

DEVICE FOR COLLECTION OF A FLUID SAMPLE, RECEPTACLE FOR RECEIVING THE DEVICE, AN ASSEMBLY FOR COLLECTION OF A FLUID SAMPLE, AND A METHOD OF COLLECTING A FLUID SAMPLE

5 FIELD OF INVENTION

The present invention relates broadly to a device for collection of a fluid sample, to a receptacle for receiving the device, to an assembly for collection of a fluid sample, and to a method of collecting a fluid sample. In one embodiment, the invention relates to collecting fluid samples and extracting the filtered or unfiltered fluid onto a dispensing channel and
10 directing the fluid to predetermined locations via micro-fluidic channeling structures.

BACKGROUND

Collection and delivery of fluidic samples in a clean and contamination free way is desired for many applications, for example urine sample collection, water sample collection or blood
15 sample collection.

Following collection, dispensing of the collected fluidic sample into the input port of a microfluidic channel is desired in such applications in an integrated way.

Some existing techniques include use of a pipette and disposable chip, a disposable syringe, or a microfluidic system with pump and valve.

Existing methods for collecting fluids in sensing systems (for example, water, urine, blood, etc.) mostly involve collecting the fluid in a cup and then either immersing dip-sticks in the cup or by dispensing the said liquid on an absorbent material which in turn carries the fluid through passive fluidic channels to a designated sensing region for qualitative measurements. In other cases, for example for pregnancy test kits involving chemical test strips, the urine
25 directly comes into contact with the test strip while urinating and is carried to the sensing location through passive microfluidics incorporated into the test kits.

The existing methods can work well with measurement systems that perform qualitative measurements for various hormones or other analytes in liquid sample solution. However, for quantitative measurement systems where the liquid sample needs to be inserted into a specific
30 location inside the measurement system, the collected sample is transported from the collection device, for example a collection cup, into the measurement system by using a pipette. This procedure can typically be used only by trained professionals and there is a very high chance of spillage when used at home by untrained users.

US 7,060,223 describes a polymeric medium for the retention of reagent species for use in a
35 hand-held device for the relatively rapid detection of the presence of an analyte of interest in a sample. An exposed swab disposed on the end of a sample wand is used to collect the sample, and the sample wand is inserted with the swab first into a chamber, where the swab and a seal

disposed above the swab are pierced to release a reagent solution stored within a reservoir in the sample wand.

US 8,025,851 describes a specimen sample collection device and test system. An exposed absorbent pad forming the free end of a handle is used to collect the sample, and the handle is inserted with the pad first into a compression tube, where the pad is compressed and sample fluid can be collected through outlets formed in the compression tube.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will be better understood and readily apparent to one of ordinary skill in the art from the following written description, by way of example only, and in conjunction with the drawings, in which:

Figure 1: Schematic top view of an assembly for collection of a fluid sample according to an example embodiment.

Figure 2: Schematic perspective view of part of the assembly for collection of a fluid sample of Figure 1.

Figure 3: Schematic perspective view of a device for collection of a fluid sample according to an example embodiment.

Figure 4: Schematic top view illustrating insertion of the device of Figure 3 into a sensor receptacle, according to an example embodiment.

Figure 5: Schematic front view illustrating the device of Figure 3 inserted into the receptacle of Figure 4, according to an example embodiment.

Figure 6: Schematic cross-sectional view illustrating direction of fluidic flow during use of an assembly for collection of a fluid sample according to an example embodiment.

Figure 7: Schematic top view of a device for collection of a fluid sample according to an example embodiment.

Figure 8: Schematic top view, partly in cross section, illustrating movement of a tip of the device of Figure 7 during insertion into a receptacle, according to an example embodiment.

Figure 9: Schematic top view, partly in cross-section, illustrating locking of the tip of the device of Figure 7 upon full insertion into a receptacle, according to an example embodiment.

