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A SWAB

Technical Field

- 5 The present invention relates to a swab for collecting a sample from a body cavity, such as a nasopharyngeal swab.

Background

- 10 Devices, such as swabs, for collecting biological specimens of organic material are known in the field of clinical and diagnostic analyses. These swabs generally include a cylindrical rod or stick containing on a collection end or tip formed from a wad of fiber material, such as rayon or a natural fiber such as cotton. The tip has hydrophilic properties to allow rapid absorption of the specimen from a body
15 cavity. Stable adherence of the fiber wrapped around the end or tip of the rod or stick is generally achieved by gluing.

- Collection swabs containing the collected material are often immersed in a viral transport medium in a receptacle such as a test tube, vial, culture dish, or culture
20 bottle, soon or immediately after collection. This is to preserve and conserve the collected specimen during storage and/or transport to, for example, a laboratory.

- Given the essentially random arrangement of fibres in the tip, the fibres may block part of the sample from release into the viral transport medium. The tip may also
25 entrain air which can further inhibit release of the sample. Since the amount of the sample released into the viral transport medium is unpredictable.

- Some swabs have been proposed that include tip having a well-defined structure or web to facilitate release of the sample. That structure is susceptible to plastic
30 deformation that reduces the contact between the tip and internal wall of the body cavity. In some cases a portion of the tip can break away, potentially injuring the subject from whom the sample is being taken. Such plastic deformation can occur

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as a result of the swab being grasped during withdrawal from packaging or otherwise during use.

In addition, swabs having a well-defined structure are typically 3D-printed. The 3-dimensional (3D) structure of such swabs, with internal volumes for sample retention, generally precludes the use of cheaper, higher throughput injection moulding processes.

It would be desirable to overcome or ameliorate at least one of the above-described problems, or at least to provide a useful alternative.

Summary

Described herein is a swab comprising:

- 15 a rod having a longitudinal axis;
- a tip comprising:
 - a proximal region at a distal end of the rod;
 - a distal region opposite the proximal region;
 - a plurality of posts extending from the proximal region to the distal
 - 20 region; and
 - a plurality of circumferential supports, each support extending between two said posts.

The posts and supports may together form a truss.

25 Each post may extend parallel to the longitudinal axis.

The circumferential supports may comprise one or more of:

- a support ring at the distal region, extending around a circumference of the
- 30 tip; and
- a support base at the proximal region and extending around a circumference of the tip.

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The tip may comprise a hollow volume and the support ring comprises an aperture that aligns with the hollow volume.

- 5 The support base may comprise a fluted section connecting the tip to the distal end of the rod.

The plurality of circumferential supports may comprise one or more webs disposed between the proximal region and the distal region. A plurality of said webs may
10 be disposed longitudinally along the posts. The webs may not be connected to one another – i.e. they are distinct.

Each web may comprise two members connected, in spaced apart relation, to the posts and are connected to each other at one or more circumferential locations
15 between the posts.

The posts may taper from a wider section at the proximal region to a narrower section at the distal region. The posts may be thinner at the distal region than at the proximal region. An internal edge of each post may be parallel. A cylindrical,
20 hollow volume may be defined, at least in part, by the internal edge of the posts. The posts may define a hollow volume that tapers in a proximal direction.

Advantageously, the posts and circumferential supports together form a frame that resists deformation due to laterally applied loads. Such loads might otherwise
25 plastically deform the tip, e.g. causing micro-cracks in the tip, resulting in breakage of the tip during use.

Advantageously, by tapering the posts towards the distal region of the tip, the tip can be pulled safely, in a proximal direction, out of an injection moulding mould.
30 In addition, some embodiments include a hollow volume between internal edges of the posts, that hollow volume tapering in a proximal direction. A pin can

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therefore be used to form the hollow volume, the pin being removed during or after injection moulding.

Brief description of the drawings

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Embodiments of the present invention will now be described, by way of non-limiting example, with reference to the drawings in which:

Figure 1 is an isometric view of a swab in accordance with present teachings;

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Figure 2 is a close-up side view of the tip of the swab of Figure 1;

Figure 3 is a close-up front view of the tip of the swab of Figure 1; and

15 Figure 4 is a photograph of a prior art swab having a uniform web structure around the tip; and

Figure 5 is an end view of the swab of Figure 1; and

20 Figure 6 is a partial close-up view of Figure 2.

Detailed description

25 Described herein are swabs for use in the collection of a sample from the body cavity of subject. The swabs have a highly regularised, open structure. That structure is designed to resist plastic deformation under lateral compression applied at the tip of the swab. The structure is also designed to release the sample – e.g. under surface tension in reservoirs in the tip – while facilitating ready release upon immersion of the tip in a viral transport medium (VTM).

