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(54) **Electrowetting optical element.**

(57) An electrowetting optical element and a method of manufacturing of such element is provided, comprising a second electrode layer stack and a first electrode layer stack, and a containment space formed between said second electrode layer stack and said first electrode layer stack said containment space at least containing a polar liquid and a non-polar liquid, the polar and non-polar liquids being immiscible with each other. Said electrowetting optical element further comprises at least one cell wall extending between said first and second electrode stacks for defining sides of said containment space. Said first electrode layer stack and said second electrode layer stack comprises a first and second electrode layer respectively for applying a voltage to said electrodes for allowing rearranging said polar liquid relative to said non-polar liquid. Said at least one cell wall having a surface interfacing said containment space and a cell wall end face. Said cell wall interface surface has a hydrophobic surface portion interfacing said containment space at an end portion of said cell wall.

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Dit octrooi is verleend ongeacht het bijgevoegde resultaat van het onderzoek naar de stand van de techniek en schriftelijke opinie. Het octrooischrift komt overeen met de oorspronkelijk ingediende stukken.

Electrowetting optical element

FIELD OF THE INVENTION

5 The present invention relates to an electrowetting optical element, a display comprising electrowetting optical elements and a method of manufacturing an electrowetting optical element.

BACKGROUND

10 Electrowetting technology is based on modification of an energy balance between on one hand surface tension forces of liquids and wetting properties of a solid surface, and on the other hand electrostatic forces induced by an applied voltage over a capacitor arrangement comprising said boundary layer.

15 In accordance with international patent application WO2012055724 an electrowetting optical element may comprise a first electrode layer stack and a second electrode layer stack, and a containment space formed between said second electrode layer stack and the first electrode layer stack, at least one cell wall extending between the first and second electrode stacks, for defining sides of the containment space, the containment space at least containing a polar liquid and a non- polar liquid, the polar and non-polar liquids being immiscible with each other.

20 The second electrode layer stack comprises a substrate, a second electrode layer and an insulating layer having a hydrophobic interface surface with said containment space, and said first electrode layer stack comprises a superstrate and a first electrode layer having a second interface surface with said containment space. Said hydrophobic interface surface has a higher hydrophobicity than the second
25 interface surface.

The cell walls are fixedly mounted on said second interface surface of said first electrode layer stack and extend towards said second electrode layer, wherein an end face of said at least one cell wall opposite said second electrode layer stack faces said hydrophobic interface surface in a loose manner. No fixation or structural
30 attachment is achieved of the end face of the cell walls with the hydrophobic interface of the second electrode layer stack. This end face may be, but is not necessarily, contiguous to the hydrophobic surface of the second electrode layer stack. Furthermore, a slit may be present in between the end face of the cell walls and the hydrophobic interface for entrainment of the non-polar liquid into the slit.

35 The electrowetting element is arranged for enabling powering of said first and second electrode layer stacks for rearranging said polar liquid relative to said non-polar liquid. In an unpowered state, i.e. when no voltage is applied over the first and

second electrode, the lowest energetic state of the system is where the non-polar liquid forms a boundary layer between the polar liquid and the hydrophobic surface of the insulating layer. This is because the polar liquid is repelled by the hydrophobic layer. The poor transmissibility of the non-polar liquid then forms an obstruction to light that penetrates the system.

When a voltage is applied over the electrodes, the lowest energetic state of the system becomes the situation wherein the (poorly conductive or insulating) non-polar liquid is pushed aside by the (conductive) polar liquid, and the polar liquid thereby is in direct contact with the insulating hydrophobic layer. Note that the voltage must be large enough for the electrostatic forces to overcome the repellent and surface tension forces that separate the polar liquid from the hydrophobic surface. In this situation, light that penetrates the system has rather unobstructed access to the insulating hydrophobic layer because of the well transmissibility of the polar liquid and the non-polar liquid being pushed aside. In the powered up state, when voltage is applied over the electrodes, the electrowetting element is thus transmissive. This working principle is used in electrowetting type displays and screens.

The cell walls extending towards the second electrode layer cause the interface surface between the polar liquid and the non-polar liquid to be curved in a convex meniscus shape when the electrowetting optical element is in an unpowered state. This causes the electrowetting optical element to be more transparent at the edges of the element near the cell walls. Incident light from the first electrode layer will then be reflected more near the cell walls than incident light at the center of the electrowetting element. This causes uneven light distribution over each electrowetting optical element and over a display comprising a plurality of concatenated electrowetting optical elements. The uneven distribution or obscuration of light is all the more evident from light passing through an electrowetting optical element from the second electrode layer to the first electrode layer due to the convex meniscus shaped interface surface between the polar and non-polar liquids. Although it is known that a cell wall end face can be provided with a hydrophobic layer or surface, this does not prevent the convex meniscus shaped interface surface to be formed.

SUMMARY OF THE INVENTION

One or more of the above mentioned problems are solved according to an aspect of the invention wherein an electrowetting optical element is provided, comprising a second electrode layer stack and a first electrode layer stack, and a

containment space formed between said second electrode layer stack and said first electrode layer stack said containment space at least containing a polar liquid and a non-polar liquid, the polar and non-polar liquids being immiscible with each other.

