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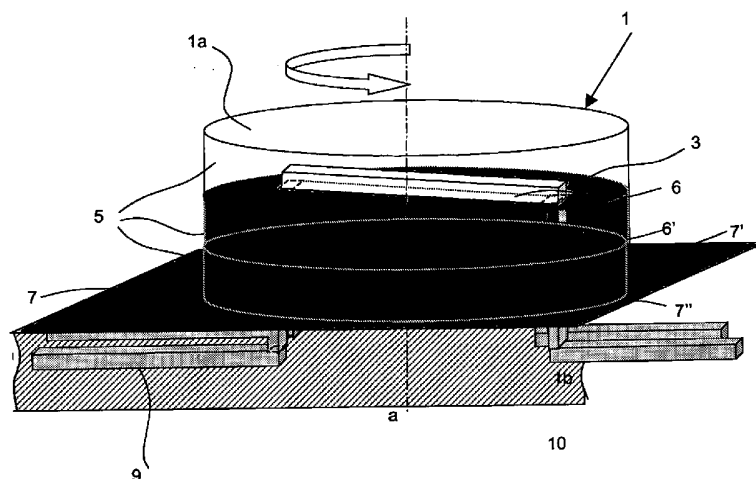
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(54) Title: MICROFLUIDIC ARRANGEMENT WITH COUPLING DEVICE HAVING A SELECTABLE OPTICAL DETECTION PORTION



(57) Abstract: A fluidic arrangement for an improved optical detection for a microfluidic device is provided, having a channel adapted to conduct a fluid, and a coupling device (1) having at least two coupling channels, one of which selectable for optical detection without interrupting processes running in the other channel(s). The coupling device is coupled with the fluidic device (2), so that the fluid flows from a channel of the fluidic device (2) into one of the coupling channels. The coupling channel having an optical detection portion (6) is part of a detection lane adapted to detect the fluid flowing therethrough, while the fluid flowing through the coupling channel without an optical detection portion is not influenced by the detecting activity. A vertical axis (a-a) permits turning of the coupling device (1) whereas the microfluidic device (2) is statically arranged. Turning leads to alternation of optical detection lane and an idle lane, enabling to detect the fluid of another lane. A method for performing optical detection of fluids processed in a fluidic device comprising one or multiple channels by use of the fluidic arrangement.

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MICROFLUIDIC ARRANGEMENT WITH COUPLING DEVICE HAVING A SELECTABLE OPTICAL DETECTION PORTION

[0001] The present invention refers to the non published international
Application WO 04/051577 to Zimmermann et al, the content of which is
5 herewith incorporated by reference.

[0002] The invention relates to a microfluidic device.

BACKGROUND ART

[0003] In sample analysis instrumentation and especially in separation
systems such as liquid chromatography and capillary electrophoresis systems,
10 smaller dimensions generally result in improved performance characteristics
and at the same time result in improved preparation and analysis efficiency due
to time saving based on short residence times in the system and reduced
consumption of solvents and additives. Miniaturized separation systems enable
scientists to obtain research results despite of using very small volumes of
15 rarely available or difficult to prepare chemical or biological materials.

[0004] Analysis of a fluidic substance or substance specimens being
separated or prepared in a miniaturized device or microfluidic device,
respectively, is performed while the fluidic substance is driven through the
channels. Micro channels are generated in microfluidic devices by use of a
20 bonding technology, as for example Kaltenbach refers to in U.S. Pat . No.
5,917,606 to and EP Pat. No. 0 762 119 B1. The miniaturisation reactors to
chip size enables scientists to perform processes with a plurality of samples in
parallel, the processing itself requiring only very limited space requirements.
To analyse the processed fluid it is necessary to insert the microfluidic device
25 into a detection device.

[0005] The most preferred analysis technology is the optical detection since
it generally does not require withdrawing a sample from the process. Optical

detection is based on UV/Vis, fluorescence, refractive index (RI), Raman and spectroscopic technologies or the like. Performing optical measurements requires the existence of at least one optical transparent part of the arrangement of microfluidic and detection device in order to provide a light path, thus enabling subjecting of the substance to light while it is passing the channel(s) within the microfluidic device.

[0006] Accordingly, microfluidic arrangements have to come up to optical and chemical demands. Swedberg et al. refer in US Pat. No. 6,033,628 to miniaturized microfluidic devices, combining a device material providing chemical inertness and an optical detection means in compact form coupled with the miniaturized column device.

[0007] Optical detection techniques generally presuppose the presence of a light path. With respect to almost all of the above named optical techniques, the quality of the results obtained depends on the pathlength of this optical light path. Suggestions how to optimise the optical pathlength have been described in U.S. Pat. No 5,571,410 to Swedberg et al. and in U.S. Pat. No 5,500071 to Kaltenbach et al.

DISCLOSURE OF THE INVENTION

[0008] It is an object of the present invention to provide an improved optical detection for a microfluidic device. The object is solved by the independent claims. Preferred embodiments are shown by the dependent claims.

[0009] Embodiments of the present invention address the aforementioned needs in the art and depict a microfluidic arrangement combining a detection unit with a microfluidic device in a way that detecting of multiple fluidic substances or substance specimens can be performed by use of a single detection unit. Fluidic substances flowing through the multiple channels of the microfluidic device are bypassed through channels comprised of a coupling

device in a way that the fluid of any desired channel or lane, respectively, can be bypassed through a specific channel of the coupling device which is designed to provide an optical detection path or light path, respectively.

[00010] Generally, the embodiments of the invention show a microfluidic arrangement combining a polymeric device to carry out a desired chemical, physical or biological process with a coupling device made of silicon dioxide, borosilicate or the like, both standing in fluidic communication with each other. The coupling devices comprise an optical detection portion which serves as part of an optical device and it comprises a number of portions comprising bypassing channels designed to bypass the fluidic substances which at the moment do not need to be detected.

[00011] One embodiment of the microfluidic arrangement with multilane coupling device is composed in that the surface of a microfluidic device with a planar geometry is coupled with the bottom surface of a bypass unit, which comprises an optical detection portion as part of an optical device. The microfluidic device comprises channels carrying the fluid being analyzed, which channels stand in fluidic communication with an appropriate number of bypassing channels in the coupling device, the channels of the coupling device being arranged in different horizons. One channel has a portion being comprised in the top horizon of the coupling device as an optical detection portion providing a light path along its longitudinal axis. The fluid is subjected to detection while passing that optical detection portion, it flows back into the microfluidic device continuing its way through the continuation parts of the channel through which it was driven before.

[00012] Thus, the coupling of the microfluidic devices' channels and the coupling device channels leads to formation of lanes, the one comprising a detection portion generally being a detection lane and the others being just bypassing idle lanes. Turning the autonomously revolving upper layer of the

bypass unit about a fractional part of a turn with respect to its vertical axis leads to inversion of the lane properties. The detection lane becomes an "idle lane" then and an "idle lane" becomes the detection lane.

5 [00013] In a second embodiment of the invention the microfluidic arrangement with multilane coupling device is substantially composed as in the embodiment depicted before, but the light path provided by the optical detection portion is arranged normal to the coupling channel being comprised in the upper portion of the bypass unit.

10 [00014] Further embodiments not shown in here may incorporate a plurality of lanes, each of which becoming a detection lane when being positioned in the upper layer, which can be turned autonomously or corresponding with the other layers with respect to its vertical axis.

15 [00015] It is a major improvement of the present invention over the prior art that any lane may be selected for fluid detection while the fluid flow through the remaining lanes is not disturbed or interrupted, thus permitting a continuous processing despite of alternately examining the fluid flowing through different lanes.

