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(54) **MULTI-FILAMENT BRISTLES FOR TOOTHBRUSHES**

(75) Inventors: **Christine Zoschke**, Frankfurt/Main (DE); **Thorsten Emge**, Rodgau (DE); **Jurgen Dornheim**, Frankfurt/Main (DE); **Christian Stief**, Frankfurt/Main (DE)

Correspondence Address:
FISH & RICHARDSON PC
P.O. BOX 1022
MINNEAPOLIS, MN 55440-1022 (US)

(73) Assignee: **BRAUN GMBH**

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(57) **ABSTRACT**

The invention relates to a bristle, e.g., for toothbrushes, and a corresponding manufacturing method whereby the bristle has at least two coextruded filaments of different materials in the longitudinal direction, and the cross-sectional area of at least one of the filaments decreases toward the free end of the bristle.

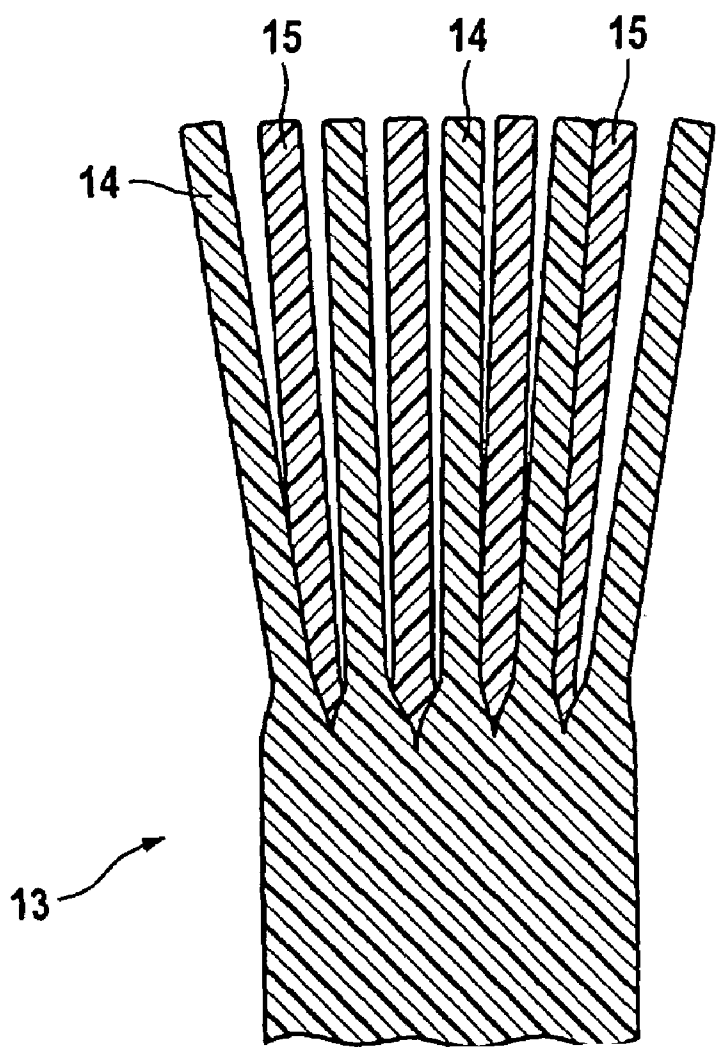


Fig. 1

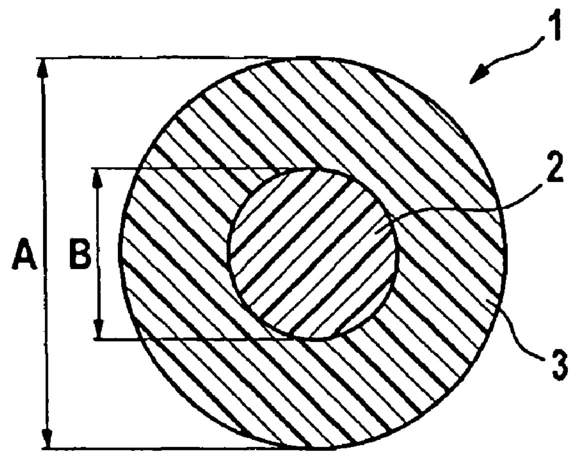