DETAILED DESCRIPTION

Embodiments of the present invention relate to collection of fluid samples through absorption by a material having a suitable absorptive power, for example an absorptive sponge, to extraction of filtered or unfiltered fluid by compressing the volume of the absorptive material

into a pre-defined port of a microfluidic channel, and to compression of the absorptive sponge, either due to its own elasticity or aided by an external spring.

The absorptive material can, by itself, also act as a filtering mechanism through which the fluidic sample can be filtered, for example filtering of substances that are considerably larger than the organisms present in the fluidic sample.

The amount of fluidic sample extracted from the absorptive material can preferably be controlled by the amount of compression and the corresponding volume change experienced by the absorptive material. This amount of fluidic sample dispensed can be critical for the microfluidic channels that transport the fluidic sample expelled by e.g. the sponge to the designated sensing regions through either active or passive microfluidic action.

To preferably prevent the backflow of the fluid through the insertion channel by maintaining a gap between the absorptive material and the exit port, the diameter of the collection stick can be made to be smaller than a receiving channel of a receptacle and increasing along the length of the collection stick to equal the diameter of the channel. This feature can also help in accommodating trapped/remaining air in the sponge and can prevent the formation of air bubbles inside the microfluidic channels.

Figure 1 shows a schematic top view of an assembly 100 for collection of a fluid sample according to an example embodiment. The example embodiment includes a sample collection and delivery device, here in the form of a collection stick 102 that can be used with a sensing device, here in the form of a card sensor 104. In the example embodiment, the sample collection stick 102 has a region (hidden in Figure 1, compare Figure 3 below) where a substance capable of absorbing fluid, for example a sponge or paper, is incorporated. The overall size of the collection stick 102 is preferably similar to that of a regular pen, and can be utilized to collect the sample either directly by wetting the absorptive material by dropping a fluid on the absorptive region or by dipping the collection stick's absorptive region into a container containing the sample fluid.

After collecting the fluid, the entire collection stick 102 is then inserted into a receptacle 106 which is designed to squeeze the absorptive material, to remove the fluid trapped inside the absorptive material, and to direct the removed fluid into an the exit port 108 of the receptacle 106. The receptacle 106, according to the example embodiment, is attached to the card sensor 104, and the exit port 108 of the receptacle 106 is aligned to a microfluidic input port 110 of the card sensor 104. After the fluid is drawn out from the absorbent sponge and into the input port 110 of the microfluidic channel in the card sensor 104, the fluid is transported to various sensing regions e.g. 112, 114 on the card sensor 104.

The volume of the fluid dispensed into the microfluidic channels e.g. 116 depends, inter alia, on the absorptive nature of the absorptive material, its surface to volume ratio and also on the compression experienced by the absorptive material. A desired dispensing volume can preferably be achieved by controlling one or more of these parameters of the absorptive material. For example, if an absorbent sponge is utilized as an absorptive material, the parameters that decide the dispensing volume include void volume, absorptive capacity, and the retaining capacity of the sponge.

Air may get trapped in the absorptive material, for example if the fluid does not completely saturate the absorbent sponge. In such a case, there can be a chance that after squeezing the absorbent sponge, the microfluidic channels may contain some air bubbles. In order to preferably address that potential problem, the collection stick 102, in one embodiment, has a designated tapered section, as will be described in more detail below. The diameter of the collection stick 102 can be made to be smaller than the channel 118 of the receptacle 106, see Figure 2, and increasing along the length of the collection stick 102 to equal the diameter of the channel 118. This can allow for the air to escape into the space between the collection stick 102 and the wall of the channel 118 in the region towards the closed end of the receptacle 106, i.e. where the diameter of the stick 102 is less than the diameter of the channel 118, when the absorbent material is compressed and the stick 102 is snapped into the receptacle 106.

In embodiments, the chances of spillage of the fluid by the user can preferably be reduced and the embodiments can also preferably provide for collecting a fluidic sample and inserting the collected fluid into the microfluidic channels of the measurement system.