BRIEF DESCRIPTION OF DRAWINGS

20 [00016] Other objects and many of the attendant advantages of embodiments of the present invention will be readily appreciated and become better understood by reference to the following more detailed description of preferred embodiments in connection with the accompanied drawings. Features that are substantially or functionally equal or similar will be referred to with the same reference signs. The Figures show:

25 [00017] FIG.1a a side view of a coupling device, comprising two coupling channels,

[00018] FIG. 1b a cross sectional side view of the coupling device of FIG. 1a,

[00019] FIG. 2a a side view of a microfluidic device with microfluidic channels opening to the upper top surface,

[00020] FIG. 2b a plan view of a microfluidic device with two microfluidic
5 channels and their corresponding channel continuations opening to the upper surface,

[00021] FIG. 3a a cross sectional side view of a microfluidic arrangement being comprised of a microfluidic device and a coupling device, showing one detection lane and one idle lane,

10 [00022] FIG. 3b a plan view of the microfluidic arrangement of FIG. 3a,

[00023] FIG. 4a a cross sectional side view of the microfluidic arrangement of FIG. 3a with the top horizontal layer comprising the optical detection portion providing a light path along its longitudinal axis,

[00024] FIG. 4b a cross sectional side view of the microfluidic arrangement of
15 FIG. 3a with the top horizontal layer comprising the optical detection portion providing a light path normal to its longitudinal axis.

DETAILED DESCRIPTION OF DRAWINGS

[00025] Before the invention is described in detail, it is to be understood that this invention is not limited to the particular component parts of the devices
20 described or to process steps of the methods described as such devices and methods may vary. It is also to be understood, that the terminology used herein is for purposes describing particular embodiments only and it is not intended to be limiting. It must be noted that, as used in the specification and the appended claims, the singular forms of "a", "an", and "the" include plural referents until
25 the context clearly dictates otherwise. Thus, for example, the reference to "a vertical portion" may include two or more such vertical portions; "a coupling

channel" or "the vertical portion" may as well include two or more such channels or portions where it is reasonable in the sense of the present invention.

[00026] In this specification and in the claims which follow, reference will be
5 made to the following terms which shall be defined to have the herewith explained meanings:

[00027] The term "microfluidic device" is used herein to refer to any material which is light-absorbing and capable of being ablated, particularly laser-ablated, and which is not silicon or a silicon dioxide material such as quartz,
10 fused silica or glass like borosilicates. Accordingly miniaturized column devices or devices comprising channels for separation or preparative purposes are formed herein using suitable materials such as laser ablatable polymers (including polyimides and the like) and ceramics (including aluminum oxides and the like), thus being "microfluidic devices". Furthermore, microfluidic
15 devices are formed herein using substrates such as laminate which is a composite formed from several different bonded layers of the same or different materials.

[00028] As used herein, an "optical detecting device" refers to any means, structure or configuration which allows one to interrogate a sample within a
20 definite compartment using optical analytical techniques known in the art. Thus, an "optical detecting device" comprises a light emitting source and a means to receive light being reflected or transmitted by the sample.

[00029] By the arrangement of a light emitting source and a light receiving means (receiver), an "optical detection path" or "light path", respectively, is
25 formed permitting electromagnetic radiation to travel from the light emitting source to the receiver, thereby traversing a sample being present within a compartment on the optical detection path. Thus, a variety of optical detection techniques can be readily interfaced with the part of the optical detection path

including, but not limited to UV/VIS, Near IR, fluorescence, refractive index (RI) and Raman index.

[00030] The "optical detection portion" is that component of the optical detection device which surrounds the compartment or part, respectively, of the optical detection path which contains the sample while it is traversed by the electromagnetic radiation.

[00031] In the following, the term "fluid" is used synonymously for "sample", "substance specimens", "substance", etc. since the focus is laying onto the analysis of fluid media no matter if they are subjected to a separation process or to a preparative process. The fluid may contain particles.

[00032] Furthermore, the term "continuation channel" shall be defined. To perform a chemical, biochemical or physical process, the reaction channel in which the process is performed needs a certain path length. If the reaction path is interrupted for certain purposes such as detection, it must be continued in order to complete the reaction or process. Thus, the "continuation channel" is that part of one definite channel which is needed to complete the process which had begun in said channel before the processed fluid has been bypassed.

[00033] Referring to the performance of a separation or preparation process, it can generally be said that there are certain moments in a process when it is most desirable to check the quality of the product to be obtained or the progress of a separation of a process or the like. Coupling single microfluidic devices in turn with optical detection devices just in the very moment of interest requires a very precise time management and can be carried out without wasting time due to "idling" when the process conducted in the microfluidic device is not interrupted for analytical purposes.

[00034] The present invention refers generally to a fluidic arrangement

wherein a fluidic device is combined with a coupling device which is designed to enable the scientist to carry out analytical examinations of one fluid stream flowing through a channel or lane of the fluidic device while in parallel at least one other fluid stream is processed within an adjacent lane, not being
5 influenced by the application of a detection technique to the first lane. Advantageously, the fluid flowing in the lane not being detected at the moment may be subjected to preparative steps in order to be detected next. When there exists a plurality of lanes into the fluidic device, the scientist can select the lanes of interest and subject them to detection one after the other, not wasting
10 time due to operative changes concerning the detecting device. A fluidic device can be a miniaturized device such as a microfluidic device or a microfluidic chip as well as a non miniaturized fluidic device.

[00035] Generally, the fluidic device of the present invention has a substantially planar geometry and comprises a plurality of channels or lanes to
15 conduct fluids. The coupling device generally has at least two coupling channels, one of which comprising an optical detection portion. The fluid may be driven by pumps or the like through the lanes of the fluidic device, as in liquid chromatography or in electrophoretic applications, for example. The coupling device and the fluidic device are arranged in a way that the fluid being
20 driven through a channel of the fluidic device is just bypassed via a coupling channel of the coupling device before it is led back into another channel of the fluidic device being a continuation of the first one. This requires precise positioning of bypass and fluidic device in order not to provoke leaking at the points where fluid transits from one device into the other. To support precise
25 positioning position holders such as pins can be arranged at one or both of the devices.

[00036] In order to subject the fluid to detection it is necessary to equip the coupling device with an appropriate facility. Accordingly one coupling channel provides an optical detection portion which is in communication with an optical

detection device. The optical detection portion is substantially designed to guide light for optical detection techniques based on fluorescence, UV/VIS, near IR, refractive index (RI) and Raman index.

[00037] Accordingly, the optical detection portion needs to be at least partially optically. To fulfill this requirement it is advantageous to make the coupling device of quartz, fused silica, glass, borosilicate glass, or any material suitable for the application of optical detection techniques, whereas the fluidic device can be made of a polymeric material such as Kapton® or any other material suitable to perform the desired chemical, biochemical or physical process.

[00038] A coupling channel is comprised of one horizontal portion and a number n of vertical portions, with n being 2 or a multiple of 2. The coupling channel which has an optical detection portion generally being identically with the horizontal portion forms a detection lane in addition with channel and continuation channel of the fluidic device, whereas the other coupling channel just serves to bypass the fluid which is not being detected at the moment. Accordingly this coupling channel is an idle lane in addition with channel and continuation channel of the fluidic device. Due to the fact that manufacturing the microfluidic arrangement of the present invention is based on the bonding technique, the channels depicted inhere have an almost rectangular cross sectional shape.

[00039] To arrange the horizontal portions in an efficient way, in particular with respect to the fact that the optical detection portion of the optical detection lane needs to be optically separated from adjacent idle lanes or coupling channels, respectively, a subdivision of the coupling device into horizontal layers is advantageous. The optical separation may be achieved by providing at least a partial coating preventing transmission of light between the horizontal layer incorporating the optical detection portion and an adjacent layer, or it may

be achieved by black staining of horizontal layers.

