Sampling device for liquid samples

The invention concerns a device for sampling liquid samples in which the sample is transported in a capillary-active channel from a sampling site to a determination site.

So-called carrier-bound tests (test carriers, test elements, test strips) are often used for the rapid and simple, qualitative or quantitative analytical determination of components of liquid samples e.g. aqueous body fluids such as blood, serum or urine. In these carrier-bound tests the detection reagents are embedded in corresponding layers of a carrier which is brought into contact with the liquid sample. The reaction of the liquid sample and reagents leads to a detectable signal when a target analyte is present e.g. a measurable electrical signal or a colour change which can be evaluated visually or with the aid of an instrument e.g. by reflection photometry.

Carrier-bound tests are frequently constructed as test strips which are essentially composed of an elongate carrier material made of plastic and detection layers as test fields which are mounted thereon. However, test carriers are also known which are designed as small quadratic or rectangular plates.

Recently test strips have been in particular offered which contain a capillary-active gap (capillary gap) which conveys sample liquid from one end of the test strip (sampling site or sample application site) to the reagent zones which are typically accommodated at a distance of a few centimetres from the sampling site. This for example makes it possible to apply a sample, in particular a blood sample, to a test strip which is located in an evaluation device without exposing the evaluation device to the risk of contamination by the blood sample. Typical representatives of such test strips are for example described in the following patent documents:

EP-A 0 359 831; US 6,071,391; US 6,156,173; WO-A 00/20626; WO-A 99/29428; WO-A 99/29429; EP-A 0 170 375.

The test elements described in the above-mentioned documents are essentially composed of a carrier, a cover and an intermediate layer between the carrier and the cover which together form the capillary-active channel. Reagents that are necessary

for the detection of the target analyte or target parameter of the blood sample or liquid sample are located in a defined region within the capillary-active channel. All carrier-bound tests of the prior art have a clearly defined and restricted area in which the sample material can be applied in order to fill the capillary channel. This area is either at the end or on one or both side edges of the test carrier. Test carriers are also known in which the liquid sample material is dosed from above or below through an opening in the carrier or in the cover. In the English-speaking area these variants of sample filling at different sites are referred to as front dosing, side dosing and top dosing.

In the case of test strips that are intended to be used by untrained persons for example by diabetics or anti-coagulation patients for so-called home monitoring, front and side dosing variants of sample filling have proven to be preferable due to the simple handling (usually a drop of blood from the fingertip is introduced onto the test strip). In contrast test strips with a top dosing variant are preferred in the professional field (doctor's offices, medical laboratories etc.) since blood is usually applied in these cases with application devices such as pipettes or capillaries and because front or side dosing is very difficult to achieve with these devices.

There has previously been a lack of carrier-bound tests that can be used equally advantageously in the home monitoring field as well as in the professional field.

The object of the present invention was to eliminate the disadvantages of the prior art. In particular it was an object to provide a device for sampling liquid samples which enable a convenient sample application with application devices such as pipettes or capillaries and also a dosing of sample liquid (in particular of blood) from body surfaces.

This object is achieved by the subject matter of the invention as characterized in the patent claims. The invention concerns a device for sampling liquid samples in which the sample is transported in a capillary-active channel from a sampling site to a determination site and in which the capillary-active channel is essentially formed by a carrier, a cover and an intermediate layer located between the carrier and cover where the carrier protrudes beyond the cover in the area of the sampling site. An essential

feature of this is that the intermediate layer which determines the geometry of the capillary-active channel is displaced towards the back in the direction of the determination site in the area of the sampling site so that the carrier as well as the cover protrude beyond the intermediate layer. This creates an opening in the area of the sampling site which essentially takes up the entire width of the device. In this connection the height of the intermediate layer determines the capillary activity of the capillary channel. It should be selected such that capillarity is formed. The thickness of the intermediate layer is typically a few hundred µm. In preferred embodiments of the invention either the carrier and intermediate layer or cover and intermediate layer or carrier, cover and intermediate layer can be manufactured from one piece.

The carrier and cover are typically foils made of a plastic material whereas the intermediate layer is a double-sided adhesive tape of suitable thickness.

Typical representatives of the device according to the invention are in particular analytical test elements (test strips, biosensors), cuvettes or sampling elements such as pipettes or such like.