Fig. 2

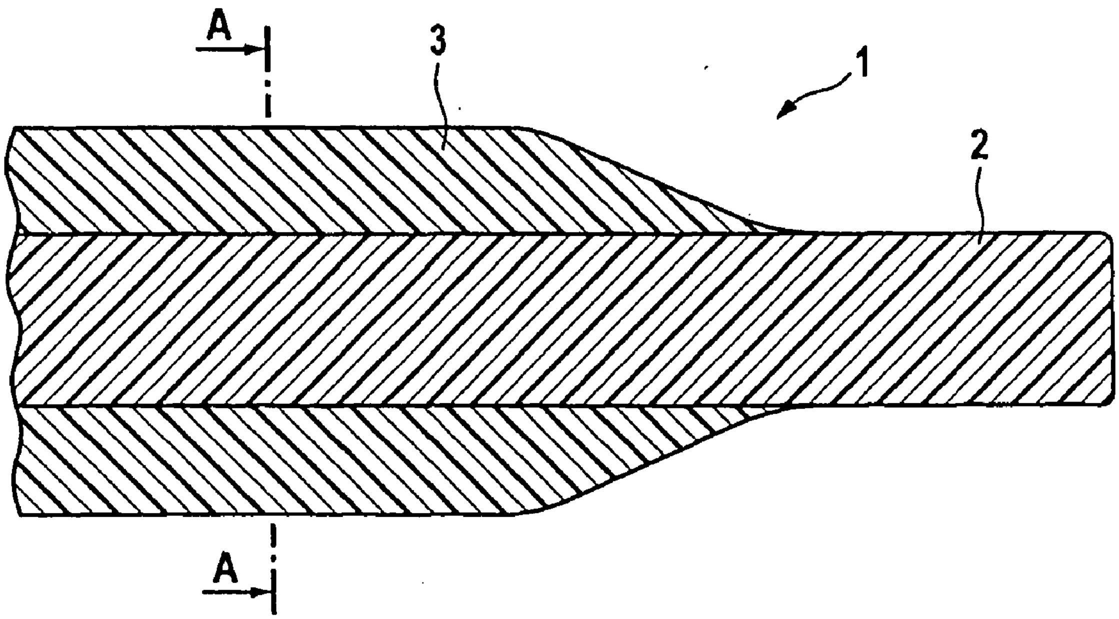


Fig. 3

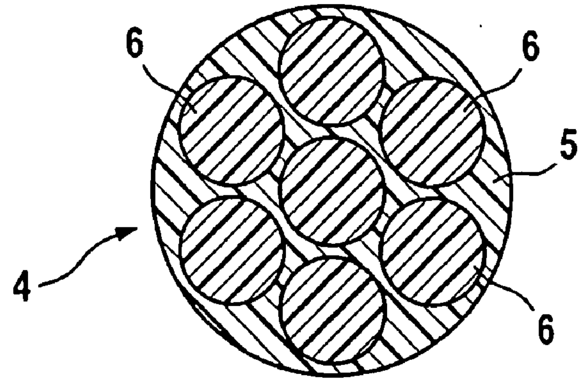


Fig. 4

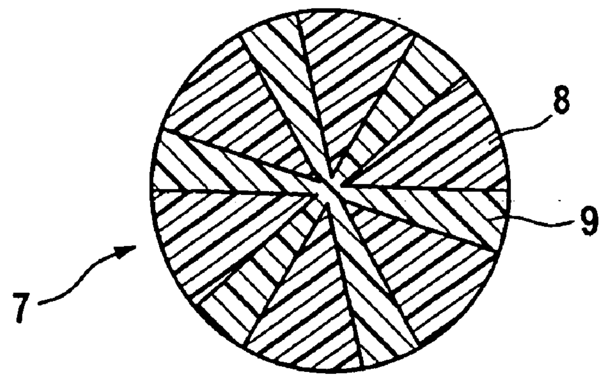


Fig. 5

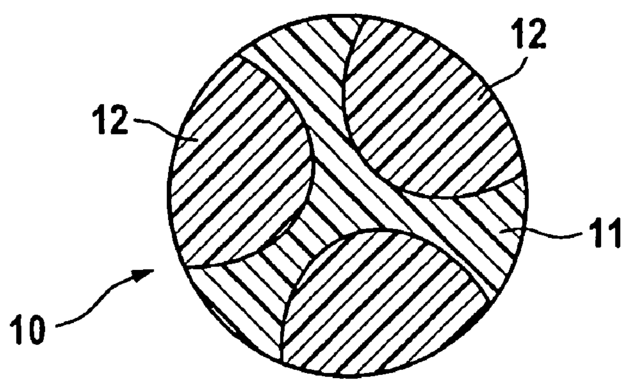
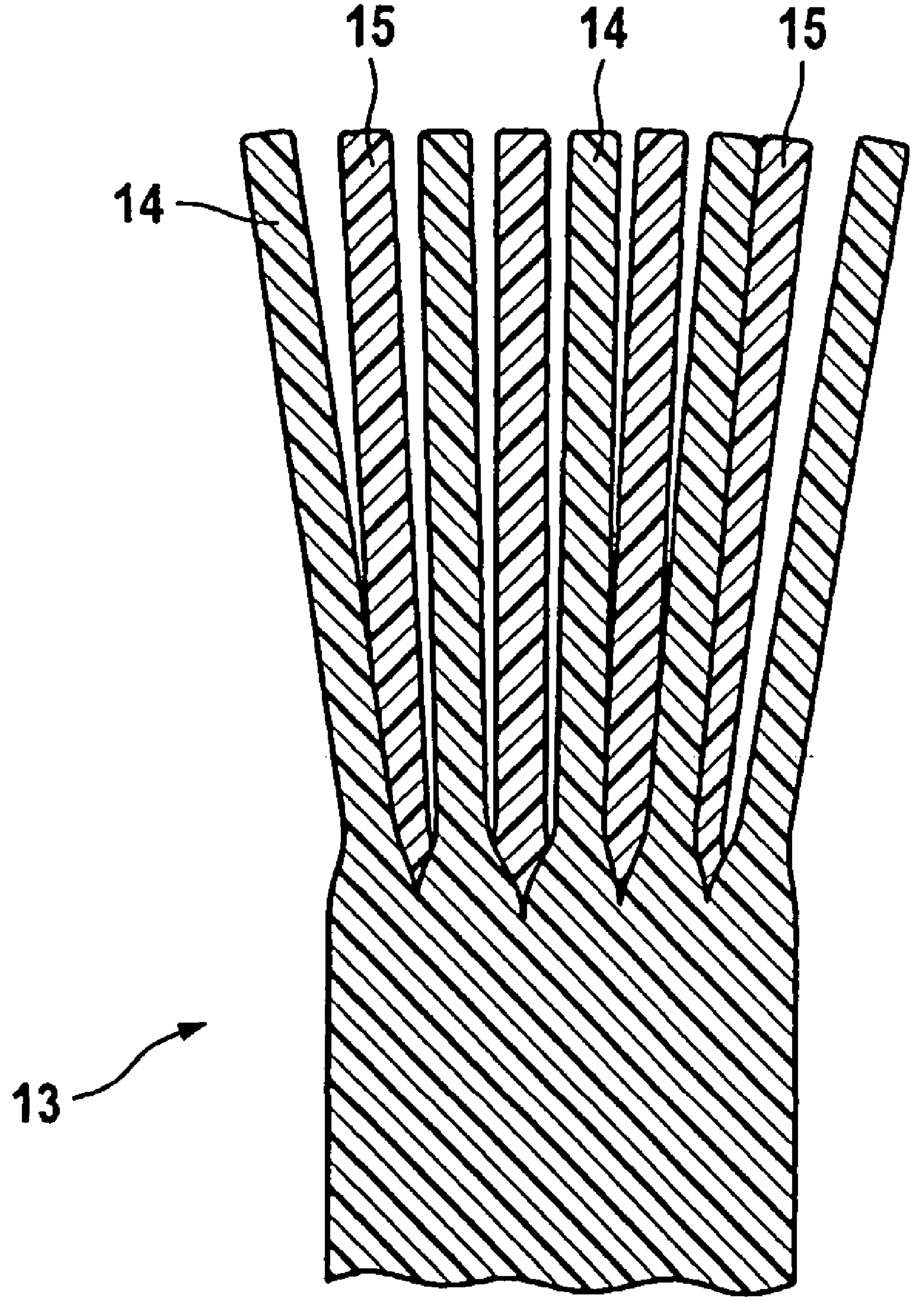


Fig. 6



MULTI-FILAMENT BRISTLES FOR TOOTHBRUSHES

TECHNICAL FIELD

[0001] This disclosure relates to a bristle, e.g., for a toothbrush, having at least two coextruded filaments of different materials.