5 Said electrowetting optical element further comprises at least one cell wall extending between said first and second electrode stacks for defining sides of said containment space. Said first electrode layer stack and said second electrode layer stack comprises a first and second electrode layer respectively for applying a voltage to said electrodes for allowing rearranging said polar liquid relative to said non-polar liquid. Said at least one cell wall having a surface interfacing said containment space
10 and a cell wall end face. Said cell wall interface surface has a hydrophobic surface portion interfacing said containment space at an end portion of said cell wall.

The hydrophobic end portion of the cell wall interface surface allows in an unpowered state of the electrowetting optical element, i.e. no voltage is applied to the first and second electrode layers respectively, the non-polar liquid to cover a portion
15 of the cell wall interface surface which would have otherwise been in contact with the polar liquid. Thus it is achieved that the interface surface between the polar and non-polar liquids is distributed more even in a cross section of the electrowetting optical element and form a flat interface between both liquids. Incident reflected or transmitted light will in this state be obscured evenly across said interface surface.
20 The electrowetting optical element or a display manufactured from concatenated electrowetting optical elements according to the invention now shows a constant, even distribution, i.e. obscuration of light. Said cell wall end face is preferably provided with a hydrophobic surface.

In an embodiment said hydrophobic surface portion is circumferentially
25 arranged around said end portion of said cell wall. This improves a more even distribution of the non-polar liquid around the end portion of said cell walls.

In a further embodiment said hydrophobic surface portion and said hydrophobic cell wall end surface form a cap shaped hydrophobic surface portion around an end portion of said cell wall facing said second electrode layer.

30 This allows the non-polar liquid to be entrained in said slit more easily, preventing polar liquid to enter the slit and preventing non-polar liquid to be exchanged between adjacent electrowetting optical elements.

According to another aspect of the invention a method of manufacturing an electrowetting optical element is provided, said method comprising:

35 - providing a first electrode layer stack, said first electrode layer stack having a first electrode layer, and

- forming at least one cell wall extending from said first electrode stack for defining sides of a containment space, said at least one cell wall having a cell wall interface surface interfacing said containment space and a cell wall end face at an end of said cell wall opposite said first electrode layer stack,

5 - forming an hydrophobic surface portion at an end portion of said cell wall interfacing said containment space,

- filling said containment space with at least a polar liquid and a non-polar liquid, said polar and non-polar liquids being immiscible with each other,

10 - providing a second electrode layer stack, covering said containment space leaving a slit between said cell wall end face and said second electrode layer stack, said second electrode layer stack having a second electrode layer for allowing a voltage to be applied to said first and second electrode layers respectively for rearranging said polar liquid relative to said non-polar liquid.

15 This allows the non-polar liquid to cover a portion of the cell wall interface surface which would have otherwise been in contact with the polar liquid. Thus it is achieved that the interface surface between the polar and non-polar liquids is distributed more even in a cross section of the electrowetting optical element and form a flat interface between both liquids.

In an embodiment the method further comprises:

20 - applying a hydrophobic compound to said cell wall interface surface at said end portion of said pixel wall prior to said step of filling for forming a hydrophobic surface portion interfacing said containment space at said end portion of said cell wall.

25 In an embodiment, said step of applying a hydrophobic compound to said cell wall interface surface comprises:

- applying said hydrophobic compound to said cell wall end face using an excess amount of hydrophobic compound;

30 - allowing said excess hydrophobic compound to spill over to said surface at said end portion of said cell wall such that at said end portion of said cell wall is covered with the hydrophobic compound during a time period depending on de viscosity of said hydrophobic compound and a length of said end portion to be covered with said hydrophobic compound .

35 This allows the hydrophobic surface portion of be formed without having to apply the hydrophobic compound to the surface end portion of the pixel wall interfacing the containment space directly.

Said hydrophobic compound is subsequently cured. This allows the hydrophobic surface portion to become stable and resistant to chemical interaction with the polar and/or non-polar liquids.

5 BRIEF DESCRIPTION OF THE DRAWING

The invention will further be described with reference to the enclosed drawing wherein embodiment of the invention is illustrated, and wherein

Figure 1 illustrates an electrowetting optical element in accordance with the state of the art;

10 Figure 2a illustrates an electrowetting optical element in accordance with an embodiment of the invention;

Figure 2b shows a detail of the electrowetting optical element of fig. 2a.

Figure 3 shows a block diagram of a method of manufacturing an electrowetting optical element according to an embodiment of the invention

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DETAILED DESCRIPTION

Figure 1 shows an electrowetting element 1 according to the state of the art in a powered state. The electrowetting element 1 may be situated between adjacent electrowetting elements, as illustrated. In the electrowetting element 1, a containment space 25 is present between a first electrode layer stack 5, a second electrode layer stack 3 and a cell wall 19, formed on the first electrode layer stack 5. The containment space 25 is filled with a polar liquid 29 and a non-polar liquid 30. The polar liquid 29 is preferably non-aqueous polar liquid, for example comprising ethylene glycol or glycerol or a mixture thereof. Water is also a polar liquid but is less suitable for use in an electrowetting optical element due to corrosion risk of electrode layers coming in contact with the water. For the non-polar liquid 30 an oil like substance such as a silicone oil or silicone oil blend can be used. Non-polar liquid 30 is preferably opaque, enabling the electrowetting optical element to block incident light 2 from passing through or from being reflected by an optional reflective layer 14. This can be achieved for example by choosing a suitable opaque non-polar liquid compound and/or by adding a colorant or pigment to the non-polar liquid 30.