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Such a swab 100 is shown in Figure 1. The swab 100 includes a rod 102 and a tip 104. The rod 102 has a longitudinal axis 106. During use, the swab 100 is inserted

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into a body cavity of a subject and the rod 102 is rotated about the longitudinal axis 106 to collect a sample from the internal wall of the body cavity. The tip 104 has a proximal region 108 at a distal end 110 of the rod 102, and a distal region 112 opposite the proximal region 108. The tip 104 further includes a plurality of posts, presently two posts 114 (see Figure 2), extending from the proximal region 108 to the distal region 112, parallel to the longitudinal axis 106, and a plurality of circumferential supports 115. Each of the circumferential supports 115 extends between the two posts and may, if more than two posts are provided (e.g. three posts spaced equidistantly around the circumference of the tip 104), extend between each post in the plurality of posts.

In general, the rod 102 will be formed in a cylindrical shape. The longitudinal axis 106 passes through the centre of the cylinder. The rod 102 comprises a handling section 116 and a tapered section 118. The tapered section 118 extends distally of the handling section 116. The tapered section 118 extends from the larger diameter handling section 116 to an intermediate diameter section 120. In the present embodiment, the rod 102 includes a further tapered section 122 extending from the intermediate diameter section 120 to a narrow diameter section 124 that includes the distal end 110 of the rod 102.

The reduction in the diameter between the handling section 116 and the distal end 110 increases the flexibility. The flexibility reduces the force applied to the internal surface of the body cavity (e.g. nostril, mouth, rectum or other orifice) from where the sample was taken.

In other embodiments, the rod 102 has a consistent diameter along its length, or any other number of reductions in diameter.

The rod 102 also includes a weakened section 126, spaced from the tip 104. After the tip 104 has been placed into VTM – e.g. in a tube or other receptacle – the weakened section 126 enables the rod 102 to be readily snapped so that the tip 104 remains in the VTM. To that end the weakened section 126 is spaced from

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the distal region 112 by a distance just less than the internal length of the receptacle – presently, the weakened section 126 is in the handling section 116 but it may instead be located between the handling section 116 and the distal end 110. Accordingly, if the receptacle is jolted or tilted while being moved, the tip
5 104 will remain in the VTM.

With reference to Figure 3, the tip 104 is designed to resist laterally applied forces (in a direction along the trajectory marked X, normal to the axis 106) that would otherwise cause plastic deformation (e.g. micro-cracks), and potentially breakage,
10 of the tip 104. Such a weakness can occur in 3-dimensional printed swabs that have a uniform web arrangement around the tip 104 (e.g. no longitudinal posts) such as that shown in Figure 4. The posts 114 and supports 115 together form a truss 128 (marked in broken lines).

15 Each post 114 extends parallel to the longitudinal axis 106. The posts 114 therefore provide a continuous support along the longitudinal extent of the tip 104 – i.e. from the proximal region 108 to the distal region 112. The posts 114 also maintain the circumferential supports 115 in position to resist deformation resulting from lateral forces. Each circumferential support 115 is a support that
20 extends circumferentially between the posts 114, to increase the strength of the tip 104 against laterally applied forces (e.g. from the fingers of a nurse pinching the tip 104 during removal of the swab 100 from packaging). In the present embodiment, the circumferential supports 115 extend around the full circumference, but in other embodiments may extend between posts 114 around
25 only part of the circumference.

The circumferential supports 115 can take a number of forms. The embodiment shown in Figure 3 includes three types of circumferential supports 115. The first circumferential support comprises a support ring 115a at the distal region 112 of the tip 104. The support ring 115a extends around a circumference of the tip 104.
30 The second circumferential support forms a support base 115b at the proximal region 108, that also extends around a circumference of the tip 104. The third

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circumferential support comprises a web, and presently a plurality of webs 115c, extending between the posts 114 and disposed between the proximal region 108 and distal region 112.

5 The present design facilitates injection moulding, despite the tip 104 enclosing a hollow volume 130 (see Figure 2). To enable this, the support ring 115a has an aperture 132 that aligns with the hollow volume 130 (see Figure 5). During injection moulding, a pin (not shown) occupies the space that will form the internal volume 130. During or after injection moulding, the pin is withdrawn in a distal
10 direction through the aperture 132, leaving behind the hollow volume 130. In some embodiments the pin, and thus the hollow internal volume 130 resulting from its withdrawal, tapers proximally. It therefore has a greater diameter in the distal region 112 than in the proximal region 108. This reduces friction between the pin and the formed tip 104, reducing the creation of non-design stresses,
15 micro-cracks and other undesirable effects.

