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, β1 to β7 are the coefficients of the odd asphere surface; and ρ is radial co-ordinate described as $\sqrt{x^2 + y^2}$; wherein the coefficients β1 values range between -3E-03 and +3E-03, β2 values range between -3E-03 and +3E-03, β3 values range between -9E-03 and +9E-03, β4 values range between -3E-03 and +3E-03, β5 values

range between -3E-04 and +3E-04, β6 values range between -6E-04 and +6E-04, β7 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:

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

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.

CLAIMS

1. A spectacle lens for a myopic eye comprising:

an integral base spectacle lens with a front and a back surface, configured with a distance base prescription to correct, at least in part, the refractive error of the myopic eye;

wherein the integral base spectacle lens has a spherical or a toric base prescription; and a plurality of regional optical elements formed within, or in conjunction with the front or the back surface of the integral base spectacle lens;

wherein each of the plurality of regional optical elements is configured with a residual sag profile, a surface area greater than 1.75 square mm and a centre-to-centre separation of at least 0.5 mm; and

wherein a total combined surface area of the plurality of regional optical elements is less than 35% of the total surface area of the integral base spectacle lens; and

wherein the combination of each of the plurality of regional optical elements and the integral base spectacle lens is configured to provide an extension of regional depth of focus for at least one portion on the retina of the myopic eye.

2. A spectacle lens of claim 1, wherein the residual sag profile 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.

3. A spectacle lens of claim 2, wherein the residual sag profile is 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, β1 to β7 are coefficients of the odd asphere surface; and ρ is radial co-ordinate described as $\sqrt{x^2 + y^2}$; wherein the coefficients β1 values range between -3E-03 and +3E-03, β2 values range between -3E-03 and +3E-03, β3 values range between -9E-03 and +9E-03, β4 values range between -3E-03 and +3E-03, β5 values range between -3E-04 and +3E-04, β6 values range between -6E-04 and +6E-04, β7 values range between -2E-04 and +2E-04.

4. A spectacle lens of claim 2, wherein the logarithmic axicon is configured to produce an optical path difference (OPD) that is defined by:

$$OPD\ (\rho) = \frac{1}{2A\ln(1 + A\frac{\rho^2}{F})}$$

wherein, ρ is the radial coordinate of a phase function (ρ= $\sqrt{x^2 + y^2}$), A = ΔF/R^2, parameter F (mm) stands for the combined focal length of the integral base spectacle lens and the regional optical element, parameter ΔF (mm) stands for the range of regional extended depth of focus obtained with the regional optical element; and R is the semi-diameter of the regional optical element; wherein ΔF is between 0.25 to 1.5 mm in width.

5. A spectacle lens of claim 2, wherein the axicon is configured as a quartic axicon or a lensacon, to produce the optical path difference (OPD) that is defined by:

$$OPD\ (\rho, \theta) = \frac{\rho^4}{4\Delta F R^4}$$

wherein, ρ is the radial coordinate of the phase function (ρ= $\sqrt{x^2 + y^2}$), parameter ΔF (mm) stands for the range of regional extended depth of focus obtained with the regional optical element; and R is the semi-diameter of the regional optical element; wherein ΔF is between 0.25 to 1.5 mm in width.

6. A spectacle lens of claims 2 to 5, wherein the regional optical element in conjunction with the integral base spectacle lens generates a ring shaped light distribution on the retina of the myopic eye with a width and an intensity pattern, such that the width is configured with a relatively constant lateral size, and the intensity pattern is configured with a relatively constant energy distribution over a through focus region of the retina; wherein the through focus region of the retina includes at least 0.5 mm in front of the retina and 0.5 mm behind the retina.

7. A spectacle lens of claim 1, wherein the regional optical element is configured by the residual sag profile utilising at least in part a light sword element, a modified light sword element, or a combination thereof, to produce an optical path difference (OPD) that is defined by:

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

wherein, ρ, and θ is radial (ρ= $\sqrt{x^2 + y^2}$) and azimuthal (θ = $\tan^{-1}\left(\frac{y}{x}\right)$) coordinates respectively; parameter F (mm) stands for the combined focal length of the integral

base spectacle lens and the regional optical element, parameter ΔF (mm) stands for the range of regional extended depth of focus obtained with the regional optical element; wherein ΔF is between 0.25 to 1.5 mm in width.