25 The second electrode layer stack 3 comprises a substrate 11, an insulating layer 12, a second electrode layer 13 and optional reflective layer 14 that will be described below. The second electrode layer 13 is formed of an electrically conducting material such as indium tin oxide (ITO) and has a hydrophobic interface surface 10 forming the interface with the containment space 25. The second electrode layer 13 is connectable to a first pole of a voltage source for controlling

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operation of the electrowetting element 1. The hydrophobic interface surface 10 can be formed by applying a suitable hydrophobic compound such as a fluoropolymer, for example CYTOP™ or AF1600™ to the interface surface 10.

5 The first electrode layer stack 5 comprises a superstrate 7 and a first electrode layer 6 supported by the superstrate 7. The first electrode layer 6 may be in contact with polar liquid 29, the first electrode layer 6 having a less hydrophobic or hydrophilic interface surface. The first electrode layer 6 is formed by a layer of transparent conductive material such as ITO or any other suitable transparent conducting material. Also a conductive organic material known in the art have lower
10 hydrophobic properties than the hydrophobic first interface surface 10 can be used.

The first electrode layer 6 must contact the polar liquid 29 in the electrowetting element 1, but does not necessarily have to be a contiguous layer as shown in figure 1. It is sufficient if it covers at least a part of the containment space 25. The first electrode layer is connectable to another pole of the voltage source.

15 The first and second electrode layer 6, 13, being connectable to the voltage source, together allow the electrowetting element 1 to be powered on and off by applying an appropriate voltage to them. In an unpowered state non-polar liquid 30 will adhere to the hydrophobic interface surface 10 of the second electrode layer stack 3. Thus incident light 2 is blocked and is not allowed to pass through the
20 electrowetting cell 1. In a powered state, when a voltage is applied to the first and second electrode layers 6, 13, the polar liquid 29 is electrostatically drawn to the hydrophobic interface surface 10, pushing the non-polar liquid 30 aside to the cell walls 21. Incident light 2 is now allowed to pass through the electrowetting element 1.

The superstrate layer 7 and substrate layer 11 may be formed by any suitable
25 material. These layers 7, 11 may for example be formed by a transparent glass layer, and dependent on whether the electrowetting optical cell is of the transparent type or reflective type, the substrate layer 11 may be formed by a non-transparent layer as well. Alternatively, superstrate layer 7 and substrate layer 11 may be formed from a rigid or flexible polymer material such as polyethersulfone (PES), polyimide (PI),
30 polythiophene (PT), phenol novolac (PN), or polycarbonate (PC).

The optionally reflective layer 14 allows the electrowetting element 1 to be used in a reflective manner having light 2 incident on the superstrate side or the side of the first electrode layer stack 5 of the element 1 being reflected by the reflecting layer 14 and exiting again through the first electrode layer stack 5 side. The reflective
35 layer 14 can be made from a metal such as aluminium, deposited on the substrate 11. In reflective type electrowetting elements, the reflective layer 14 may also act as second electrode layer.

The electrically insulating layer 12 can be formed of for example silicon dioxide or aluminium oxide or any other suitable material which prevents a short circuit in applying the electrical voltage and allows an electrical field to build up such that the polar liquid is attracted to the second electrode layer 13, driving the non-polar liquid aside.

Cell walls 19 which can be for example made from acryl or acrylic material, are fixedly mounted on the less hydrophobic or hydrophilic surface of the first electrode layer 6. As a result of the mounting of the cell walls 19 on the first electrode layer, and due to the physical properties of the less hydrophobic surface, a strong mechanical connection between the cell walls 19 and the hydrophilic surface interface 6 is achieved. This results in a good structural integrity of the cell walls as mounted on the first electrode layer stack 5.

The cell walls 19, and the first and second electrode layer stacks 3 and 5 respectively, define the containment space 25 of the electrowetting optical cell 1. The containment space 25 is filled with a polar liquid 29 and a non-polar liquid 30. The polar liquid 29 and non-polar liquid 30 are immiscible with each other. In addition, the polar liquid 29 is formed of a substance having molecules with non-zero chemical polarity. The non-polar liquid is formed of a substance having molecules with negligible or very small chemical polarity. As a result, switching of the electrodes in the powered up and powered off state modifies the balance of forces between the non-polar liquid and the polar liquid and the hydrophobic surface, causing these liquids to rearrange suitably for opening and closing the electrowetting optical cell.

The cell walls 19 can be dimensioned such that they span the distance between the first electrode layer stack 5 and the second electrode layer stack 3. This way, the cell walls 19 prevent spreading of the non-polar liquid 30 to adjacent electrowetting elements.

The cell walls 19 may comprise end faces 34 opposite the hydrophobic surface 10 of the second electrode layer 3. In figure 1 a small slit 32 is shown in between the end faces 34 and the hydrophobic surface layer 10 of the second electrode layer 12. This enables the non-polar liquid 30 to entrain the slits 32, and to form a small interface 24 on the other side of the slit near the edge of the cell walls 19 resulting from capillary action within the slit 32. An effect of the small capillary interface is that it greatly reduces the amount of light scattering caused by the cell walls 19 in the electrowetting optical cell 1. The capillary action can be further improved by providing the end faces 34 with a hydrophobic surface. The non-polar liquid 30 is consequently drawn more easily into slit 32.

