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(54) BRISTLE WITH AN ANTIMICROBIAL FINISH, BRUSHWARE WITH SUCH BRISTLES AND PACK FOR SUCH BRISTLES OR BRUSHWARE

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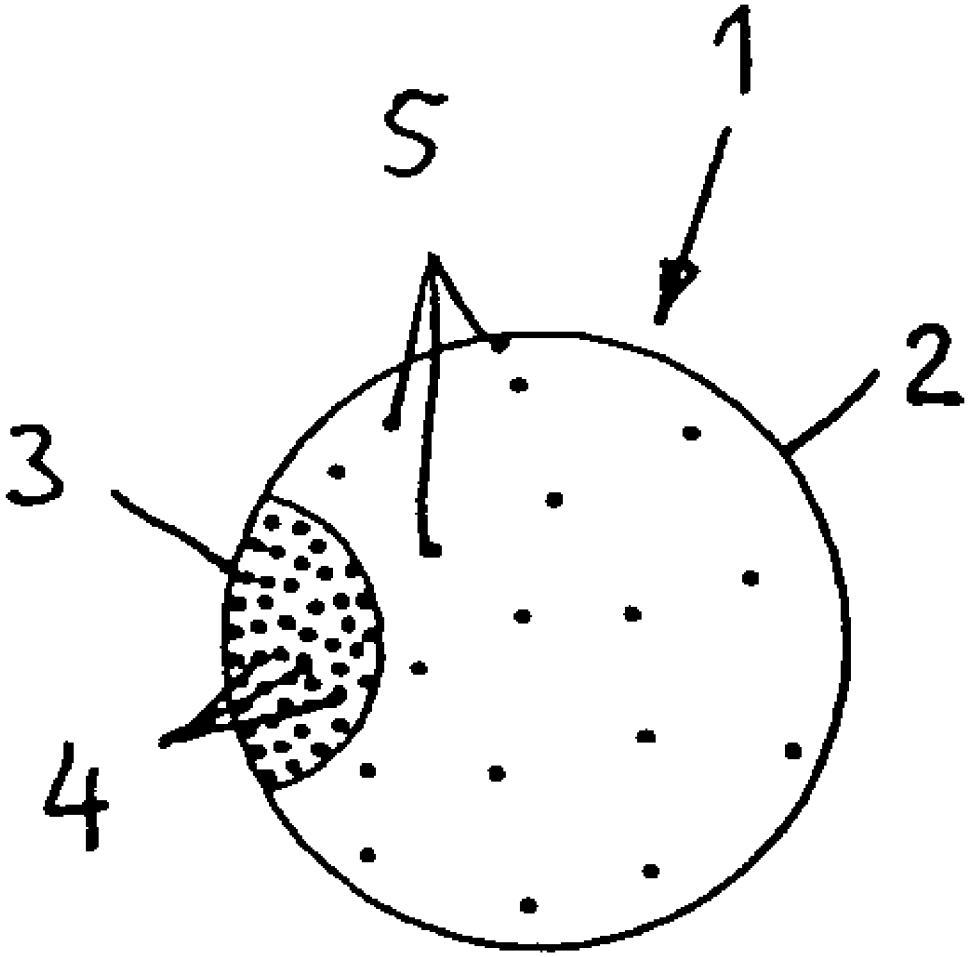
(57) **ABSTRACT**

A bristle with an antimicrobial finish is proposed, which is preponderantly made from thermoplastic material and which is doped with an antimicrobial substance, which, during use, diffuses to the bristle surface. The bristle is manufactured in a multicomponent extrusion process and has at least one first cross-sectional area of a plastic component determining the mechanical use characteristics of the bristle and at least one further cross-sectional area of the other plastic component. The other cross-sectional area or the sum of all the other cross-sectional areas controls the diffusion rate of the antimicrobial substance.



