

LIGHT ENGINE AND WAVEGUIDE ASSEMBLY WITH SWAPPABLE PRESCRIPTION LENS FUNCTIONALITY

BACKGROUND

Field

[0001] The present disclosure relates to augmented reality optical device assemblies with a swappable prescription lens function, and related apparatus and methods.

Description of the Related Art

[0001] Virtual reality is generally considered to be a computer-generated simulated environment in which a user has an apparent physical presence. A virtual reality experience can be generated in 3D and viewed with a head-mounted display (HMD), such as glasses or other wearable display devices that have near-eye display panels as lenses to display a virtual reality environment that replaces an actual environment.

[0002] Augmented reality, however, enables an experience in which a user can still see through the display lenses of the glasses or other HMD device to view the surrounding environment, yet also see images of virtual objects that are generated for display and appear as part of the environment. Augmented reality can include any type of input, such as audio and haptic inputs, as well as virtual images, graphics, and video that enhances or augments the environment that the user experiences. As an emerging technology, there are many challenges and design constraints with augmented reality.

[0003] Accordingly, what is needed in the art are optical device assemblies having a waveguide, a push lens, a corrective lens, and a carrier to retain a projector and the corrective lens.

SUMMARY

[0004] The present disclosure relates to augmented reality optical device assemblies with a swappable prescription lens function, and related apparatus and methods.

[0005] In one or more embodiments, an optical device assembly includes a carrier. The carrier has a first carrier portion and a second carrier portion. The optical device

assembly further includes a push lens coupled to the first carrier portion and the second carrier portion. The first carrier portion and the second carrier portion are spaced to retain the push lens. The optical device assembly further includes a waveguide disposed over a waveguide-side surface of the push lens between the first carrier portion and the second carrier portion. The waveguide includes at least an incoupler grating disposed over a first surface or a second surface opposing the first surface of the waveguide. The first carrier portion includes a projection portion operable to retain a projector aligned with incoupler grating.

[0006] In one or more embodiments, an optical device assembly includes a carrier. The carrier has a first carrier portion and a second carrier portion. The optical device assembly further includes a push lens coupled to the first carrier portion and the second carrier portion. The first carrier portion and the second carrier portion are spaced to retain the push lens. The optical device assembly further includes a waveguide disposed over a waveguide-side surface of the push lens between the first carrier portion and the second carrier portion. The waveguide includes at least an incoupler grating disposed over a first surface or a second surface opposing the first surface of the waveguide. The optical device assembly further includes a corrective lens retained by the carrier disposed over the waveguide. The corrective lens includes a projection seat having an aperture to operable to align a projector to the incoupler grating.

[0007] In one or more embodiments, a method of fabricating an optical device assembly includes a carrier. The carrier has a first carrier portion and a second carrier portion. The method further includes coupling a push lens to the carrier, between the first carrier portion and the second carrier portion. The first carrier portion and the second carrier portion are spaced to retain the push lens. The method further includes coupling a waveguide to the push lens. The waveguide is disposed over a waveguide-side surface of the push lens between the first carrier portion and the second carrier portion. The waveguide includes at least an incoupler grating disposed over a first surface or a second surface opposing the first surface of the waveguide. The first carrier portion includes a projection portion operable to retain a projector aligned with the incoupler grating.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] So that the manner in which the above recited features of the present disclosure can be understood in detail, a more particular description of the disclosure, briefly summarized above, may be had by reference to embodiments, some of which are illustrated in the appended drawings. It is to be noted, however, that the appended drawings illustrate only exemplary embodiments and are therefore not to be considered limiting of its scope, and may admit to other equally effective embodiments.

[0009] Figure 1 is a perspective, frontal view of a waveguide according to one or more embodiments described herein.

[0010] Figure 2 is a cross sectional view of an optical device assembly, according to one or more embodiments.

[0011] Figures 3A – 3E are a cross sectional views of an optical device assembly during a method of fabrication, according to one or more embodiments.

[0012] Figure 4 is a cross sectional view of an optical device assembly, according to one or more embodiments.

