

## **Metering Brush for Targeted Local Application**

The invention concerns a brush according to the preamble of claim 1.

Brushes are known in the prior art in very different forms. Brushes for application of liquids typically have a configuration of bristles from a variety of materials very close to each other or directly against each other either entirely or in bundles. Owing to the fact that the bristles are close to each other or touch each other, the bristle configuration develops a significant capillary effect. It can therefore absorb a significant amount of the liquid being applied.

The liquid absorbed by the bristle configuration is released from it again by brushing the bristle configuration over the surface being treated so that the sections of the bristles coming in contact with the surface release the liquid surrounding them to the surface being treated. Liquid flows from the area of the bristle configuration lying farther in into the area of the bristles that was brushed against the surface being treated. The longer the surface being treated is brushed with the bristle configuration, the more liquid is released by the bristle configuration to the surface being treated, until the storage capacity of the bristle configuration is exhausted. The user must then wet the bristle configuration again with the liquid provided for treatment, if he intends to apply additional liquid.

In ordinary brushes the absorbed amount of liquid can be adjusted relatively well (especially by the number of bristles, the bristle thickness and the bristle length), but how much of the absorbed amount of liquid the brush releases again in a specified time unit can only be slightly influenced by design. This is because the released amount of liquid per unit time, as already described, depends strongly on the user, i.e., on how the user guides the brush.

In addition, the bristles very close to each other in the prior art are also disadvantageous because even after a short time part of the liquid being applied settles between them and is no longer released, which is both an economic and hygienic problem in cosmetic and pharmacy brushes.

In view of this, the task of the invention is to devise a brush with a bristle configuration, by means of which the amount of liquid to be applied can be better metered.

This task is solved with the features of claim 1.

The brush according to the invention has a configuration of a number of bristles arranged at least essentially parallel. One speaks of essentially parallel arrangement whenever the bristle length axes enclose an angle of less than  $10^\circ$ , better less than only  $5^\circ$ . Ideally the bristles are arranged fully parallel to each other, apart from the unavoidable manufacturing tolerances.

Viewed overall, the bristle configuration of the brush according to the invention is preferably fully or at least essentially round. This favors the metering behavior according to the invention decisively or permits it at all in a bristle configuration having a rectangular or square base surface, in which the liquid being applied in metered fashion runs "broadly" and can then no longer be released in sufficiently controlled fashion so that metering is generally no longer controllable.

The preferably round (possibly conical in the longitudinal direction) bristles are grouped around a configuration center, ideally in a circle. It is best that the individual bristles each form rows having the shape of a circular ring.

Adjacent bristles, ideally adjacent along a circular line in the peripheral direction, are spaced in their foot area above the rounding with which they grade into the bristle support, by at least  $1/5$ , better by at least  $1/4$  and in the ideal case by at least  $1/3$  their

corresponding diameter. Ideally the maximum spacing between two such adjacent bristles, however, is at least 25% and better at least 40% smaller than the maximum bristle diameter that the bristles have in said foot area.

Adjacent bristles, ideally set up along adjacent circular lines in the radial direction in their foot area, are spaced from each other above the rounding with which they grade into the bristle carrier by at least  $\frac{1}{5}$ , better by at least  $\frac{1}{4}$  and in the ideal case by  $\frac{1}{3}$  of their corresponding diameter. It also applies here that the maximum spacing between two such adjacent bristles is ideally at least 25% and better at least 40% smaller than the maximum bristle diameter that the bristles have in said foot area.

The length of the employed bristles is preferably 2 mm to 10 mm, ideally 2 mm to 5 mm.

The bristles are molded on as one or two components to a bristle carrier, which is an independent component or an integral part of a handle. The bristles are preferably molded on there as one component and are therefore produced together with the bristle carrier in one "shot".

The configuration has an outer configuration area completely enclosing the inner configuration area, including the configuration center, in the peripheral direction. In this outer configuration area the bristle density is higher than in the inner configuration area enclosed by the outer configuration area. The term bristle density is understood to mean the number of bristles per unit surface.

As an alternative or in addition, the outer configuration area is configured so that its bristles are finer than the bristles of the inner configuration area.

The bristle arrangement according to the invention permits the bristle field to be laid out so that the liquid being applied forms a single drop in the central area of the applicator

because of its surface tension, which is initially held by the enclosing bristles up to its intended application.

The invention therefore consists of devising a bristle configuration, which can be set up so that it ultimately forms one drop after actual dripping off of any excess amount of liquid, which the bristle field may have initially absorbed during immersion of the brush and which the bristle field cannot keep stored over the long term because of "oversaturation". This drop, however, does not drip off immediately. Instead it is stored in the bristle configuration and only released again from the bristle configuration when application is started and contact with the surface being treated has occurred during this application.

In this manner an application principle deviating from the previously known application principle of the brush can be exploited. This is because the teaching of the invention makes it possible to design the brush so that the liquid being applied is no longer released continuously (albeit in undefined amount), but designed so that during contact with the surface being treated most of the liquid stored by the bristle field is instantaneously released. Ideally this instantaneously released part is at least 75% and better at least 85% of the liquid stored by the bristle field.