[00040] Furthermore, a coupling device according to the present invention has a vertical axis of revolution, permitting to turn the coupling device and in particular single horizontal layers autonomously, whereas the fluidic device is substantially statically arranged. Therefore, it is recommended to select a cylindrical shape for the coupling device.

[00041] Referring now to **FIG. 1a**, a side view of a coupling device 1 having a cylindrical shape with an upper surface 1a and a bottom surface 1b can be seen. The coupling device 1 is subdivided into three horizontal layers 5, an upper, middle and bottom layer. It comprises two coupling channels to carry fluids, both of which opening to the bottom surface 1b. The channel which is incorporated in the top horizontal layer 5 consists of one horizontal portion 6 being an optical detection portion and of four vertical portions 7. Both ends of the horizontal portion 6 open downwards into two vertical portions 7; the first of which extending through the middle layer, opening into the second vertical portions which are arranged below the first ones, thus extending through the bottom layer and therefore opening to the bottom surface 1b.

[00042] The channel incorporated within the middle horizontal layer consists of one horizontal portion 6' being just a bypassing portion, and two vertical portions 7. Both ends of the horizontal portion 6 open downwards into two vertical portions 7, both of which extending through the bottom layer and therefore opening to the bottom surface 1b, too.

[00043] Other embodiments not shown inhere might have a plurality of middle layers, each of which having one horizontal portion being an optical portion and a number n of vertical portions, with n being 2 or a multiple of 2 depending on the number of coupling channels to be formed. An embodiment which has four layers, for example, would have one horizontal portion being an optical portion in the top layer (fourth layer), one horizontal portion just being a

bypassing portion and two vertical portions in the third layer (counting starts at the bottom layer), one horizontal portion just being a bypassing portion and four vertical portions in the second layer and no horizontal portion but six vertical portions in the bottom layer (first layer).

- 5 [00044] Summarizing it can be said each horizontal layer 5 except of the top layer comprises n vertical layers, with n being 2 or a multiple of 2, and each of the horizontal layers 5 except of the bottom layer comprises one horizontal portion.

- 10 [00045] With reference to **FIG. 1b** a cross sectional side view of the coupling device of **FIG. 1a** can be seen. **FIG. 1b** depicts clearly that the horizontal portions 6 being the optical portion and the horizontal portion 6' serving only for bypassing purposes are spaced from each other and are arranged in different horizontal layers 5. The optical detection portion 6, which is optically transparent, needs to be optically separated. To achieve the optical separation,
15 the material of which the middle and bottom layers are made is black stained.

[00046] Of course, the optical separation which is needed to prevent transmission of light could be provided by other means than black staining 3, such as by a coating between the top horizontal and the adjacent horizontal.

- 20 [00047] Furthermore, **FIG. 1** shows the vertical axis of revolution a-a, which permits turning of the coupling device 1 as indicated by the arrow, whereas the microfluidic device 2 is statically arranged. Generally, each of the horizontal layers 5 can be turned autonomously.

- 25 [00048] **FIG. 2a** shows a side view of a microfluidic device with microfluidic channels 9,9',10,10' to conduct fluids, each of them opening to the upper surface 2a of the microfluidic device. The plan view of the microfluidic device shown in **FIG. 2b** indicates that the channels 9',10' are continuation channels of the channels 9,10, all of them opening to the upper surface 2a, being

arranged in a way that a linking element between channel 9 and continuation channel 9' needs only to be turned around a centre of rotation 15 to link the channel 10 and continuation channel 10'. This is how the optical detection portion 6 functions.

5 [00049] Referring now to **FIG. 3b**, the cross sectional side view of a microfluidic arrangement consisting of the microfluidic device 2 and the coupling device 1 indicates clearly how a detection lane and a idle lane are constituted. The arrangement of the coupling device 1 and the fluidic device 2 allows that a fluid flowing from a channel 9 can be led via a coupling channel
10 back into a channel 9', thus passing approximately the same path length as a fluid flowing from a channel 10 being led via a coupling channel comprising a detection portion 6 back into a channel 10'. Despite of the detection of the fluid flowing through the detection lane, no interruption of the process occurs. It is very advantageous that the channel path length of both lanes is the same, thus
15 guaranteeing that the fluid in both lanes is subjected to the processes performed in the fluidic device 2 for the same time. Accordingly, the operation parameters can be controlled optimally.

[00050] In **FIG. 3a** it can be seen easily that a vertical portion 7 comprised in the middle and the bottom layer has two ends, one of which providing an
20 opening 7' to an upper surface and the other one providing an opening 7'' to a bottom surface of the horizontal layer 5. The horizontal portions 6, 6' have two open ends, too, with the horizontal portions 6, the optical detection portion, opening to the bottom surface of the top horizontal layer 5 and with the horizontal portions 6' opening to the bottom surface of the middle horizontal
25 layer 5 where it is comprised in.

[00051] The open ends of the horizontal portion 6 in the top layer face the openings 7' of the vertical portion 7 in the middle layer, whereas the second openings 7'' of the vertical portion 7 in the middle layer of the vertical portion 7

face the openings 7' of the vertical portion 7 in the bottom layer.

[00052] Generally, a coupling device comprising more than three layers - not shown in the figures - is constituted in a way that each lower opening of a vertical portion comprised in a middle horizontal layer 5 faces an upper opening of a vertical portion of the adjacent horizontal layer 5 below. The lower openings of a vertical portion comprised in a bottom layer generally face openings of channels comprised in the fluidic device being coupled with, whereas the open ends of the horizontal portions generally face upper openings of the vertical portions in the adjacent layer below. Accordingly, the vertical portions being comprised in the superimposed layers and the horizontal portions can be so arranged that any channel of the fluidic device is continued via a coupling channel to its corresponding continuation channel.

[00053] It should be taken into consideration that a continuation channel may be provided by a second fluidic device. Accordingly the fluid flows via the coupling device from one into another fluidic device.

[00054] Of course, this arrangement can be performed for a number of channels in the fluidic device exceeding 2.

[00055] **Fig. 3a** makes clear that turning of the top horizontal layer 5 and the middle horizontal layer 5 for a quarter-turn around the vertical axis a-a of rotation results in a change of the idle lane, involving channels 9,9', into the optical detection lane, involving channels 10, 10', and vice versa, since the optical detection portion 6 becomes now coupled with the vertical portions 7 facing the openings 8 of channels 10,10'. The bottom layer does not need to be turned.

[00056] The plan view of the fluidic arrangement of **FIG. 3a** shown in **FIG. 3b** indicates the bridging function of the horizontal portions 6, 6'. One can see clearly that the horizontal portion 6 being at the same time the optical detection

portion 6 is superimposing the horizontal portion 6' which fulfills only bypassing purposes.

[00057] **FIG. 4a** and **FIG. 3b** refer to the light path 17,18 needed for optical detection.

5 [00058] In **FIG. 4 a** the light path 17 is depicted, which is provided by the detection portion 6 indicated by the arrow. It is incorporated in the top horizontal layer 5, being aligned with the longitudinal axis b-b of the optical detection portion 6. **FIG. 4b** shows a cross sectional side view of an alternative embodiment of the microfluidic arrangement of **FIG. 3a** with the light path 18
10 being normal to the longitudinal axis b-b of the optical detection portion 6, see the arrow.

[00059] Of course it is generally most advantageous to select an embodiment with a long light path since the results obtained by optical measurements depend on the length of the light path, as an increasing light path optimizes the
15 signal/noise ration. Accordingly one is aiming even in an embodiment with the light path 18 being normal to the longitudinal axis b-b of the optical detection portion for a maximum length of the light path 18, thus the light path 18 may be extended by widening of the channel providing the optical detection portion.

