CLAIMS:

1. An ophthalmic lens comprising:

a base lens configured to direct light to at least a first plane; and

one or more light modulating cell zones comprising a plurality of light modulating cells located in at least one of a surface or embedded in the base lens of any combination of one or more of a central optical zone, a mid-peripheral optical zone and a peripheral optical zone of the base lens and configured for directing or shifting light to one or more planes;

wherein light transmitted through the one or more light modulating cell zones results in a through focus light distribution (TFLD) that extends to one or more additional planes in at least one of a posterior (hyperopic defocus) and anterior (myopic defocus) direction relative to the first plane, and the one or more light modulating cell zones are configured to direct light to one or more planes located posteriorly (hyperopic defocus) to the first plane and one or more planes located anteriorly (myopic defocus) to the first image plane.

2. The ophthalmic lens of claim 1, wherein the plurality of light modulating cells are at least one of refractive and/or diffractive in nature.

3. The ophthalmic lens of any of the preceding claims, wherein the sagittal depth of the light modulating cells varies from 20nm to 1mm, from 20nm to 500µm, from 20nm to 400µm, from 20nm to 300µm, from 20nm to 200µm, from 20nm to 100µm, and/or from 20nm to 50µm.

4. The ophthalmic lens of any of the preceding claims, wherein the light modulating cells are at least one of plano in power, and/or positive in power, and/or negative in power and/or has a plurality of powers.

5. The ophthalmic lens of any of the preceding claims, wherein the proportion of TFLD that is anterior to the first image plane is >20% of the light transmitted through the one or more light modulating cell zones.

6. The ophthalmic lens of any of the preceding claims, wherein the proportion of TFLD that is posterior to the first image plane is >20% of the light transmitted through theone or more light modulating cell zones.

7. The ophthalmic lens of any of the preceding claims, wherein the one or more light modulating cell zones incorporating one or more light modulating cells is configured to provide a TFLD wherein the ratio of light that is distributed in myopic defocus compared to hyperopic defocus is about < 1.0, about <0.9, about <0.8, about <0.7, about <0.6, about <0.5, about <0.4, about <0.3, about <0.2, about <0.1.

8. The ophthalmic lens of any of the preceding claims, wherein the one or more light modulating cell zones incorporating one or more light modulating cells is configured to provide a TFLD wherein the ratio of light that is distributed in myopic defocus compared to hyperopic defocus is about > 1.0, about >1.1, about >1.2, about >1.3, about >1.4, about >1.5, about >1.6, about >1.7, about >1.8, about >1.9.

9. The ophthalmic lens of any of the preceding claims, wherein the one or more light modulating cell zones incorporating one or more light modulating cells is configured to provide a TFLD with no substantial hyperopic defocus.

10. The ophthalmic lens of any of the preceding claims, wherein one or more light modulating cell zones incorporating one or more light modulating cells is configured to provide to provide a TFLD with no substantial myopic defocus.

11. The ophthalmic lens of any of the preceding claims, wherein the light modulating cell zones have a geometrical fill factor that is designed so the peak amplitude of defocused light anterior to the image plane is substantially greater, substantially similar to, or substantially less than the amplitude of defocused light posterior to the image plane.

12. The ophthalmic lens of any of the preceding claims, wherein the distance of the peak amplitude of the light directed to in front of the image plane is positioned substantially closer to the image plane than the distance of the peak amplitude of the light directed posterior to the image plane.

13. The ophthalmic lens of any of the preceding claims, wherein the TFLD, at least in part, forms an aperiodic and non-monotonic amplitude of myopically defocused light, hyperopically defocused light or both.

14. The ophthalmic lens of any of the preceding claims, wherein the light amplitude of any band of defocused light is at least about 20% of the total light amplitude, about 25%, about 30%, about 40 %, about 50%, about 60%, about 70%, about 80%, about 10% to 50%, about 10% to 40%, about 10% to 30% or about 10% to 20%.

15. The ophthalmic lens of any of the preceding claims, wherein the peak amplitude of the TFLD anterior to the image plane (or in front or in myopic defocus) is about 50% of all light directed anterior to the retinal plane.