[0013] Figures 5A – 5E are a cross sectional views of the of an optical device assembly during a method of fabrication, according to one or more embodiments.

[0014] Figure 6 is a cross sectional view of an optical device assembly, according to one or more embodiments.

[0015] Figures 7A – 7D are a cross sectional views of the of an optical device assembly during a method of fabrication, according to one or more embodiments.

[0016] Figure 8 is a cross sectional view of an optical device assembly, according to one or more embodiments.

[0017] Figures 9A – 9E are a cross sectional views of the of an optical device assembly during a method of fabrication, according to one or more embodiments.

[0018] To facilitate understanding, identical reference numerals have been used, where possible, to designate identical elements that are common to the figures. It is

contemplated that elements and features of one embodiment may be beneficially incorporated in other embodiments without further recitation.

DETAILED DESCRIPTION

[0019] The present disclosure relates to augmented reality optical device assemblies with a swappable prescription lens function, and related apparatus and methods.

[0020] Figure 1 is a perspective, frontal view of a waveguide 100, according to one or more embodiments. It is to be understood that the waveguide 100 described herein is an exemplary waveguide and that other waveguides may be used with or modified to accomplish aspects of the present disclosure. The waveguide 100 includes a plurality of structures 102. The structures 102 may be disposed over, under, or on a first surface 103 of a substrate 101, or disposed in the substrate 101. The structures 102 are nanostructures have a sub-micron critical dimension, e.g., a width less than 1 micrometer. Regions of the structures 102 correspond to one or more gratings 104. Any of the grating 104 may be disposed over, under, or on the first surface 103 or over, under, or on a second surface 105 (Figure 2) opposing the first surface 103. In one embodiment, which can be combined with other embodiments described herein, the waveguide 100 includes at least a first grating 104a corresponding to an input coupling grating ("Incoupler") and a third grating 104c corresponding to an output coupling grating ("Outcoupler"). In another embodiment, which can be combined with other embodiments described herein, the waveguide 100 further includes a second grating 104b. The second grating 104b corresponds to a pupil expansion grating ("Pupil Expander") or a fold grating.

[0021] Figure 2 is a cross sectional view of an optical device assembly 200, according to one or more embodiments. The optical device assembly 200 has an assembled configuration 200A and a shipped configuration 200B as shown in Figure 3E. The assembled configuration 200A includes the waveguide 100, a push lens 201, a corrective lens 203, a carrier 210, and a perimeter adhesive 220, and a projector 230. The shipped configuration 200B includes the waveguide 100, the push lens 201, a protective tape 310, the carrier 210, and a perimeter adhesive 220. In some embodiments, the shipped configuration 200B includes the projector 230.

[0022] The carrier 210 is a monolithic circumferential component. In one or more embodiments the carrier 210 is a monolithic component. For example, the carrier 210 is round and may be larger than the carried components, e.g. the push lens 201 and the corrective lens 203. The carrier 210 may be one of many shapes, such as in a shape typical to standard eyeglass lenses. Furthermore, the carrier 210 may be an integrated part of an eyeglass, AR lens, or VR device. The carrier 210 includes a first carrier portion 211 and a second carrier portion 212 that are part of the carrier 210, i.e., the first carrier portion 211 and the second carrier portion 212 are portions of the circumferential carrier 210. The first carrier portion 211 and a second carrier portion 212 are spaced to retain the push lens 201 and the waveguide 100. The first carrier portion 211 corresponds to the temporal side of the carrier. The second carrier portion 212 corresponds to the nasal side of the carrier. The first carrier portion 211 includes a projection portion 213. The projection portion 213 has an aperture 214 to align the projector 230 to the first grating 104a. In some embodiments, the first carrier portion 211 and the projection portion 213 are a monolithic body. The push lens 201 is fixed to the carrier 210 using an adhesive such as a UV curable glue. The push lens 201 has a refractive adjustment with a positive diopter. The refractive adjustment is used to negate all or some of the power in the corrective lens 203. The push lens 201 has as a refractive adjustment in a range of about 0.5 diopter to about 1 diopter. The carrier 210 includes a plastic material or metal material. The metal material may include aluminum. The plastic material includes, but is not limited to, include a polycarbonate, a 3-D printed resin, or acrylonitrile butadiene styrene (ABS). The push lens 201 has a world-side surface 205 configured to be facing the outside world. The push lens 201 has a waveguide-side surface 206 oriented to the waveguide 100. The push lens 201 is a world-side lens.

