

CLAIMS

1. A spectacle lens for a myopic eye comprising: an integral base spectacle lens, configured with a distance base prescription to correct, at least in part, the refractive error of the myopic eye; and at least one auxiliary optical element formed within, or in conjunction, or in juxtaposition to the integral base spectacle lens; wherein the at least one auxiliary optical element is configured to provide an optical effect to the eye that is different to that provided by the integral base spectacle lens; and wherein the combination of the integral base spectacle lens and the at least one auxiliary optical element is configured to provide an elongation of depth of focus for at least one portion on the retina of the myopic eye.
2. A spectacle lens of claim 1, wherein the integral base spectacle lens has a spherical or toric base prescription.
3. A spectacle lens of claims 1 to 2, wherein the diameter of each auxiliary optical element is greater than 0.75 mm.
4. A spectacle lens of claims 1 to 3, wherein the surface area of each auxiliary optical element is greater than 1.75 square mm.
5. A spectacle lens of claims 1 to 4, wherein the total combined surface area of substantially all auxiliary optical elements is less than 30% of the total surface area of the spectacle lens.
6. A spectacle lens of claims 1 to 5, wherein at least one of the auxiliary optical element utilises at least in part an axicon, a linear axicon, a forward axicon, a backward axicon, an inverse logarithmic axicon, a logarithmic axicon, or a combination thereof.
7. A spectacle lens of claims 1 to 6, wherein the sag of at least one auxiliary optical element is characterised by the axicon surface which is further characterised by an odd asphere represented by an equation;

$$\text{sag}(z) = \beta_1 \rho^1 + \beta_2 \rho^2 + \beta_3 \rho^3 + \beta_4 \rho^4 + \beta_5 \rho^5 + \beta_6 \rho^6 + \beta_7 \rho^7$$

wherein, β_1 to β_7 are the coefficients of the odd asphere surface; and ρ is radial co-ordinate described as $\sqrt{x^2 + y^2}$; wherein the coefficients β_1 values range between -3E-03 and +3E-03, β_2 values range between -3E-03 and +3E-03, β_3 values range between -9E-03 and +9E-03, β_4 values range between -3E-03 and +3E-03, β_5 values

range between -3E-04 and +3E-04, β_6 values range between -6E-04 and +6E-04, β_7 values range between -2E-04 and +2E-04.

8. A spectacle lens of claims 1 to 7, wherein the axicons combined at least in part with the integral base spectacle lens generates a ring shaped light distribution with a width and an intensity pattern, such that the ring shaped light distribution is substantially of similar width and an intensity pattern over a substantial through focus region of the retina; wherein the substantial through focus region of the retina includes at least 0.5 mm in front of the retina and 0.5 behind the retina.
9. A spectacle lens of claims 1 to 6, wherein at least one of the auxiliary optical element utilises at least in part a light sword element, a modified light sword element, a single peacock-eye element, a double peacock-eye element, or a combination thereof peacock-eye element.
10. A spectacle lens of claims 1 to 6 and claim 9, wherein the optical effect provided to the eye is achieved by configuring the at least one light sword, or modified light sword, element auxiliary optical element in combination of the integral base spectacle lens with an optical path difference (OPD) that is defined by:

$$OPD(\rho, \theta) = \frac{\rho^2}{2 \left[F + \Delta F \left(\frac{\theta}{2\pi} \right) \right]}$$

wherein, ρ , and θ is the radial ($\rho = \sqrt{x^2 + y^2}$) and azimuthal ($\theta = \tan^{-1} \left(\frac{y}{x} \right)$) coordinates respectively; and parameters F and ΔF stand for the focal length of the lens and the range of extended depth of focus of the optical element, both in lens units (mm); wherein F approximately matching the underlying refractive error of the eye, ΔF may between 0.25 to 1.5 mm in width; wherein at the interface adjoining any of the auxiliary optical elements and integral base spectacle lens is substantially ledge, ridge, edge free.

11. A spectacle lens of claims 1 to 6 and claim 9, wherein the optical effect provided to the eye by the at least one peacock-eye auxiliary optical element in combination of the integral base spectacle lens utilising an optical path difference (OPD) that is defined by:

$$OPD(x, y) = \frac{[F - (\Delta F/2)]d^2}{\Delta F^2} \ln\left(\frac{\Delta F}{d}x + (F)\right) - \frac{d}{\Delta F}x - \frac{y^2}{2\left(\frac{\Delta F}{d}x + (F)\right)}$$

wherein, x and y are cartesian coordinates of the optical phase function of the regional or auxiliary optical element; parameters F and ΔF stand for the focal length of the integral base spectacle lens and the regional optical element, and the range of extended depth of focus of the regional or auxiliary optical element, both defined in lens units (mm); and 'd' is the diameter of the auxiliary optical element; wherein F approximately matching the underlying refractive error of the eye, ΔF is defined about the retina and may be between 0.25 to 1.5 mm in width; and d is between 0.375 and 2 mm; wherein at the interface adjoining any of the auxiliary optical elements and integral base spectacle lens is substantially ledge, ridge, edge free.

12. A spectacle lens of claims 10 or 11, wherein the elongation of depth of focus comprises a positive end and the negative end, and wherein the elongation of depth of focus is configured such that the negative end is positioned substantially in front of the retina and positive end is positioned substantially on the retina of the myopic eye.
13. A spectacle lens of claims 10 or 11, wherein the elongation of depth of focus provided by each of the auxiliary optical element is between 0.2 mm and 1.5 mm in width.
14. A spectacle lens of one or more preceding claims, wherein the elongation of depth of focus is achieved for a plurality of wavelengths of visible light between 460 nm and 760 nm, inclusive.
15. A spectacle lens of one or more preceding claims, wherein the elongation of depth of focus is achieved for a plurality of pupil diameters between 3 mm and 6 mm, inclusive.
16. A spectacle lens of one or more preceding claims, wherein the at least one portion on the retina is within 30 degree visual field of the myopic eye.
17. A spectacle lens of one or more preceding claims, wherein the at least one auxiliary optical element is configured on the anterior surface, or posterior surface, or both surface of the spectacle lens.
18. A spectacle lens of one or more preceding claims, wherein the at least one auxiliary optical element is configured within the matrix of the spectacle lens.

19. A spectacle lens of one or more preceding claims, wherein the at least one auxiliary optical element has one or more of the following shapes: circular, elliptical, regular polygon or irregular polygon.
20. A spectacle lens of one or more preceding claims, wherein the spectacle lens is cosmetically indistinguishable from a traditional or conventional single vision spectacle lens.
21. A spectacle lens of one or more preceding claims, wherein the spectacle lens is configured to provide a progressing eye for at least 50% of the total of the viewing angles of the region of the spectacle lens that contains the at least one regional optical element.