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(54) Title: MICROFLUIDIC FOIL STRUCTURE FOR METERING OF FLUIDS

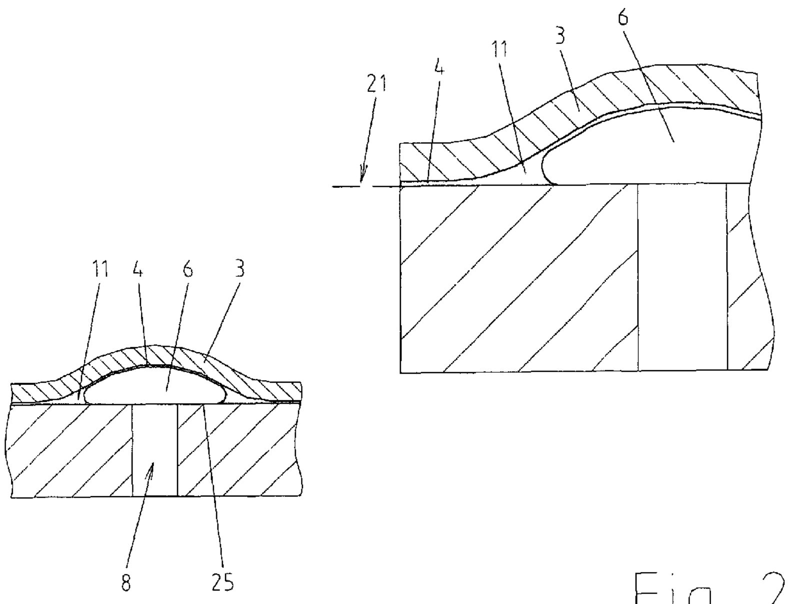

Fig. 2

(57) Abstract: The invention relates to a microfluidic device for metering liquids into a microfluidic network. The microfluidic channels or chambers are at least partly formed by the introduction of suitable structures into a film above the substrate carrier, so that at least some of the flow of fluid through the network takes place above the plane of the substrate. In order to form a stable channel structure or chamber structure in the film, it is envisaged that in the edge zone between the unattached and attached portions a wedge of material is formed by the viscous flow of the film material as the film is bonded to the substrate, this wedge forming a transition between the chamber wall and the substrate and raising the chamber wall above the plane of the substrate. In one method of producing a finished microfluidic structure a flat planar film is laminated onto a flat sheet-like substrate. During the lamination a mask having at least one recess or opening is pressed onto the film and onto the substrate under pressure and/or under the effect of heat. The film is thereby brought to a temperature at which there is a viscous flow of film and/or substrate medium into the region of the recess or opening, so that a wedge of material is formed and the film bulges up in the region of the recess to form a chamber. The invention further relates to methods of metering at least one liquid in a microfluidic network, in which a capillary stop is overcome by actuating the film, the film being wetted as the capillary stop is removed.

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AMENDED CLAIMS
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1. Microfluidic structure, comprising a substrate (1), and a film (2) attached flat to the substrate (1) with unattached portions (25), so that a chamber (6) or a channel (5) is formed above the substrate plane (21) in an unattached portion (25), characterised in that in that the film (2) is a multilayer film, in particular a two-layer film, whereby the film (2) comprises a sealing layer (4) arranged on the substrate and a covering layer (3) arranged above it and whereby the sealing layer (4) has a lower melting and/or softening temperature than the covering layer (3) and whereby in the edge zone between the unattached (25) and attached portions (24) a wedge of material (11) is formed by the viscous flow of the film material as the film (2) is bonded to the substrate (1), this wedge of material (11) forming a transition between the chamber wall and the substrate (1) and lifting the chamber wall away from the substrate plane (21).

2. Microfluidic structure according to claim 1, characterised in that the softening temperature of the sealing layer (4) is 60°C to 200°C, in particular 85°C to 110°C and the softening temperature of the covering layer (3) is 150°C to 350°C, in particular 200°C to 300°C

3. Microfluidic structure according to claim 1, characterised in that a microfluidic network is formed by the chamber (6) and/or channels (5) above the substrate plane.

4. Microfluidic structure according to claim 1, characterised in that recesses (22) in the form of channels (5) are formed in the substrate (1) and a chamber (6) or a channel (5) in the film covers one end of a channel section (5) in the substrate and that the walls of the channel section in the substrate (1) form a step to the chamber (6) or a step to the channel (5) in the film (2).