BACKGROUND

[0002] Bristles for toothbrushes typically consist of polyester monofilaments or nylon monofilaments i.e., plastic fibers that are extruded, drawn and fixed. Nylon bristles are flexible, easily deformable and in particular are water-absorbent. They must therefore be designed to be relatively thick, so that predefined flexibility requirements are met. This requires a rounding of the bristle ends to prevent injury to the gingiva.

[0003] In contrast, polyester bristles, which are made of polybutylene terephthalate (PBT) and/or polyethylene terephthalate (PET), for example, have a low water absorbency and have good stability properties. However, these bristles generally do not meet the requirements of elasticity or flexural rigidity. They are typically too stiff and inflexible and may thus cause injury to the gingiva.

[0004] EP 1 234 525 B1 describes a method for manufacturing toothbrushes with highly conical bristles to increase the flexibility of polyester bristles. Polyester monofilament bristles are immersed here in corrosive chemicals until the immersed part of the monofilaments is completely eroded. This ultimately leads to a conically tapering bristle end.

[0005] The chemically tapered ends of the bristles are attacked and subject to massive damage due to the etching process. Reject production is therefore high due to the etching process, which has a negative effect on production costs. In addition, the conically tapered bristles produced from monofilament therefore have a low stability because of the eroded lateral surface and their flexural rigidity is already too low. Furthermore, shaping of the conically tapered bristles is determined essentially only by the etching process and cannot be designed to conform to predefined requirements.

[0006] In addition, EP 1 030 937 B1 describes that bristles or interdental cleaning devices may be made of a monofilament comprising at least two coextruded polymers. For example, two polymers are coextruded here to form a monofilament, and after successful drawing and optionally stabilizing through the action of mechanical forces across the monofilament axis, the bristles are slotted along the interfacial layers between the polymers for a locally limited length. This allows fissure-like slots to be formed on the sheath of the monofilament, so the slots can be used to receive media, in particular dental care agents or dental medical preparations and/or antibacterial preparations.

[0007] To form fissure-like slots in a coextruded monofilament comprising two polymers, the action of mechanical forces is always provided for splitting the monofilament along the boundary layers between the at least two polymers. The mechanical creation of slots, gaps and flags is complicated and also relatively inaccurate because the formation of such gaps depends significantly on the amplitude and direction of the applied force and on the binding forces between the polymers. Slots produced in this way therefore often have different lengths, irregular shapes and frayed lateral surfaces that are difficult to monitor.

[0008] Also, DE 199 42 147 A1 describes bristles that can be produced by multicomponent extrusion and that are tapered, rounded or designed in several individual filaments in their end area due to erosion of material.

[0009] It is known from DE 199 32 376 A1 that multicomponent bristles can be processed chemically.

SUMMARY

[0010] A bristle has at least two coextruded filaments of different materials extending in the longitudinal direction and the cross-sectional area of at least one of the two filaments decreases toward the free end of the bristle. At least one of the coextruded filaments changes its geometry in the area of the bristle end. Since the two coextruded filaments are made of different materials, e.g., polyester and polyamide, the filaments can be subjected to a material-selective processing operation to form the bristle.

[0011] The choice and arrangement of the different materials for the coextruded filaments of the bristles allows the flexural elastic properties of the bristle as well as their geometric design to be shaped in virtually any manner, in particular in the area of the bristle ends.

[0012] According to a first embodiment, the cross-sectional area of the at least one filament decreases steadily toward the free end of the bristle. A steady decrease in the cross-sectional area is associated with a steadily decreasing lateral surface and a steadily declining diameter of this bristle filament. This prevents sharp corners or edges, which are characteristics of surfaces and/or lateral surfaces having an irregular profile in an advantageous manner. The risk of injury for sensitive areas in the oral cavity, e.g., the gingiva can thus be reduced in an advantageous manner.

