LIQUID MENISCUS LENS INCLUDING VARIABLE VOLTAGE ZONES

RELATED APPLICATIONS

This application claims priority to Provisional Patent Application U.S. Serial No. 61/387597 which was filed on September 29, 2010 and entitled "LIQUID MENISCUS LENS INCLUDING VARIABLE VOLTAGE ZONES", and as a Continuation in Part Application to Non-Provisional Patent Application U.S. Serial No. 13/095786 which was filed on April 27, 2011 and entitled "ARCUATE LIQUID MENISCUS LENS", as well as Non-Provisional Patent Application U.S. Serial No. 13/149105 which was filed on May 31, 2011 and entitled "LENS WITH CONICAL FRUSTUM MENISCUS WALL", as a Continuation in Part Application, the contents of each of which are relied upon and incorporated by reference.

FIELD OF USE

The present invention relates generally to a liquid meniscus lens, more specifically, it includes an arcuate liquid meniscus lens with variable voltage zones on the meniscus wall.

BACKGROUND

Liquid meniscus lenses have been known in various industries. As discussed more fully below with reference to Figs. 1A and 1B, known liquid meniscus lenses were engineered in cylindrical shapes with a perimeter surface formed by points at a fixed distance from an axis which is a straight line. Known liquid meniscus lenses have been limited to designs with a first interior surface generally parallel to a second interior surface and each perpendicular to a cylindrical axis. Known examples of the use of liquid meniscus lenses include devices such as electronic cameras.

Traditionally, an ophthalmic device, such as a contact lens and an intraocular lens included a biocompatible device with a corrective, cosmetic or therapeutic quality. A contact lens, for example, can provide one or more of: vision correcting functionality; cosmetic enhancement; and therapeutic effects. Each function is provided by a physical characteristic of

increments of axis correction, although other embodiments may be envisioned with more voltage zones, allowing for more precise astigmatism correction, or with fewer zones.

While the preceding discussion has indicated the correction of astigmatism, it will be apparent to those of skill in the art that other corrections of optical aberrations may be achieved according to the present invention, for example, prism, trefoil, quadrafoil, secondary astigmatism, or other well-defined "higher order" optical aberrations or others not presently described by Zernike polynomials or other analytical treatments.

In the present embodiment, the meniscus wall upon which the variable voltage zones are found generally forms the shape of a conical frustum, a cross section of which shows the meniscus wall to be linear. Examples of a lens including a linear meniscus wall are described in the U.S. Patent Application Serial Number 61,359,548, filed June 29, 2010 and entitled "LENS WITH CONICAL FRUSTUM MENISCUS WALL", which is incorporated herein by reference. In some embodiments, variable voltage zones may be included on meniscus walls of varying shapes and designs, such as by way of non-limiting example, a convex torus-segment meniscus wall, a concave torus-segment meniscus wall, a compound linear-convex meniscus wall, a multi-convex meniscus wall, a multi-concave meniscus wall, a multi-segmented linear meniscus wall, and a wall with microchannels.

While the invention has been described with reference to particular embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the scope of the invention.

Therefore, it is intended that the invention not be limited to the particular embodiments disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope and spirit of the appended claims.

Claims

1. An optical lens comprising:

a front lens comprising a front lens exterior surface and a front lens interior surface;

a back lens comprising a back lens interior surface and a back lens exterior surface, said back lens positioned proximate to said front lens such that said front lens interior surface and said back lens interior surface form a cavity therebetween;

a volume of saline solution and oil contained within the cavity formed between said front lens interior surface and said back lens interior surface, said volume of saline solution and oil comprising a meniscus therebetween; and

a meniscus wall formed on an area of the interior surface of the front lens, the meniscus wall comprising a general shape of a conical frustum with multiple voltage zones formed in one or both of the front lens and back lens and bordering the meniscus formed between the saline solution and oil, wherein at least two of the voltage zones are capable of receiving a different applied voltage.