[0023] The waveguide 100 is coupled to the push lens 201 via the perimeter adhesive 220 disposed on the waveguide-side surface 206. An edge of the waveguide 100 contacts the sidewalls of the first carrier portion 211 and the second carrier portion 212. The assembled configuration 200A includes a corrective lens 203. The corrective lens 203 is retained by the carrier 210 between the projection portion 213 and the second carrier portion 212. The corrective lens 203 is a plano lens or a prescription lens. The plano lens is an optometric lens. The plano lens may be plano-concave lens. The plano lens, includes but is not limited to, polycarbonate, glass,

plastic, or polyurethane. The prescription lens is also an optometric lens. The prescription includes but is not limited to, polycarbonate, glass, plastic, or polyurethane. The prescription lens has varying shapes and curvatures depending on the power of the correction needed by the user. The corrective lens 203 has an eye-side surface 207 configured to be facing the eye of the user. The corrective lens 203 has a waveguide-side surface 208 oriented to the waveguide 100. The push lens 201 and the corrective lens 203 include but are not limited to, polycarbonate, glass, plastic, polyurethane, or combinations thereof.

[0024] The corrective lens 203 is formed by surfacing a blank lens to the desired shape. The corrective lens can also be injection molded to the desired shape. A hard coat (HC) or a hard multi-coat (HMC) is applied to the blank lens to complete the corrective lens 203. The world-side surface 205 includes one or more of a hard coat, an anti-reflection layer (AR), and an anti-smudge layer (AS) disposed thereon. A HC and an AR layer are applied to the waveguide-side surface 206 of the push lens 201, and the waveguide-side surface 208 of the corrective lens 203. The edges of the corrective lens 203 are further machined down to the desired dimensions so that the corrective lens 203 can be coupled to the carrier 210 between the projection portion 213 and the second carrier portion 212 as shown. The corrective lens 203 is coupled to the carrier 210 using an adhesive or the corrective lens 203 is coupled mechanically. The adhesive may include glue. The corrective lens 203 is coupled mechanically by being snapped into place or using a wire. In some embodiments, the corrective lens 203 is a prescription (Rx) lens. The prescription lens adjusts the light beams traveling through the prescription lens to the desired ophthalmic correction according to the user's needs. The ophthalmic correction of the corrective lens 203 may be customized so that the ophthalmic correction of the optical device assembly 200 can be tuned. This allows the optical device assembly 200 to have a swappable prescription lens function. For example if the push lens 201 has a refractive adjustment of +0.5 diopter and the corrective lens 203 has an ophthalmic correction of +0.5 diopter, then the overall ophthalmic correction of the optical device assembly is +1.0 diopter. In one or more embodiments, the ophthalmic correction of the corrective lens 203 is used to negate the correction of the push lens 201, so that the optical device assembly 200 has no overall ophthalmic correction. For example if the push lens 201 has a refractive adjustment of +0.5 diopter and the corrective lens 203

has an ophthalmic correction of -0.5 diopter, then the overall ophthalmic correction of the optical device assembly 200 is 0 diopter. The optical device assembly 200 has an overall ophthalmic correction within a range of about +3.0 diopter to about -8.0 diopter. In one or more embodiment, the overall ophthalmic correction includes a cylinder power to correct astigmatism.

[0025] Figures 3A – 3E are a cross sectional views of the of an optical device assembly 200 during a method of fabrication, according to one or more embodiments. As shown in Figure 3A, the push lens 201 is coupled to the carrier 210. The carrier 210 includes the first carrier portion 211 and the second carrier portion 212. The first carrier portion 211 and the second carrier portion 212 are spaced to retain the push lens 201 and the waveguide 100. The carrier 210 includes the projection portion 213. The projection portion 213 has an aperture 214 to align the projector 230 to the first grating 104a.