16. The ophthalmic lens of any of the preceding claims, wherein the peak amplitude of the TFLD posterior to the retinal plane (or behind or in hyperopic defocus) is about 50% of all light directed posterior to the retinal plane.

17. The ophthalmic lens of any of the preceding claims, wherein the amplitude of the TFLD anterior to the retinal plane (or in front or in myopic defocus) and within 1.00D of the retinal plane is about < 10%, or about < 20%, or about <30% or about < 50% of the total light in front of the retinal plane.

18. The ophthalmic lens of any of the preceding claims, wherein the amplitude of the TFLD posterior to the retinal plane (or behind or in hyperopic defocus) and within 1.00D of the retinal plane is about < 10%, or about < 20%, or about <30% or about < 50% of the total light behind the retinal plane.

19. The ophthalmic lens of any of the preceding claims, wherein the power of the base lens varies across the lens.

20. The ophthalmic lens of any of the preceding claims, wherein a peripheral optical zone of the base lens is more positive or more negative in power compared to the central and/or a mid-peripheral optical zone.

21. The ophthalmic lens of any of the preceding claims, wherein a peripheral and a mid-peripheral optical zone of the base lens are more positive in power compared to a central optical zone.

22. The ophthalmic lens of any of the preceding claims, wherein the change in power from central to mid-peripheral and/or peripheral zone is stepped or gradually increases in a monotonic or a non-monotonic manner.

23. The ophthalmic lens of any of the preceding claims, wherein a change in power from central to peripheral zone is across the entire base lens and/or is applied to certain regions or quadrants or sections of the lens.

24. The ophthalmic lens of any of the preceding claims, wherein the base lens of the ophthalmic lens incorporates a filter and/or incorporates a phase-modifying mask (e.g., an amplitude mask).

25. The ophthalmic lens of any of the preceding claims, wherein a filter is applied across the entire base lens and/or is applied to select regions or quadrants or sections of the lens.

26. The ophthalmic lens of any of the preceding claims, wherein a phase-modifying mask is applied across the entire base lens and/or is applied to select regions or quadrants or sections of the lens.

27. The ophthalmic lens of any of the preceding claims, wherein the ophthalmic lens further comprises one or more concentric rings or annular zones or at least a portion of a ring or annular zone or zones with one or more powers and a plurality of light modulating cells.

28. The ophthalmic lens of any of the preceding claims, wherein the one or more of the light modulating cells may be positioned or packed on one or more zones of the base lens either individually or in arrays or arrangements, or in aggregates, or stacks, or clusters or other suitable packing arrangement.

29. The ophthalmic lens of any of the preceding claims, wherein the individual arrangements, aggregates, arrays, stacks, or clusters of the light modulating cells is positioned on the base lens in a square, hexagonal or any other suitable arrangement (e.g., a repeating pattern corresponding to a square, hexagonal or any other suitable arrangement or any non-

repeating or random arrangement) and/or centered around the geometric or optical center of the base lens and/or not centered around the geometric or optical center of the base lens.

30. The ophthalmic lens of any of the preceding claims, wherein the ratio of the length of the longest (x) meridian or axis to the shortest meridian or axis (y) of at least one of the one or more light modulating cells is about 1.1, about 1.2, about 1.3, about 1.4, about 1.5, about 1.6, about 1.7, about 1.8, about 1.9 and about 2.0.

31. The ophthalmic lens of any of the preceding claims, wherein the one or more light modulating cells is arranged such that either one of the principal meridians or axes or the longest meridian of the light modulating cells is lined parallel to one another or may be aligned radially or may be lined circumferentially or in any suitable geometric arrangement (e.g., a triangular arrangement or a square or a rectangle or a hexagon).

32. The ophthalmic lens of any of the preceding claims, wherein the one or more light modulating cells comprise a phase-modifying mask such as an amplitude mask, binary amplitude mask, phase-mask, or kinoform, or binary phase-mask, or phase-modifying surfaces such as meta-surface or nanostructures.