2. The optical lens of claim 1 wherein at least one of the front lens and the back lens is essentially flat.

3. The optical lens of claim 1 wherein the front lens and the back lens comprise an arcuate lens.

4. The optical lens of claim 3 additionally comprising a conductive coating on at least a portion of said meniscus wall.

5. The optical lens of claim 4 wherein the volume of oil is less than the volume of saline solution contained within the cavity.

6. The optical lens of claim 5 wherein the volume of oil comprises about 66% or more by volume as compared to an amount of saline solution.

7. The optical lens of claim 5 wherein the volume of oil comprises about 90% or less by volume as compared to an amount of saline solution.

8. The optical lens of claim 4 wherein the volume of oil comprises a density about equal to a density of the saline solution.

9. The optical lens of claim 4 wherein the volume of oil comprises density within about 10% of a density of the saline solution.

10. The optical lens of claim 4 wherein the volume of oil comprises density within about 5% of a density of the saline solution.

11. The optical lens of claim 4 wherein the conductive coating extends from an area interior to the cavity to an area external to the cavity.

12. The optical lens of claim 11, wherein the area of conductive coating external to the cavity forms an electrical terminal for providing an electrical potential to the liquid meniscus lens.

13. The optical lens of claim 11 wherein the saline solution and the oil form a meniscus and an application of an electrical potential to the area of conductive coating external to the cavity causes a change in position of contact of the meniscus along the meniscus wall.

14. The optical lens of claim 11 wherein the electrical potential is applied using direct current.

15. The optical lens of claim 11 wherein the electrical potential comprises between about 5.0 volts to 60.0 volts.

16. The optical lens of claim 15 wherein the electrical potential comprises about 20.0 volts.

17. The optical lens of claim 15 wherein the electrical potential comprises about 5.0 volts.

18. The optical lens of claim 11 wherein the electrical potential comprises between about 3.5 volts to about 7.5 volts.

19. The optical lens of claim 5 wherein the front curve lens exterior surface comprises an optical power other than about 0.

20. The optical lens of claim 5 wherein the front curve lens interior surface comprises an optical power other than about 0.

21. The optical lens of claim 5 wherein the back curve lens exterior surface comprises an optical power other than about 0.

22. The optical lens of claim 5 wherein the back curve lens interior surface comprises an optical power other than about 0.

23. The optical lens of claim 5 additionally comprising a channel through one or both of the front curve lens and the back curve lens and a conductive material filling the channel.

24. The optical lens of claim 23 additionally comprising a terminal in electrical communication with the conductive material filling the channel.

25. The optical lens of claim 24 wherein application of an electrical potential to the terminal causes a change in the shape of the meniscus.

26. The optical lens of claim 5 additionally comprising an insulator coating along at least a portion of the interior surface of the front curve lens, wherein the insulator coating comprises an electrical insulator.

27. The optical lens of claim 26, wherein the insulator comprises one of Parylene C™ and Teflon AF.

28. The optical lens of claim 26 wherein the insulator comprises a boundary area to maintain separation between the conductive coating and a saline solution contained in the cavity between the front curve lens and the back curve lens.

29. The optical lens of claim 5 wherein an angle of the conical frustum comprising the meniscus wall comprises between about 30° and 50°.

30. The optical lens of claim 29 additionally comprising a meniscus sharp adjacent to the meniscus wall, said sharp comprising a angular feature for containing the volume of saline solution and oil.

31. The optical lens of claim 29 wherein the sharp comprises a radial surface portion.

32. The optical lens of claim 30 wherein the radial surface portion comprises a radius in the range of 5 microns to 50 microns.

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increments of axis correction, although other embodiments may be envisioned with more voltage zones, allowing for more precise astigmatism correction, or with fewer zones.

While the preceding discussion has indicated the correction of astigmatism, it will be apparent to those of skill in the art that other corrections of optical aberrations may be achieved according to the present invention, for example, prism, trefoil, quadrafoil, secondary astigmatism, or other well-defined "higher order" optical aberrations or others not presently described by Zernike polynomials or other analytical treatments.