The fact that the bristles are injection molded and can be provided on this account with a precisely defined spacing from each other makes a decisive contribution to this. The fact that production in the injection molding process permits targeted use of materials that are essentially resistant to diffusion of liquid is then of even greater significance. Wherever a targeted choice of the bristle spacing and the material of the bristles is not sufficient to achieve the required degree of emptying (see above), the injection molded bristles can be deliberately provided with hydrophobic or hydrophilic additives and/or surface structures that act in this way.

Through these expedients, with appropriate layout of the bristle field the volume that the released part of the liquid has can be stipulated with comparative precision.

Valid rules for precise layout of the bristle field generally cannot be stated, of course, since individual conditions of the specific case matter significantly, i.e., among other things, the viscosity and surface tension of the liquid being applied, as well as the bristle density, bristle diameter and bristle length. The specific values of these parameters, which are to be maintained in the individual case to implement the invention, however, can be determined easily by one skilled in the art by ordinary experiments, if he keeps the principle of the invention further outlined below in mind. In his attempts one skilled in the art will expediently use a 3D pattern print. With it he can very quickly produce with CAD support experimental brushes with different bristles and with systematically varied bristles in order to study the corresponding dripping behavior of the corresponding bristle configuration, which it exhibits relative to the liquid that is to be processed with the brush.

The principle of the invention is based on devising an outer configuration area that implements an edge that encloses the liquid absorbed by the bristle configuration and directs it to the center of the bristle configuration. The principle of the invention is also based on devising an inner configuration area, within which the bristle density is reduced so far that the liquid absorbed by the bristle configuration in this area is no longer completely retained by the capillary effect between the bristles but only in reduced fashion. Because of this the liquid absorbed by the bristle configuration and ultimately remaining in the bristle configuration after dripping off of the brush, as intended, agglomerates in the inner configuration area to a last drop. The bristles still present in the inner configuration area then prevent the drop from being lost inadvertently, i.e., already during the dripping phase, which any brush loaded by dipping passes through.

Instead the drop is kept labile in the bristle configuration at least for a time stipulated by the layout of the bristle configuration, which goes beyond the timeframe of the dripping

phase. As soon as bristles holding these drops and/or the outer skin of the drop itself come in contact with the surface being treated, the forces that retain the drop in labile fashion in the bristle configuration are overcome and the drop is essentially fully released to the surface being treated.

Significantly better metering of the liquid applied with the brush can be achieved on this account than in the prior art.

This effect could be achieved not only by variation of the bristle density, but similarly also controlled via the fineness of the bristles, i.e., via the diameter that the bristles of the different configuration areas have.

In many cases it is ideal if the bristle density and fineness of the bristles are simultaneously varied. Particularly good adaptation to the requirements of the individual case are possible from case to case on this account.

It is critical for successful implementation of the invention that the invention be implemented by means of injection-molded bristles. Only if the bristles are produced by injection molding can both the spacing of the bristles and the fineness of the bristles be controlled in the desired manner with the necessary precision.

In the context of a preferred embodiment it is proposed that the inner configuration area include a central area that makes up only part of its surface, which is fully bristle-free. In individual cases (namely with correspondingly high viscosity or surface tension of the liquid being applied) it is conceivable to configure the inner configuration area completely bristle-free, which, however, is not preferred.

In a modification of the preferred embodiment just described, it is proposed that the inner configuration area (preferably along an imaginary circular line) have confinement bristles, which delimit a bristle-free volume in the center of the configuration. This

spatial volume forms a precisely definable drop space in which at least a first part of said "last" liquid drop can collect, which is large enough so that it triggers immediate release of most of the liquid to be applied in the form of a drop when the surface being treated is touched. Such a bristle-free area in the center of the bristle configuration promotes formation of the desired drop henceforth kept labile by the bristle configuration.

This occurs owing to the fact that a first liquid drop can agglomerate unhampered by the bristles or the capillary forces generated by them in the central area, which with its surface tension possibly attracts additional liquid from the surrounding bristle configuration.

Because of this the invention differs from traditional brushes with a narrow bristle configuration. This is because the known narrow bristle configuration develops such high capillary forces that drop formation is suppressed from the outset. This corresponds to the objective that forms the basis of the brushes known in the prior art of ordinarily designing them as free of drip as possible.

Here again it applies that no generally valid formula can be stated as to how large the spatial volume of the drop space must be in each individual case. Instead it is also the case here that the spatial volume of the drop space must be determined for each specific individual case by ordinary experiments as a function of the bristle density, bristle diameter, bristle length, viscosity and surface tension of the liquid being applied, possibly again with the aid of rapid prototyping. This is possible by heeding the aforementioned instructions but without unduly large expense.

The aforementioned embodiment can be further developed in that the volume of the drop space is chosen large enough that a last drop is formed but at the same time is chosen small enough that the drop (with the fixed brush aligned vertically downward with its bristle configuration suspended in space, whose dripping phase has ended) can be maintained at least 15 s, better at least 30 s and ideally at least 150 s by the bristle

configuration before it drips out, i.e., without it or the bristles coming in contact beforehand with the surface onto which the drop is to be applied.