Fig. 1 shows the electrowetting element 1 in an unpowered state, i.e. no voltage is applied between the first and second electrode layers 13, 6. With the cell walls having a neutral or hydrophobic end face surface 34, the non-polar liquid tends to form a convex meniscus shaped surface 38 due to the surface tension of the polar liquid 29, the capillary action to the non polar liquid 30 of the slit 32 and the less hydrophobic or hydrophilic properties of the cell wall surface 21, which tends to keep the non polar liquid 30 away from the cell wall surface 21.

Figure 2a shows the electrowetting cell 1 of figure 1 also in an unpowered state, wherein the cell wall interface surfaces 21 at their end portions provided with a hydrophobic portion 35 interface the containment space. Such a hydrophobic portion can be formed by applying a hydrophobic compound such as a fluoropolymer, like in hydrophobic interface surface 10, to the end portion of the cell wall interface surface 21 at the end of the pixel wall 19 facing the second electrode layer stack opposite the slit 32.

Figure 2a shows the electrowetting cell 1 of figure 3 wherein the cell wall end faces 34 are at their end portions provided with a hydrophobic surface interfacing the containment space. Such a hydrophobic portion can be formed by for example applying a fluoropolymer such as CYTOP™ or AF1600™, as in the hydrophobic interface surface 10, to the cell wall end faces 34 at the end of the pixel wall 19 facing the second electrode layer stack opposite the slit 32 and to the surface 21 interfacing the containment space 25 near the end portion of the cell wall 19.

Figure 2b show an enlarged cross section of the cell wall 19 of fig. 2a with the hydrophobic compound applied to the end portion, such that an end face 34 and surface 21 at the end portion 35 of the cell wall 19 are now hydrophobic. Both hydrophobic surface portion 35 and hydrophobic end face form a hydrophobic cap over the end portion of the cell wall 19.

Fig. 3 shows a method of manufacturing an electrowetting optical element in accordance with fig. 2.

In step 301 a first electrode stack 5 is provided comprising a first electrode layer (6).

In step 302 at least one cell wall 19 is formed extending from the first electrode stack. The cell walls 19 define sides of a containment space 25. The cell walls 19 have a cell wall interface surface 21 interfacing the containment space 25 and a cell wall end face 34 at an end of the cell wall 19 opposite said first electrode layer stack 5. Cell walls 19 can for example be provided by applying a layer of photo resist lacquer i.e. an acrylic compound, curing and subsequently etching this layer in a desired shape such that the cell walls 19 remain. A cell wall 19 when viewed from

above can form a continuous barrier surrounding containment space 25, such that polar liquid 29 of an electrowetting optical element 1 is trapped within the cell wall 19.

In step 303, a hydrophobic end portion of the cell wall 19 is formed. To this end, a hydrophobic compound, such as a fluoropolymer, is applied to the cell wall interface surface 21 of end face 34 of the cell wall 19.

The hydrophobic compound can be applied to the cell wall end face 34 of the at least one pixel wall 19 facing the second electrode layer stack 3 opposite the slit 32. The applying can be achieved by for example using a printing process, such as flexographic printing. This is a process well known to the skilled person (see for example <http://www.flexography.org>). By applying an amount of hydrophobic compound in excess to what would be needed to cover the cell wall end face 34, the hydrophobic compound is allowed to spill over the end face surface 34 of the cell wall 19 and cover the end portion of the cell wall 19 including a part of the surface 21 interfacing the containment space 25.

Curing the thus formed hydrophobic end face 34 and hydrophobic surface portion 35 of the cell wall 19 results in a stable hydrophobic cap formed around the cell wall end portion. The hydrophobic cap allows the non-polar liquid 30 of the electrowetting optical element 1 to contact the cell wall surface 21 interfacing the containment space 25 and form a flat interface or meniscus 38 with the polar liquid 29.

An amount of spilling over of the hydrophobic compound, i.e. a length from the cell wall end face extending towards the first electrode layer stack 6, is determined by the viscosity of the hydrophobic compound and the time period in which the hydrophobic compound is allowed to spill over. The time period can be set by controlling a time between applying the hydrophobic compound to the cell wall end face and the curing of the hydrophobic compound. This time in practice can range depending on hydrophobic compound properties from a few tens of second to a few seconds.

In the flexographic printing process, the cell walls 19 can advantageously face upwards, such that gravity can cause the hydrophobic compound to spill over the edge of the cell wall end face 34 forming the hydrophobic surface portion 35 of the cell wall end portion.

Alternatively, once deposited by the flexographic printing process, adhesion of the hydrophobic compound to the surface 21 of the cell wall end portion can cause the hydrophobic compound to spill over the edge of the cell wall end face 34 forming the hydrophobic surface portion 35 of the cell wall end portion.

Cell wall 19 as a continuous barrier around containment space 25, can thus be provided circumferentially with the hydrophobic surface portion 35, i.e. at all sides. This allows the non-polar liquid 30 to be evenly distributed along the entire circumference or all sides of cell wall 19 of an electrowetting optical element 1 in
 5 unpowered state. This causes the optical density of the non-polar liquid 30 to be more uniform over the entire surface of the electrowetting optical element 1 when viewed from below or from above.