[0013] According to another aspect, the cross-sectional area of the free end of the bristle is determined by a second filament. In a preferred embodiment, the cross-sectional area is essentially constant in the longitudinal direction of the bristles. In particular, at least one filament has a cross-sectional area of zero on the free end of the bristle, so that the total cross section of the bristle on the free end of the bristle is determined essentially by the remaining second filament.

[0014] Due to the effective reduction in cross-sectional area of the bristle ends, the entire bristle may conform better to the given requirements in terms of elasticity and/or flexural rigidity.

[0015] According to another embodiment, the second filament is surrounded radially by the at least one filament in at least some regions. The second filament forms a core section of the bristle which is on the interior radially, while the first filament surrounds this internal core filament as a sheathing. Finally, this core sheathing tapers toward the end of the bristle until only the other filament forming the core of the bristle remains at the free end of the bristle and forms a tapered bristle cross section.

[0016] In particular, the second filament, e.g., the core filament, extends in the axial direction farther than the first filament, e.g., the lateral surface filament. The free end of the bristle is thus formed only by the filament whose cross-sectional area does not change significantly.

[0017] It may also be provided that multiple filaments which do not change in cross section are distributed regularly over the cross section of the bristle and are surrounded in at least some areas in the radial direction by the first filament whose cross-sectional area has a change toward the end of the bristle. Due to the taper in the cross-sectional area of the at least one filament toward the free end of the bristle, ultimately a configuration may be formed at the end of the bristle by a plurality of individual filaments separated from one another by interspaces. Such filament configurations are advantageous for holding dental care agents or dental medical preparations and/or antibacterial preparations, for example.

[0018] According to another embodiment, it is provided that the second filament is rounded or chamfered on its free end. The filaments forming the free end of the bristle thus essentially no longer have any edges that could cause injury in the oral cavity.

[0019] According to another embodiment, the first and second filaments have a different elasticity and/or a different flexural rigidity. Depending on the amount of filaments comprising different materials in the total material of the bristle, the elasticity properties and/or the flexural rigidity properties of the bristle can be adjusted to a predetermined extent in a targeted manner.

[0020] In addition, the first filament can be eroded by means of an etchant, in particular a chemical etchant, such as sodium hydroxide solution, sulfuric acid or formic acid, whereby the second filament is essentially resistant to the respective chemical etchant. With the help of a chemical etching process, the free end of the bristle can be processed in a material-selective manner through the choice of different materials for the first filament and the second filament and a suitable choice of a chemical etchant. Furthermore, through any arrangement and geometry of individual filaments, almost any elasticity properties of the bristle ends and corresponding versatile bristle end geometries can be implemented.

[0021] According to another embodiment, polyamide and/or polyester is provided as the material for the filaments. These materials have different elasticity and rigidity properties. Furthermore, only one of these materials is attacked by the chemicals provided for a chemical etching process, such as sodium hydroxide solution, sulfuric acid or formic acid, whereas the respective other material is essentially resistant to these chemicals. The polyamide may be in particular nylon, PA 6.6, PA 6.10 and PA 6.12, while the polyester may be essential PET and/or PBT.

[0022] According to another independent aspect, a method for manufacturing or processing bristles, in particular toothbrush bristles which have at least two coextruded filaments comprising different materials extending in the longitudinal direction and comprising a first filament, and a second filament that is essentially resistant against an etchant. The method erodes at least a partial region of the first filament in an area of a free end of the bristles by a chemical etching process where the etching process at least partially exposes the second filament. The second filament becomes corroded to a negligible extent at most in the chemical etching process.

[0023] According to a preferred embodiment of the method, the second filament that is essentially resistant to the etchant is exposed by means of the etching process in at least some areas, preferably in the area of the free end. The parameters of the etching process such as the depth of immersion of the bristle ends in the chemicals and their dwell time in the chemicals are preferably adapted to the shape and geometry of the filaments, in particular the radial dimensions of the filaments. In this manner, the etching process can be optimized so that the at least one filament is completely eroded in the area of the free end of the bristle so that the at least one other filament can be essentially exposed there.

[0024] This is important in particular when the core of the bristle is formed by a filament that is resistant to the chemicals used and is surrounded radially by the filaments that are corroded in the etching process as sheathing. Therefore, the lateral surfaces of the multifilament bristle surrounding the internal bristle core is eroded by the chemical etching process to the extent that it tapers conically toward the end of the bristle. Consequently, only the lateral surface of the bristle tapers, while a bristle core that is not damaged chemically protrudes beyond the end of the lateral surface of the bristle.

