinyl ether, tetra(ethylene glycol) monovinyl ether, poly(ethylene glycol) monovinyl ether, ethylene glycol methyl vinyl ether, di(ethylene glycol) methyl vinyl ether, tri(ethylene glycol) methyl vinyl ether, tetra(ethylene glycol) methyl vinyl ether, poly(ethylene glycol) methyl vinyl ether, and combinations thereof; (9) an allyl ether monomer selected from the group consisting of ethylene glycol monoallyl ether, di(ethylene glycol) monoallyl ether, tri(ethylene glycol) monoallyl ether, tetra(ethylene glycol) monoallyl ether, poly(ethylene glycol) monoallyl ether, ethylene glycol methyl

- allyl ether, di(ethylene glycol) methyl allyl ether, tri(ethylene glycol) methyl allyl ether, tetra(ethylene glycol) methyl allyl ether, poly(ethylene glycol) methyl allyl ether, and combinations thereof; (10) a phosphorylcholine-containing vinylic monomer selected from the group consisting of (meth)acryloyloxyethyl phosphorylcholine, (meth)acryloyloxypropyl phosphorylcholine, 4-((meth)acryloyloxy)butyl-2'-(trimethylammonio)ethylphosphate, 2-[(meth)acryloylamino]-ethyl-2'-(trimethylammonio)-ethylphosphate, 3-[(meth)acryloylamino]propyl-2'-(trimethylammonio)ethylphosphate, 4-[(meth)acryloylamino]butyl-2'-(trimethylammonio)ethylphosphate, 5-((meth)acryloyloxy)pentyl-2'-(trimethylammonio)ethyl phosphate, 6-((meth)acryloyloxy)hexyl-2'-(trimethylammonio)-ethylphosphate, 2-((meth)acryloyloxy)-ethyl-2'-(triethylammonio)ethylphosphate, 2-((meth)acryloyloxy)ethyl-2'-(tripropylammonio)ethylphosphate, 2-((meth)acryloyloxy)ethyl-2'-(tributylammonio)ethyl phosphate, 2-((meth)acryloyloxy)propyl-2'-(trimethylammonio)-ethylphosphate, 2-((meth)acryloyloxy)-butyl-2'-(trimethylammonio)ethylphosphate, 2-((meth)acryloyloxy)pentyl-2'-(trimethylammonio)ethylphosphate, 2-((meth)acryloyloxy)hexyl-2'-(trimethylammonio)ethyl phosphate, 2-(vinylloxy)ethyl-2'-(trimethylammonio)ethylphosphate, 2-(allyloxy)ethyl-2'-(trimethylammonio)ethylphosphate, 2-(vinylloxycarbonyl)ethyl-2'-(trimethylammonio)ethyl phosphate, 2-(allyloxycarbonyl)ethyl-2'-(trimethylammonio)-ethylphosphate, 2-(vinyl-carbonylamino)ethyl-2'-(trimethylammonio)ethylphosphate, 2-(allyloxycarbonylamino)ethyl-2'-(trimethylammonio)ethyl phosphate, 2-(butenoyloxy)ethyl-2'-(trimethylammonio)-ethylphosphate, and combinations thereof; (11) allyl alcohol; (12) N-2-hydroxyethyl vinyl carbamate; (13) N-carboxyvinyl- β -alanine (VINAL); (14) N-carboxyvinyl- α -alanine; (15) or combinations thereof.
15. The method of claim 14, wherein the lens-forming composition comprises: at least one blending vinylic monomer; said at least one blending vinylic monomer that comprises C₁-C₁₀ alkyl (meth)acrylate, cyclopentylacrylate, cyclohexylmethacrylate, cyclohexylacrylate, isobornyl (meth)acrylate, styrene, 4,6-trimethylstyrene (TMS), t-butyl styrene (TBS), trifluoroethyl (meth)acrylate, hexafluoro-isopropyl (meth)acrylate, hexafluorobutyl (meth)acrylate, or combinations thereof; at least one polymerizable component selected from the group consisting of a UV-absorbing vinylic monomer, a UV/HEVL-absorbing vinylic monomer, a photochromic vinylic monomer, a polymerizable dye, and combinations thereof; or combinations thereof.