[0026] The push lens 201 is formed by surfacing a blank lens to the desired shape. The push lens 201 can also be injection molded to the desired shape. A HC and an AR layer are applied to the waveguide-side surface 206 of the push lens 201. The edges of the push lens 201 are further machined down to the desired dimensions so that the push lens 201 can be coupled to the carrier 210 as shown.

[0027] As shown in Figure 3B, the waveguide 100 is disposed between the sidewalls of the first carrier portion 211 and the second carrier portion 212. The waveguide 100 is fixed to the push lens 201 using a perimeter adhesive 220. The perimeter adhesive 220 is applied to the waveguide-side surface 206 of the push lens 201 and a second surface 105 of the waveguide 100. The perimeter adhesive 220 includes pressure sensitive adhesives (PSA) or UV curable glue.

[0028] As shown in Figure 3C, a protective tape 310 applied to the between the projection portion 213 and the second carrier portion 212 of the carrier 210 of the optical device assembly 200. The protective tape 310 is a removable protective tape and helps protect the waveguide 100 during shipping, handling, or storage. Figure 3D shows the projector 230 coupled to the projection portion 213 of the optical device assembly 200. The projector 230 is aligned in with the aperture 214 in order for the projector 230 to project light beams through the aperture 214 into the first grating 104a. In some embodiments, the projector 230 is coupled to the carrier 210 prior to

the protective tape 310 being applied to the carrier 210 in the shipped configuration 200B. In other embodiments, the projector 230 is coupled to the carrier 210 at substantially the same time that the protective tape 310 is applied to the carrier 210 in the shipped configuration 200B. In additional embodiments the projector 230 is coupled to the carrier 210 after the protective the protective tape 310 is applied to the carrier 210 in the shipped configuration 200B. In some embodiments the projector 230 is not included in the shipped configuration 200B.

[0029] As show in Figure 3E, the shipped configuration 200B of the optical device assembly 200 is assembled. To assemble the assembled configuration 200A, the protective tape 310 is removed. The corrective lens 203 is coupled to the carrier 210 after the protective tape 310 is removed. The corrective lens 203 is coupled between the projection portion 213 and the second carrier portion 212 of the carrier 210. It is contemplated that in some embodiments, the corrective lens 203 is included in the shipped configuration 200B.

[0030] Figure 4 is a cross sectional view of an optical device assembly 400, according to one or more embodiments. The optical device assembly 400 is similar to the optical device assembly 200 shown in Figure 2, and includes one or more of the aspects, features, components, properties, and/or operations thereof. The optical device assembly 400 has an assembled configuration 400A and a shipped configuration 400B as shown in Figure 5E. The assembled configuration 400A includes the waveguide 100, a push lens 201, a corrective lens 203, a carrier 210, and a perimeter adhesive 220, a projector 230, and a protective plate 410. The shipped configuration 400B includes the waveguide 100, the push lens 201, the carrier 210, a perimeter adhesive 220, and a protective plate 410. In some embodiments, the shipped configuration 400B includes the projector 230.

[0031] Figures 5A – 5E are a cross sectional views of the of the optical device assembly 400 during a method of fabrication, according to one or more embodiments. As shown in Figure 5A, the push lens 201 is coupled to the carrier 210. The carrier 210 includes the first carrier portion 211 and the second carrier portion 212. The first carrier portion 211 and the second carrier portion 212 are spaced to retain the push lens 201 and the waveguide 100. The first carrier portion 211 includes the projection portion 213. The projection portion 213 has an aperture 214 to align the projector 230

to the first grating 104a. As shown in Figure 5B, the waveguide 100 is disposed between the sidewalls of the first carrier portion 211 and the second carrier portion 212. The waveguide 100 is fixed to the push lens 201 using a perimeter adhesive 220. The perimeter adhesive 220 is applied to a waveguide-side surface 206 of the push lens 201 and a second surface 105 of the waveguide 100. The perimeter adhesive 220 includes pressure sensitive adhesives (PSA) or UV curable glue.