[0025] In addition, the etching process is universally applicable to a number of different configurations of different filaments. For example, the free ends of several filaments, preferably arranged regularly and a distance apart from one another, can be determined by the etching process. Ultimately this even allows inexpensive chemical production of slots which may be used to hold media. Furthermore, production of bristles with a split use end comprising multiple individual filaments is also possible by chemical methods which are therefore inexpensive.

[0026] According to another aspect, the ends of the bristles are chamfered or rounded by grinding after the etching process.

[0027] According to another aspect, the bristles are secured on a bristle carrier provided for the bristles, e.g. a toothbrush head, before the etching process. Thus the bristles are already on their predetermined position on the bristle head even before the etching and grinding process which processes the ends of the bristles, and need not be attached to this bristle carrier after the etching process, which would be associated with a disproportionately greater effort because the bristles which are designed with a taper at their ends would have to be treated with greater care.

[0028] Attaching the bristles to the bristle head before processing the ends of the bristles allows in particular a simplified production of complex cluster geometries of bristles on the bristle carrier.

[0029] According to another independent aspect, the invention therefore relates to bristle materials of any type, but in particular toothbrushes having a bristle carrier with a plurality of tapered multifilament bristles.

[0030] Additional goals, advantages, features and advantageous properties of the present invention are derived from the following description of exemplary embodiments on the basis of the drawings. All the features described and/or illustrated here in any reasonable combination constitute the subject matter of the present invention, even independently of the patent claims or their reference back to previous claims.

BRIEF DESCRIPTION OF DRAWINGS

[0031] FIG. **1** shows a cross section through a two-filament bristle in cross section A-A.

[0032] FIG. **2** shows a longitudinal section of the two-filament bristle shown in FIG. **1**.

[0033] FIG. **3** shows a cross section of a multifilament bristle.

[0034] FIG. **4** shows a bristle having filaments arranged in segments.

[0035] FIG. **5** shows a bristle having filaments on the outside.

[0036] FIG. **6** shows a bristle end having several exposed filaments.

DETAILED DESCRIPTION

[0037] FIGS. **1** and **2** illustrate a cross section of a bristle **1**, e.g. for a toothbrush, having two filaments **2**, **3** of different materials which are extruded, drawn and secured together. A first filament **2** forms an internal core of the bristle **1** while a second filament **3** surrounds the internal filament **2** as sheathing. In one aspect, for example, the first filament, is made of polyamide, e.g., nylon, while the second filament **3** is made of polyester.

[0038] By immersing the free end of the bristle **1** into a chemical that is corrosive for the lateral surface **3** of the bristle, e.g., sodium hydroxide solution or sulfuric acid, the originally cylindrical lateral surface **3** is eroded in a material-selected manner, while the bristle core **2** which is resistant to chemicals retains an unchanged geometry in comparison with its basic state (not shown). The polyester filament **3** forming the bristle material is etched away by immersion into the chemicals, so that the lateral surface **3** of the bristle, before reaching the free end of the bristle, tapers conically with a cross-sectional area that decreases steadily toward the end of the bristle.

[0039] One advantage of this material-selective etching process is that the internal core **2** of the bristle is not damaged by the etching process. Thus, the bristle still has the required flexural rigidity and can easily be pointed or rounded mechanically with further processing. In addition, the material-selective etching of the bristle end ensures that the thickness cannot drop below the predefined minimum of the bristle end and reliably counteracts the risk of a bristle breaking out or breaking off in an uncontrolled manner.

[0040] In addition, such a material-selective etching process reduces the amount of material to be eroded so that, on the whole, a higher yield of the etching process can be achieved with corresponding cost advantages.

[0041] FIG. **3** shows another embodiment of a multifilament bristle **4**. Several filaments **6** comprising the same material are distributed over the cross section of the bristle **4** and at a distance from one another. The interspaces between the filaments **6** are filled with a filament **5**, which is eroded by the chemicals used in the etching process. By immersing such a bristle end into the etching chemical, the filament **5** can be removed completely at the free bristle end, so that the individual filaments **6** remain standing with a smaller diameter. The individual filaments **6** are suitable for accommodating material in the filament interspaces and for penetrating into extremely small dental interspaces.