[00060] An optical separation which separates the top layer incorporating the
20 optical detection portion 6 from the other horizontal layers 5 optically has to be provided in order to prevent disadvantageous influence of the horizontal layers 5 below the top horizontal layer 5, or back scattering or any other light effects. In **FIG. 4a** and **FIG. 4b** a separating film 16 being arranged between the top layer and the middle layer can be seen in order to serve as optical separating
25 device. Of course, the desired optical separation effect may be achieved by use of other means such as by application of a coating of the bottom surface which prevents transmission of light, or by black staining of the material constituting the horizontal layers below the top layer.

[00061] Generally, the fluidic arrangement described in the present invention may be used in applications such as liquid chromatography or electrophoresis, but other applications are possible. The microfluidic or fluidic devices may be prepared separately, being coupled with the bypassing device
5 at the desired moment. Since the coupling can be detached, the coupling device can be used for numerous procedures if not reasons such as contamination indicate not to do so. The handling of the coupling device is very flexible and easy. Turning the horizontal layers may be done automatically.

10 [00062] It has to be taken into consideration that the coupling has to be performed in a way that the both components fluidic device and bypass instrument are attached tightly for the time of operation. Leaking at the coupling positions has to be prevented. Any interfaces of channels, particularly those interfaces between the microfluidic device and the coupling device, need
15 to be positioned precisely, which means that openings being interconnected have to be brought in congruence. This could be facilitated by position holders as pins, for example, which can be mounted on the devices. Furthermore, the openings have to be fixed tightly on one another and they should be sealed with a high pressure proof sealing in order to prevent leakage due to the
20 pressure of the fluid. The pressure which has to be resisted may reach about 200 bar.

[00063] The method for optically detecting fluids being processed in microfluidic devices can be performed in any embodiment of a microfluidic arrangement according to the present invention. This requires bringing the
25 fluidic arrangement, in particular the optical portion of the coupling device into the course of rays of an optical detection device.

[00064] Fluids can be moved with conventional moving means in order to obtain a definite flow through rate when the fluid passes the part of an optical

detection path which is relevant for detection.

[00065] The light can be directed versus the probe directly or by coupling means; it can be directed along a longitudinal axis of the optical device or normal to it.

- 5 [00066] The present invention provides a fluidic combining of a microfluidic device material being chemically inert with respect to the processes to be performed with a bypassing device comprising an optical portion having optimal optical properties permitting to carry out the desired technology for optical detection. Multiple lanes may carry fluids to perform chemical or
- 10 physical processes or reactions while at any time one lane may be selected to detect its contents. Additionally, the fluidic arrangement can be used flexible, allowing economic handling of the detection since the optical device can be used for a number of detections with differing microfluidic devices.

CLAIMS

1. A fluidic arrangement comprising:
a fluidic device (2) having a channel adapted to conduct a fluid,
and a coupling device (1) having at least two coupling channels, one of
5 which comprising an optical detection portion (6),
wherein the coupling device is coupled with the fluidic device (2), so that
the fluid flows from the channel of the fluidic device (2) into one of the
coupling channels, wherein
the coupling channel having the optical detection portion (6) being
10 coupled with the channel provides a detection lane adapted for providing
a detection of the fluid when coupled with the channel of the fluidic
device.
2. Fluidic arrangement of claim 1 comprising:
the fluidic device (2) having a plurality of channels (9,9',10,10') to conduct
15 fluids,
wherein the coupling device is coupled with the fluidic device (2), so that
the fluid flows from the channel (9,10) of the fluidic device (2) into one of
the coupling channels of the coupling device and back into a channel
(9',10') being a continuation of the channels (9,10) of the fluidic device,
20 wherein the coupling channel having the optical detection portion (6)
being coupled with one channel (9,10) and one channel (9',10') provides
a detection lane adapted for providing a detection of the fluid when
coupled with the channel of the fluidic device
and wherein the coupling channel without an optical detection portion is
25 an idle lane.
3. The fluidic arrangement of claim 1 or 2, wherein the fluidic device (2) is a
microfluidic device or a microfluidic chip.
4. The fluidic arrangement of claim 1 or any one of the above claims,

wherein the coupling device (1) has a cylindrical shape with an top surface (1a) and a bottom surface (1b).

5. The fluidic arrangement of claim 1 or any one of the above claims, wherein the coupling device (1) has horizontal layers (5).
- 5 6. The fluidic arrangement of claim 1 or any one of the above claims, wherein a vertical axis (a-a) allows turning of the coupling device (1) whereas the microfluidic device (2) is statically arranged.
7. The fluidic arrangement of claim 6 or any one of the above claims, wherein the vertical axis (a-a) of revolution permits turning of each of the
10 horizontal layers (5) autonomously whereas the microfluidic device (2) is statically arranged.
8. The fluidic arrangement of claim 1 or any one of the above claims, wherein the optical detection portion (6) is at least partially optically transparent.
- 15 9. The fluidic arrangement of claim 1 or any one of the above claims, comprising an optical separation which separates the horizontal layer (5) incorporating the optical detection portion (6) from the other horizontal layers (5) optically.
10. The fluidic arrangement of claim 1 or any one of the above claims, wherein the optical separation is provided by a coating of the bottom
20 surface which prevents transmission of light, or by black staining (3) of the horizontal layers (5) below the horizontal layer (5) incorporating the optical detection portion (6), or by an application of a film being impervious for light being arranged below the horizontal layer (5)
25 incorporating the optical detection portion (6).
11. The fluidic arrangement of claim 1 or any one of the above claims,

wherein a coupling channel is comprised of one horizontal portion (6,6') and n vertical portions (7), with n being 2 or a multiple of 2.

12. The fluidic arrangement of claim 1 or any one of the above claims, wherein each horizontal layer (5) except of the one adjacent to the top surface (1a) comprises n vertical portions (7), with n being 2 or a multiple of 2, and wherein each of the horizontal layers (5) except of the one adjacent to the bottom surface (1b) comprises a horizontal portion (6,6').
13. The fluidic arrangement of claim 1 or any one of the above claims, wherein the vertical portion (7) has two open ends providing an opening (7') to an upper surface and an opening (7'') to a bottom surface of the horizontal layer (5).
14. The fluidic arrangement of claim 1 or any one of the above claims, wherein the horizontal portion (6,6') has two open ends opening to the bottom surface of the layer where it is comprised in.
15. The fluidic arrangement of claim 1 or any one of the above claims, wherein the open end of the horizontal portion (6,6') faces the opening (7') of the vertical portion (7), whereas the opening (7') of the vertical portion (7) faces the open end of the horizontal portion (6,6') or the opening (7'') of the vertical portion (7) comprised in the adjacent above horizontal layer (5).
16. The fluidic arrangement of claim 1 or any one of the above claims, wherein a channel (9,9', 10, 10') provided in the fluidic device (2) opens to a surface of said fluidic device (2) which faces the bottom surface (1b) of said coupling device (1), thus providing an opening (8) which faces the opening (7'') of the vertical portion (7).
17. The fluidic arrangement of claim 1 or any one of the above claims, wherein the opening (7'') of the vertical portion (7) faces the opening (7')

of the vertical portion (7) comprised in the adjacent below horizontal layer (5) or faces the opening of the channel (9,9',10,10').

