Claims

1. A light distribution structure ~~(10)~~ in the form of an optically functional layer, comprising:

~~an~~ at least one three-dimensional feature pattern ~~(11, 11A)~~ established in a light-transmitting carrier medium by a plurality of internal optical cavities ~~(12)~~,

wherein

each said optical cavity ~~(12)~~ is configured to establish ~~an~~ at least one optical function at its~~'~~ horizontal surface ~~(121)~~ and at its~~'~~ ~~essentially vertical~~ inclined surface ~~(122)~~, the ~~latter~~ optical cavities being arranged in a direction along an essentially longitudinal ~~of~~ light propagation path in the light-transmitting carrier medium,

wherein

- by said horizontal surface ~~(121)~~ the optical cavity ~~(12)~~ is configured to mediate light propagation in the light-transmitting carrier medium along ~~an~~ the essentially longitudinal light propagation path, and to further distribute light rays ~~(51)~~ reflected from said horizontal surface, in the light-transmitting carrier medium, towards the ~~essentially vertical surface~~ inclined surface of the subsequent optical cavity of cavities ~~(12)~~ via a plurality of light passage~~s~~ areas~~(13)~~, and

- by said ~~essentially vertical~~ inclined surface ~~(122)~~ the optical cavity ~~(12)~~ is configured to extract light ~~(52)~~ out of the structure ~~(10)~~ in a predetermined direction essentially transverse to the longitudinal light propagation path, and

wherein

~~said at least one optical function is established by a configuration of the light passage area (13) combined with an at least one of the dimensions, periodicity, orientation and disposition of the optical cavities (12) within the feature pattern (11, 11A)~~an edge of the inclined surface of each said optical cavity has a curved shape or a wave-shape when viewed along a normal to the horizontal surface.

2 The light distribution structure ~~(10)~~ of claim 1, wherein said at least one optical function is the total internal reflection ~~(TIR)~~ function.

3. The light distribution structure ~~(10)~~ of ~~any one of~~ claim~~s~~ 1 ~~or 2~~, wherein each optical cavity ~~(12)~~ is configured to receive and to further distribute light arriving thereto at an angle of incidence equal to or greater than the critical angle relative to the surface normal.

4. The light distribution structure ~~(10)~~ of ~~any preceding~~ claim 1, wherein the established optical cavities ~~(12)~~ are filled with a gaseous material, such as air.

5. The light distribution structure ~~(10)~~ of ~~any preceding~~ claim 1, wherein each individual optical cavity ~~(12)~~ is configured variable in terms of at least one of the cross-sectional profile, dimensions, periodicity, orientation and disposition thereof within the feature pattern.

~~6. The light distribution structure (10) of any preceding claim, in which the optical cavities (12) are established with the three-dimensional profiles selected from one of the essentially blazed, curved or wave-shaped profiles.~~

~~7~~6. The light distribution structure ~~(10)~~ of ~~any preceding~~ claim 1, ~~in which in which the optical cavities (12) are established with the three-dimensional profiles provided as~~ wherein the edge of the inclined surface of each said optical cavity has a symmetrical sinusoidal waveform~~s~~ or an asymmetrical sinusoidal waveform~~s~~.

~~8~~7. The light distribution structure ~~(10)~~ of ~~any preceding~~ claim 1, wherein cross-sectional profile variability, curvature angle variability and /or curvature radius variability is established, for each individual optical cavity ~~(12)~~, with a predetermined periodicity.

~~9~~8. The light distribution structure ~~(10)~~ of ~~any preceding~~ claim 1, wherein the at least one feature pattern ~~(11, 11A)~~ comprises a plurality of optical cavities ~~(12)~~ with discrete profiles or at least partly continuous profiles.

~~10~~9. The light distribution structure ~~(10)~~ of ~~any preceding~~ claim 1, wherein cross-sectional variability is established, for each individual optical cavity ~~(12)~~, in three dimensions by the at least one of the: curvature angle, curvature radius, length of a pitch, width, height, period, phase, configuration of a light passage area ~~(13)~~, and the like.

~~11~~10. The light distribution structure ~~(10)~~ of ~~any preceding~~ claim 1, wherein the feature pattern is configured to extend over the entire optically functional layer.

~~12~~11. The light distribution structure ~~(10)~~ of ~~any preceding~~ claim 1~~-10~~, further comprising: a number of feature patterns arranged on ~~an~~ at least one optically functional layer according to a predetermined order.

~~13~~12. The light distribution structure ~~(10)~~ of ~~any preceding~~ claim 1, wherein, within the at least one feature pattern, the plurality of optical cavities ~~(12)~~ is arranged into an array or arrays extending along and/or across an entire area occupied by said feature pattern.

~~14~~13. The light distribution structure ~~(10)~~ of ~~any preceding~~ claim 1, wherein the optically functional layer has a fill factor for the feature pattern equal to 100% or less than 100%.

~~15~~14. The light distribution structure ~~(10)~~ of ~~any preceding~~ claim 1, further comprising: at least two optically functional layers with the at least one feature pattern established on each said layer.

~~16~~15. The light distribution structure ~~(10)~~ of ~~any preceding~~ claim 1, provided in the form of a film, a sheet or a coating.