In step 304 the containment space 25 is filled with at least a polar liquid 29 and a non-polar liquid 30, the polar and non-polar liquids being immiscible with each
 10 other. First the polar liquid as described above is supplied into the containment space 25 such that the cell walls 19 do not overflow. Subsequently the non-polar liquid 30 is supplied such that the cell walls 19 overflow between adjacent electrowetting elements 1 and which are then covered with the non-polar liquid. This step can be performed with the first electrode layer stack 5 in horizontal position with the cell
 15 walls 19 in upright position.

In step 305 a second electrode layer stack 3 is provided, covering the containment space 25 having the polar and non-polar liquids 29, 30, leaving a slit 32 between the cell wall end face 34 and the second electrode layer stack 3. The second electrode layer stack 5 has a second electrode layer 13 for allowing a voltage
 20 to be applied to the first and second electrode layers 13, 6 respectively for rearranging the polar liquid 29 relative to the non-polar liquid 30 as described above. Excess non-polar liquid 30 is removed sideways when the second electrode layer stack 3 is placed on top of the electrowetting optical element 1.

The embodiments described above are intended as examples only, not to
 25 limit the scope of protection of the invention as defined in the claims below.

Reference numerals

	1	Electrowetting optical element
	2	Incident light
30	3	Second electrode layer stack
	5	First electrode layer stack
	6	First electrode layer
	7	Superstrate
	10	Hydrophobic interface surface
35	11	Substrate
	12	Insulating layer
	13	Second electrode layer

	14	Reflective layer
	19	Cell wall
	21	Cell wall interface surface
	25	Containment space
5	29	Polar liquid
	30	Non-polar liquid
	32	Slit
	34	Cell wall end face
	35	Hydrophobic surface portion
10	38	Convex meniscus shaped surface
	301	Providing first electrode layer stack
	302	Forming cell wall
	303	Forming hydrophobic cell wall end portion
	304	Filling containment space
15	305	Providing second electrode layer stack

CONCLUSIES

1. Elektrowetting optisch element (1) omvattende
 - een eerste elektrodelaagstapeling (5) en een tweede
 - 5 elektrodelaagstapeling (3), en
 - een insluitingsruimte (25) gevormd tussen de eerste elektrodelaagstapeling (5) en de tweede elektrodelaagstapeling (3),
 - waarbij de insluitingsruimte (25) ten minste een polaire vloeistof (29) en een niet-polaire vloeistof (30) bevat, waarbij de polaire en niet-polaire
 - 10 vloeistoffen niet mengbaar met elkaar zijn,
 - ten minste een celwand (19) die zich uitstrekt tussen de eerste en de tweede elektrodestapelingen (3, 5) voor het definiëren van zijden van de insluitingsruimte (25), waarbij de celwand (19) een materiaal omvat waaruit de celwand (19) is samengesteld,
 - 15 - waarbij elk van de tweede elektrodelaagstapeling (3) en de eerste elektrodelaagstapeling (5) een elektrode (13, 6) omvat voor het aanbrengen van een spanning tot de elektroden (13, 6) voor het mogelijk maken dat de polaire vloeistof zich herrangschikt ten opzichte van de niet-polaire vloeistof,
 - waarbij de ten minste ene celwand (19) een oppervlak (21) heeft
 - 20 dat een interface vormt met de insluitingsruimte (25) en een hydrofobe kopse kant van de celwand (34),
 - gekenmerkt doordat
 - het celwandinterface-oppervlak (21) een hydrofoob oppervlakdeel (35) heeft dat een interface vormt met de insluitingsruimte (25) aan
 - 25 een einddeel van de celwand (19).
2. Elektrowetting optisch element (1) overeenkomstig conclusie 1, waarbij het hydrofobe oppervlakdeel (25) ringvormig rond het einddeel van de celwand (19) is aangebracht.
3. Elektrowetting optisch element (1) overeenkomstig conclusie 2,
- 30 waarbij het hydrofobe oppervlakdeel (35) en het hydrofobe celwandeindoppervlak een continu kapvormig hydrofoob (34, 35) oppervlakdeel vormt rond een einddeel van de celwand gekeerd naar de tweede elektrodelaag (3).
4. Werkwijze voor het vervaardigen van een elektrowetting optisch element (1), omvattende:

- het verschaffen (301) van een eerste elektrodelagstapeling (5), waarbij de eerste elektrodelagstapeling (5) een eerste elektrodelag (6) heeft; en

- het verschaffen (302) van ten minste een celwand (19) die zich uitstrekt van de eerste elektrodelagstapeling (5) voor het definiëren van zijden van een insluitingsruimte (25), waarbij de ten minste ene celwand (19) een celwand-interface-oppervlak (21) heeft dat de interface vormt met de insluitingsruimte (25) en een kopse kant van de celwand (34) aan een einde van de celwand (19) tegenover de eerste elektrodelagstapeling (5);

- het vullen (304) van de insluitingsruimte (25) met ten minste een polaire vloeistof (29) en een niet-polaire vloeistof (30), waarbij de polaire en niet-polaire vloeistoffen niet mengbaar met elkaar zijn;

- het verschaffen (305) van een tweede elektrodelagstapeling (3), die de insluitingsruimte (25) bedekt waarbij een gleuf (32) tussen het kopse einde van de celwand (34) en de tweede elektrodelagstapeling (3) overblijft, waarbij de tweede elektrodelagstapeling (5) een tweede elektrodelag (13) heeft voor het mogelijk maken om een spanning aan te brengen tussen de eerste en tweede elektrodelagen (13, 6) respectievelijk voor het opnieuw rangschikken van de polaire vloeistof (29) ten opzichte van de niet-polaire vloeistof (30);

gekenmerkt doordat de werkwijze verder omvat:

- het vormen (303) van een hydrofoob oppervlakdeel (35) aan een einddeel van de celwand (19) dat een interface vormt met de insluitingsruimte (25).