The bristle-free central area preferably has a bristle-free base surface, which corresponds to at least three times, or at least 3.5 times and better at least 4.5 times, ideally even at least 5.5 times the cross-sectional area of one of the confinement bristles in its foot area. Ideally, however, the situation is such that the bristle-free base surface of the bristle-free central area has a base surface that corresponds as a maximum to 15 times and better a maximum of 12.5 times the cross-sectional area of one of the confinement bristles (in its foot area above any rounding with which the corresponding confinement bristles grade into the bristle support). Otherwise the amount of liquid stored in the bristle-free central area tends to run broadly within the bristle configuration instead of remaining stored to a significant part in the bristle-free central area or "suspended" in the drop space assigned to it, and can be deliberately released on this account, for example, in which the confinement bristles are moved by contact with the application location. The significant foot area here is the area of the bristles directly above the beginning of the rounding with which the bristles grade into the bristle support. The bristle-free base surface is then preferably essentially rotationally symmetric, especially almost circular. Preferably the base surface of the bristle-free central area is understood to mean the surface that has an imaginary circle that inscribes the confinement bristles so that it touches them on its radially inward side.

In the context of another preferred variant it is proposed that the distal (i.e., facing away from the brush handle) ends of the bristles of the inner area extend beyond the distal ends of the bristles of the outer area. Such a configuration of the bristles favors drop formation in the central area of the bristle configuration and generally also holding of the drop in the central area.

The distal ends of the confinement bristles preferably extend beyond the distal ends of all other bristles of the bristle configuration. This also in most cases advantageously

influences drop formation and holding of the drop. However, release of the drop on first subsequent contact with the surface onto which the liquid is to be applied is positively influenced above all by this. This is because the long confinement bristles hold the drop or at least a significant part of the drop between them. Release of the drop is initiated at the latest as soon as the distal ends of one or more of the confinement bristles protruding beyond the other bristle configuration are deformed when the brush contacts the surface. For this purpose only very limited forces are required, because only one or more of the confinement bristles standing almost alone in the area of its distal end must be "activated".

In the context of an advantageous modification it is proposed that the distal end of the bristle configuration be designed conically tapered, preferably so that the imaginary surface that the distal bristle ends span in their entirety as an envelope surface is essentially a conical surface with a vertex angle  $\alpha$  for which  $35^\circ \leq \alpha \leq 55^\circ$  applies.

Such centering of the ends of the bristle configuration toward the central area of the bristle configuration promotes drop formation.

Advantageously the confinement bristles are set up in one row (preferably along a circular line) and the row of confinement bristles is enclosed on its side facing away from the drop space by at least one additional row of bristles, whose bristles are separated from each other by a larger bristle spacing than the maximum spacing  $Ab_{\max}$ , which two directly adjacent confinement bristles maintain from each other.

An important aspect of the invention is the use of the brush according to the invention for application of an aqueous cosmetic and/or drug onto the skin of the eyelid. There is a demand in practice to stimulate the growth activity of eyelashes. For this purpose an agent or stimulant that has an appropriate effect for this purpose must be applied to the skin part of the eyelid close to the roots of the eyelashes, preferably to the upper eyelid. The corresponding agents are either part of the expensive cosmetic or medical agents and

are costly to produce. In addition, effective agents should only be applied very sparsely anyway, since otherwise the excess that is distributed in or around the eye can trigger undesired side effects.

This makes the previously proposed application by means of a fine pipette disadvantageous. Even the theoretically conceivable (but still apparently not proposed) application of such agents by means of a type of "classic mascara brush", which is brought to the base of the eyelashes and the adjacent skin part, would have serious drawbacks, namely especially that an intolerably large amount of agent is consumed by dipping the relatively voluminous mascara brush, which also runs the risk of dripping in uncontrolled fashion during application to a significant degree.

These difficulties and drawbacks are remedied by the use according to the invention of the metering brush proposed and claimed in the context of this invention. This metering brush is capable of essentially storing the amount of agent that is actually required at the application location in its drop space furnished extra for this purpose. The amounts stored in the drop space can be released again in controlled fashion. This is especially true when the bristles enclosing the drop space are the bristles that protrude farthest outward when viewed in the longitudinal direction and therefore protrude beyond the other bristles of the bristle field.

The use according to the invention preferably occurs for application of agents that have an easily flowing consistency, as further specified below.

Accordingly, an application system consisting of a brush according to one of the preceding claims and an agent to be applied, preferably in the form of an eyelash growth serum, whose surface tension OBSF is less than that of pure water, is also an object of the invention, in which the number and/or arrangement of bristles relative to each other and/or the bristle length, on the one hand, and the parameters that determine the flow and drip behavior of the agent, on the other, are adjusted to each other so that the bristle

configuration keeps a predetermined amount of agent (preferably mostly or essentially) in its drop space and can release it again on contact with the skin part being treated.

The brush preferably has 6 to 12 confinement bristles, which delimit the drop space and in so doing define it.