18. The fluidic arrangement of claim 1 or any one of the above claims, wherein turning of the horizontal layers (5) around the vertical axis (a-a) results in formation of a coupling channel (6,6') extending from the bottom surface (1b) via at least one vertical portion, one horizontal portion and at least another vertical portion back to the bottom surface (1b) of the coupling device.
19. The fluidic arrangement of claim 1 or any one of the above claims, wherein the number of vertical portions comprised in the coupling channel (6,6') is changed by turning of at least one horizontal layer (5).
20. The fluidic arrangement of claim 1 or any one of the above claims, wherein a channel (10) of the fluidic device (2) is in fluidic communication with a channel (10') via the coupling channel (6) forming an optical lane and wherein a channel (9) of the fluidic device (2) is in fluidic communication with a channel (9') via the coupling channel (6') forming an idle lane, wherein the fluid being driven through the optical lane is subjected to optically detection and the fluid being driven through the idle lane flows unnoticed.
21. The fluidic arrangement of claim 1 or any one of the above claims, wherein the fluidic device (2) is detachably coupled with the coupling device (1).
22. The fluidic arrangement of claim 1 or any one of the above claims, wherein the optical detection portion (6) provides a light path (17,18) for optical detection.
23. The fluidic arrangement of claim 22 or any one of the above claims, wherein the light path (17) for optical detection is aligned with a

longitudinal axis (b-b) of the optical detection portion (6) of the coupling channel.

24. The fluidic arrangement of claim 22 or any one of the above claims, wherein the light path (18) for optical detection is arranged substantially normal to the optical detection portion (6) of the coupling channel.
25. The fluidic arrangement of claim 1 or any one of the above claims, wherein the optical detection portion is designed to guide light for is fluorescence, UV/VIS, near IR, refractive index (RI) and Raman index optical detection techniques.
26. The fluidic arrangement of claim 1 or any one of the above claims, wherein the fluidic device (2) comprises a polymer device, in particular a Kapton[®] substrate.
27. The fluidic arrangement of claim 1 or any one of the above claims, wherein the fluidic device (2) has a substantially planar geometry.
28. The fluidic arrangement of claim 1 or any one of the above claims, wherein the coupling device (1) is made of quartz, fused silica, glass, borosilicate glass or any material suitable to incorporate an optical detection portion (6).
29. The fluidic arrangement of claim 1 or any one of the above claims, wherein the coupling device (1) is positioned on the fluidic device (2) by position holders.
30. The fluidic arrangement of claim 29 or any one of the above claims, wherein the position holders comprise pins.
31. A method for performing optical detection of fluids processed in a fluidic device comprising a channel by use of a fluidic arrangement, in particular of a fluidic arrangement of claim 1 or anyone of the above claims,

- comprising the steps of
coupling the fluidic arrangement (2) with the coupling device (1) in a way
that there is a fluidic communication between the channel of the fluidic
device (2) and the coupling channels, thus providing one detection lane
5 and at least one idle lane,
driving the fluid through the detection lane and/or through the at least one
idle lane,
detecting the fluid flowing through the detection lane, and bypassing the
fluid flowing through the idle lane.
- 10 32. Method according to claim 31, wherein fluids are processed in a fluidic
device comprising multiple channels by use of a fluidic arrangement, in
particular of a fluidic arrangement of claim 2 or anyone of the above
claims, comprising the steps of
coupling the fluidic arrangement (2) with the coupling device (1) in a way
15 that there is a fluidic communication between the channels (9,9',10,10') of
the fluidic device (2) and the coupling channels,
driving the fluid through the detection lane and/or through at least one
idle lane,
detecting the fluid flowing through the detection lane and bypassing the
20 fluid flowing through the idle lane.
33. The method of claim 31 or anyone of the above claims, comprising the
steps of
turning at least one horizontal layer (5) of the coupling device around the
vertical axis (a-a), thus alternating the detection lane and one of the at
25 least one idle lanes,
detecting the fluid flowing through a lane now being the detection lane.

AMENDED CLAIMS

[received by the International Bureau on 04 July 2005 (04.07.2005);
original claims 1-33 amended, claims 34, 35 added]

CLAIMS

1. A microfluidic coupling device (1) adapted to be coupled to a microfluidic device (2) having a device channel adapted to conduct a fluid, the microfluidic coupling device (1) comprising:
5 a detection channel adapted to be coupled to the device channel, said detection channel comprising an at least partially transparent optical detection portion (6) adapted for providing a detection of the fluid when said detection channel is coupled with the device channel,
wherein the microfluidic coupling device (1) is adapted to be
10 moveably, preferably rotatably, coupled with the microfluidic device (2), so that the fluid flows from the device channel into the detection channel.
2. The microfluidic coupling device (1) according to claim 1, further comprising a bypass channel adapted to be rotatably coupled with the microfluidic device (2), so that the fluid flows from the device channel into
15 the bypass channel, wherein said bypass channel is not provided with an optical detection portion, thus being an idle lane.
3. The microfluidic coupling device (1) according to the above claims, wherein:
- the microfluidic device (2) has a plurality of device channels
20 (9,9',10,10'),
- the microfluidic coupling device (1) is coupled with the microfluidic device (2),
so that the fluid flows from the device channel (9,10) of the microfluidic device (2) via the detection channel or the bypass channel comprised of
25 the microfluidic coupling device (1), and back into the device channel (9',10') which is a continuation of the device channels (9,10) of the microfluidic device.
4. The microfluidic coupling device (1) according to claim 1 or any one of the above claims, wherein said microfluidic coupling device (1) has a

cylindrical shape with a top surface (1a) and a bottom surface (1b).

5. The microfluidic coupling device (1) according to claim 1 or any one of the above claims, wherein the microfluidic coupling device (1) has a vertical axis of revolution (a-a) around which the microfluidic coupling device (1) rotates, whereas the microfluidic device (2) is statically arranged.
6. The microfluidic coupling device (1) according to claim 1 or any one of the above claims, wherein the microfluidic coupling device (1) has horizontal layers (5).
7. The microfluidic arrangement according to the preceding claim, wherein each of the horizontal layers (5) is separately rotatable around the vertical axis of revolution (a-a), whereas the microfluidic device (2) is statically arranged.
8. The microfluidic arrangement according to claim 6 or any one of the above claims, comprising an optical separation which separates the horizontal layer (5) incorporating the optical detection portion (6) from the other horizontal layers (5) optically.
9. The microfluidic arrangement according to the preceding claim, wherein the optical separation is provided by a coating of the bottom surface (1b) which prevents transmission of light, or by black staining (3) of the horizontal layers (5) below the horizontal layer (5) which incorporates the optical detection portion (6), or by an application of a film being impervious for light being arranged below the horizontal layer (5) incorporating the optical detection portion (6).
10. The microfluidic arrangement according to claim 2 or any one of the above claims, wherein the detection channel and the bypass channel is comprised of a horizontal portion (6,6') and a number of n vertical portions (7), with n being 2 or a multiple of 2.

11. The microfluidic arrangement according to the preceding claim, wherein each horizontal layer (5) except of that one adjacent to the top surface (1a) comprises n vertical portions (7), with n being 2 or a multiple of 2, and wherein each of the horizontal layers (5) except of that one adjacent to bottom surface (1b) comprises one horizontal portion (6,6').
12. The microfluidic arrangement according to the preceding claim, wherein the vertical portion (7) has two open ends providing an opening (7') to an upper surface and an opening (7'') to a bottom surface of the horizontal layer (5).
13. The microfluidic arrangement according to the preceding claim, wherein the open end of the horizontal portion (6,6') faces the opening (7') of the vertical portion (7), whereas the opening (7') of the vertical portion (7) faces the open end of the horizontal portion (6,6') or the opening (7'') of the vertical portion (7) comprised in the horizontal layer (5) adjacent above.
14. The microfluidic arrangement according to claim 12 or any one of the above claims, wherein a device channel (9,9',10,10') provided in the microfluidic device (2) opens to that surface of said microfluidic device (2) which faces the bottom surface (1b) of said coupling device (1), thus providing an opening (8) which faces the opening (7'') of the vertical portion (7).
15. The microfluidic arrangement according to the preceding claim, wherein the number of vertical portions (7) comprised in the detection channel and the bypass channel is changed by turning of at least one horizontal layer (5).
16. The microfluidic arrangement according to claim 12 or any one of the above claims, wherein the opening (7'') of the vertical portion (7) faces the opening (7') of the vertical portion (7) comprised in the horizontal layer (5)

adjacent below or faces an opening of the device channel (9,9',10,10').

