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Ophthalmic procedure contact lens with enhanced vitreous visualization

Abstract

In certain embodiments, an ophthalmic procedure contact lens for ophthalmic treatment of an eye with a laser beam includes a frame, an objective lens, and an illumination ring. The frame has an eye end, an operator end, and a flange-like shape with an interior region. The eye end is configured to be disposed outwardly from the eye. The objective lens is disposed within the interior region of the frame. The objective lens transmits the laser beam through the eye end to treat the eye. The illumination ring is coupled to the frame and provides annular illumination through the eye end to illuminate the eye. The illumination ring includes a ring substrate and light emitters coupled to the ring substrate. The light emitters emit light.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS (1) This application claims priority to and benefit of U.S. Provisional Patent Application No. 63/281,298, filed Nov. 19, 2021, the entire contents of which are incorporated by reference herein in its entirety.

TECHNICAL FIELD

(1) The present disclosure relates generally to ophthalmic systems, and more particularly to an ophthalmic procedure contact lens with enhanced vitreous visualization.

BACKGROUND

(2) Vitreoretinal eye procedures are performed in the vitreoretinal region of the eye. Examples of such procedures include: breaking up vitreous clumped pre-existing collagen fibers ("floaters"); vitreous traction of a flap tear ("horseshoe tear") before in-office pneumatic retinopexy for limited retinal detachments; residual vitreoretinal traction after surgical vitrectomy; residual retinal tissue causing retinal detachment (elevation) due to incomplete surgical retinectomy; selected small diabetic traction retinal detachments; and selected vitreomacular traction syndrome cases.

(3) A doctor must be able to see the vitreoretinal region in order to successfully perform a procedure. Moreover, appropriate illumination is key to effective vitreoretinal visualization. Unfortunately, in some situations, known systems fail to provide illumination that yields effective visualization.

BRIEF SUMMARY

(4) In certain embodiments, an ophthalmic procedure contact lens for ophthalmic treatment of an eye with a laser beam includes a frame, an objective lens, and an illumination ring. The frame has an eye end, an operator end, and a flange-like shape with an interior region. The eye end is configured to be disposed outwardly from the eye. The objective lens is disposed within the interior region of the frame. The objective lens transmits the laser beam through the eye end to treat the eye. The illumination ring is coupled to the frame and provides annular illumination through the eye end to illuminate the eye. The illumination ring includes a ring substrate and light emitters coupled to the ring substrate. The light emitters emit light.

(5) Embodiments may include none, one, some, or all of the following features: The light emitters comprise light sources, which may comprise light-emitting diode (LED) lights. The light emitters comprise optical fibers coupling a light source to the illumination ring, where an optical fiber delivers light from the light source to the illumination ring. The optical fiber may comprise a delivery fiber and an output fiber. The light source may provide a laser beam, such as a laser beam with a speckle pattern. The illumination ring is disposed between the objective lens and the eye. The

objective lens is disposed within the illumination ring. The objective lens is a member of a set of interchangeable objective lenses, where at least two interchangeable objective lenses have different focus points. The ophthalmic procedure contact lens includes a controller that controls the illumination of the illumination ring. The controller may control a feature of light emitted by one or more of the light emitters and/or may control a pattern of illumination emitted by the light emitters. The objective lens is disposable. The illumination ring is disposable.

(6) In certain embodiments, an ophthalmic procedure contact lens for ophthalmic treatment of an eye with a laser beam includes a frame, an objective lens, and an illumination ring. The frame has an eye end, an operator end, and a flange-like shape with an interior region. The eye end is configured to be disposed outwardly from the eye. The objective lens is disposed within the interior region of the frame. The objective lens transmits the laser beam through the eye end to treat the eye. The illumination ring is coupled to the frame and provides annular illumination through the eye end to illuminate the eye. The illumination ring includes a ring substrate and light emitters coupled to the ring substrate. The light emitters are light sources comprising light-emitting diode (LED) lights that emit light.

(7) Embodiments may include the following feature: The ophthalmic procedure contact lens includes a controller that controls the illumination of the illumination ring.