Ideally the confinement bristles have a bristle length  $LB$  for which  $2.7 \text{ mm} \leq LB \leq 5.5 \text{ mm}$  applies.

It has proven preferable that the bristles, ideally at least the confinement bristles, have a bristle foot diameter in the foot area (directly above the beginning of the rounding with which they grade into the bristle support), for which  $DF \leq 0.06 \text{ mm}$  or ideally  $DF \leq 0.04 \text{ mm}$  applies.

The bristle configuration overall is preferably round or essentially round and then includes a total of between 30 and 90 bristles, better between 50 and 70 bristles.

The agent to be applied at  $20^\circ\text{C}$  preferably has a surface tension  $OBFS$  that lies in the range  $15 \text{ mN/m} \leq OBFS \leq 60 \text{ mN/m}$  and ideally in the range  $20 \text{ mN/m} \leq OBFS \leq 40 \text{ mN/m}$  – measured with a so-called "capillary effect" or a common surface tension measurement instrument operating according to this method.

The agent to be applied preferably has a specific weight of 0.6 to 1.5 g/mL, ideally only a specific weight of 0.6 to 0.9 g/mL, in each case measured at  $20^\circ\text{C}$ .

The agent to be applied at  $20^\circ\text{C}$  preferably has a viscosity between about 1 mPas to about 100 mPas (in the individual case to 150 mPas, not preferred), ideally between about 1 mPas and about 50 mPas, in each case measured with an ordinary viscosimeter, preferably an Engler viscosimeter. The agent to be applied is therefore easily flowing.

Additional configuration possibilities, advantages and method of action of the invention are apparent from the following description of three practical examples with reference to the figures.

In the figures:

- Figure 1: shows a first practical example of an applicator for a brush according to the invention in a side view;
- Figure 2: shows a first practical example of an applicator for a brush according to the invention in a longitudinal view;
- Figure 3: shows a first practical example of an applicator for a brush according to the invention in a perspective view;
- Figure 4: shows a first practical example of an applicator for a brush according to the invention in a frontal view;
- Figure 5: shows the model of an individual bristle, which corresponds to the bristles with which the applicator for the brush according to the invention is occupied;
- Figure 6: shows a first practical example of the applicator for a brush according to the invention in an enlarged frontal view;
- Figure 7: shows a second practical example of an applicator for a brush according to the invention in a side view;
- Figure 8: shows a second practical example of an applicator for a brush according to the invention in a longitudinal view;

- Figure 9: shows a second practical example of an applicator for a brush according to the invention in a perspective view;
- Figure 10: shows a second practical example of an applicator for a brush according to the invention in a frontal view;
- Figure 11: shows a second practical example of an applicator for a brush according to the invention in an enlarged frontal view;
- Figure 12: shows a third practical example of an applicator for a brush according to the invention in a side view;
- Figure 13: shows a third practical example of an applicator for a brush according to the invention in a longitudinal section;
- Figure 14: shows a third practical example of an applicator for a brush according to the invention in a perspective view;
- Figure 15: shows a third practical example of an applicator for a brush according to the invention in a frontal view;
- Figure 16: shows a third practical example of an applicator for a brush according to the invention in an enlarged frontal view;
- Figure 17: shows a fourth practical example claimed as protected independently from the other practical examples of an applicator for a brush according to the invention in a center section;
- Figure 18: shows the fourth practical example of an applicator according to Figure 17 in a perspective view;

Figure 19: shows a fourth practical example of an applicator for a brush according to the invention in an enlarged frontal view;

Figure 20: shows a fifth practical example claimed as protected independently of the first three practical examples for a brush according to the invention in a side view;

Figure 21: shows the fifth practical example of the applicator according to the invention in a perspective view from the front;

Figure 22: shows the fifth practical example of the applicator for a brush according to the invention in an enlarged frontal view.

Figures 1 to 6 show a first practical example of the invention.

The brush to be further explained with reference to this practical example consists of a handle (not shown here) and a bristle support 1 that can be fastened in this handle or stem.

The figures just presented each show strongly enlarged views on a scale of roughly 7.5:1. The brushes according to the invention are very delicate and preferably have a head diameter KD in the range between 2.5 mm and 6 mm, in the practical examples shown in the figures it is 4 mm.

The bristle support 1 has a longitudinal axis L, which regularly coincides with the longitudinal axis of the stem (not shown).

The bristle support 1 is provided with a bristle support base surface 2, which runs essentially perpendicular to longitudinal axis L. Bristles are molded on in one piece to the bristle support base surface 2 in this practical example. These form a bristle field, whose

bristles are arranged essentially parallel to each other and whose bristle longitudinal axis BL runs essentially parallel to the longitudinal axis L of the bristle support and the entire brush.

The bristle support 1 with its bristle support base surface 2 in this practical example was injection molded in a single work step (single shot) with the bristles, for which reason all mentioned components consist here of the same plastic. This is ideal from a hygienic standpoint, because unlike during the use of a "bristle dummy" or inserted bristle bundles no gap can form in which part of the liquid to be applied remains behind.