5. Werkwijze overeenkomstig conclusie 4, waarbij het vormen (303) van een hydrofoob oppervlakdeel omvat:

- het aanbrengen van een hydrofoob materiaal op het interface-oppervlak (21) aan een einddeel van de celwand (19) voorafgaand aan de stap van het vullen (303) voor het vormen van een hydrofoob oppervlakdeel (35) dat een interface vormt met de insluitingsruimte (25) aan het einddeel van de celwand (19).

6. Werkwijze voor het vervaardigen van een elektrowetting optisch element (1) overeenkomstig conclusie 5, waarbij de stap van het aanbrengen van een hydrofoob materiaal aan het celwandinterface-oppervlak (21) omvat:

- het aanbrengen van het hydrofobe materiaal op het kopse einde van de celwand (34) gebruikmakend van een overmaat hoeveelheid hydrofoob materiaal;

- het laten overlopen van de overmaat hydrofoob materiaal over het oppervlak (21) aan het einddeel (35) van de celwand (19), zodat het einddeel (35) van de celwand (19) bedekt wordt met het hydrofobe materiaal, gedurende een tijdperiode afhankelijk van de viscositeit van het hydrofobe materiaal en een lengte
- 5 van het met het hydrofobe materiaal te bedekken einddeel (35); en
- het uitharden van het hydrofobe materiaal.

