US 20070179373 A1 describes apparatus and methods for collecting a fluid sample. It discloses inter alia an integrated collection device having an analyte detector and a gradient means to drive the transport of a sample fluid from a point of contact to a point of detection. The integrated collection device has a layered structure including multiple layers. The design features inter alia a first layer and a second layer which forms a surface layer. A hydrophilic surface is generated by powder coating with fumed silica nanoparticles.

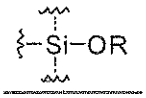
There is therefore a need for analytical aids with hydrophilic coatings, which have sufficient stability, in particular sufficient stability even in the presence of volatile, as a rule nonpolar, constituents of packaging materials.

The problem to be solved by the invention

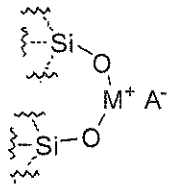
The present invention is therefore concerned with the problem of providing an analytical aid with a hydrophilic coating, which has advantageous wetting properties and is characterized by high stability of the coating.

Summary

In one aspect, there is provided an analytical aid, comprising a surface coated at least partially with a hydrophilic coating, wherein the hydrophilic coating contains nanoparticles with silica structure and an average particle size, determined according to DIN ISO 22412:2008, in the range from 1 to 500 nm and the nanoparticles comprise groups of structure (I) or (II)

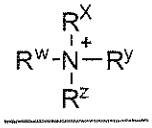


(I)

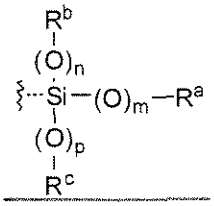


(II)

wherein in each of the groups of structure (I), independently of one another, R is selected from the group consisting of H, a metal-containing ion,



and



and wherein R^w, R^x, R^y and R^z, independently of one another, are selected from H and alkyl,

and wherein R^a, R^b and R^c, independently of one another, are optionally substituted residues, selected from the group consisting of H, alkyl, aryl, heteroaryl, cycloalkyl, cycloheteroalkyl, alkenyl and alkoxyalkyl,

and wherein n, m and p, independently of one another, are 0 or 1,

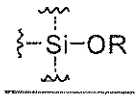
and wherein M^+ is a metal ion and A^- is a physiologically compatible anion.

In another aspect, there is provided a method of production of an analytical aid, comprising a surface that is coated at least partially with a hydrophilic coating, wherein the method comprises:

(a) providing the analytical aid,

(b) coating the analytical aid by bringing the analytical aid into contact with a mixture G comprising at least one dispersant and nanoparticles with silica structure, which have an average particle size, determined according to DIN ISO 22412:2008, in the range from 1 to 500 nm,

wherein the nanoparticles comprise groups of structure (I) or (II)



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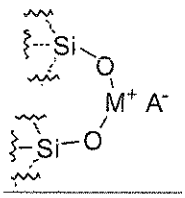

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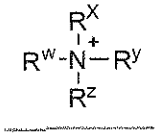

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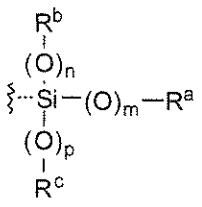


and wherein R^w, R^x, R^y and R^z, independently of one another, are selected from H and alkyl,

and wherein R^a, R^b and R^c, independently of one another, are optionally substituted residues, selected from the group consisting of H, alkyl, aryl, heteroaryl, cycloalkyl, cycloheteroalkyl, alkenyl and alkoxyalkyl,

and wherein n, m and p, independently of one another, are 0 or 1,

and wherein M^+ is a metal ion and A^- is a physiologically compatible anion,

(c) drying the analytical aid obtained according to (b), and

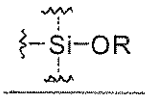
(d) optionally sterilizing the analytical aid obtained according to (c),

wherein the bringing into contact in (b) preferably takes place by dip coating and/or spray coating and/or contact coating, and wherein the analytical aid and/or the surface of the analytical aid preferably consists at least partially of a metal and/or a metal alloy and/or a metal oxide and/or a mixed metal oxide and/or a mixed metal oxide.

In another aspect, there is provided an analytical aid, producible or produced by a method as defined above.

In another aspect, there is provided a sampling device for taking a sample of body fluid, containing at least one analytical aid as defined above referring to an analytical aid, with the proviso that the analytical aid is selected from the group consisting of a needle element and a testing element.