Turning now to Figure 3, the stick 102 has a non-absorptive tip portion, here in the form of a rigid tip 300. This can advantageously reduce or eliminate spillage of the absorbed sample fluid through inadvertent compression of the absorptive material 302, for example through misalignment with the channel 118 (Figure 2) and resulting hitting or touching of the wall of the receptacle.

Advantageously, the tip 300 has substantially the same cross-sectional dimensions as the absorptive material 302. In this example embodiment, the tip 300 and the absorptive material 302 are adjoining cylinders or discs. Accordingly, a force applied to the rigid tip 300 as a result of hitting or touching the wall of the receptacle prior to or during insertion is preferably spread and the resulting pressure on the absorptive material 302 is reduced, compared to localized pressure that would result from hitting or touching the wall with a portion of the absorptive material directly. Such localized higher pressure could result in localized compression and undesired expulsion of absorbed sample fluid.

In addition to collecting the fluidic sample, the absorptive material 302 can preferably also be utilized to filter the fluidic sample. In example embodiments, the absorptive material 302 can be designed to have a certain specific pore size in order to exclude particles having sizes larger than the pore size. In this way, contaminants in the form of macroscopic particles such as dust or sediments can preferably be excluded from the fluidic sample during sample collection, and such macroscopic particles are thus preferably not delivered into the microfluidic channel sensing structure.

With reference to Figure 4, an example embodiment provides an integrated way of collecting and delivering a fluidic sample through microfluidic channels into the designated sensing regions on the sensing device. The stick 102 provides a rod like support structure for the absorptive material 302. The absorptive material 302 is attached, at one end thereof, to a face 400 of a first rod like support portion 402. The absorptive material 302 may be attached to the face 400 using an adhesive material such as a suitable bonding material such as acrylic or

epoxy glue ..., and/or through mechanical means such as hooks (not shown) mounted or formed on the face 400 and mechanically engaging the absorptive material 302.

In another embodiment shown in Figure 6, the mechanical means comprises a biasing structure in the form of a spring 600 connected to the face 601 of a first rod like portion 602 and extending towards a face 603 of the rigid tip 604 to provide mechanical strength and tensile properties to the absorptive material 606.

Returning now to Figure 4, the rigid tip 300 preferably acts as a point of resistance during insertion of the stick 102 into the receptacle 106. The hollow receptacle channel 118 has a lengthwise dimension shorter than the length 404 from the free end of the rigid tip 300 to a rim 406 between a second rod like support portion 408 and a grip portion 410 of the stick 102 by a specific amount. Accordingly, during the last part of insertion of the stick 102 into the receptacle 106, the rigid tip 300 will move towards the face 400, thereby exerting a force on the absorptive material 302, resulting in compression of the absorptive material 302 for expulsion of the fluidic sample. The exit port 108 perpendicular to the receptacle channel 118 is aligned to the microfluidic channel 116 on the card sensor 104.

A snap feature in the form of a biased protrusion 412, which is receivable in a corresponding hole 414 on the second rod like support portion 408, is provided in the example embodiment. An alignment feature in the form of a key 416, which is received in a corresponding slot 418 formed in the wall of the receptacle 106, is also provided. The snap feature and the alignment feature advantageously function as indicators that the stick 102 is fully inserted and in correct alignment.

In the example embodiments, the fluidic sample can be collected by wetting the absorptive material 302 directly by contacting a fluidic stream or by dipping the absorptive material 302 into the sample after the sample is collected in a container. Preferably, all surfaces of the stick 102, other than the absorptive material 302, are made of hydrophobic material(s) to ensure that only the designated region, i.e. the absorptive material 302, will be wet and excess sample does not remain on the stick 102.

Subsequently, the stick 102 is inserted into the receptacle 106. The combination of the rigid tip 300 and the support structure including the first and second rod like support portions 402, 408 will preferably allow the stick 102 to maintain its mechanical strength as the stick 102 is being inserted into the receptacle 106t.

