ELECTRO-SWITCHABLE SPECTACLES FOR MYOPIA TREATMENT

RELATED APPLICATIONS

[0001] This application claims the benefit under 35 U.S.C. § 119(e) of U.S. Provisional Patent Application No. 63/024,379, filed May 13, 2020, and titled "ELECTRO-SWITCHABLE SPECTACLES FOR MYOPIA TREATMENT," which is incorporated, in its entirety, by this reference.

[0002] The subject matter of the present application is related to PCT/US2020/044571, filed on July 31, 2020, entitled "DEVICE FOR PROJECTING IMAGES ON THE RETINA", published as WO/2021/022193 on February 4, 2021, the entire disclosure of which is incorporated herein by reference.

BACKGROUND

[0003] Work in relation to the present disclosure suggests that myopically defocused light to the peripheral retina can decrease the progression of myopia. However, at least some of the prior approaches can be less than ideal in at least some respects. For example, at least some of the prior approaches can be more complex than would be ideal and may provide less than ideal treatment results. Also, at least some of the prior approaches can degrade vision more than would be ideal.

[0004] In light of the above, improved methods and apparatus for treating refractive error that ameliorate at least some of the limitations of the prior approaches are needed.

SUMMARY

[0004a] In a first aspect, the present disclosure provides an apparatus to treat refractive error of an eye, the apparatus comprising: a lens comprising an optical zone; and a switchable zone extending around the optical zone, wherein the switchable zone comprises an electroactive material switchable between a first configuration to substantially scatter or defocus light and second configuration to substantially transparently transmit light through the lens

[0005] In some embodiments, an apparatus to treat refractive power of one or both eyes such as an eyeglass optic comprises a lens to correct refractive power and a switchable optical component. The switchable optical component can be configured with an electroactive material to provide optical power or light scattering to treat refractive error of the eye. The switchable optical component can be configured to turn on and off manually or automatically using an electronic control system. In an off state, the

additional optical component functions as a substantially transparent optical layer with no substantial optical power or light scattering. In an on state, the optical component is either switched to a fixed or controllable amount of optical power, or a fixed or controllable amount of light scatter. In some embodiments, the switchable component comprises an electro-active optic comprising a plurality of optical elements, such as pixels. In some embodiments, the electro-active optical component comprises a

CLAIMS

WHAT IS CLAIMED IS:

1. An apparatus to treat refractive error of an eye, the apparatus comprising:

a lens comprising an optical zone; and

a switchable zone extending around the optical zone, wherein the switchable zone comprises an electroactive material switchable between a first configuration to substantially scatter or defocus light and second configuration to substantially transparently transmit light through the lens.

2. The apparatus of claim 1, wherein the switchable zone is substantially translucent in the first configuration and substantially transparent in the second configuration.

3. The apparatus of claim 1, wherein images viewed through the switchable zone in the first configuration appear blurry.

4. The apparatus of claim 1, wherein an optical power of the optical zone remains substantially fixed for the first configuration and the second configuration of the switchable zone.

5. The apparatus of claim 3, wherein the switchable zone comprises particles to blur the viewed images in response to a difference between an index of refraction of the particles and the electroactive material.

6. The apparatus of claim 3, wherein switchable zone comprises a liquid crystal material configured to vary an optical power of the switchable zone and wherein the optical power in the first configuration differs from an optical power of the second configuration.

7. The apparatus of claim 6, wherein the switchable zone comprises a plurality of switchable lenslets to vary the optical power, the plurality switchable lenslets comprising one or more of an optical surface profile or an electrode profile to vary the optical power and defocus light in the first configuration.

8. The apparatus of claim 3, wherein the switchable zone comprises one or more optical structures comprising an optical surface profile to blur the viewed images in response to a difference between an index of refraction of the one or more optical structures and an index of refraction of the electroactive material.

9. The apparatus of claim 8, wherein the optical surface profile comprises a diffractive optic profile to provide optical power in response to the difference in the index of refraction of the one or more optical structures and the index of refraction of the electroactive material.

10. The apparatus of claim 9, wherein the diffractive optic profile comprises a plurality of echelletes.

11. The apparatus of claim 9, wherein switchable zone is configured to focus an image of an object anterior or posterior to the retina in the first configuration and to focus the image of the object onto the retina in the second configuration.

12. The apparatus of claim 3, wherein the switchable zone comprises an electrode profile to blur the viewed images with diffraction in response to a difference between a first index of refraction of the electroactive material at first location and a second index of refraction of the electroactive material at a second location, the first location closer to the electrode than the second location.

13. The apparatus of claim 12, wherein electrode profile is configured to provide optical power to the switchable zone to focus light away from the retina in the first configuration.

14. The apparatus of claim 13, wherein electrode profile is configured to generate positive optical power and negative optical power with diffraction related to the difference between the first index at the first location and the second index at the second location.

15. The apparatus of claim 12, wherein electrode profile comprises a plurality of gaps corresponding to the second location of the electroactive material.

16. The apparatus of claim 15, wherein electrode profile comprises an electrode trace extending along a substrate corresponding to the first location of the

electroactive material and wherein the electrode profile comprises a plurality of gaps defined by the traces of the electrode

17. The apparatus of claim 16, wherein the second location of the electroactive material comprises a plurality of second locations and wherein the plurality of gaps corresponds to the plurality of second locations of the electroactive material.

18. The apparatus of claim 1, wherein the lens comprises an optical power, the optical zone comprising the optical power and wherein the switchable zone is located on the lens to transmit light with the optical power in the second configuration.

19. The apparatus of claim 18, wherein the lens comprises a first side and a second side, the switchable zone located on the first side, the second side comprising a curvature to provide a majority of the optical power of the lens.

20. The apparatus of claim 1, wherein the switchable zone comprises the first configuration when a voltage is applied to the zone and the second configuration without the voltage applied to the zone.