In another aspect, there is provided the use of nanoparticles with silica structure and an average particle size, determined according to DIN ISO 22412:2008, in the range from 1 to 500 nm as hydrophilic coating for a surface of an analytical aid, more preferably as hydrophilic coating for a needle element of a sampling device for taking a sample of body fluid, wherein the nanoparticles comprise groups of structure (I) or (II)



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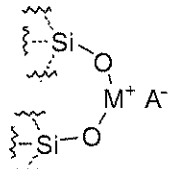

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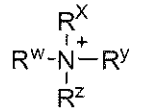

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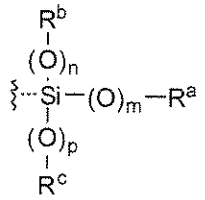


and wherein R^w, R^x, R^y and R^z, independently of one another, are selected from H and alkyl,

and wherein R^a, R^b and R^c, independently of one another, are optionally substituted residues, selected from the group consisting of H, alkyl, aryl, heteroaryl, cycloalkyl, cycloheteroalkyl, alkenyl and alkoxyalkyl,

and wherein n, m and p, independently of one another, are 0 or 1,

and wherein M^+ is a metal ion and A^- is a physiologically compatible anion.

Disclosure of the invention

According to the invention, this problem is solved by the objects of the independent claims. Advantageous embodiments are the object of the dependent claims.

Surprisingly, it was found that when nanoparticles with silica structure and an average particle size, determined according to DIN ISO 22412:2008 (dynamic light scattering), in the range from 1 to 500 nm are used for coating analytical aids, analytical aids with especially advantageous properties are produced. The analytical aids so coated are characterized by advantageous hydrophilicity and wettability. Moreover, high stability of the coating is provided.

Accordingly, the present invention also relates to an analytical aid, comprising a surface coated at least partially with a hydrophilic coating, wherein the hydrophilic coating

wherein R^b and R^c, independently of one another, are selected from the group consisting of H and alkyl.

7. Analytical aid according to one of Claims 1 to 5, wherein the hydrophilic coating consists of the nanoparticles with silica structure.

8. Analytical aid according to one of Claims 1 to 7, wherein the surface of the analytical aid, coated at least partially with the hydrophilic coating, consists at least partially of a metal and/or a metal alloy and/or a metal oxide and/or a mixed metal oxide.

9. Analytical aid according to one of Claims 1 to 7, wherein the nanoparticles have an average particle size in the range from 1 to 100 nm and wherein the hydrophilic coating has a thickness, in particular an average thickness, in the region of max. 500 nm, preferably of max. 300 nm and especially of max. 100 nm.

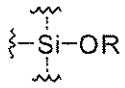
10. Analytical aid according to one of Claims 1 to 9, wherein the surface of the hydrophilic coating has a contact angle with water of less than 50°, preferably measured according to DIN 55660.2.

11. Analytical aid according to one of Claims 1 to 10, wherein the analytical aid is selected from the group consisting of a needle element, in particular a lancet, a capillary, in particular a capillary gap, a cannula, a testing element for detecting at least one analyte in a body fluid and a distributing element for distributing a sample of a body fluid that has been collected, in particular a spreading network, optionally coated with a metal and/or a metal alloy and/or a metal oxide and/or a mixed metal oxide, or a plastic film, optionally coated with a metal and/or a metal alloy and/or a metal oxide and/or a mixed metal oxide.

12. Analytical aid according to one of Claims 1 to 11, wherein the analytical aid is a needle element ~~(112)~~ of a sampling device ~~(110)~~ for taking a sample of body fluid.

19. Sampling device ~~(110)~~ for taking a sample of body fluid, containing at least one analytical aid according to one of the preceding claims referring to an analytical aid, with the proviso that the analytical aid is selected from the group consisting of a needle element ~~(112)~~ and a testing element.

20. Use of nanoparticles with silica structure and an average particle size, determined according to DIN ISO 22412:2008, in the range from 1 to 500 nm as hydrophilic coating ~~(122)~~ for a surface of an analytical aid, more preferably as hydrophilic coating ~~(122)~~ for a needle element ~~(112)~~ of a sampling device ~~(110)~~ for taking a sample of body fluid, wherein the nanoparticles comprise groups of structure (I) or (II)



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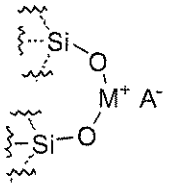

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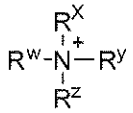

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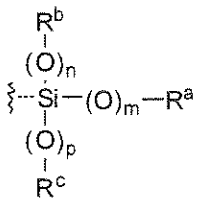

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and wherein R^a, R^b and R^c, independently of one another, are optionally substituted residues, selected from the group consisting of H, alkyl, aryl, heteroaryl, cycloalkyl, cycloheteroalkyl, alkenyl and alkoxyalkyl,