[0042] FIG. **4** illustrates a cross section of another embodiment of the bristle **7**, having segments of different filaments **8**, **9** in radial symmetry. In contrast with the embodiment shown in FIG. **3**, in this embodiment, all the filaments **8**, **9** run from the midpoint of the bristle to the edge of the bristle. Again, individual filaments **8** or **9** can be removed in a targeted manner at the free end of the bristle through a suitable etching process.

[0043] FIG. **5** shows another example of a bristle end where individual filaments **12** made of one material are arranged with a distance between them but adjacent to the bristle circumference, and a second filament **11** fills up the core area of the bristle. In this embodiment, the second filament **11** is partially removed by the etching process, so that in at least some of the areas, the individual bristle filaments **12** are exposed—forming a spread end of the bristle **10**.

[0044] FIG. **6** shows a schematic side view of another bristle end **13**, which has different filaments **14**, **15**, which are preferably dissolved away by means of a chemical etching process, forming a bristle end that fans out. For example, in an aspect, the filaments **14**, **15**, which are made of different materials, are initially held together by another filament (not shown explicitly here) which is ultimately removed in the etching process. A fan-like structure, illustrated in FIG. **6**, is formed at the end of the bristle.

1. A bristle for use in toothbrushes, the bristle comprising:
at least two coextruded filaments comprising different materials, the filaments extending in a longitudinal direction and comprising:
a first filament having a cross-sectional area that decreases towards the free end of the bristle wherein the first filament is erodable by an etchant, and
a second filament that is essentially resistant against the etchant.

2. The bristle according to claim **1**,
wherein the cross-sectional area of the first filament decreases steadily.

3. The bristle according to claim **1**,
wherein the cross-sectional area of the second filament is essentially constant in the longitudinal direction of the bristle.

4. The bristle according to claim **1**,
wherein the bristle forms a taper towards a free end,

5. The bristle according to claim **1**,
wherein the second filament is at least partially surrounded radially by the first filament.

6. The bristle according to claim **1**,
wherein the second filament extends further in the axial direction than the first filament.

7. The bristle according to claim **1**,
wherein the second filament is rounded or chamfered at a free end.

8. The bristle according to claim **1**,
wherein the first and second filaments have different.

9. The bristle according to any one or more of the preceding claim **1**,
wherein at least one of the filaments comprises a polyamide material.

10. A method for processing bristles for use, in a toothbrush, the method comprising:
providing at least two coextruded filaments comprising different materials, the filaments extending in the longitudinal direction and comprising:
a first filament, and
a second filament that is essentially resistant against an etchant,
eroding at least a partial region of the first filament in an area of a free end of the bristles by a chemical etching process, the etching process at least partially exposing the second filament.

11. The method according to claim **10**, wherein the etching process erodes at least some areas of a sheath of first filaments that are arranged to surround an inner core of the bristle.

12. The method according to claim **10**, comprising a plurality of first filaments, wherein the etching process exposes the free ends of a plurality of the first filaments.

13. The method according to claim **10**, further comprising, after completing the etching process, grinding the bristle ends such that the ends are chamfered or rounded.

14. The method according to claim **10**, further comprising securing the bristles on a bristle carrier before beginning the etching process.

15. A toothbrush comprising:

a bristle carrier,

a plurality of bristles secured on the bristle carrier, each bristle comprising:

at least two coextruded filaments comprising different materials, the filaments extending in a longitudinal direction and comprising:

a first filament having a cross-sectional area decreasing towards the free end of the bristle such that the filament is erodable by an etchant and

a second filament that is essentially resistant against the etchant.

16-17. (canceled)

18. The bristle according to claim **4** wherein the taper forms a conical shape.

19. The bristle according to claim **4** wherein the taper forms a pointed edge.

20. The bristle according to claim **1**, wherein the first and second filaments have a different flexural rigidity.

21. The bristle according to claim **9**, wherein the polyamide comprises at least one of nylon, PA6.6, PA6.10, or PA6.12.

22. The bristle according to claim **1**, wherein at least one of the filaments comprises a polyester material.

23. The bristle according to claim **22**, wherein the polyester comprises at least one of polyethylene terephthalate (PET) or poly-butylene terephthalate (PBT).

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