1/2

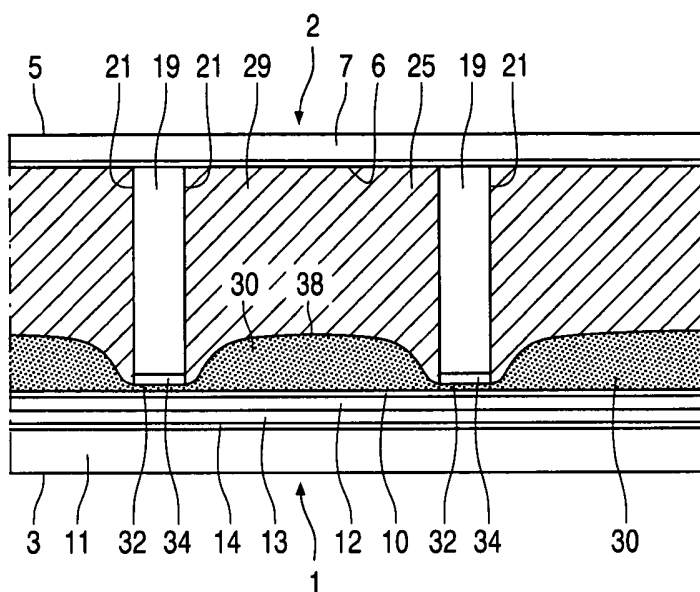


Fig. 1

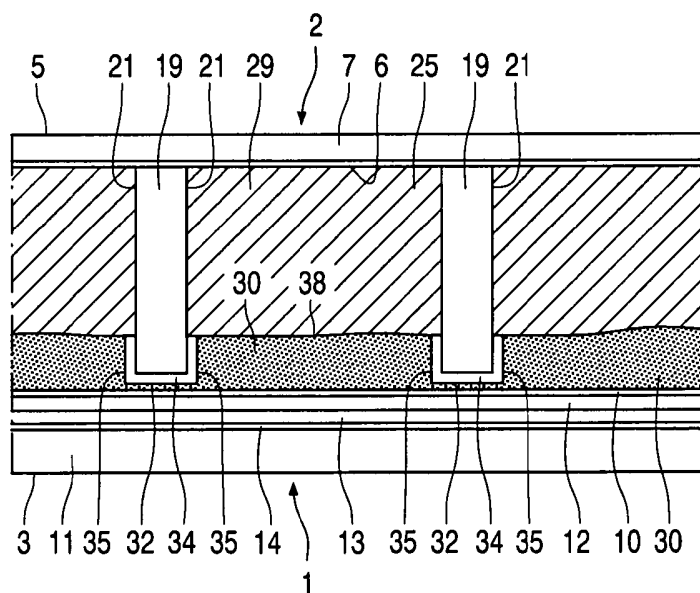


Fig. 2a

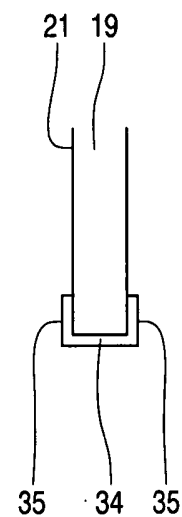


Fig. 2b

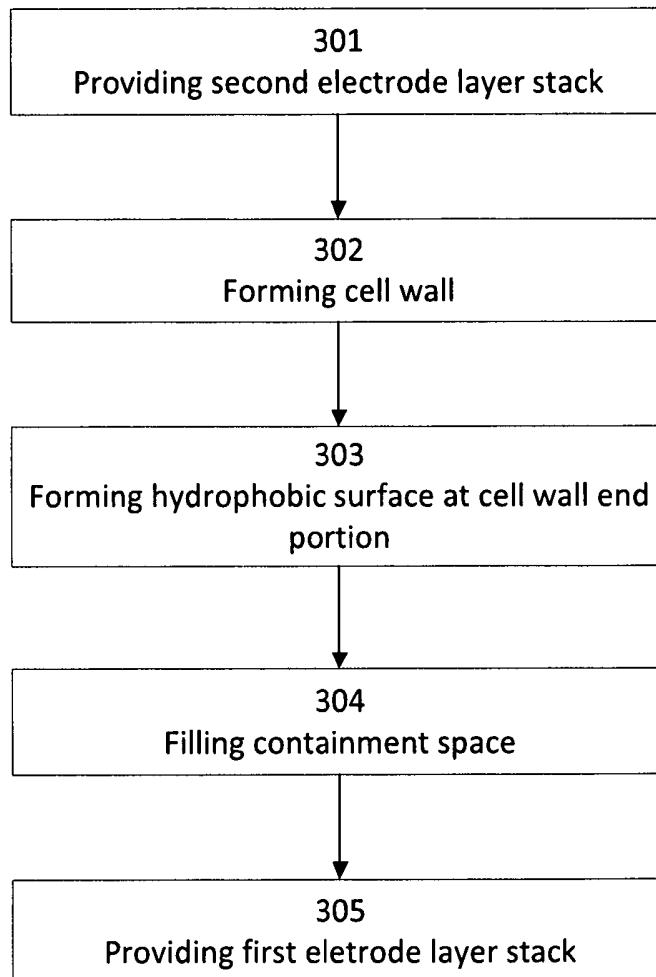


Fig. 3

SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE		KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE	
		55497NL	
Nederlands aanvraag nr. 2010578		Indieningsdatum 05-04-2013	
		Ingeroepen voorrangsdatum	
Aanvrager (Naam) Miortech Holding B.V.			
Datum van het verzoek voor een onderzoek van internationaal type 08-06-2013		Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr. SN 60175	
I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)			
Volgens de internationale classificatie (IPC) G02B26/00 G09G3/34			
II. ONDERZOCHE GEBIEDEN VAN DE TECHNIEK			
Onderzochte minimumdocumentatie			
Classificatiesysteem	Classificatiesymbolen		
IPC	G02B G09G		
Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen			
III.	☐	GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES (opmerkingen op aanvullingsblad)	
IV.	☐	GEBREK AAN EENHEID VAN UITVINDING (opmerkingen op aanvullingsblad)	

**ONDERZOEKSRAPPORT BETREFFENDE HET
RESULTAAT VAN HET ONDERZOEK NAAR DE STAND
VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE**

Nummer van het verzoek om een onderzoek naar
de stand van de techniek
NL 2010578

A. CLASSIFICATIE VAN HET ONDERWERP
INV. G02B26/00 G09G3/34
ADD.

Volgens de Internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOCHE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimum documentatie (classificatie gevolgd door classificatiesymbolen)
G02B G09G

Onderzochte andere documentatie dan de minimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)
EPO-Internal, WPI Data

C. VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X	WO 2012/055724 A1 (MIORTECH HOLDING B V [NL]; FEIL HERMANUS [NL]) 3 mei 2012 (2012-05-03) * het gehele document *	1-6
A	WO 2012/039471 A1 (SEKISUI CHEMICAL CO LTD [JP]; NAKASUGA AKIRA [JP]; UNATE TAKAO [JP]; W) 29 maart 2012 (2012-03-29) * alinea [0065] - alinea [0076] * * figuren 1-10 *	1-6
A	US 2009/296218 A1 (RYYTTY PASI [FI]) 3 december 2009 (2009-12-03) * alinea [0046] - alinea [0061] * * figuren 1, 2 *	1-6
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☒ Verdere documenten worden vermeld in het vervolg van vak C.

☒ Leden van dezelfde octrooifamilie zijn vermeld in een bijlage

° Speciale categorieën van aangehaalde documenten

"A" niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft

"D" in de octrooiaanvraag vermeld

"E" eerdere octrooi(aanvraag), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven

"L" om andere redenen vermelde literatuur

"O" niet-schriftelijke stand van de techniek

"P" tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur

"T" na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvraag, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding

"X" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

"Y" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

"&" lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid

12 december 2013

Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type

Naam en adres van de instantie

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De bevoegde ambtenaar

Szachowicz, Marta

**ONDERZOEKSRAPPORT BETREFFENDE HET
RESULTAAT VAN HET ONDERZOEK NAAR DE STAND
VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE**

Nummer van het verzoek om een onderzoek naar
de stand van de techniek

NL 2010578

C. (Vervolg). VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
A	EP 2 472 312 A1 (SHARP KK [JP]) 4 juli 2012 (2012-07-04) * alinea [0009] - alinea [0034] * * alinea [0064] - alinea [0066] * * alinea [0113] - alinea [0121] * * figuren 13, 15 * -----	1-6

**ONDERZOEKSRAPPORT BETREFFENDE HET
RESULTAAT VAN HET ONDERZOEK NAAR DE STAND
VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE**

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar
de stand van de techniek

NL 2010578

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
WO 2012055724	A1	03-05-2012	CN 103270446 A 28-08-2013
			US 2013278994 A1 24-10-2013
			WO 2012055724 A1 03-05-2012