8. A spectacle lens of claim 1, wherein the regional optical element is configured by the residual sag profile utilising at least in part a light sword element, a modified light sword element, or a combination thereof, to produce an optical path difference (OPD) that is defined by:

$$OPD\ (\rho, \theta) = A\rho^2 + B\theta\rho^2$$

wherein, ρ, and θ is the radial (ρ= $\sqrt{x^2 + y^2}$) and azimuthal (θ = $\tan^{-1}\left(\frac{y}{x}\right)$) coordinates respectively; and parameters A and B stand for:

$$A = \frac{1}{2F}\ and\ B = \frac{1}{4\pi}\left[\frac{1}{F} - \frac{1}{F + \Delta F}\right]$$

wherein, parameter F (mm) stands for the combined focal length of the integral base spectacle lens and the regional optical element, parameter ΔF (mm) stands for the range of regional extended depth of focus obtained with the regional optical element; wherein ΔF is between 0.25 to 1.5 mm in width.

9. A spectacle lens of claims 7 and 8, wherein the residual sag profile comprises of at least a horizontal and vertical orientation of the regional optical element resulting in an asymmetry of at least 2 microns.

10. A spectacle lens of claim 1, wherein the regional optical element is configured by the residual sag profile utilising at least in part an axilens, to produce an optical path difference (OPD) that is defined by:

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

wherein, ρ is the radial coordinate (ρ= $\sqrt{x^2 + y^2}$) of the phase function; parameter F (mm) stands for the combined focal length of the integral base spectacle lens and the regional optical element, parameter ΔF (mm) stands for the range of regional extended depth of focus obtained with the regional optical element; wherein ΔF is between 0.25 to 1.5 mm in width; R is the semi-diameter of the

regional optical element, and b is a constant that determines an intensity distribution of a central peak.

11. A spectacle lens of claim 1, wherein the regional optical element is configured by the residual sag profile utilising at least in part one peacock-eye element or one double peacock-eye element to produce 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 an optical phase function of the regional optical element; parameter F (mm) stands for the combined focal length of the integral base spectacle lens and the regional optical element, parameter ΔF (mm) stands for the range of regional extended depth of focus obtained with the regional optical element; and d is the diameter of the regional optical element; wherein ΔF is defined about the retina and is between 0.25 to 1.5 mm in width.

12. A spectacle lens of claims 1 to 11, wherein the extension of regional depth of focus is gauged using through focus optical transfer function which comprises a positive end and a negative end, and wherein the extension of regional depth of focus is configured such that the negative end is positioned in front of, and the positive end is positioned behind, the at least one portion of the retina of the myopic eye; and wherein the extension of regional depth of focus is between +0.5 D and +2 D and the through focus optical transfer function is not bimodal.

13. A spectacle lens of claims 1 to 12, wherein the extension of regional depth of focus is configured over at least 10% of the viewing angles for the myopic eye.

14. A spectacle lens of claims 1 to 13, wherein the extension of regional depth of focus is achieved for a pupil diameter between 2.5 mm and 6 mm.

15. A spectacle lens of claims 1 to 14, wherein a plurality of regional optical elements are configured in an arrangement on the integral base spectacle lens, wherein the arrangement is circular, non-circular, semi-circular, annular, oval, rectangular, octagonal, hexagonal, random, or square in shape.

16. A spectacle lens of claims 1 to 15, wherein the plurality of regional optical elements include a combination of axicons, axilenses, lensacons, light sword elements,

modified light sword elements and peacock-eye elements described in claims 2 to 5, 7, 8, 10, and 11.

17. A spectacle lens of claims 1 to 16, wherein the integral base spectacle lens comprises a distinct distance zone and a distinct near zone, wherein the plurality of regional optical elements are configured or arranged substantially differently between the distinct distance and distinct near zones.

18. A pair of spectacle lenses of claims 1 to 17, wherein the pair of spectacle lenses are configured for a right myopic eye and a left myopic eye; wherein the plurality of regional optical elements are configured or arranged differently for the right myopic eye and the left myopic eye.

19. A method of spectacle lens of claims 1 to 18, to reduce progression of the myopic eye comprising: measurement of refraction of the myopic eye; identifying a distance prescription based at least in part on the refraction measurement of the myopic eye, choosing a spectacle lens for the myopic eye, wherein the spectacle lens is configured with the distance base prescription matching the refraction measurement of the myopic eye; and wherein the method includes wearing the spectacle lens for extended periods during the day.

20. A method of spectacle lens of claims 1 to 19, wherein the process for manufacturing the spectacle lens includes: (a) moulding and/or cutting a material to form at least one regional optical element comprising an interface adjoining the front or back surface of the integral base spectacle lens; and (b) desired steps taken to configure the interface to substantially eliminate any surface discontinuity and minimise formation of a ledge, a ridge, or an edge on the spectacle lens.