The bristles of the bristle field are highly elastic bristles. The distal end of these bristles can be deflected under the influence of the forces occurring during the intended application by the length  $\Delta L$  of at least 1.25 mm, even better by at least 2 mm and ideally by at least 2.75 mm orthogonal from the position that the center line of the corresponding bristle assumes in the unloaded state (cf. Figure 5).

The bristles each have a conical outer surface, which runs sloped at an angle  $\beta$  of about  $1^\circ$  to the bristle longitudinal axis, see Figure 5.

It is also worth noting that the bristles of the bristle configuration all maintain a defined spacing from each other, i.e., the individual bristles do not come in contact in the unloaded state with neighboring bristles.

As is best apparent with reference to Figure 6, the bristle configuration 7 is subdivided into an outer configuration area 3 and an inner configuration area 4 (only a single bristle of a bristle arranged in a circular ring is shown in Figure 6 to represent the other equivalent bristles and marked with a reference number along with the imaginary boundary line GR between the outer configuration area 3 and the inner configuration area 4 as a black solid line).

In the outer configuration area 3 the bristle density, i.e., the number of bristles per area, is higher in section than the bristle density BDI in the inner configuration 4 enclosed by the outer configuration area 3. Depending on the liquid being applied in the individual case,  $BDA/BDI \geq 1.3$  and preferably  $BDA/BDI \geq 1.5$  applies. For certain cases  $BDA/BDI \geq 3$  is ideal.

In this specific practical example, which is shown in Figures 1 to 6,  $BDA/BDI$  is just above 1.3.

At the same time the bristles of the outer configuration area 3 are finer in cross section (i.e., averaged over the number of bristles belonging to the corresponding area). The bristles of the outer configuration area 3 mainly all have (or at least on average) at least 25% smaller bristle diameter than the bristles of the inner configuration area 4.

This practical example is a preferred practical example in which the outer configuration area 3 includes at least two bristle rows set up along a circular line, which are designed as barrier row 8 and barrier row 9, which cooperate. These two barrier rows 8 and 9 are mainly set up so that the bristles of one barrier row, when viewed in the radial outward direction, cover the intermediate spaces between the bristles of the other barrier row so that a ring-shaped locally dense bristle configuration is produced. The bristle configuration of the outer configuration area 3 is therefore laid out so that it delimits the total amount of liquid absorbed by the bristle configuration, holds it and directs it to the center 7 of the bristle configuration.

The inner configuration area 4 in this practical example consists of a bristle field, which has a smaller average bristle density per unit surface in comparison with the outer configuration area 3.

This practical example then implements any preferred embodiment in which the central area 7 has a bristle-free base surface. This bristle-free base surface corresponds to

roughly more than 4.5 times the cross-sectional area in the above defined foot area of one of the confinement bristles 10.

As is readily apparent with reference to Figure 6, this practical example implements the preferred embodiment in which a number of confinement bristles 10 set up along a circular ring surface is present within the inner configuration area 4, which delimit a bristle-free area in the center of the bristle configuration and in so doing form a so-called drop space 11, which is shown in Figure 6 by the imaginary black solid line close to the center.

This drop space 11 defines the center axis of the drop that forms as intended in the loaded and dripped off bristle configuration and therefore also the heaviest area of the drop.

The confinement bristles 10 here are those bristles of the bristle configuration that have the largest bristle diameter in their foot area. The confinement bristles 10 are at the same time the bristles of the bristle configuration whose length is greatest and the bristles that protrude outward with the distal end beyond all other bristles of the bristle configuration, cf. especially Figure 2.

The confinement bristles, despite their large bristle diameter, are arranged at a very limited spacing from each other. The foot spacing of two directly adjacent confinement bristles is less than half the bristle foot diameter of the confinement bristles. The foot area just in front of the rounding with which the bristles grade into the bristle support base surface is uninfluenced.

As can best be seen with reference to Figure 4, the bristle field that forms the inner bristle configuration area here is composed overall of bristles whose bristle foot diameter in the radial direction diminishes from the inside out.

The innermost row of bristles of the inner configuration area 4 forms a row of said confinement bristles 10. In the radial direction viewed outward a row of middle bristles 12 follows, whose foot diameter is preferably more than 15% and ideally more than 20% smaller than that of the confinement bristles 10. Preferably the bristles of this bristle row have roughly the same bristle spacing from each other as the confinement bristles (up to 15% larger spacing). A row of outer bristles 13 is connected to this row of bristles 12 outward in the radial direction, which forms the boundary of the inner bristle area 4 relative to the outer bristle area 3. This row of outer bristles 13 preferably consists of bristles whose foot diameter is more than 30% and ideally more than 40% smaller than the foot diameter of the confinement bristles 10.

As is readily apparent in Figure 2, the bristle support has a convex curved bristle base surface 2, to which the bristles are fastened and from which the bristles protrude. This bristle base surface in the present practical example is configured as a spherical cap whose deepest point T coincides with the brush longitudinal axis when the brush is held so that the bristle configuration points vertically downward.

It is also worth noting that all bristles of the bristle configuration in the circular rows are set up concentric to the center of the bristle configuration.