(8) In certain embodiments, an ophthalmic procedure contact lens for ophthalmic treatment of an eye with a laser beam includes a frame, an objective lens, and an illumination ring. The frame has an eye end, an operator end, and a flange-like shape with an interior region. The eye end is configured to be disposed outwardly from the eye. The objective lens is disposed within the interior region of the frame. The objective lens transmits the laser beam through the eye end to treat the eye. The illumination ring is coupled to the frame and provides annular illumination through the eye end to illuminate the eye. The illumination ring includes a ring substrate and light emitters coupled to the ring substrate. The light emitters emit light and comprise optical fibers that couple a light source to the illumination ring. An optical fiber delivers light from the light source to the illumination ring, where the light source provides a laser beam.

(9) Embodiments may include the following feature: The light source provides a laser beam with a speckle pattern.

(10) In certain embodiments, an ophthalmic procedure contact lens for ophthalmic treatment of an eye with a laser beam includes a frame, an objective lens, an illumination ring, and a controller. The frame has an eye end, an operator end, and a flange-like shape with an interior region. The eye end is configured to be disposed outwardly from the eye. The objective lens is disposed within the interior region of the frame, and transmits the laser beam through the eye end to treat the eye. The illumination ring is coupled to the frame and provides annular illumination through the eye end to illuminate the eye. The objective lens and the illumination ring are disposable. The illumination ring includes a ring substrate and light emitters coupled to the ring substrate. The light emitters emit light and include: light sources that include light-emitting diode (LED) lights; or optical fibers coupling a light source to the illumination ring, where an optical fiber comprises a delivery fiber and an output fiber that delivers light from the light source to the illumination ring and the light source provides a laser beam with a speckle pattern. The controller controls the illumination of the illumination ring by: controlling a feature of light emitted by one or more of the light emitters, and controlling a pattern of illumination emitted by the light emitters.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

- (1) FIG. 1 illustrates an example of an ophthalmic procedure contact lens that enhances vitreous visualization, according to certain embodiments;
- (2) FIG. 2 illustrates an example of an ophthalmic procedure contact lens with an illumination ring, according to certain embodiments;
- (3) FIGS. 3A and 3B illustrate examples of ophthalmic procedure contact lenses with an illumination ring that illuminates an eye with annular illumination, according to certain embodiments; and
- (4) FIGS. 4A and 4B illustrate examples of illumination rings in communication with a controller, according to certain embodiments.

DESCRIPTION OF EXAMPLE EMBODIMENTS

- (5) Referring now to the description and drawings, example embodiments of the disclosed apparatuses, systems, and methods are shown in detail. The description and drawings are not intended to be exhaustive or otherwise limit the claims to the specific embodiments shown in the drawings and disclosed in the description. Although the drawings represent possible embodiments, the drawings are not necessarily to scale and certain features may be simplified, exaggerated, removed, or partially sectioned to better illustrate the embodiments.
- (6) Vitreoretinal visualization (i.e., visualization of the vitreous and/or retina) can be difficult because some targets, such as eye floaters, are almost transparent and absorb very little light. In addition, external illumination of the vitreoretinal area is limited by Purkinje images, which are reflections from the surfaces of the cornea and lens. Moreover, laser vitreoretinal procedures are typically real-time, see-aim-and-shoot procedures, so visualization should be in real-time, stereo, and in color. For example, when treating eye floaters, the doctor should have real-time visualization to see movement of the floaters in response to laser shots. In addition, the doctor should be able to see the lens and retina in stereo and in color, as they provide anatomic landmarks that prevent spatial disorientation.

(7) These and other challenges render known vitreoretinal imaging techniques unsatisfactory in certain situations. Accordingly, an ophthalmic procedure contact lens that illuminates an eye with annular illumination is described herein. If the axis of the annular illumination is substantially coaxial with an axis of the eye (e.g., visual or optical axis), retinal reflections and Purkinje images may be reduced, thus enhancing vitreoretinal visualization.

(8) FIG. 1 illustrates an example of an ophthalmic procedure contact lens **110** that enhances vitreous visualization, according to certain embodiments. As an overview, contact lens **110** is disposed outwardly from cornea **114** of eye **112**. Contact lens **110** includes an illumination system implemented as an illumination ring **120**. Illumination ring **120** provides annular illumination that enhances vitreous visualization. Laser beam **116** is transmitted through an optical element of contact lens **110** to treat eye **112**.