In the present embodiment, the meniscus wall upon which the variable voltage zones are found generally forms the shape of a conical frustum, a cross section of which shows the meniscus wall to be linear. Examples of a lens including a linear meniscus wall are described in the U.S. Patent Application Serial Number 61,359,548, filed June 29, 2010 and entitled "LENS WITH CONICAL FRUSTUM MENISCUS WALL".

In some embodiments, variable voltage zones may be included on meniscus walls of varying shapes and designs, such as by way of non-limiting example, a convex torus-segment meniscus wall, a concave torus-segment meniscus wall, a compound linear-convex meniscus wall, a multi-convex meniscus wall, a multi-concave meniscus wall, a multi-segmented linear meniscus wall, and a wall with microchannels.

While the invention has been described with reference to particular embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the scope of the invention.

Therefore, it is intended that the invention not be limited to the particular embodiments disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope and spirit of the appended claims.

Claims

1. An optical lens comprising:

a front lens comprising a front lens exterior surface and a front lens interior surface;

a back lens comprising a back lens interior surface and a back lens exterior surface, said back lens positioned proximate to said front lens such that said front lens interior surface and said back lens interior surface form a cavity therebetween;

a volume of saline solution and oil contained within the cavity formed between said front lens interior surface and said back lens interior surface, said volume of saline solution and oil comprising a meniscus therebetween; and

a meniscus wall formed on an area of the interior surface of the front lens, the meniscus wall comprising a general shape of a conical frustum with multiple voltage zones formed in one or both of the front lens and back lens and bordering the meniscus formed between the saline solution and oil, wherein at least two of the voltage zones are capable of receiving a different applied voltage.

2. The optical lens of claim 1 wherein at least one of the front lens and the back lens is essentially flat.

3. The optical lens of claim 1 wherein the front lens and the back lens comprise an arcuate lens.

4. The optical lens of claim 3 additionally comprising a conductive coating on at least a portion of said meniscus wall.

5. The optical lens of claim 4 wherein the volume of oil is less than the volume of saline solution contained within the cavity.

6. The optical lens of claim 5 wherein the volume of oil comprises about 66% or more by volume as compared to an amount of saline solution.

7. The optical lens of claim 5 wherein the volume of oil comprises about 90% or less by volume as compared to an amount of saline solution.

8. The optical lens of claim 4 wherein the volume of oil comprises a density about equal to a density of the saline solution.

9. The optical lens of claim 4 wherein the volume of oil comprises density within about 10% of a density of the saline solution.

10. The optical lens of claim 4 wherein the volume of oil comprises density within about 5% of a density of the saline solution.

11. The optical lens of claim 4 wherein the conductive coating extends from an area interior to the cavity to an area external to the cavity.

12. The optical lens of claim 11, wherein the area of conductive coating external to the cavity forms an electrical terminal for providing an electrical potential to the liquid meniscus lens.

13. The optical lens of claim 11 wherein the saline solution and the oil form a meniscus and an application of an electrical potential to the area of conductive coating external to the cavity causes a change in position of contact of the meniscus along the meniscus wall.

14. The optical lens of claim 13 wherein the electrical potential is applied using direct current.

15. The optical lens of claim 13 wherein the electrical potential comprises between about 5.0 volts to 60.0 volts.

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24. The optical lens of claim 23 additionally comprising a terminal in electrical communication with the conductive material filling the channel.

25. The optical lens of claim 24 wherein application of an electrical potential to the terminal causes a change in the shape of the meniscus.

26. The optical lens of claim 5 additionally comprising an insulator coating along at least a portion of the interior surface of the front curve lens, wherein the insulator coating comprises an electrical insulator.

27. The optical lens of claim 26, wherein the insulator comprises one of Parylene C™ and Teflon AF.

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32. The optical lens of claim 30 wherein the radial surface portion comprises a radius in the range of 5 microns to 50 microns.