The device according to the invention is preferably an analytical test element in which suitable detection reactions which allow the determination of the presence or amount of an analyte in the sample or are suitable for detecting certain sample properties occur either already during or after uptake of the sample liquid. Analytical test elements in this sense are test elements that can be evaluated visually or optically by means of an apparatus e.g. test strips, biosensors such as e.g. enzymatic biosensors or optical biosensors (optrodes, wave conductors etc.), electrochemical sensors and such like. Enzymatic, immunological or nucleic acid-based methods are preferably used in the analytical test element to detect the analyte. However, the sampling device in the sense of the invention can also be a cuvette or pipette which is only used for sampling and which either release the sample again for analysis or where the analysis occurs without subsequent reactions. The sampling device in the sense of the invention can of course also be used to store sample liquid. The fundamentals of such sampling devices are comprehensively described in the prior art and are familiar to a person skilled in the art in numerous embodiments.

The capillary-active channel or capillary channel of the device according to the invention serves to transport the liquid sample from a first site on the device to a distant second site. In the sense used here the first site should be the sampling site; the second site is referred to as the determination site.

In the case of strip-shaped test elements, the sampling site for example essentially corresponds to one of the short edges or lateral faces of the test element. The determination site for example essentially corresponds to the site at which the detection reaction for the target analyte is observed and which usually carries the detection reagents. In general terms the determination site is usually the opposite end of the capillary-active channel to the sampling site.

In a preferred embodiment of the device according to the invention one or more or all surfaces of the carrier, the cover and the intermediate layer facing the capillary channel are made hydrophilic.

As a result of the inventive property according to which the carrier protrudes beyond the cover in the area of the sampling site, the carrier provides a flat application zone which enables the sample to be easily applied by means of application devices such as pipettes or capillaries.

The inventive property according to which the intermediate layer of the device is displaced towards the back in the direction of the determination site in the area of the sampling site such that the carrier and the cover protrude beyond the intermediate layer ensures that areas remain at the edges of the device which enable a side dosing of sample liquid.

In a preferred embodiment of the device according to the invention the capillary-active channel is widened in the area of the sampling site preferably up to at least one side edge of the device. The widening is especially preferably funnel shaped. This funnel can have an essentially straight (triangular) or curved (trumpet form) shape. Since the geometry of the capillary-active channel is essentially determined by the intermediate layer, the intermediate layer contains a correspondingly shaped recess.

In a preferred embodiment the bottom foil consequently provides a flat application zone. This is bounded by the funnel-shaped start of the capillary. This funnel extends on both sides to the edge of the strip. This funnel is covered by the cover in such a manner that a capillary gap forms between the cover, edge of the intermediate layer and the carrier.

In another particularly preferred embodiment of the invention the sampling device contains a means for receiving excess sample on the part of the carrier in the area of the sampling site (application zone) which protrudes beyond the cover. This means is not in direct contact with the cover. This means preferably contains a capillary-active gap or an absorbent material (e.g. a fleece, fabric, knitted fabric, sponge etc.) such that excess sample liquid can be taken up therein. The capillarity of this region that is also referred to as a waste zone is less than the capillarity of the capillary-active channel which runs from the sampling site to the site of determination of the sample such that sample material which is applied to the device preferably firstly fills the capillary-active channel which leads from the sampling site to the sample determination site and only after it has been filled, is the means for taking up excess sample filled. Means for taking up excess sample can advantageously also serve as a handling aid for the device according to the invention.

The device according to the invention has a number of advantages:

1. The sample application site is within a relatively large area and can be freely selected over the entire width of the test strip.

2. The device according to the invention is self-dosing in all positions for use.

3. The device according to the invention can be filled with sample from above as well as from the sides which enables an application with pipettes, capillaries or sample application directly from a body surface (finger tip, lower arm etc.). Especially in the case that the device according to the invention is an analytical test element, it can thus serve different market segments (home monitoring, professional market).

4. With regard to the amount of sample to be applied the device according to the invention is very flexible since due to the design of the application area, different sample volumes can be applied to the device without having to increase the minimum required sample volume.

5. In a preferred embodiment means can be provided which prevent an over-dosing of the sample quantity by safely taking up excess sample in the interior of the device.

The invention is further elucidated by the attached figures:

Figure 1 shows a schematic top-view of a test element according to the invention.

Figure 2 shows a diagram of the individual layers involved in the construction of the test element from figure 1.

Figure 3 shows an enlarged cut-out from the test element of figure 1 in the area of the sampling site in a side-view.

The numbers in the figures denote:

1: sampling device (in this case: test element)
2,2': capillary-active channel
3: sampling site
4: determination site
5: carrier
6, 6': cover
7, 7': intermediate layer
8: means for taking up excess sample (waste zone)
9: vent opening
10: electrode structures

Figure 1 shows a diagram of a top-view of the analytical test element (1) according to the invention. Figure 1 in conjunction with figure 2 shows how the analytical test element (1) is composed of a carrier (5) on which an intermediate layer (7) is glued

in the form of a double-sided adhesive tape. The intermediate layer (7) contains a cut-out for the capillary-active channel (2) which in the embodiment shown here is widened in a funnel shape in the area of the sampling site (3). A second intermediate layer (7') is also mounted on the carrier (5) which can optionally contain a second capillary-active channel (2') (dashed). The intermediate layer (7') is also a double-sided adhesive tape in the embodiment shown in the figures on which a cover (6') is glued to simplify the handling of the test element (1).