The collection stick 102 also comprises a tapered section 411 disposed between the first and second rod like support portions 402, 408. The dimensions (here the diameter) of the first rod like support portion 402 is smaller than that of the channel 118 of the receptacle 106, while the dimensions (here the diameter) of the second rod like support portion 408 is substantially equal to that of the channel 118. The tapered section 411 provides for a gradual change in dimensions between the first and second rod like support portions 402, 408.

With reference to Figure 5, once the rigid tip 300 comes into contact with the end 500 of the channel 118, further insertion force will cause the absorptive material 302 to compress. The absorptive material 302 will continue to compress until the second rod like portion 408 of the

stick 102 is inserted into the receptacle 106. The alignment key 416 (Figure 4) will be received in the slot 418 (Figure 4) and the biased protrusion 412 (Figure 4) will snap into the hole 414 (Figure 4) and prevent the absorptive material 302 from further decompressing. Accordingly, the volume dispensed from the absorptive material can preferably be controlled and any backflow of the fluidic sample can preferably be prevented. In this embodiment, the free end of the tip 300 has a concave shape, and is received in a corresponding convex wall 500 terminating the hollow channel 118 of the receptacle 106.

In the embodiment shown in Figure 6, the length of the spring 600 is preferably less than or equal to the total uncompressed length of the absorptive material 606 and the diameter of the spring 600 is preferably less than that of the absorptive material 606. The compression of the absorptive material 606, and the spring 600 in this embodiment, in turn preferably cause the fluidic sample collected within the absorptive material 606 to be squeezed out and into the exit port 608 located perpendicular of the direction of insertion indicated at numeral 610, i.e. perpendicular to the insertion channel 611 formed in the receptacle 612. The fluidic sample, e.g. a liquid, preferably then flows through the microfluidic systems e.g. 614 to the respective designated sensing locations e.g. 616, 618 on the card sensor 620.

Figure 7 shows a schematic top view of a device 700 for collection of a fluid sample according to another embodiment. In this embodiment, the support structure includes first and second rod like support portions 702, 704, a taper portion 705, and a cover 706 around the absorptive material 708 to maintain the mechanical strength of the device 700 once fluid has been absorbed and collected by the absorptive material 707, which can cause the absorptive material 707 to have a reduced mechanical strength and tensile properties. The cover 706 comprises one or more openings 709 for fluid communication to and from the absorptive material 707. The cover 706 is attached to the first rod like support portion 702 at a periphery thereof and is coupled to the rigid tip 710 via a uni-directional locking mechanism that preferably prevents the absorptive material 707 from springing back after compression, as will be described below in more detail with reference to Figures 8 and 9.

Figure 8 shows a schematic top view, partly in cross-section, illustrating movement of the rigid tip 710 of the device 700 during insertion into a receptacle (not shown). In a first state for use of the device 700 to collect a fluidic sample, the rigid tip 710 is disposed with a protrusion 800 received in a corresponding groove 802 formed on the cover 706. The protrusion 800 and the groove 802 extend ring like in this embodiment. It will be appreciated that in different embodiments, the protrusion and/or the groove can take different forms, including one or more, preferably at least two, more preferably at least three, individual protrusions and a corresponding groove or grooves.

As shown in Figure 8, the groove 802 has a higher wall 804 facing towards the free end of the tip 710 compared to the wall 806 at the opposite site of the groove 802. Accordingly, dislodging of the tip 710 is preferably inhibited. At the same time, the lower wall 806 requires a predetermined force to be applied to the tip 710 so as to initiate movement of the tip in a direction as indicated at numeral 808, i.e. for achieving flexing to dislodge the protrusion 800 from the groove 802. This preferably inhibits un-intentional movement of the tip 710 as a

result of hitting or touching the wall of the receptacle (not shown) prior or during insertion, which may otherwise result compression and undesired expulsion of absorbed sample fluid.