[0032] As shown in Figure 5C, a protective plate 410 applied to the between the first carrier portion 211 the second carrier portion 212 of the carrier 210 of the optical device assembly 400. The protective plate 410 is fixed to the waveguide 100 using a perimeter adhesive 220. The perimeter adhesive 220 is applied to the first surface 103 of the waveguide 100 and a waveguide-side surface 412 of the protective plate 410. The protective plate 410 is a permanent fixture and helps protect the waveguide 100 during shipping, handling or storage. The protective plate 410 further protects the waveguide 100 in the event the corrective lens 203 is replaced. Figure 5D shows the projector 230 coupled to the projection portion 213 of the optical device assembly 400. The projector 230 is aligned in with the aperture 214 in order for the projector 230 to project light beams through the aperture 214 and the protective plate 410 into the first grating 104a. In some embodiments, the projector 230 is coupled to the carrier 210 prior to the protective plate 410 being applied to the carrier 210 in the shipped configuration 400B. In other embodiments, the projector 230 is coupled to the carrier 210 at substantially the same time that the protective plate 410 is applied to the carrier 210 in the shipped configuration 400B. In additional embodiments the projector 230 is coupled to the carrier 210 after the protective the protective plate 410 is applied to the carrier 210 in the shipped configuration 400B. In some embodiments the projector 230 is not included in the shipped configuration 400B.

[0033] As show in Figure 5E, the shipped configuration 400B of the optical device assembly 400 is assembled. It is contemplated that in some embodiments the corrective lens 203 is included in the shipped configuration 400B.

[0034] Figure 6 is a cross sectional view of an optical device assembly 600, according to one or more embodiments. The optical device assembly 600 is similar to the optical device assembly 200 shown in Figure 2, and optical device assembly 400 shown in Figure 4, and includes one or more of the aspects, features, components,

properties, and/or operations thereof. The optical device assembly 600 has an assembled configuration 600A and a shipped configuration 600B as shown in Figure 7B. The assembled configuration 600A includes the waveguide 100, a push lens 201, a corrective lens 603, a carrier 610, and a perimeter adhesive 220, and a projector 230. The shipped configuration 600B (Figure 7B) includes the waveguide 100, the push lens 201, the carrier 610, and a perimeter adhesive 220.

[0035] The carrier 610 is a monolithic circumferential component. The carrier 610 includes a first carrier portion 611 and a second carrier portion 612 that are part of the carrier 610, i.e., the first carrier portion 611 and the second carrier portion 612 are portions of the circumferential carrier 610. The first carrier portion 611 corresponds to the temporal side of the carrier. The second carrier portion 612 corresponds to the nasal side of the carrier. The first carrier portion 611 and a second carrier portion 612 are spaced to retain the push lens 201 and the waveguide 100. The push lens 201 is fixed to the carrier 610 using an adhesive such as a UV curable glue. The push lens 201 has a refractive adjustment with a positive diopter. The refractive adjustment is used to negate the power in the corrective lens 203. The push lens 201 has a refractive adjustment in a range of about 0.5 diopter to about 1 diopter. The carrier 610 includes a plastic material or metal material. The metal material may include aluminum. The plastic material includes, but is not limited to, include a polycarbonate, a 3-D printed resin, or acrylonitrile butadiene styrene (ABS). The push lens 201 has a world-side surface 205 configured to be facing the outside world. The push lens 201 has a waveguide-side surface 206 oriented to the waveguide 100. The push lens 201 is a world-side lens.