Figures 7 to 11 show a second practical example of the invention. Except for the deviations mentioned below, it corresponds to the first named practical example so that what was said there also identically applies for the second practical example (cf. especially the practically identical side views of the practical examples in their decisive points).

In this practical example the bristle support base surface 2 has an unoccupied edge which is not assigned to the outer configuration area 3, cf. Figure 10.

The outer configuration area 3 is designed here less densely occupied and in this practical example consists merely of the barrier rows 8 and 9.

The inner configuration area 4 is also much less densely occupied. It includes a row of confinement bristles 10. On the outside a thinned out row of auxiliary bristles 14 is connected. Their bristle diameter is preferably more than 15% and ideally more than 20% smaller than that of the confinement bristles 10. The bristle spacing of two auxiliary bristles 14 spaced from each other is preferably more than three times the auxiliary bristle foot diameter.

After the auxiliary bristles the bristle configuration grades into the outer configuration area. The bristle foot diameter of the bristles 8 and 9 of the outer configuration area is preferably smaller than the bristle diameter of the bristles of the inner configuration area.

It is also worth noting that the confinement bristles 10 are further spaced from each other here than in the previous practical example.

In this specific practical example, which Figures 7 to 11 show, BDA/BDI lies just above the value 4.

Figures 12 to 16 show a third practical example of the invention, which is conceptually much closer to the first than the second practical example. Except for the deviations mentioned below, it corresponds to the first practical example so that what was stated there also identically applies for this third practical example, cf. especially the practically identical side views of the practical examples in the important points.

The innermost row of bristles of the inner configuration area 4 is again formed by a row of said confinement bristles 10, which enclose a drop space 11, which is shown by the imaginary black solid line. Outward in the radial direction a row of middle bristles 12 is connected whose average diameter is preferably insignificantly (to about 15%) smaller

than that of the confinement bristles 10. A bristle spacing of two directly adjacent middle bristles also preferably corresponds to roughly that of the confinement bristles (to about +15%). Outward in the radial direction a row of outer bristles 13 is connected to this row of bristles 12, which forms the boundary of the inner bristle area 4 relative to the outer bristle area 3 and whose diameter is preferably about 50% ( $\pm 10\%$ ) smaller than the diameter of the confinement bristles 10. Directly adjacent bristles of this row of bristles preferably have a bristle spacing that is at least equal to double the bristle foot diameter of these bristles.

In this specific practical example, which Figures 12 to 16 show, BDA/BDI lies just above the value 1.5.

An entire series of embodiments can be implemented with the brushes according to the invention.

Both multiple use packages and hygienically advantageous disposable packages can therefore be equipped (for example, comparable to liquid eyeliner common on the market). The applicators according to the invention can be designed as loose applicators whose loading occurs by dripping or injection (through an internally supplied central outlet opening in the bristle support base surface) from a metering vessel, dipping in a supply vessel or by absorption from a separate carrier, onto which drops were applied previously.

In the disposable area a single-dose package can advantageously be implemented, which contains an applicator as well as the liquid for one application.

The brush according to the invention is especially advantageous in pharmaceutical liquids, since here precise meterability must be present (in the range  $\pm 0.01$  mL), which can also be achieved with skillful layout according to the invention. The precise meterability opens up new application areas in competition with other metering systems

that were previously used for this purpose in order to ensure that no wasting of the expensive active liquid occurs – for which reason brushes have thus far not been considered because of their unutilized/excess amounts in the bristle configuration.

Defined absorption of the amount required to achieve the desired makeup result is also advantageous in cosmetics.

The injection-molded bristles described according to the invention exhibit significant advantages.

Since all essential bristle parameters (length, diameter, positioning, setup density) are precisely adjustable in injection-molded bristles, brushes can be made that permit largely complete release of the liquid absorbed by them to the skin, hair or hair appendage (at least 80%; preferably 90 to 95%). In addition, injection molding permits a soft version of the bristles, free of burrs, edges and points to avoid injury. The latter is often not the case in bristles made from cut filament. Injection-molded bristles permit very exact application and no brush hairs protruding because of inadvertent kinking appear. A bristle configuration injection-molded in one piece with the bristle support base surface has no cavities that favor occupation by bacteria, etc.

In addition, brushes with injection-molded bristles have the major advantage that the wetted area overall can be produced from a single material, for which it is ensured that this material does not enter into a reaction of any type with the active ingredient of the liquid being applied. In particular, no adhesives are required for fastening of the bristles, which could be very critical from the standpoint of occurrence of undesired reactions.

Moreover, such injection-molded bristles are much easier to produce sterile than brushes with a regular configuration of traditional bristles. This is because the plastic material as such is heated to a point during injection molding that it becomes sterile so that after

injection molding it need only be ensured that soiling is not applied again from the outside (clean room technique).

In addition, injection molding permits additional advantageous properties of the bristles to be set. Antibacterial additives can be added very simply (for example, silver ions), which make the bristles per se bacteria-resistant to a large extent.

Hydrophilic or hydrophobic properties of the bristles can also be generated by additives and/or production with correspondingly treated die surfaces, which are formed in the plastic surfaces molded from them and produce the required effect.