As shown in Figure 9, in a second state upon full insertion of the device 700 into the receptacle (not shown) to deliver the fluidic sample, for example to a card sensor (not shown), the rigid tip 710 is disposed with the protrusion 800 received in a second corresponding groove 900 formed on the cover 706. The protrusion 800 and the groove 900 extend ring like in this embodiment. It will be appreciated that in different embodiments, the protrusion and/or the groove can take different forms, including one or more, preferably at least two, more preferably at least three, individual protrusions and a corresponding groove or grooves. As shown in Figure 9, the groove 900 has a higher wall 902 facing towards the first rod like support portion 702 compared to the wall 904 at the opposite site of the groove 900.

Together with snap and alignment features, for example similar to the ones described above with reference to Figure 4, the higher wall 902 advantageously prevents further compression of the absorptive material 707, facilitating control of the volume of the fluidic sample delivered. At the same time, with the protrusion 800 received in the groove 900, the rigid cap is locked in place, whereby springing back of the absorptive material can preferably be prevented, which may otherwise result in undesired backflow of the delivered fluidic sample.

As seen e.g. in Figure 9, the rigid tip 710 in this embodiment comprises an inner rod like portion 906 disposed within a jacket 908 and joint together at a base 910 of the tip 710. The inner rod like portion 906 has a dimension suitable to be slidably received in an inner channel 912 within the cover 706, to compress the absorptive material 707 during movement from the first to the second state. Preferably, the dimensions (here the diameter) of the inner rod like portion 906 is substantially the same as that of the absorptive material 707.

The collection and delivery mechanisms in the described embodiments can be used to collect and deliver fluidic samples including, but not limited to, urine, water, blood, or any other types of fluids to designated sensing locations on a sensing device.

The absorptive material in example embodiments can be modified to incorporate different forms of absorption and filtration capabilities. This can be done by for example controlling the pore size and material type of the absorptive material.

Different volumes of the fluidic sample can be delivered in different embodiments by controlling the length difference between the receptacle channel and the insert length of the collection stick.

In example embodiments, the absorptive material can be impregnated e.g. with a desired colorimetric reagent in its dry form, which changes color on reaction with the analytes in the fluidic sample. The colored solution can be delivered to a specific region on the sensing device for detection through the microfluidic channels.

In the described embodiments, non-limiting examples of materials for respective components can include:

Rod like support structure including the first and second rod like support portions and the grip portion: Any form of hydrophobic plastics, such as Polymethylmethacrylat (PMMA), Polypropylen (PP), etc.

5 Absorptive material: Any form of common sponge materials such as cellulose wood fibers, foamed plastic polymers, low density polyether, polyvinyl acetal (PVA) or polyester.

Bias structure: Non-corrosive materials, such as stainless steel or Acrylnitril-Butadien-Styrol (ABS), PP.

Rigid tip: Any form of hydrophobic plastics, such as PMMA, PP, etc.

Hollow receptacle: Any form of hydrophobic plastics, such as PMMA, PP, etc.

10 Sensing device: Any form of sensing chip that could include optical and/or electronic components. Preferably, the material is plastic but it can also be either glass or silicon as well.

Snap feature and alignment feature: Any form of hydrophobic plastics, such as PMMA, PP, etc.

15 It will be appreciated by a person skilled in the art that numerous variations and/or modifications may be made to the present invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects to be illustrative and not restrictive. Also, the invention includes any combination of features, in particular any combination of features in the patent claims, even if the feature or combination of features is
20 not explicitly specified in the patent claims or the present embodiments.

One or more of the various parts of the described embodiments may be formed separately and the attached to each other, for example using a suitable glue or adhesive or mechanical means, or may be formed integrally.