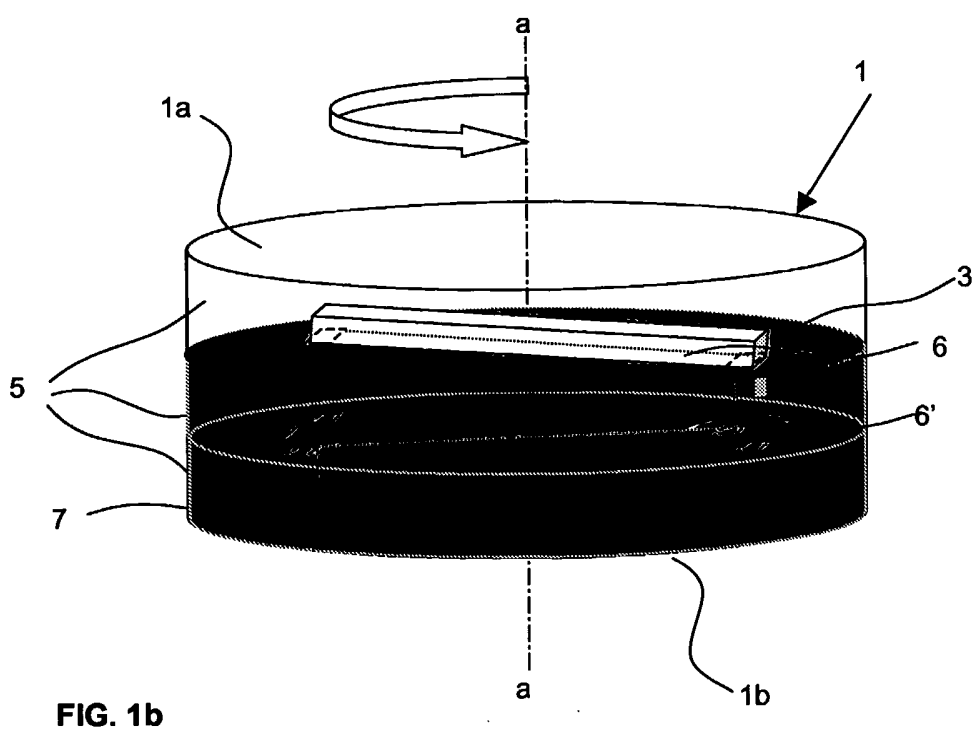
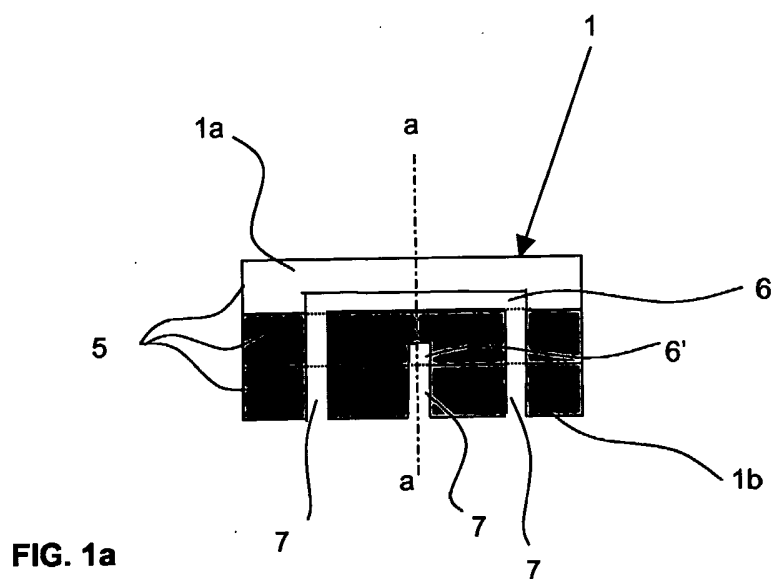
17. The microfluidic arrangement according to claim 10 or any one of the above claims, wherein the horizontal portion (6,6') has two open ends opening to the surface of the layer where it is comprised in.
- 5 18. The microfluidic arrangement according to claim 10 or any one of the above claims, wherein rotating of the horizontal layers (5) around the vertical axis of revolution (a-a) results in forming of a detection channel and at least one bypass channel extending from the bottom surface (1b) via at least one vertical portion (7), one horizontal portion (6,6') and at
10 least another vertical portion (7) back to the bottom surface (1b) of the coupling device.
19. The microfluidic arrangement according to claim 3 or any one of the above claims, wherein the device channel (10) of the microfluidic device (2) is in fluidic communication with the device channel (10') via the
15 detection channel and wherein the device channel (9) of the microfluidic device (2) is in fluidic communication with the device channel (9') via the bypass channel forming an idle channel, so that the fluid being driven through the optical channel is subjected to optical detection and the fluid being driven through the idle channel flows undetected.
- 20 20. The microfluidic arrangement according to claim 1 or any one of the above claims, wherein the microfluidic device (2) is detachably coupled with the microfluidic coupling device (1).
21. The microfluidic arrangement according to claim 1 or any one of the above claims, wherein the optical detection portion (6) provides a light
25 path (17,18) for optical detection.
22. The microfluidic arrangement according to the preceding claim, wherein the light path (17) for optical detection is aligned with a longitudinal axis (b-b) of the optical detection portion (6) of the detection channel.

23. The microfluidic arrangement according to claim 21 or any one of the above claims, wherein the light path (18) for optical detection is arranged substantially normal to the optical detection portion (6) of the coupling channel.
- 5 24. The microfluidic arrangement according to claim 1 or any one of the above claims, wherein the optical detection portion (6) is designed to guide light for fluorescence, UV/VIS, near IR, refractive index (RI) and Raman index optical detection techniques.
- 10 25. The microfluidic arrangement according to claim 2 or any one of the above claims, wherein the microfluidic coupling device (1) is positioned on the microfluidic device (2) by position holders.
26. The microfluidic arrangement according to the preceding claim, wherein the position holders comprise pins.
- 15 27. A microfluidic arrangement comprising:
a microfluidic device (2) having a device channel adapted to conduct a fluid, and
a microfluidic coupling device (1) according to claim 1, said microfluidic coupling device (1) being adapted to be movably coupled to the microfluidic device (2).
- 20 28. The microfluidic arrangement according to claim 27, comprising:
a detector coupled to the detection channel and being adapted to detect an optical property of the fluid when passing the optical detection portion (6).
- 25 29. The microfluidic arrangement according to claim 27 or any one of the above claims, wherein the microfluidic device (2) comprises a polymer device material such as a polyimide substrate, in particular a transparent or amber polyimide substrate.