33. The ophthalmic lens of any of the preceding claims, wherein a light phase of the one or more light modulated cells is modulated (e.g., an outer region of the light modulating cell represents the region where the light phase has been modulated for example, by pi/2, pi, 3.pi/2, or between 0 and pi/2, between pi/2 and pi, between pi and 3.pi/2 or between 3.pi/2 and 2.pi; an inner white circle represents a second region of the light modulating cell for which the light phase has been modulated to be different from the phase of the first region; and/or an intermediate grey circle represents a third region of the light modulating cell for which the light phase has been modulated to be different from the phase of the first and/or the second region.

34. The ophthalmic lens of any of the preceding claims, wherein any combination of one or more of the size, density per square mm and/or the packing arrangement of the light modulating cells is uniform across the zones or vary across the zones (e.g., the density of the light modulating cells is greater or less in the peripheral zone compared to the mid-peripheral zone).

35. The ophthalmic lens of any of the preceding claims, wherein lens designers and clinicians may use the light modulating cell geometrical distribution and/or fill factor as a guide to clinical performance of the ophthalmic lens including any combination of one or more of myopia control efficacy, vision and wearability.

36. The ophthalmic lens of any of the preceding claims, wherein the surface area corresponding to the central optical zone does not comprise light modulating cells or does comprise a plurality of light modulating cells.

37. The ophthalmic lens of any of the preceding claims, wherein the geometrical fill ratio of the light modulating cells in the central optical zone to the surface area corresponding to the central optical zone is about 5%, about 10%, about 15%, about 20%, about 25%, about 30%, about 35%, about 40%, about 45%, about 50%, about 55%, about 60%, about 65%, about 70%, about 75%, about 80% or about 85% , at least 5%, at least 10%, at least 15%, at least 20%, at least 25%, at least 30%, at least 35%, at least 40%, at least 45%, at least 50%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80% or at least 85% or between 5-15%, 20-30%, 35-45%, 40-50%, 45-55%, 60-70%, 70-75%, 70-80% or 75-85%.

38. The ophthalmic lens of any of the preceding claims, wherein the geometrical fill ratio of the light modulating cells in the peripheral optical zone and/or the mid-peripheral optical zone to the surface area corresponding to the peripheral optical zone and/or the mid-peripheral optical zone is about 5%, about 10%, about 15%, about 20%, about 25%, about 30%, about 35%, about 40%, about 45%, about 50%, about 55%, about 60%, about 65%, about 70%, about 75%, about 80% or about 85% , at least 5%, at least 10%, at least 15%, at least 20%, at least 25%, at least 30%, at least 35%, at least 40%, at least 45%, at least 50%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80% or at least 85% or between 5-15%, 20-30%, 35-45%, 40-50%, 45-55%, 60-70%, 70-75%, 70-80% or 75-85%.

39. An ophthalmic lens comprising

a baselens with a front and a rear surface configured to direct light to at least a first image plane;

one or more light modulating cell zones on or in the base lens, the one or more light modulating cell zones comprising a plurality of light modulating cells positioned in a specific configuration;

wherein any combination of one or more of the geometrical arrangement, fill factor ratio, diameter, sagittal depth, curvature, power and cell to cell spacing of the light modulating cells are configured such light transmitted through the light modulating cell zone results in a through focus light distribution that is directed to a plurality of planes located anteriorly and posteriorly relative to the first image plane.

40. A method for designing/manufacturing an ophthalmic lens comprising:

selecting a base lens having a power profile and configured to direct light to at least a first plane;

determining to locate one or more light modulating cell zones in any combination of one or more of a central optical zone, a mid-peripheral optical zone and/or a peripheral optical zone of the base lens, the one or more light modulating cell zone comprising a plurality of light modulating cells, the light modulating cells located in at least one of a surface or embedded in the base lens;

utilizing any combination of one or more of a geometrical arrangement, fill factor ratio, light modulating cell diameter, light modulating cell sagittal depth, light modulating cell curvature, light modulating cell power and cell to cell spacing of the light modulating cells to configure the ophthalmic lens such that light transmitted through the one or more light modulating cell zones results in a through focus light distribution (TFLD) extends to one or more additional planes in at least one of a posterior (hyperopic defocus) and anterior (myopic defocus) direction relative to the first plane.