~~17~~16. The light distribution structure ~~(10)~~ of ~~any preceding~~ claim 1, wherein the optically functional layer is established in an optical polymer or glass.

~~18~~17. The light distribution structure ~~(10)~~ of ~~any preceding~~ claim 1, wherein the optical cavities ~~(12)~~ are formed at an interface with an additional flat, planar carrier layer, selected from a transparent layer, a reflector layer, and/or a coloured layer.

~~19~~18. The light distribution structure ~~(10)~~ of ~~any preceding~~ claim 1, configured to receive light from a plurality of point light sources.

19. The light distribution structure of claim 1, wherein each said optical cavity has the horizontal surface, the inclined surface and another surface, and an angle between the horizontal surface and the inclined surface is smaller than an angle between the horizontal surface and the other surface.

20. The light distribution structure of claim 19, wherein the angle between the horizontal surface and the inclined surface is about 50 degrees and the angle between the horizontal surface and the other surface smaller is about 85 degrees.

~~20. A method for manufacturing a light distribution structure (10) in the form of an optically functional layer comprising an at least one feature pattern (11, 11A) established in a light-~~

~~transmitting carrier by a plurality of three-dimensional optical features variable in terms of at least one of the cross-sectional profile, dimensions, periodicity, orientation and disposition thereof within the feature pattern,~~

~~said method comprises:~~

~~- manufacturing a patterned master tool for said three-dimensional feature pattern (11, 11A) by a piezoelectric cutting method selected from a fast tool servo (FTS) method and a stylus engraving method, or by a laser engraving method,~~

~~and~~

~~- transferring the three-dimensional feature pattern (11, 11A) onto the light-transmitting carrier.~~

~~21. The method of claim 20, wherein the step of manufacturing the patterned master tool comprises provision of the three-dimensional feature pattern (11, 11A) configured as symmetrical or asymmetrical sinusoidal waveforms.~~

~~22. The method of any one of claims 20 or 21, wherein the master tool is fabricated in a planar or a cylindrical format.~~

~~23. The method of any preceding claim 20-22, wherein the step of transferring the three-dimensional feature pattern onto the light-transmitting carrier is implemented by a roll-to-roll method, a roll-to-sheet method or a sheet-to-sheet method.~~

~~24. The method of any preceding claims 20-23, further comprising a surface polishing treatment.~~

~~25~~21. A light distribution element ~~(100)~~, comprising: an optically transparent substrate configured to establish a path for light propagation therealong, and ~~an~~ at least one light distribution structure ~~(10)~~, as defined in ~~any one of~~ claims ~~1-19~~.

~~26~~22. The light distribution element ~~(100)~~ of claim ~~25~~21, further comprising: the light distribution structure ~~(10)~~ in the form of an additional layer, such as a film, a sheet or a coating, disposed on an at least one surface of the optically transparent substrate.

~~27~~23. The light distribution element ~~(100)~~ of claim ~~25~~21, further comprising: the light distribution structure ~~(10)~~ fully integrated and/or embedded into the optically transparent substrate.

~~28~~24. The light distribution element ~~(100)~~ of ~~any preceding~~ claim~~s 25-27~~21, configured as a light guide, a light pipe, a light-guide film or a light-guide plate.

~~29~~25. The light distribution element ~~(100)~~ of ~~any preceding~~ claim~~s 25-28~~ 21, further comprising: ~~an~~ at least one light source, selected from: a Light Emitting Diode (LED), an Organic Light Emitting Diode (OLED), a laser diode, a LED bar, an OLED strip, a microchip LED strip, and a cold cathode tube.

~~30~~26. Use of the light distribution element ~~(100, 100A)~~ as defined in ~~any one of~~ claim ~~25-29~~21 in illumination and indication.

~~31~~27. Use according to claim ~~30~~26, in illumination of wall- and roof panels, in window and facade illumination, in signage illumination, in greenhouse illumination, in display illumination, in passive matrix illumination, in signal illumination, in touch signal solutions, in security systems, in producing light-directing films, in creating light masks for a non-transparent mode, in security systems, in indicator devices, in reflectors, and/or in light collector solutions.

~~32. A roll of a light distribution element comprising:~~

~~an optically functional layer comprising an at least one feature pattern (11, 11A) established in a light-transmitting carrier by a plurality of three-dimensional optical features variable in terms of at least one of the cross-sectional profile, dimensions, periodicity, orientation and disposition thereof within the feature pattern, and~~

~~a light filter layer (141) formed of a substrate material having a refractive index than the refractive index lower that the refractive index of the carrier medium constituting the optically functional layer, and comprising a plurality of apertures.~~

~~33~~28. ~~The roll of a light distribution element, according to claim 32~~A roll of a light distribution element, comprising:

an optically functional layer comprising at least one feature pattern established in a light-transmitting carrier by a plurality of three-dimensional optical features variable in terms of at least one of the cross-sectional profile, dimensions, periodicity, orientation and disposition thereof within the feature pattern, and

a light filter layer formed of a substrate material having a refractive index than the refractive index lower that the refractive index of the carrier medium constituting the optically functional layer, and comprising a plurality of apertures,

in which the optically functional layer is established by the structure, as defined in ~~any one of~~ claim~~s~~ 1~~-19~~.