[0036] The waveguide 100 is coupled to the push lens 201 via the perimeter adhesive 220 disposed on the waveguide-side surface 206. The assembled configuration 600A includes a corrective lens 603. The corrective lens 603 is retained by the carrier 610 between the first carrier portion 611 and the second carrier portion 612. The corrective lens 603 includes a projection seat 613. The projection seat 613 has an aperture 614 to align the projector 230 to the first grating 104a. The corrective lens 603 is a plano lens or a prescription lens. The plano lens is an optometric lens. The plano lens may be a plano-concave lens. The plano lens, includes but is not limited to, polycarbonate, glass, plastic, or polyurethane. The prescription lens is also an optometric lens. The prescription includes but is not limited to, polycarbonate, glass, plastic, or

polyurethane. The prescription lens has varying shapes and curvatures depending on the power of the correction needed by the user. The corrective lens 603 has an eye-side surface 607 configured to be facing the eye of the user. The corrective lens 603 has a waveguide-side surface 608 oriented to the waveguide 100. The push lens 201 and the corrective lens 603 include but are not limited to, polycarbonate, glass, plastic, polyurethane, or combinations thereof.

[0037] The corrective lens 603 is formed by surfacing a blank lens to the desired shape. The corrective lens can also be injection molded to the desired shape. A hard coat (HC) or a hard multi-coat (HMC) is applied to the blank lens to form the corrective lens 603. The edges of the corrective lens 603 are further machined down to the desired dimensions so that the corrective lens 603 can be coupled to the carrier 610 between the first carrier portion 611 and the second carrier portion 612 as shown. The corrective lens 203 is coupled to the carrier 210 using an adhesive such as glue, or the corrective lens 203 may be coupled in mechanically by being snapped into place or using a wire. In some embodiments the corrective lens 603 is a prescription (Rx) lens. The prescription lens adjusts the light beams traveling through the prescription lens to the desired ophthalmic correction according to the user's needs. The ophthalmic correction of the corrective lens 603 may be adjusted so that the ophthalmic correction of the optical device assembly 600 can be tuned. This allows the optical device assembly 600 to have a swappable prescription lens function. For example if the push lens 201 has a refractive adjustment of +0.5 diopter and the corrective lens 603 has an ophthalmic correction of +0.5 diopter, then the overall ophthalmic correction of the optical device assembly is +1.0 diopter. In one or more embodiments, the ophthalmic correction of the corrective lens 603 is used to negate the correction of the push lens 201, so that the optical device assembly 600 has no overall ophthalmic correction. For example if the push lens 201 has a refractive adjustment of +0.5 diopter and the corrective lens 603 has an ophthalmic correction of -0.5 diopter, then the overall ophthalmic correction of the optical device assembly is 0 diopter. The optical device assembly 600 has an overall ophthalmic correction within a range of about +3.0 diopter to about -8.0 diopter. In one or more embodiment, the overall ophthalmic correction includes a cylinder power if needed to correct astigmatism.

[0038] Figures 7A – 7D are a cross sectional views of the of an optical device assembly 600 during a method of fabrication, according to one or more embodiments. As shown in Figure 7A, the push lens 201 coupled to the carrier 610. The carrier 610 includes the first carrier portion 611 and the second carrier portion 612. The first carrier portion 611 and the second carrier portion 612 are spaced to retain the push lens 201 and the waveguide 100.

[0039] As shown in Figure 7B, the waveguide 100 is disposed between the sidewalls of the first carrier portion 611 and the second carrier portion 612. The waveguide 100 is fixed to the push lens 201 using a perimeter adhesive 220. The perimeter adhesive 220 is applied to the waveguide-side surface 206 of the push lens 201 and a second surface 105 of the waveguide 100. The perimeter adhesive 220 pressure sensitive adhesives (PSA) or UV curable glue.

[0040] Figure 7B shows the shipped configuration 600B of the optical device assembly 600 as assembled. In some embodiments a protective tape 310 (Figure 3C) is disposed the first carrier portion 611 and the second carrier portion 612 of the carrier 610 of the optical device assembly 600. The protective tape 310 is a removable protective tape and helps protect the waveguide 100 during shipping.

[0041] As shown in Figure 7C, the corrective lens 603 applied to the between the first carrier portion 611 and the second carrier portion 612 of the carrier 610 of the optical device assembly 600. The corrective lens 603 is fixed to the waveguide 100 using a perimeter adhesive 220. The perimeter adhesive 220 is applied to the first surface 103 of the waveguide 100 and a waveguide-side surface 608 of the corrective lens 603. Figure 7D shows the projector 230 coupled to the projection seat 613 of the corrective lens 603. The projector 230 is aligned in with the aperture 614 in order for the projector 230 to project light beams through the aperture 614 into the first grating 104a. In some embodiments the projector 230 and the corrective lens 603 are included in the shipped configuration 600B.

