

Claims

1. An optical device (1), comprising:
- a first optical transparent thermoplastic layer (2),
 - 5 - a second optical transparent thermoplastic layer (3), and;
in between both thermoplastic layers (2,3)
 - a diffractive optical element (4) adjacent to the first thermoplastic layer (2),
 - a spacer (5) in between the diffractive optical element (4) and the second thermoplastic layer (3), and;
 - 10 • a border (6) enclosing the diffractive optical element (4) thereby forming a sealed cavity (7).
2. The device of claim 1, wherein:
the diffractive optical element (4), the spacer (5) and the border (6) have the same material
15 composition (12).
3. The device of claim 1 or 2, wherein:
both optical transparent thermoplastic layers (2,3) are curved.
- 20 4. The device of any of the foregoing claims, wherein:
the border (6) comprises, remote from the cavity (7), a notch (16) containing an adhesive (15)
in contact with the second thermoplastic layer (3).
5. The device of any of the foregoing claims further comprising:
- 25 - a layer (13) of a planarizing material (17) covering the diffractive optical element (4) and
whereby at least part of the border (6) adjacent to the diffractive optical element (4) is
made of the planarizing material (17), and;
 - the spacer (5), the planarizing layer (13) and the diffractive optical element (4) being
stacked on each other thereby maintaining a controlled distance (d) between both
30 thermoplastic layers (2, 3).
6. The device of claim 5, wherein:
the border (6) comprises, remote from the cavity (7), a notch (16) formed in the planarizing
material (17), the notch containing an adhesive (15) in contact with the second thermoplastic
35 layer (3).

7. The device of any of the foregoing claims, further comprising:
a channel (19) extending through the border (6) into the cavity (7).

8. The device of any of the foregoing claims, further comprising:

- 5 - a first optical transparent electrode (8) adjacent to the first optical transparent thermoplastic layer (2),
 - a second optical transparent electrode (9) adjacent to the second optical transparent thermoplastic layer (3), and;
 - whereby at least the cavity (7) is in between both optical transparent electrodes (8, 9).

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9. The device of any of the foregoing claims, wherein:

the first transparent electrode (8) is in between the diffractive optical element (4) and the first optical transparent thermoplastic layer (2).

15 10. The device of any of the claims 1 to 8, wherein:

the first transparent electrode (8) is on the surface of the diffractive optical element (4) facing the other optical transparent thermoplastic layer (3).

11. An optical instrument (15) comprising:

20 at least one optical device (1) according to any of the foregoing claims.

12. A method of manufacturing an optical device (1) according to any of the claims 1 to 10, the method comprising:

- providing a first optical transparent thermoplastic layer (2) ,
25 - forming by nanoimprint on the first optical transparent thermoplastic layer (2), at least one of a spacer (5), an optical diffractive element (4) and a border (6) which encloses the optical diffractive element (4) and the spacer (5), and;
 - providing a second optical transparent thermoplastic layer (3) thereby forming a sealed cavity (7) containing the spacer (5) and the optical diffractive element (4) whereby the
30 spacer (5) is in between the optical diffractive element (4) and the second optical transparent thermoplastic layer (2).

13. The method of claim 12, wherein forming by nanoimprint the spacer (5), the optical diffractive element (4) and the border (6) enclosing the optical diffractive element (4) comprises:

- 35 - providing a layer (18) of a material composition (12) on the first optical transparent layer (2), and,

- nanoimprinting in the layer (18) the spacer (5), the optical diffractive element (4) and the border (6) enclosing the optical diffractive element (4), whereby the spacer (5) and the optical diffractive element (4) are stacked on each other thereby maintaining a controlled distance (d) between both thermoplastic layers (2,3).

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14. The method of claim 12 or 13, further comprising:

thermoforming the optical device (1) thereby given each optical transparent thermoplastic layer (2,3) a predetermined curvature.

10 15. The method of any of the claims 12 to 14, wherein nanoimprinting further comprises:

forming, at least in the upper part of the border (6), a channel (19) extending through the border (6) into the cavity (7).

15 16. The method of any of the claims 12 to 15, wherein forming by nanoimprint the spacer (5), the optical diffractive element (4) and the border (6) enclosing the optical diffractive element (4) further comprises:

forming in the border (5), remote from the cavity (7), a notch (16) for containing an adhesive (15) in contact with the second thermoplastic layer (3), and,

further comprising:

20 providing, prior to providing a second optical transparent thermoplastic layer (3), an adhesive (15) in the notch (16) only.

17. The method of any of the claims 12 to 15, further comprising, prior to providing a second optical transparent thermoplastic layer (3):

- 25
- providing a layer (13) of planarizing material (17) thereby covering the diffractive optical element (4) and at least part of the border (6) adjacent to the diffractive optical element (4),
 - nanoimprinting in the planarizing layer (13) the spacer (4) and part of the border, and;
 - whereby the spacer (5), the planarizing layer (13) and the diffractive element (4) are stacked on each other thereby maintaining a controlled distance (d) between both
- 30 thermoplastic layers (2,3).

18. The method of claim 17, wherein forming by nanoimprint the spacer (5), the optical diffractive element (4) and the border (6) enclosing the optical diffractive element (4) comprises:

35 forming in the planarizing layer (13), remote from the cavity (7), a notch (16) for containing an adhesive (15) in contact with the second thermoplastic layer (3), and, further comprising:

providing, prior to providing a second optical transparent thermoplastic layer (3), an adhesive (15) in the notch (16) only.

19. The method of any of the claims 12 to 18 further comprising:

- 5 - forming a first optical transparent electrode (8) adjacent to the first optical transparent thermoplastic layer (2),
- forming a second optical transparent electrode (9) adjacent to the second optical transparent thermoplastic layer (3), and;
- whereby at least the cavity (7) is in between both optical transparent electrodes (8).

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20. The method of any of the claims 12 to 19, wherein forming by nanoimprint the spacer (5), the optical diffractive element (4) and the border (6) enclosing the optical diffractive element (4) comprises:

- forming an array of: a spacer (5) and an optical diffractive element (4), enclosed by a
- 15 border (6).