Round brushes are preferred but oval brushes can also be produced according to the invention.

In conclusion, the preferred embodiment of the invention can be summarized again as follows in terms of key words:

A small number of bristles in the core are surrounded by a ring of a number of bristles that can become finer outward, the core or narrowest core area being optionally bristle-free.

The spatial volume that is bounded by the outer configuration area corresponds to the dose to be applied. The liquid to be applied because of its surface tension forms a drop in the center of the applicator, which is held by the surrounding bristles.

On contact of the brush or the drops situated in it with the skin/hair/hair appendage, the drop is fully released from the brush by movement of the bristles and possibly slight spreading of the bristles.

With the outside of the applicator the liquid, if necessary, can then be further distributed and worked into the surface being treated.

It should be mentioned in the interest of order that the above outlines state specifications for the so-called "dosage-relevant part of the bristle configuration", i.e., for the part of the total bristle configuration present, which dictates the magnitude of the drop applied to the surface being treated. Moreover, additional further bristles can also be present in the edge area of the bristle configuration essentially irrelevant for dosage, which do not satisfy the requirements previously established for bristles, for example, because these bristles protrude laterally, transverse to the bristle longitudinal axis of the dosage-relevant and therefore invention-relevant bristles.

In the context of this application protection is additionally and independently also claimed for a brush, which is described by the following features and is also shown by the figures without essential back reference to other claims:

Brush for metered application with injection-molded bristles, which are injection-molded onto a bristle support base surface in one piece or in shape-mated fashion, in which the configuration has confinement bristles 10, which in the center 7 of the configuration directly border an essentially bristle-free spatial volume and are delimited from the remaining bristle configuration. The spatial volume then preferably forms a drop space 11, in which a dose of the liquid being applied can accumulate, which is large enough so that it causes preferably ad hoc release of most of the liquid being applied in the form of a drop when the surface being treated is touched.

Such a brush naturally can also have additional features as reflected in the claims of this application or discussed in the above description.

Such an alternative claimed fourth practical example is shown in Figures 17 to 19.

For the bristle configuration of this practical example everything already stated previously for the other practical examples applies with the difference that a distinction is necessarily made here between an outer configuration area in which the bristle density is higher than in the inner configuration area enclosed by the outer configuration area and an inner configuration area. This practical example, however, corresponds to the previous examples to the extent that an outer configuration area 3 is present in a precise sense, whose bristles are finer than the bristles of the inner configuration area 4.

This is because the inner bristles have a somewhat greater diameter than the radially outward bristles, cf. Figure 19.

It is critical here that a central area is present, which is completely bristle-free. The central area is delimited by six confinement bristles 10 from the remaining bristle field set up preferably along a circular line, cf. Figure 19. In this way a drop space 11 is also produced in the center of this bristle configuration, with which a defined amount of the agent being applied can be stored. The confinement bristles 10 that delimit the drop space 11 are then the longest bristles of the bristle field so that release of the stored agent can be produced by bringing the confinement bristles protruding beyond the remaining bristle configuration in contact with the surface to be applied and then moving them. It is again explicitly pointed out that all parameters mentioned above for the other practical examples that are decisive for the size of the drop space also apply for this practical example.

As can best be seen with reference to Figure 17, a brush according to this practical example can also have the peculiarity that it is injection molded as a multicomponent part. For this purpose, a support, which consists of different cylindrical or conical sections, is injection molded. A cylindrical or conical section is then molded onto it on the distal end facing away from the handle, which serves as bristle support 1, from which the bristles protrude, preferably in a direction parallel to the longitudinal axis.

Figures 20 to 22 show a fifth practical example, which essentially corresponds to the aforementioned fourth practical example with the only difference that the brush in this practical example is preferably injection molded within a single component and is configured somewhat differently in the area of the brush on the other side of the actual bristle support section. The bristle configuration, however, corresponds to the fourth practical example and therefore what was stated there also applies here.

Finally it is stated that protection is also claimed for a bristle that has the features of the first claim and additional other features as described in several independent steps subsequently. The brush claimed as above is therefore characterized by the fact

- that the bristles of the bristle configuration (3, 4), which have the greatest bristle foot diameter, belong to the confinement bristles (10),
- and/or that the bristle support has a convex, preferably a bristle support base surface (2) corresponding essentially to a spherical cap, to which the bristles are fastened and from which the bristles protrude,
- and/or that the outer surface of the individual bristles is designed conical, preferably with an included angle  $\beta$  of  $0.5^\circ$  to  $3^\circ$  relative to the bristle longitudinal axis.