30. The microfluidic arrangement according to claim 27 or any one of the above claims, wherein the microfluidic device (2) has a planar geometry.
31. The microfluidic arrangement according to claim 27 or any one of the above claims, wherein the microfluidic coupling device (1) is made of quartz, fused silica, glass, borosilicate glass or any material suitable to incorporate an optical detection portion (6).
32. A method comprising:
- movably, preferably rotatably, coupling a detection channel of a microfluidic coupling device (1) to a device channel of a microfluidic device (2), and
- detecting an optical property of a fluid, when passing an optical detection portion (6) of the detection channel of the microfluidic coupling device (1).
33. The method of claim 32 or any one of the above claims, comprising:
- rotatably coupling a bypass channel of a microfluidic coupling device (1) to a device channel of a microfluidic device (2), providing the fluid flowing from the device channel into the bypass channel, wherein said bypass channel is not provided with an optical detection portion so hat the fluid is not detected.
34. The method of the preceding claim, wherein fluids are processed in a microfluidic arrangement, in particular in a microfluidic arrangement according to claim 27 or anyone of the above claims, comprising:
- coupling the microfluidic coupling device (2) with the microfluidic device (1) in a way that there is a fluidic communication between the device channels (9,9',10,10') of the microfluidic device (2) and the detection and/or bypassing channels,
 - driving the fluid through the detection channel and/or through at least one bypassing channel,
 - detecting the fluid flowing through the detection channel and bypassing

the fluid undetected which flows through the idle channel.

35. The method of claim 32 or any one of the above claims, comprising:
- turning of the at least one horizontal layer (5) of the coupling device around the vertical axis (a-a), thus alternating the detection channel and one of the at least one idle channels,
 - detecting the fluid flowing through a channel now being the detection channel.



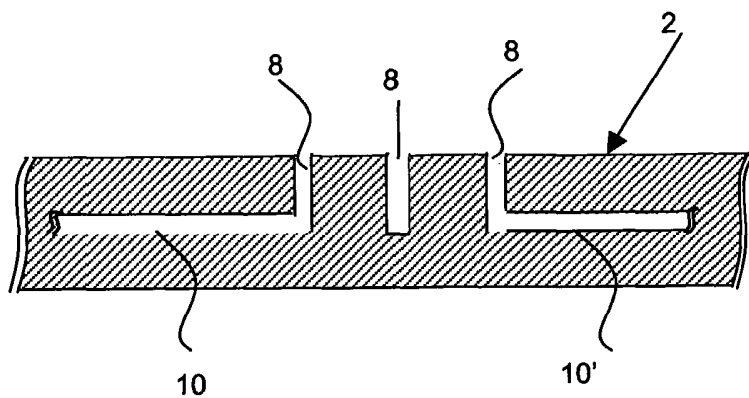


FIG. 2a

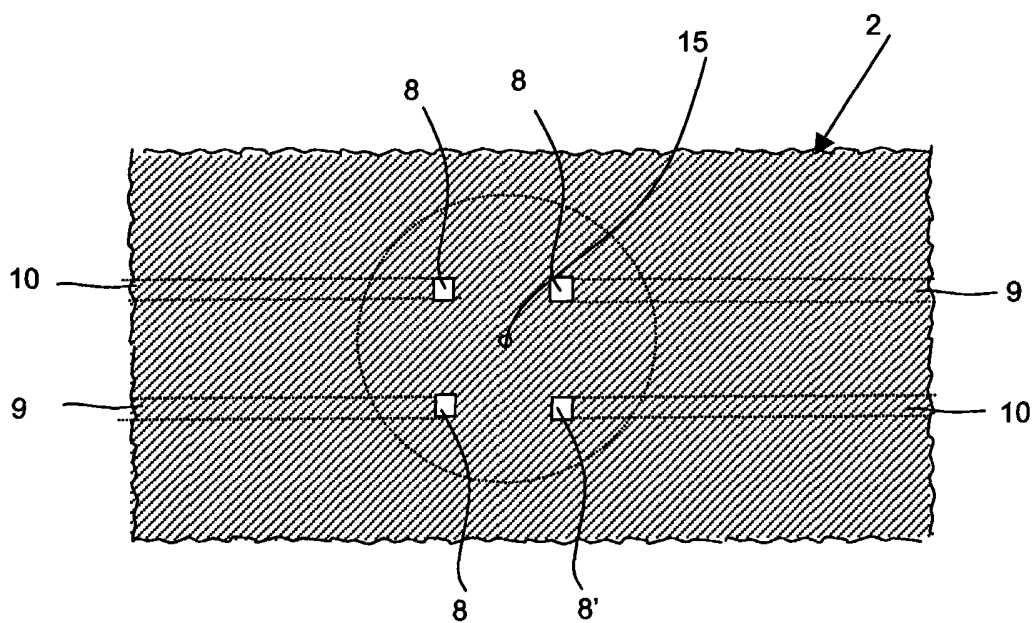


FIG. 2b

FIG. 3a

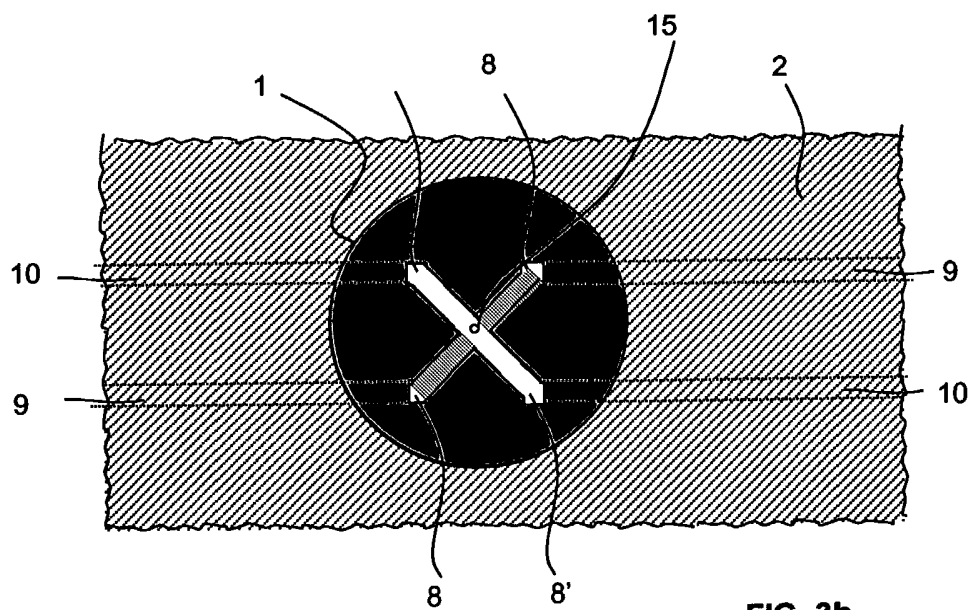
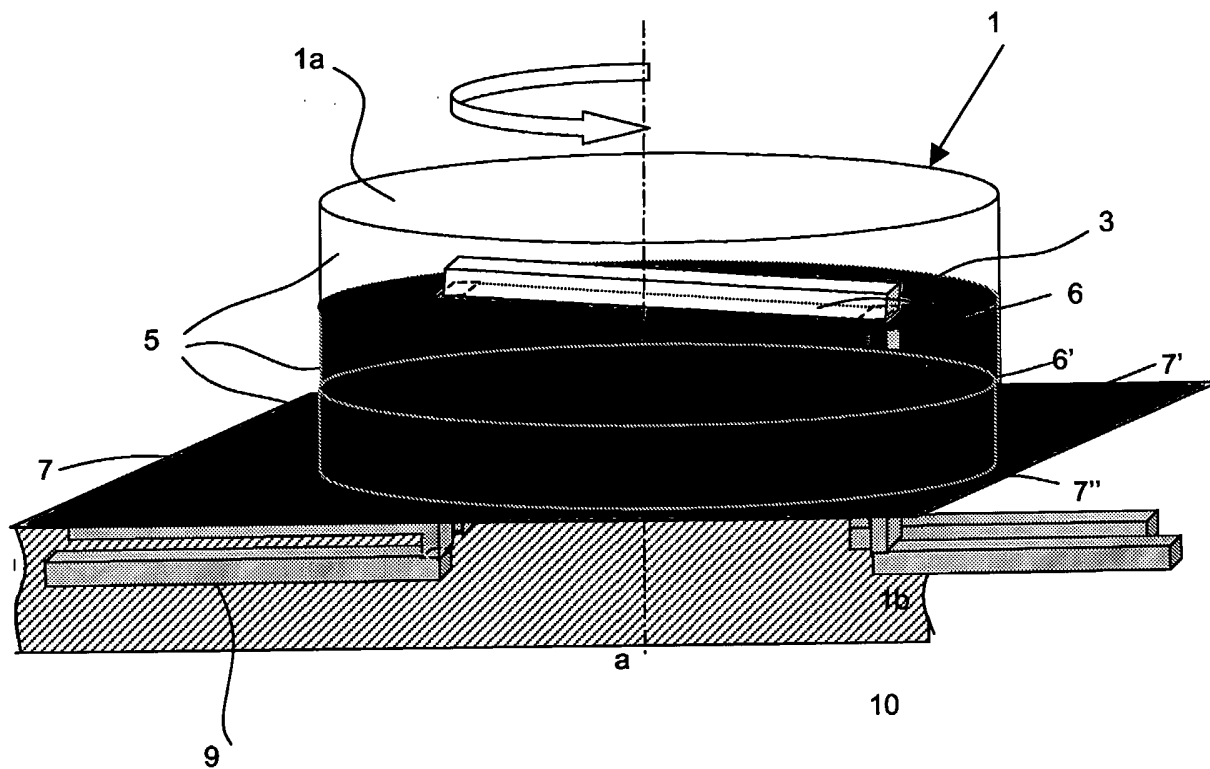