(9) Turning to the details, the illumination system provides light to illuminate at least a part or all of the vitreoretinal region, e.g., the vitreous and/or retina. The illumination light may be any suitable light, e.g., a laser beam such as a laser beam with an intrinsic spackle pattern. Optical elements **136** may modify the illumination light to yield any suitable illumination, e.g., one or more of the following types of illumination:

(10) (1) Annular Illumination (AN): Annular illumination is light (e.g., white light-emitting diode (LED) light) provided as a tube or a hollow cone (such as a truncated cone), where light is absent from the interior. In an example of use, annular illumination strikes the eye as a ring located, e.g., just inside where sclera meets cornea. Annular illumination has an axis, e.g., the axis of the tube or cone of illumination. If the axis of the annular illumination is substantially coincident with an axis of the eye (e.g., visual or optical axis), retinal reflections and Purkinje images may be reduced.

(11) (2) Multi-Beam Illumination (MB): Multi-beam illumination is light provided as a plurality of light beams, e.g., a plurality of laser beams. In certain embodiments, the multiple light beams may yield annular illumination. Multi-beam illumination enhances visualization of targets, e.g., vitreous floaters.

(12) (3) Speckle Pattern (SP): The mutual interference of a set of coherent wavefronts of light (such as laser light) produce a speckle pattern. The speckle pattern enhances visualization of vitreous of targets, e.g., vitreous floaters. The speckle pattern may be used with any suitable optical configuration. For example, speckle pattern light may be provided as, e.g., a single beam, a slit beam, and/or multiple beams.

(13) FIG. 2 illustrates an example of ophthalmic procedure contact lens **110** with illumination ring **120**, according to certain embodiments. As an overview, contact lens **122** comprises a frame **130** with an eye end **132** and an operator end **134**. Illumination ring **120** and optical elements **136** are coupled to and disposed within frame **132**.

(14) Examples of contact lens **122** include an ocular Singh mid-vitreous lens, a Peyman multi-segment lens, a Karickhoff off-axis lens, a Karickhoff four-mirror lens, and other frames with optical elements that allow an operator to view the interior of an eye. For example, a Singh mid-vitreous lens has a lens that provides views of the vitreous, e.g., from the lens posterior to the retina. As another example, a Peyman multi-segment lens may include separate lens inserts for viewing different regions of the eye, e.g., the anterior chamber to the posterior capsule, mid-vitreous, and deep vitreous. As another example, a Karickhoff off-axis lens has a lens that provides a view of an off-axis region of the eye. The operator rotates the lens to view other off-axis regions, without patient moving their eye.

(15) As yet another example, a Karickhoff four-mirror lens has four mirrors and a central axis view. The mirrors are positioned at different angles to provide different fields of view of the eye interior. For example, 62° mirror provides a view of the peripheral fundus near the ora serrata; a 67° mirror provides a view from the equator to the mid ora serrata; a 76° mirror provides a view of the equator to the mid peripheral field; and an 80° mirror provides a view of the major vessel arcades. The fields of view may overlap so that areas from the central area to the periphery may be viewed by rotating the lens.

(16) Turning to the details, a frame **130** has a flange-like shape (e.g., a skirt around an optical portion with a radius of curvature similar to that of, e.g., the eye, sclera, or cornea) with an interior region. Eye end **132** is to be disposed outwardly from eye **112**. The scleral conjunctival contact surface may be treated with a sticky material to increase friction. A thixotropic fluid may be used. Operator end **134** is to be handled by an operator such as a doctor, and may have texture that allows the operator to easily handle end **134**.

(17) Optical elements **136** serve to magnify and/or focus the interior of eye **112**. In general, an optical element transmits, refracts, reflects, or otherwise modulates light. In certain embodiments, optical elements **136** include one or more lens(es) and/or mirror(s) that magnify and/or focus the interior of eye **112**. For example, optical elements **136** include an objective lens disposed within the interior region of frame **130**. In general, an objective lens is an optical element that gathers light from an object and focuses the light rays to produce an image of the object. The objective lens of contact lens **110** transmits a laser beam through eye end **132** to treat an eye.

(18) Illumination ring **120** provides annular illumination through eye end **132** to illuminate eye **112**. In the example, illumination ring **120** includes a ring substrate **142** and light emitters **142** coupled to ring. Illumination ring **120** is described in more detail with reference to FIGS. 4A and 4B.

(19) FIGS. 3A and 3B illustrate examples of ophthalmic procedure contact lenses **110** (**110a** and **110b**) with illumination ring **120** that illuminates eye **112** with annular illumination, according to certain embodiments. In an example of use, annular illumination strikes the eye as a ring located, e.g., just inside where sclera meets cornea. If the axis of the annular illumination is substantially coaxial with an axis of the eye (e.g., visual or optical axis), retinal reflections and Purkinje images may be reduced. The annular illumination separates the illumination and visualization pathways similar

to the Koehler principle in microscopy, which increases the contrast and visibility of floaters.