[0042] Figure 8 is a cross sectional view of an optical device assembly 800, according to one or more embodiments. The optical device assembly 800 is similar to the optical device assembly 200 shown in Figure 2, the optical device assembly 400 shown in Figure 4, and the optical device assembly 600 shown in Figure 6, and includes one or more of the aspects, features, components, properties, and/or

operations thereof. The optical device assembly 800 has an assembled configuration 800A and a shipped configuration 800B as shown in Figure 9E. The assembled configuration 800A includes the waveguide 100, a push lens 201, a corrective lens 203, a carrier 610, and a perimeter adhesive 220, a projector 230, and a projection mount 810. The shipped configuration 400B includes the waveguide 100, the push lens 201, the carrier 210, a perimeter adhesive 220, and the projection mount 810. In some embodiments, the shipped configuration 800B includes the projector 230.

[0043] The waveguide 100 is coupled the push lens 201 via the perimeter adhesive 220 disposed on the waveguide-side surface 206. The assembled configuration 600A includes a corrective lens 603. The corrective lens 603 is disposed between the projection mount 810 and the second carrier portion 612. The corrective lens 603 is fixed to the waveguide 100 using a perimeter adhesive 220. The perimeter adhesive 220 is applied to the first surface 103 of the waveguide 100 and the waveguide-side surface 208 of the corrective lens 203. In some embodiments the perimeter adhesive is applied between the projection mount 810 and the corrective lens 203.

[0044] Figures 9A – 9E are a cross sectional views of the of an optical device assembly 800 during a method of fabrication, according to one or more embodiments As shown in Figure 9A, the push lens coupled to the carrier 610. The carrier 610 includes the first carrier portion 611 and the second carrier portion 612. The first carrier portion 611 and the second carrier portion 612 are spaced to retain the push lens 201 and the waveguide 100. As shown in Figure 5B, the waveguide 100 is disposed between the sidewalls of the first carrier portion 611 and the second carrier portion 612. The waveguide 100 is fixed to the push lens 201 using a perimeter adhesive 220. The perimeter adhesive 220 is applied to the waveguide-side surface 206 of the push lens 201 and a second surface 105 of the waveguide 100. The perimeter adhesive 220 includes cyanoacrylates or other adhesives.

[0045] As shown in Figure 9C, a projection mount 810 is applied to the first carrier portion 611 of the carrier 610 of the optical device assembly 800. The projection mount 810 is fixed to the waveguide 100 using a perimeter adhesive 220. The perimeter adhesive 220 is applied to the first surface 103 of the waveguide 100 and a waveguide-side surface 812 of the projection mount 810. The projection mount 810 has an aperture 814 to align the projector 230 to the first grating 104a. Figure 5D

shows the projector 230 coupled to the projection mount 810 of the optical device assembly 800. The projector 230 is aligned in with the aperture 814 in order for the projector 230 to project light beams through the aperture 814 and the into the first grating 104a. In some embodiments the projector 230 is not included in the shipped configuration 400B.

[0046] As show in Figure 9E, the shipped configuration 800B of the optical device assembly 800 is assembled. It is contemplated that in some embodiments the corrective lens 203 is included in the shipped configuration 800B.

[0047] Benefits of the present disclosure include decreased contaminates between the lens and the waveguide; decreased risk to damaging the waveguide; increased production efficiency; decreased cost; decreased maintenance; decreased number of parts; and enhanced device performance.

[0048] It is contemplated that one or more aspects disclosed herein may be combined. As an example, one or more aspects, features, components, operations, and/or properties of the various embodiments of the waveguide 100; the gratings 104; the optical device assembly 200, the push lens 201, the corrective lens 203, the carrier 210; the perimeter adhesive 220; the projector 230; the protective tape 310; the optical device assembly 400; the protective plate 410; the optical device assembly 600; the corrective lens 603; the carrier 610; the optical device assembly 800; and/or the projection mount 810 may be combined. Moreover, it is contemplated that one or more aspects disclosed herein may include some or all of the aforementioned benefits.