FIG. 3b

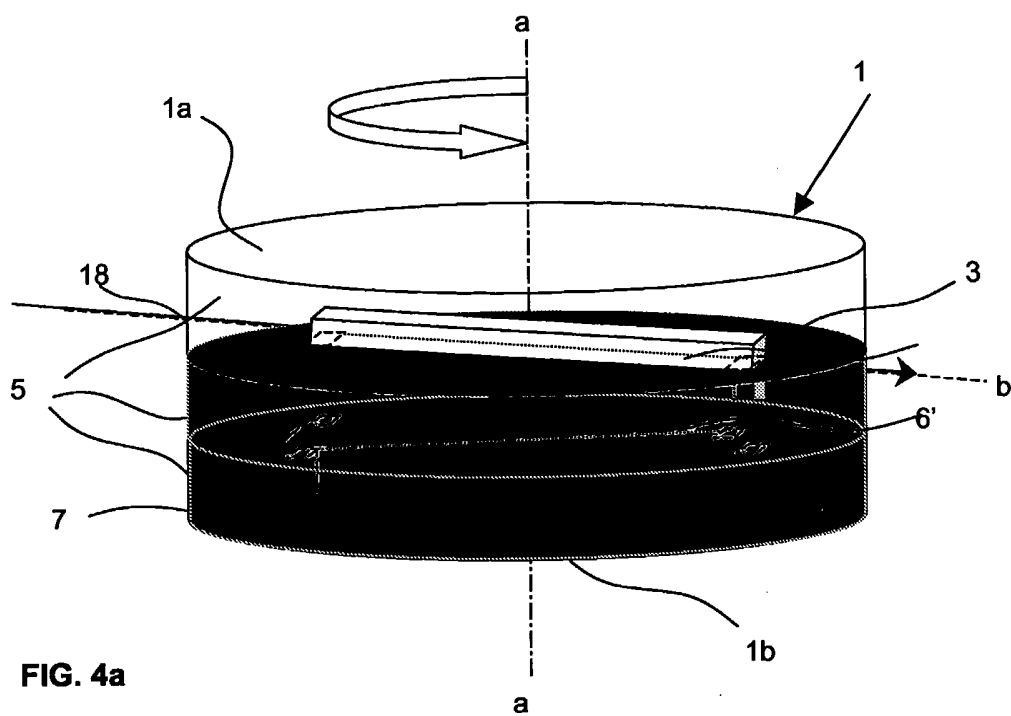


FIG. 4a

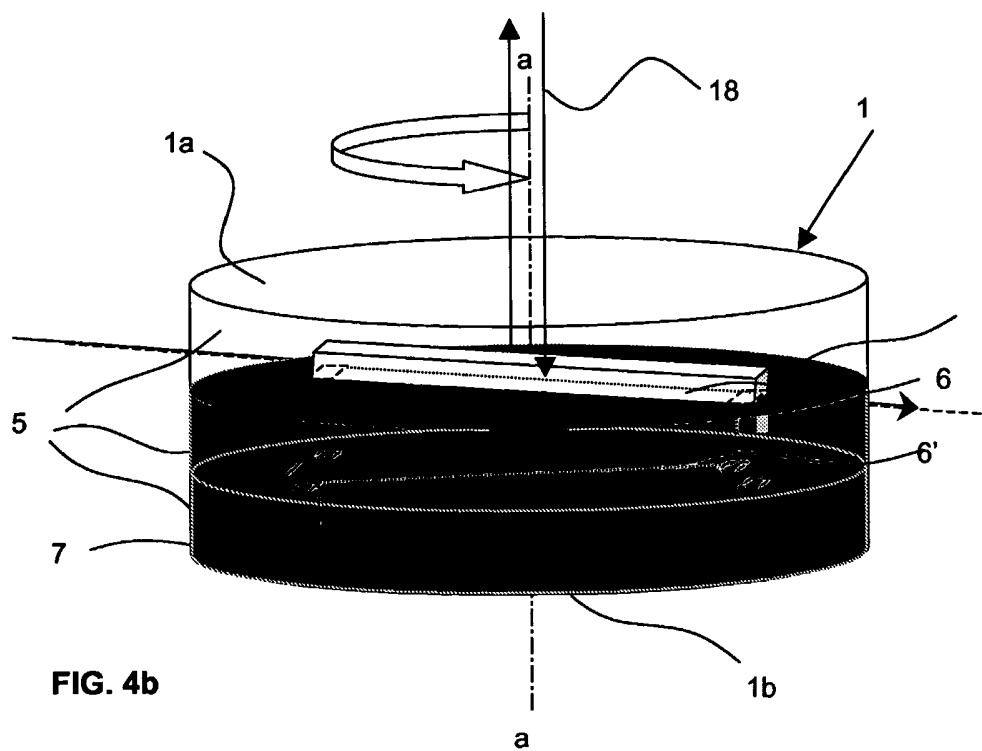


FIG. 4b

INTERNATIONAL SEARCH REPORT

International Application No

P/EP2004/053104

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B01L3/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 648 015 B1 (CHOW CALVIN Y. H) 18 November 2003 (2003-11-18) column 1, line 59 - column 2, line 3 column 6, line 50 - column 7, line 23; figures 1A-C column 12, lines 3-62 column 14, lines 21-34; figure 4 -----	1-3,5,8, 11, 22-25, 27,28, 31,32
X	WO 02/11887 A (CALIPER TECHNOLOGIES CORP) 14 February 2002 (2002-02-14) paragraphs '0038! - '0040!, '0057!, '0092!; figures 2,3 ----- -/--	1-3,5,6, 8,11, 21-25, 27,28

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

22 April 2005

Date of mailing of the international search report

09/05/2005

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INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

EP2004/053104

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