(20) Turning to the specific examples, contact lens **110** includes an objective lens **150**. In contact lens **110a** of FIG. 3A, illumination ring **120** is disposed on the side of objective lens **150** closest to eye **112**, i.e., between objective lens **150** and eye **112**. In contact lens **110b** of FIG. 3B, objective lens **150** is disposed within the interior region of illumination ring **120**. These arrangements eliminate reflected light from the contact lens and cornea and reduce reflections from the lens or intraocular lens (IOL). Objective lens **150** gathers light from eye **112** and forms an image of eye **112** from the gathered light.

(21) In certain embodiments, lens **150** may be a member of a set of interchangeable lenses, where different lenses **150** may have focus points at different depths of eye **112**. For example, different lenses **150** may be used to focus on the anterior, mid, and posterior vitreous of eye **112**. In certain embodiments, lens **150** may be disposable, or, in other embodiments, may be reusable after cleaning. Lens **150** may be formed in any suitable manner (e.g., by injection molding) with any suitable coating(s) (e.g., glare and/or anti-fogging coatings) and any suitable wafer-level optics.

(22) FIGS. 4A and 4B illustrate examples of illumination rings **120** (**120a** and **120b**) in communication with a controller **160**, according to certain embodiments. In the examples, illumination ring **120** (**120a** and **120b**) includes a ring substrate **140** and light emitters **142**, coupled as shown. Ring substrate **140** supports light emitters **142** and may have any suitable diameter to be disposed within frame, e.g., 1 to 3 centimeters. Light emitters **142** emit light to yield the annular illumination and may be arranged on ring substrate **140** in any suitable manner. For example, emitters **142** may be adjacent to each other or may be separated from each other. Generally, emitters **142** may be symmetrically and/or evenly distributed around ring substrate **140**, but need not be in certain embodiments. Controller **160** may control the illumination of light emitters **142**. Illumination ring **120b** of FIG. 4B includes optical fibers **164** that couple a light source **162** to illumination ring **120b**.

(23) Turning to the specific embodiments, illumination ring **120a** of FIG. 4A includes light emitters **142** that are light sources that generate light, e.g., light-emitting diode (LED) lights such as white or RGB micro-LED lights. Light emitter **142** may have any suitable dimensions, e.g., 0.1 to 3.0 millimeter (mm) in length, width, and height (e.g., 0.65 mm length×0.35 mm width×0.2 mm height). Light emitter **142** may have smaller dimensions achieved by future LED lights.

(24) Illumination ring **120b** of FIG. 4B includes light emitters **142** that are light outputs. In the example, light emitters **142** are the outputs of optical fibers that deliver light from light source **162** to illumination ring **120b**. Light source **162** may be, e.g., a laser beam source that provides a laser beam, such as a laser beam with a speckle pattern. In certain embodiments, illumination ring **120** may be disposable and/or may be reusable after cleaning.

(25) Optical fiber **164** may have any suitable features. As an overview, in certain embodiments, optical fiber **164** includes one or more optical fibers comprising a delivery fiber coupled to an output fiber, where the delivery fiber is coupled to light source **162** and the output fiber is coupled to substrate **140**. In the embodiments, the delivery fiber may be a larger diameter fiber that delivers light from light source **162** to multiple output fibers. The output fibers may be smaller diameter fibers, such as nanofibers, with ends that emit the light.

(26) Turning to the details of certain embodiments, the delivery fiber may have any features suitable for delivering light from light source **162** to the output fibers. In certain embodiments, the delivery fiber has a lower numerical aperture NA (e.g., 0.0 to 0.5) and a larger diameter (e.g., 50 to 100 micrometers) than that of the output fiber. An example of a delivery fiber is a multimode fiber. A multi-mode fiber has a large core diameter that enables multiple light modes to be propagated and that yields higher light-gathering capacity than a single mode fiber.

(27) An output fiber may have any suitable features. In certain embodiments, the output fiber may be, e.g., a nanofiber (with a diameter in the nanometer range) or a micron fiber (with a diameter in the micrometer range). The distal end may have a numerical aperture NA of 0.5 to 1.0, a critical angle of 30 to 70 degrees, and a launch cone angle of 70 to 130 degrees (which is not output into the eye). For example, a 30-micron output fiber may have NA 0.66, critical angle 41.3°, and launch cone angle 82.6°. As another example, an output fiber may have NA 0.86, critical angle 59.32°, and launch cone angle 118.6°. The distal end may be tapered to provide the annular illumination.