CLAIMS

1. A device for collection of a fluid sample, the device comprising:
 - a collection stick;
 - an absorptive material disposed on the collection stick;
 - 5 a compression mechanism disposed on the collection stick for compressing the absorptive material under a force applied to the compression mechanism;
 - wherein the compression mechanism comprises a non-absorptive tip portion of the collection stick, the tip portion being moveable to compress the absorptive material under the force applied to the tip portion; and
 - 10 a cover for the absorptive material.
2. The device as claimed in claim 1, wherein the tip portion is rigid.
3. The device as claimed in claims 1 or 2, wherein the cover is supported on the collection stick.
4. The device as claimed in any one of claims 1 to 3, wherein the cover comprises one or
 - 15 more openings for fluid communication to and from the absorptive material.
5. The device as claimed in any one of claims 1 to 4, further comprising a locking mechanism coupling the tip portion to the cover.
6. The device as claimed in claim 5, wherein the locking mechanism is uni-directional such that upon movement in a first direction for a predetermined distance to compress the
 - 20 absorptive material, the tip portion is locked against movement in a direction opposite to the first direction.
7. The device as claimed in claim 6, wherein the locking mechanism is configured such that the tip portion is restricted from movement beyond the predetermined distance in the first direction.
8. The device as claimed in any one of the preceding claims, wherein the tip portion and the absorptive material have substantially the same cross-sectional dimensions.
9. The device as claimed in any one of the preceding claims, comprising a snap mechanism member for indicating full insertion of the device into a receptacle.
10. The device as claimed in any one of the preceding claims, comprising an alignment
 - 30 member for indicating correct alignment of the device in a receptacle.
11. The device as claimed in any one of the preceding claims, wherein the collection stick comprises a bias member for extending at least partially within the absorptive material.
12. A receptacle for a device for collection of a fluid sample, the receptacle comprising:

a channel for receiving the device, the channel comprising a wall for abutting a non-absorptive tip portion of the device, the tip portion being moveable to compress an absorptive material under a force applied by the wall of the channel to the tip portion;

the wall of the channel disposed for applying the force to a compression mechanism
5 during receiving of the device in the channel;

an opening formed in the receptacle, the opening being in fluid communication with the channel, for dispensing a fluid exiting the compressed absorptive material; and

a snap mechanism member for indicating full insertion of the device into the receptacle and for preventing decompression of the absorptive material.

10 13. The receptacle as claimed in claim 12, comprising an alignment member for indicating correct alignment of the device in the receptacle.

14. The receptacle as claimed in any one of claims 12 to 13, wherein the device comprises a device as claimed in any one of claims 1 to 11.

15. An assembly for collection of a fluid sample, the assembly comprising:

15 a collection stick;

an absorptive material disposed on the collection stick;

a compression mechanism disposed on the collection stick for compressing the absorptive material under a force applied to the compression mechanism;

a cover for the absorptive material;

20 a receptacle having a channel formed therein for receiving the collection stick with the cover;

a wall of the channel disposed for applying the force to the compression mechanism during receiving of the collection stick in the channel; and

25 an opening formed in the receptacle, the opening in fluid communication with the channel, for dispensing a fluid exiting the compressed absorptive material

wherein the compression mechanism comprises a non-absorptive tip portion of the collection stick, the tip portion being moveable to compress the absorptive material under the force applied to the tip portion.

30 16. The assembly as claimed in claim 15, wherein the channel comprises the wall for abutting the non-absorptive tip portion of the collection stick, the tip portion being moveable to compress the absorptive material under a force applied by the wall of the channel to the tip portion

17. A method of collecting a fluid sample, the method comprising the steps of:

absorbing a fluid in an absorptive material disposed on a collection stick and provided with a cover;

receiving the collection stick with the cover in a channel formed in a receptacle;

5 compressing the absorptive material during receiving of the collection stick in the channel; and

dispensing the fluid exiting the compressed absorptive material through an opening formed in the receptacle;

10 wherein the compressing comprises applying a force to the non-absorptive tip portion of the collection stick and moving the tip portion to compress the absorptive material under the force applied to the tip portion.