**Reference numbers:**

- |   |                                     |
|---|-------------------------------------|
| 1 | Bristle support                     |
| 2 | Bristle support base surface        |
| 3 | Outer configuration area            |
| 4 | Inner configuration area            |
| 7 | Center of the bristle configuration |

|          |                                                         |
|----------|---------------------------------------------------------|
| 8        | Barrier row                                             |
| 9        | Barrier row                                             |
| 10       | Confinement bristles                                    |
| 11       | Drop space                                              |
| 12       | Center bristles                                         |
| 13       | Outer bristles                                          |
| 14       | Auxiliary bristles                                      |
| L        | Longitudinal axis                                       |
| KD       | Head diameter of the brush                              |
| BL       | Bristle longitudinal axis                               |
| GR       | Boundary line to the outer and inner configuration area |
| LB       | Bristle length                                          |
| BDA      | Bristle density in the outer configuration area         |
| BDI      | Bristle density in the inner configuration area         |
| T        | Deepest point of the bristle support base surface       |
| $\alpha$ | Conical surface angle                                   |
| $\beta$  | Slope of the bristle outer surface                      |

## Claims

1. Brush for metered application of a cosmetic or pharmaceutical liquid with a configuration from a number of at least essentially parallel-arranged bristles, which are grouped around a configuration center (7), characterized by the fact that the bristles are molded onto a bristle support (1), the configuration having an outer configuration area (3) enclosing the configuration center in the peripheral direction, in which the bristle density is higher than in the inner configuration area (4) enclosed by the outer configuration area (3) and/or whose bristles are finer than the bristles of the inner configuration area (4).
2. Brush for metered application according to claim 1, characterized by the fact that the inner configuration area (4) includes a central area that is completely bristle-free.
3. Brush for metered application according to one of the preceding claims, characterized by the fact that the inner configuration area (4) has confinement bristles (10), which delimit an essentially bristle-free spatial volume in the center (7) of the configuration, which forms a drop space (11), in which a dose of the liquid being applied can collect, which is large enough so that it produces abrupt release of most of the liquid being applied in the form of a drop, when the surface being treated is touched.
4. Brush for metered application according to one of the preceding claims, characterized by the fact that the volume of the drop space (11) (as a function of bristle length, density of the enclosing bristles, drop behavior and surface tension of the liquid being applied) is chosen small enough that the drop can be held at least 5 seconds, better 10 seconds and even better at least 150 seconds before it essentially drips out as a whole by itself.

5. Brush for metered application according to one of the preceding claims, characterized by the fact that the drop space (11) has a bristle-free base surface, which corresponds to at least 3.5 times and ideally at least 5.5 times the cross-sectional area occurring in the foot area of one of the confinement bristles (10), in which case the bristle-free base surface is preferably essentially rotationally symmetric.
6. Brush for metered application according to one of the preceding claims, characterized by the fact that the drop space (11) has a bristle-free base surface that corresponds to a maximum of 15 times and better a maximum of 12.5 times the cross-sectional area of one of the confinement bristles and in the individual case only 10 times the cross-sectional area of one of the confinement bristles.
7. Brush for metered application according to one of the preceding claims, characterized by the fact that the distal ends of the bristles of the inner area (4) protrude beyond the distal ends of the bristles of the outer area (3).
8. Brush for metered application according to one of the preceding claims, characterized by the fact that the confinement bristles (10) protrude beyond the distal ends of all other bristles of the bristle configuration (3).
9. Brush for metered application according to one of the preceding claims, characterized by the fact that the distal end of the bristle configuration (3, 4) is configured as conically tapered as a whole, preferably so that the imaginary surface that the distal bristle ends span (envelope surface) is essentially a conical surface with a vertex angle  $\alpha$  for which  $35^\circ \leq \alpha \leq 55^\circ$  applies.
10. Brush for metered application according to one of the preceding claims, characterized by the fact that the confinement bristles (10) are set up in one row

and the row of limitation bristles is enclosed on its side facing away from drop space (11) by at least an additional row of bristles (12), whose bristles are separated from each other by a larger bristle spacing than the maximum spacing  $Ab_{\max}$  of the confinement bristles.

11. Brush for metered application according to one of the preceding claims, characterized by the fact that the bristles in the foot area (directly above the beginning of the rounding with which they grade into the bristle support) has a bristle foot diameter DF for which  $DF \leq 0.06 \text{ mm}$  or ideally  $DF \leq 0.04 \text{ mm}$  applies.
12. Brush for metered application according to one of the preceding claims, characterized by the fact that the confinement bristles have a bristle length LB for which  $2.75 \text{ mm} \leq LB \leq 5.5 \text{ mm}$  applies.
13. Brush for metered application of a cosmetic or pharmaceutical liquid with a configuration from a number of at least essentially parallel-arranged bristles, which are grouped around a configuration center (7), characterized by the fact that the bristles are molded onto a bristle support (1), the configuration having confinement bristles (10), which in the center (7) of the configuration directly delimit a bristle-free spatial volume and are delimited from the remaining bristle configuration.
14. Application system consisting of a brush according to one of the preceding claims and an agent to be applied, preferably in the form of an eyelash growth serum, whose surface tension is less than that of pure water, in which the arrangement of the bristles relative to each other and/or the bristle length, on the one hand, and the parameters that determine the flow and drip behavior of the agent, on the other hand, are adjusted to each so that the bristle configuration can hold a

predetermined amount of the agent preferably mostly or essentially stored in its drop space and can release it again on contact with the skin part being treated.

15. Use of a brush or application system according to one of the preceding claims for application of an easily flowing cosmetic and/or pharmaceutical to human or animal hair, especially the skin of the eyelid.