(28) Any suitable technique may be used to couple the delivery and output fibers to transport light from light source **162** to the output of emitters **142**. Optical fiber **164** may include tapers, connectors (e.g., butt joint connections), and/or optical element(s) (e.g., lenses, transparent balls) to couple the fibers. When coupling the output and delivery fibers (plus taper or optical element), the radiometric $A \cdot \Omega$ product may be used to match the fibers. The $A \cdot \Omega$ product is the area A of the fiber cross-section times the solid angle Ω of the light cone. The $A \cdot \Omega$ product of the delivery fiber should match the $A \cdot \Omega$ product of the output fiber.

(29) Light emitters **142** may be used with any suitable optical elements to yield annular illumination (e.g., uniform annular illumination or a ring of beams). For example, the output fibers may be disposed along the periphery of substrate perpendicular or not perpendicular to the front surface of the contact. If the fibers are not perpendicular (e.g., are parallel) to the front surface, optical elements (e.g., molded prisms or light pipes) may be used to redirect the light towards the eye to yield annular illumination.

(30) In certain embodiments, controller **160** controls the illumination of the illumination ring **120**. Controller **160** may control one or more features of the light, e.g., intensity, wavelength (such as color), coherence, direction, and/or polarization. For example, controller **160** may instruct illumination ring **120** to use a blue light to decrease red reflex.

Controller **160** may also control the pattern of light emitted by emitters **142**. The pattern of light may include, e.g., which emitters **142** are emitting light, when and how long they emit light, and/or the features of the emitted light. For example, controller **160** may instruct illumination ring **120** to use multiple emitters **142** to yield multi-beam annular illumination. As another example, controller **160** may instruct illumination ring **120** to use a laser beam with a speckle pattern to enhance visualization.

(31) A component (such as controller **160**) of the systems and apparatuses disclosed herein may include an interface, logic, and/or memory, any of which may include computer hardware and/or software. An interface can receive input to the component and/or send output from the component, and is typically used to exchange information between, e.g., software, hardware, peripheral devices, users, and combinations of these. A user interface is a type of interface that a user can utilize to communicate with (e.g., send input to and/or receive output from) a computer. Examples of user interfaces include a display, Graphical User Interface (GUI), touchscreen, keyboard, mouse, gesture sensor, microphone, and speakers.

(32) Logic can perform operations of the component. Logic may include one or more electronic devices that process data, e.g., execute instructions to generate output from input. Examples of such an electronic device include a computer, processor, microprocessor (e.g., a Central Processing Unit (CPU)), and computer chip. Logic may include computer software that encodes instructions capable of being executed by an electronic device to perform operations. Examples of computer software include a computer program, application, and operating system.

(33) A memory can store information and may comprise tangible, computer-readable, and/or computer-executable storage medium. Examples of memory include computer memory (e.g., Random Access Memory (RAM) or Read Only Memory (ROM)), mass storage media (e.g., a hard disk), removable storage media (e.g., a Compact Disk (CD) or Digital Video or Versatile Disk (DVD)), database, network storage (e.g., a server), and/or other computer-readable media. Particular embodiments may be directed to memory encoded with computer software.

(34) Although this disclosure has been described in terms of certain embodiments, modifications (such as changes, substitutions, additions, omissions, and/or other modifications) of the embodiments will be apparent to those skilled in the art. Accordingly, modifications may be made to the embodiments without departing from the scope of the invention. For example, modifications may be made to the systems and apparatuses disclosed herein. The components of the systems and apparatuses may be integrated or separated, or the operations of the systems and apparatuses may be performed by more, fewer, or other components, as apparent to those skilled in the art. As another example, modifications may be made to the methods disclosed herein. The methods may include more, fewer, or other steps, and the steps may be performed in any suitable order, as apparent to those skilled in the art.

(35) To aid the Patent Office and readers in interpreting the claims, Applicants note that they do not intend any of the claims or claim elements to invoke 35 U.S.C. § 112(f), unless the words “means for” or “step for” are explicitly used in the particular claim. Use of any other term (e.g., “mechanism,” “module,” “device,” “unit,” “component,” “element,” “member,” “apparatus,” “machine,” “system,” “processor,” or “controller”) within a claim is understood by the applicants to refer to structures known to those skilled in the relevant art and is not intended to invoke 35 U.S.C. § 112(f).