In other embodiments, the hollow internal volume is of uniform diameter substantially along its length – i.e. uniform ‘in substance’ (it is foreseeable it may be slightly rounded in the proximal region, though it will be uniform in diameter
20 elsewhere.

To further support the injection moulding process, the posts 114 are thinner at the distal region 108 than at the proximal region 112 – i.e. the posts 114 taper distally. As a result, the tip 104 tapers from a wider section w_1 at the proximal
25 region 108 to a narrower section w_2 at the distal region 112 – see Figure 5. This reduces friction, and facilitates release from the injection moulding moulds, when a small force directed in the proximal direction is applied to the swab 100.

The taper of the posts 114 is substantially uniform along the length of the tip 104
30 and, similarly, the webs 115c have progressively smaller diameter in the distal direction, as shown in end view in Figure 5. The posts 114 have an internal edge 134 that defines, at least in part (e.g. together with webs 115c) the hollow,

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cylindrical internal volume 130. In some embodiments, the edges 134 are parallel and the hollow volume has a consistent diameter substantially along its length. In other embodiments, the edges 134 diverge distally, thereby producing a hollow volume 130 that tapers in the proximal direction and thus enlarges in the distal direction.

The support base 115b connects the tip 104 to the rod 102. There is a significant change in diameter from the larger diameter tip 104 to the smaller diameter section 124 of the rod 102. To accommodate this diameter variation, the support base 115b comprises a fluted section connecting the tip 104 to the distal end of the rod 102. The fluted section avoids providing a step change in diameter that might otherwise encounter localised stress concentrations during removal from the injection moulding mould and during use (i.e. when taking a sample).

To increase the circumferential force or stress the tip 104 can withstand during use, a plurality of webs 115c are disposed between the proximal region 108 and the distal region 112. In some embodiments, there may only be a single web 115c though there will usually be multiple webs 115c disposed longitudinally along the posts.

The webs 115c of the embodiments shown in Figures 2 and 3 are not connected to one another. Given the webs 115c do not need to lend support from each other directly – i.e. by being interconnected or sharing members – this increases the spacing between neighbouring webs 115c and therefore the freedom with which the sample can enter the internal volume 130. In addition, the posts 114 may provide a scraping action similar to a blade, to draw the sample from the internal wall of the body cavity into which the swab 100 is inserted.

As shown in Figure 6, each web 115c comprises two members 136, 138. The members 136, 138 are connected to the posts 114 in spaced apart relation (i.e. not at the same point). In addition, as the members 136, 138 extend between neighbouring posts 114, they come together and connect to each other to form

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the web 115c. Where the web 115c passes only partway around the circumference of the tip 104 the members 136, 138 may only connect at one circumferential location (i.e. location that defines part of the circumference, or external surface, of the tip 104). However, in preferred embodiments, the members 136, 138
5 connect more than once and, presently, connected twice – once of each side of the post 114 as shown.

The particular arrangement of members 136, 138 is also significant. Member 148 extends in a direction that is, or is nearly, perpendicular to the longitudinal
10 extension of the posts 114 and thus of the swab 100 (e.g. nearly perpendicular being “in substance” perpendicular such that absolute perpendicularity to the longitudinal is not required, by near perpendicularity is necessary to resist deformation from nearly perpendicularly applied loads – this may be $\pm 5^\circ$ from perpendicular, $\pm 10^\circ$ from perpendicular, or some other figure). As such, each
15 member 138 of each web 115c forms a circumferential support ring between the proximal region 108 and the distal region 112, to protect against plastic deformation from laterally applied forces. Member 136 buttresses member 138, reducing the amount by which member 138 flexes when it experiences longitudinally applied forces – e.g. during insertion of the swab 100 into a body
20 cavity, or during subsequent withdrawal from the body cavity.

As a result, the structure of the tip 104 is resistant to deformation that would cause plastic deformation, including cracking and breakage, in known swabs.

25 It will be appreciated that many further modifications and permutations of various aspects of the described embodiments are possible. Accordingly, the described aspects are intended to embrace all such alterations, modifications, and variations that fall within the spirit and scope of the appended claims.

30 Throughout this specification and the claims which follow, unless the context requires otherwise, the word “comprise”, and variations such as “comprises” and “comprising”, will be understood to imply the inclusion of a stated integer or step

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or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

5 The reference in this specification to any prior publication (or information derived from it), or to any matter which is known, is not, and should not be taken as an acknowledgment or admission or any form of suggestion that that prior publication (or information derived from it) or known matter forms part of the common general knowledge in the field of endeavour to which this specification relates.