The cover (6) which in the embodiment shown here contains a vent opening (9) and electrode structures (10) is glued onto the intermediate layer (7). The vent opening (9) enables air to escape when the capillary channel (2) is filled. In the area of the determination site (4) for the sample liquid, the electrode structures (10) contain structures for working and counter electrodes. The test carrier (1) shown in figure 1 can for example be used for amperometric analyte determinations for example in order to determine certain blood parameters (glucose, lactate, cholesterol etc.) or blood properties (haematocrit, clotting times).

Of course it is also possible to accommodate reagents instead of the electrode structures (10) in the area of the determination site for an optical and in particular reflection photometric detection of analytes. For this purpose it is advantageous that either the carrier (5) or the cover (6) is transparent at least in the area of the determination site (4).

As was shown in particular in figure 3, the intermediate layer (7) (and in the embodiment shown also the intermediate layer 7') is set back i.e. away from the sampling site (3) in the area of the sampling site (3) i.e. at the site where the sample liquid is applied to the test element (1). Carrier (5) and cover (6) (and also the cover 6' in the case shown here) protrude beyond the intermediate layer (7) (and also beyond the intermediate layer 7' in the case shown here) in the area of the sampling site (3). This also enables a side dosing of sample liquid. A capillary gap forms between the carrier (5) and cover (6, 6') which extends to the edge of the test element (1). As a result the capillary channel (2) can be filled from the side (side dosing) as

well as from above by placing an aliquot of a blood sample on the exposed surface of the carrier (5) in the area of the sample application zone (3).

Excess sample which may be present is withdrawn from the sampling site (3) through the capillary channel (2') which is part of the means for taking up excess sample. The means for taking up excess sample (8) also seals excess sample and prevents contamination of the environment. At the same time the zone in which the means (8) is located can be used as a handling aid for the test element (1).

The capillarity of the means (8) is preferably less than the capillarity of the capillary channel (2) such that sample liquid that is applied to the test element (1) in area (3) at first preferably mainly enters the capillary channel and only sample which cannot enter the capillary channel (2) because it is already filled is taken up by the means (8).

The capillarity of the competing capillary channel (2) and waste zone (8) areas can for example be controlled by using different hydrophilic materials to construct the capillaries or by varying the height of the capillary gap.

Other preferred embodiments which are shown in the figures can contain elements which enable the sample application sites to be more easily identified by the user. For example one or both side edges of the strip-shaped test element from figure 1 can have semicircular or notch-shaped cut-outs in the area of the sample application zone which form a depression on which a finger tip can be placed thus enabling a tactile identification of this site in addition to a visualization of the sample application site. It is also possible to mark the cover in the area of the sample application site for example by an appropriately placed notch.

CLAIMS

1. Device (1) for sampling liquid samples in which the sample is transported in a capillary-active channel (2) from a sampling site (3) to a determination site (4) and in which the capillary-active channel (2) is essentially formed by a carrier (5), a cover (6) and an intermediate layer (7) located between the carrier (5) and cover (6) where the carrier (5) protrudes beyond the cover (6) in the area of the sampling site (3), characterized in that
the intermediate layer (7) is displaced towards the back in the direction of the determination site (4) in the area of the sampling site (3) so that the carrier (5) as well as the cover (6) protrude beyond the intermediate layer (7).

2. Device as claimed in claim 1, characterized in that
the carrier and intermediate layer or cover and intermediate layer or carrier and cover and intermediate layer are manufactured from one piece.

3. Device as claimed in claim 1 or 2, characterized in that
the capillary-active channel is widened in the area of the sampling site.

4. Device as claimed in claim 3, characterized in that
the capillary-active channel is widened in the area of the sampling site to at least one side edge of the device.

5. Device as claimed in claim 4, characterized in that
the capillary-active channel is widened in the area of the sampling site to both side edges of the device.

6. Device as claimed in claims 3, 4 or 5, characterized in that
the capillary-active channel is essentially widened into a funnel shape.

7. Device as claimed in one of the previous claims, characterized in that
means (8) for taking up excess sample which is not in direct contact with the cover is mounted on the part of the carrier that protrudes beyond the cover in the area of the sampling site.

8. Device as claimed in claim 7, characterized in that
the means (8) for taking up excess sample has a lower capillarity than the capillary-active channel (2).

9. Device as claimed in claim 7 or 8, characterized in that
the means (8) contains a capillary-active gap or an absorbent material.