5. Microfluidic structure according to one of claims 3 or 4, characterised in that the chamber (6) or the channel (5) covers a throughflow opening (8), in particular a transverse bore (8) through the substrate (1) and the outer edge of the chamber (6) is arranged above the transverse bore (8) such that a capillary gap of 1 micron to 20 µm, in particular from 3 – 10 microns is produced between the chamber wall and the edge (12) of the step and/or a channel (5) opens into the transverse bore (8) on the top and bottom and/ or the films (2) are arranged on the top and bottom of the substrate.

6. Microfluidic structure according to claim 1, characterised in that the chamber (6) and/or the channel (5) is disc-shaped in cross-section, particularly in the shape of a spherical segment, the cross-sectional width being at least 20 times the cross-sectional height and the angle formed between the chamber wall in the edge region of the cross-section and the substrate plane (21) being 1° to 20°, in particular 5° to 12°.

7. Microfluidic structure according to claim 6, characterised in that the chamber height is 10 to 15 microns in a first cross-sectional region at the apex (13) of the chamber, 5-10 µm in a second cross-sectional region between the apex (13) and the edge and 0.1 µm to 5 µm in a third edge region, so that as a result of the varying cross-sectional height blood fluid particles of different sizes arrange themselves in different flow regions, whereby predominantly red blood cells flow in the first region, predominantly thrombocytes flow in the second region and predominantly blood plasma flows in the third region.

8. Microfluidic structures according to claim 6, characterised in that the centre (13) of the cupola or dome to the substrate plane (21) is lowered relative to an outer region such that the distance of the substrate plane (21) from the centre of the dome is less than half the maximum vertical distance between the wall of the dome and the substrate plane (21) and whereby a throughflow opening (8), in particular a transverse bore (8) is arranged underneath the chamber dome (13) such that the lowered centre of the dome acts as a capillary initiating point.

9. Microfluidic structure according to one of claim 4, characterised in that the edge (12) of the step forms a capillary stop, while by actuation of the flexible chamber wall the gap spacing between the chamber wall and the edge of the step can be altered so that the gap is wetted.

10. Microfluidic structure according to claim 6, characterised in that at least two channel ends formed in the substrate are covered by the dome-shaped chamber and that the substrate (1) has a recess (22) in the region underneath the unattached film, particularly on the bottom of the substrate, remote from the film whereby the recess (22) is wedge-shaped or spherical or hemispherical or rectangular.

11. Microfluidic structure according to claim 10, characterised in that the substrate (1) is flexible, in particular can be subjected to a flexural stress, in particular can be bent elastically in a reversible manner in the wedge region and whereby the substrate (1)

comprises means for mechanical clamping whereby the clamping means are guides and contact points (23).

12. Microfluidic structure according to claim 1, characterised in that the substrate material is elastic whereby the substrate thickness is reduced along a portion of the extent of a chamber and/or a channel so that this region deforms under reduced bending force, more particularly brings about a change in the cross-section of the fluid chamber or fluid channel in the film and whereby a support member (26), particularly an anvil, is arranged underneath the substrate (1) for supporting the reduced-thickness substrate such that the fluid channel forms a constriction that can be adjusted by bending the structure.

13. Method of producing a microfluidic structure constructed in particular according to the preceding claims, wherein a flat, planar film (2) is laminated onto a flat sheet-like substrate (1), characterised in that for the lamination a mask (31) with at least one recess (22) or opening is pressed onto the film (2) on the substrate under pressure and/or under the effect of heat, whereby the film is brought to at least a temperature at which there is a viscous flow of film and/or substrate medium into the region of the recess or opening, so that a wedge of material (11) is formed and the film bulges in the region of the recess to form a chamber.

14. Method according to claim 13, characterised in that an at least two-layered film (2) is laminated onto the substrate, while the film layer adjoining the substrate, particularly the sealing layer (4), has a lower softening point and/or melting point than an outer covering film (3) and during the lamination a temperature close to the melting and/or softening temperature of the sealing film (4) is set, whereby the laminating temperature is 70°C to 350°C, particularly 120°C to 150°C.

15. Method according to one of claims 31 to 34, characterised in that the film (2) is laminated onto the substrate (1) using a mask in the form of a roller die and or a plate-shaped mask (31) and/or the films are laminated onto the substrate by means of a mask in the form of a die laminator.