WO 2012039471	A1	29-03-2012	CN 103229098 A 31-07-2013
			TW 201241474 A 16-10-2012
			US 2013222880 A1 29-08-2013
			WO 2012039471 A1 29-03-2012

US 2009296218	A1	03-12-2009	CN 101389995 A 18-03-2009
			EP 2002302 A1 17-12-2008
			JP 4763809 B2 31-08-2011
			JP 2009528552 A 06-08-2009
			KR 20080096677 A 31-10-2008
			US 2009296218 A1 03-12-2009
			WO 2007096687 A1 30-08-2007

EP 2472312	A1	04-07-2012	CN 102576178 A 11-07-2012
			EP 2472312 A1 04-07-2012
			RU 2012114779 A 27-10-2013
			US 2012154889 A1 21-06-2012
			WO 2011033802 A1 24-03-2011



OCTROOICENTRUM NEDERLAND

WRITTEN OPINION

File No. SN60175	Filing date (day/month/year) 05.04.2013	Priority date (day/month/year)	Application No. NL2010578
International Patent Classification (IPC) INV. G02B26/00 G09G3/34			
Applicant Miortech Holding B.V.			

This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the application
- ☐ Box No. VIII Certain observations on the application

	Examiner Szachowicz, Marta
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WRITTEN OPINION

Application number
NL2010578

Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.
2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:
 - a. type of material:
 - ☐ a sequence listing
 - ☐ table(s) related to the sequence listing
 - b. format of material:
 - ☐ on paper
 - ☐ in electronic form
 - c. time of filing/furnishing:
 - ☐ contained in the application as filed.
 - ☐ filed together with the application in electronic form.
 - ☐ furnished subsequently for the purposes of search.
3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes: Claims	2, 3
	No: Claims	1, 4-6
Inventive step	Yes: Claims	
	No: Claims	1-6
Industrial applicability	Yes: Claims	1-6
	No: Claims	

2. Citations and explanations

see separate sheet

Re Item V

1 Reference is made to the following documents:

- D1 WO 2012/055724 A1 (MIORTECH HOLDING B V [NL]; FEIL HERMANUS [NL]) 3 mei 2012 (2012-05-03)
- D2 WO 2012/039471 A1 (SEKISUI CHEMICAL CO LTD [JP]; NAKASUGA AKIRA [JP]; UNATE TAKAO [JP]; W) 29 maart 2012 (2012-03-29)

2 The present application does not meet the criteria of patentability, because the subject-matter of claim 1 is not new.

D1 (see Figure 1) discloses:

Elektrowetting optisch element (1) omvattende

- een eerste elektrodelagstapeling (5) en een tweede elektrodelagstapeling (3), en
- een insluitingsruimte (25) gevormd tussen de eerste elektrodelagstapeling en de tweede elektrodelagstapeling,
- waarbij de insluitingsruimte ten minste een polaire vloeistof (29) en een niet-polaire vloeistof (30) bevat, waarbij de polaire en niet-polaire vloeistoffen niet mengbaar met elkaar zijn (page 8, lines 33-34),
- ten minste een celwand (19) die zich uitstrekt tussen de eerste en de tweede elektrodestapelingen voor het definiëren van zijden van de insluitingsruimte, waarbij de celwand een materiaal omvat waaruit de celwand is samengesteld (page 8, lines 25-32),
- waarbij elk van de tweede elektrodelagstapeling en de eerste elektrodelagstapeling een elektrode omvat voor het aanbrengen van een spanning tot de elektroden voor het mogelijk maken dat de polaire vloeistof zich herrangschikt ten opzichte van de niet-polaire vloeistof (page 7, line 20 - page 8, line 4)
- waarbij de ten minste ene celwand een oppervlak heeft dat een interface vormt met de insluitingsruimte en een hydrofobe kops kant van de celwand (page 9, lines 10-12), waarbij
- het celwandinterface-oppervlak een hydrofoob oppervlakdeel heeft dat een interface vormt met de insluitingsruimte aan een einddeel van de celwand (page 9, lines 20-24).

3 The subject matter of independent method claim 4 is not new for reasons set out in the above paragraph, mutatis mutandis.

- 4 Dependent claims 2, 3, 5 and 6 do not appear to contain any additional features which, in combination with the features of any claim to which they refer, meet the requirements of novelty or inventive step.

The hydrophobic cover over the cell wall, as specified in claims 2 and 3, is described in document D2 (paragraphs [0066]-[0069], [0074]-[0076]) as providing the same advantages as in the present application. Namely, by assuring uniform distribution of the non polar liquid disposed in the respective pixels, even light distribution is provided, in particular in the corners of the pixels. The skilled person would therefore regard it as a normal design option to extend the hydrophobic coverage to the side parts of the cells wall of the electrowetting optical element described in D1 in order to better control the distribution of the non-polar liquid. Although the structure of D1 differs slightly from the present application, it gives a straightforward indication to the skilled person how the non-polar liquid will behave in the presence of the hydrophobic material on the sides of the cell walls. The subject-matter of claims 2 and 3 is therefore not inventive.

The subject-matter of claim 5 and 6 is disclosed in D1 (page 5, line 27 - page 7, line 5, page 9, line 25 - page 12, line 10) and therefore not new.