[0049] While the foregoing is directed to embodiments of the present disclosure, other and further embodiments of the disclosure may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims that follow.

What is claimed is:

1. An optical device assembly comprising:
a carrier, the carrier having a first carrier portion and a second carrier portion;
a push lens coupled to the first carrier portion and the second carrier portion,
the first carrier portion and the second carrier portion are spaced to retain the push lens; and
a waveguide disposed over a waveguide-side surface of the push lens between the first carrier portion and the second carrier portion, the waveguide comprising at least an incoupler grating disposed over a first surface or a second surface opposing the first surface of the waveguide, the first carrier portion including a projection portion operable to retain a projector aligned with incoupler grating.
2. The optical device assembly of claim 1, further comprising the projector coupled to the projection portion, wherein the projector is aligned with the incoupler.
3. The optical device assembly of claim 1, further comprising a protective tape coupled to the first carrier portion and the second carrier portion.
4. The optical device assembly of claim 1, further comprising a protective plate disposed over the first surface of the waveguide between the first carrier portion and the second carrier portion.
5. The optical device assembly of claim 1, further comprising an adhesive disposed between the waveguide-side surface of the push lens, and the second surface of the waveguide.
6. The optical device assembly of claim 4, further comprising an adhesive disposed between the waveguide-side surface of the protective plate, and the first surface of the waveguide.
7. The optical device assembly of claim 1, wherein the first carrier portion and the projection portion are a monolithic body.

8. The optical device assembly of claim 1, wherein the projection portion is a projection mount coupled to the first carrier portion.
9. The optical device assembly of claim 8, wherein an adhesive is disposed between the projection mount and the first carrier portion.
10. The optical device assembly of claim 1, further comprising a corrective lens disposed between the projection portion and the second carrier portion.
11. The optical device assembly of claim 10, wherein the corrective lens is a prescription lens.
12. The optical device assembly of claim 10, wherein the corrective lens is a plano lens.
13. An optical device assembly comprising:
a carrier, the carrier having a first carrier portion and a second carrier portion;
a push lens coupled to the first carrier portion and the second carrier portion, the first carrier portion and the second carrier portion are spaced to retain the push lens;
a waveguide disposed over a waveguide-side surface of the push lens between the first carrier portion and the second carrier portion, the waveguide comprising at least an incoupler grating disposed over a first surface or a second surface opposing the first surface of the waveguide; and
a corrective lens retained by the carrier disposed over the waveguide, the corrective lens includes a projection seat having an aperture to operable to align a projector to the incoupler grating.
14. The optical device assembly of claim 13, further comprising the projector coupled to the projection seat, wherein the projector is aligned with the incoupler.
15. The optical device assembly of claim 13, wherein the corrective lens is a prescription lens.

16. The optical device assembly of claim 13, wherein the corrective lens is a plano lens.

17. A method of fabricating an optical device assembly comprising:
a carrier, the carrier having a first carrier portion and a second carrier portion;
coupling a push lens to the carrier, between the first carrier portion and the second carrier portion, the first carrier portion and the second carrier portion are spaced to retain the push lens; and
coupling a waveguide to the push lens, the waveguide disposed over a waveguide-side surface of the push lens between the first carrier portion and the second carrier portion, the waveguide comprising at least an incoupler grating disposed over a first surface or a second surface opposing the first surface of the waveguide, the first carrier portion including a projection portion operable to retain a projector aligned with the incoupler grating.

18. The method of claim 17, further comprising:
coupling the projector to the projection portion, wherein the projector is aligned with the incoupler grating.

19. The method of claim 17, further comprising:
coupling a corrective lens to the carrier between the projection portion and the second carrier portion.

20. The method of claim 17, further comprising:
coupling a corrective lens to the waveguide between the first carrier portion and the second carrier portion.