Claims

1. An ophthalmic procedure contact lens system for ophthalmic treatment of an eye with a laser beam, comprising: a frame with an eye end and an operator end, the frame having a flange-like shape with an interior region, the eye end configured to be disposed outwardly from the eye; an objective lens disposed within the interior region of the frame, the objective lens configured to transmit the laser beam through the eye end to treat the eye; and an illumination ring coupled to the frame and configured to provide annular illumination through the eye end to illuminate the eye, the illumination ring comprising: a ring substrate; and a plurality of light emitters coupled to the ring substrate, the plurality of light emitters configured to emit light, the plurality of light emitters comprising a plurality of optical fibers coupling a light source to the illumination ring, an optical fiber configured to deliver light from the light source to the illumination ring; and the light source configured to provide a laser beam with a speckle pattern.
2. The ophthalmic procedure contact lens system of claim 1, the optical fiber comprising a delivery fiber and an output fiber.
3. The ophthalmic procedure contact lens system of claim 1, the optical fiber comprising: a delivery fiber comprising a multimode fiber; and an output fiber comprising a nanofiber.
4. The ophthalmic procedure contact lens system of claim 1, the illumination ring disposed between the objective lens and the eye.
5. The ophthalmic procedure contact lens system of claim 1, the objective lens disposed within the illumination ring.
6. The ophthalmic procedure contact lens system of claim 1, the objective lens being a member of a plurality of interchangeable objective lenses, at least two interchangeable objective lenses having different focus points.
7. The ophthalmic procedure contact lens system of claim 1, further comprising a controller configured to control the illumination of the illumination ring.
8. The ophthalmic procedure contact lens system of claim 7, the controller configured to control a feature of light

emitted by one or more of the plurality of light emitters.

9. The ophthalmic procedure contact lens system of claim 7, the controller configured to control a pattern of illumination emitted by the plurality of light emitters.

10. The ophthalmic procedure contact lens system of claim 1, the objective lens being disposable.

11. The ophthalmic procedure contact lens system of claim 1, the illumination ring being disposable.

12. An ophthalmic procedure contact lens for ophthalmic treatment of an eye with a laser beam, comprising: a frame with an eye end and an operator end, the frame having a flange-like shape with an interior region, the eye end configured to be disposed outwardly from the eye; an objective lens disposed within the interior region of the frame, the objective lens configured to transmit the laser beam through the eye end to treat the eye; and an illumination ring coupled to the frame and configured to provide annular illumination through the eye end to illuminate the eye, the illumination ring comprising: a ring substrate; and a plurality of light emitters coupled to the ring substrate, the plurality of light emitters configured to emit light, the plurality of light emitters comprising a plurality of optical fibers coupling a light source to the illumination ring, an optical fiber configured to deliver light from the light source to the illumination ring, the light source configured to provide a laser beam, the light source configured to provide a laser beam with a speckle pattern.

13. An ophthalmic procedure contact lens for ophthalmic treatment of an eye with a laser beam, comprising: a frame with an eye end and an operator end, the frame having a flange-like shape with an interior region, the eye end configured to be disposed outwardly from the eye; an objective lens disposed within the interior region of the frame, the objective lens configured to transmit the laser beam through the eye end to treat the eye; an illumination ring coupled to the frame and configured to provide annular illumination through the eye end to illuminate the eye, the illumination ring disposed between the objective lens and the eye or the objective lens disposed within the illumination ring, the objective lens being a member of a plurality of interchangeable objective lenses, at least two interchangeable objective lenses having different focus points, the objective lens being disposable, the illumination ring being disposable, the illumination ring comprising: a ring substrate; and a plurality of light emitters coupled to the ring substrate, the plurality of light emitters configured to emit light, the plurality of light emitters comprising: a plurality of light sources comprising a plurality of light-emitting diode (LED) lights; or a plurality of optical fibers coupling a light source to the illumination ring, an optical fiber comprising a delivery fiber and an output fiber configured to deliver light from the light source to the illumination ring, the light source configured to provide a laser beam with a speckle pattern; and a controller configured to control the illumination of the illumination ring, the controller configured to control a feature of light emitted by one or more of the plurality of light emitters, the controller configured to control a pattern of illumination emitted by the plurality of light emitters.