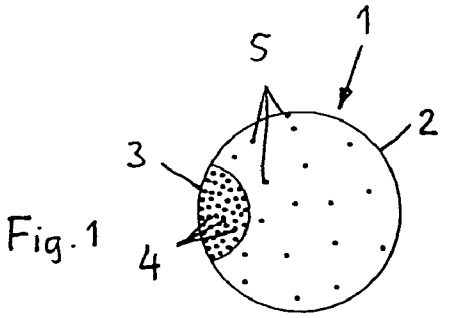


Fig. 1

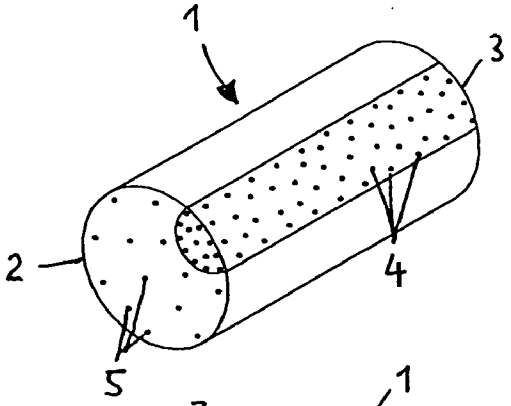


Fig. 2

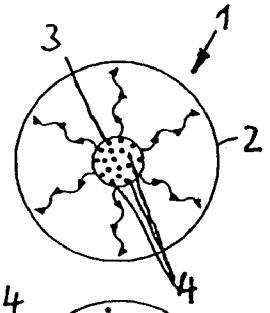


Fig. 3

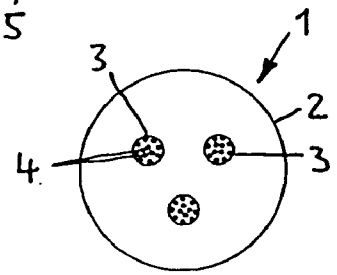


Fig. 4

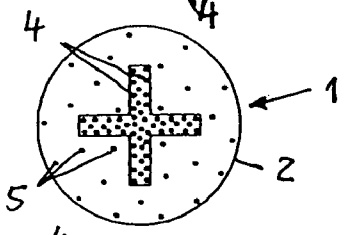


Fig. 5

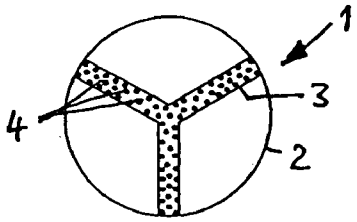


Fig. 6

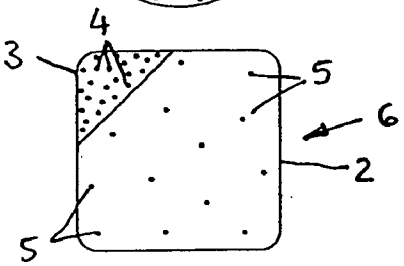


Fig. 7

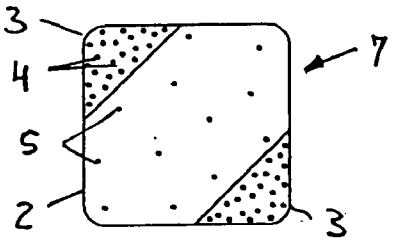


Fig. 8

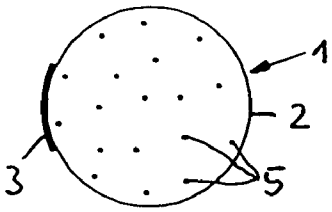


Fig. 9

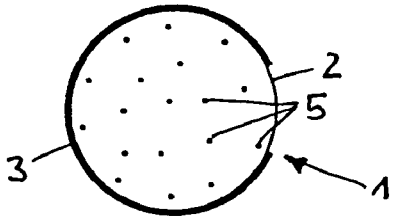


Fig. 10

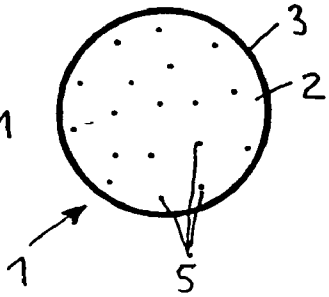


Fig. 11

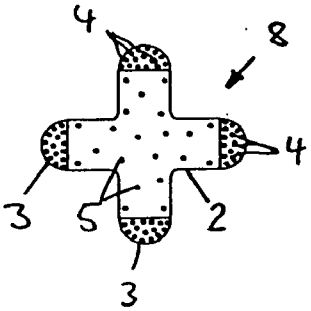


Fig. 12

BRISTLE WITH AN ANTIMICROBIAL FINISH, BRUSHWARE WITH SUCH BRISTLES AND PACK FOR SUCH BRISTLES OR BRUSHWARE

[0001] This application is a continuation of Ser. No. 10/204,968 filed Aug. 27, 2002 as the national stage of PCT/EP01/01289 filed on Feb. 7, 2001 and also claims Paris Convention priority of DE 100 10 572.6 filed Mar. 3, 2000.

BACKGROUND OF THE INVENTION

[0002] The invention relates to a bristle with an antimicrobial finish, which is mainly of thermoplastic material and which is doped with an antimicrobial substance, which during use diffuses to the bristle surface. The invention is also directed at brushware having such bristles and to a pack for such bristles or brushware.

[0003] Bristles having an antimicrobial finish have long been known, but have scarcely been used in practice. Thus, at a very early date the known antimicrobial action of silver in colloidal form and its possibility of use in toothbrushes was recognized (GB 446 303), in that oligodynamic, colloidal silver was embedded in bristle monofilaments or applied to the bristle carrier. It is also known to embed in the bristle material or apply to the bristle monovalent or polyvalent ion forming agents, including silver and silver compounds (EP 678 548), silver being proposed in particle form <10 μm with a content of 100 ppm to 10 mass %. It is finally known (DE 195 08 539) to fill a bristle with particles of different size, the larger particles being of silver with the oxidation number 0 and having a size of 1 to 50 μm.

[0004] It is also known (EP 413 833) to coat bristle monofilaments with a solution or emulsion of a polymer with free acid radicals and a mixed in, cationic antibactericide, e.g. chlorohexidine and to then dry the coating. Production is very complicated and the adhesion of the coating to the bristle core is inadequate. The antibactericide also diffuses out too rapidly.

[0005] It is also known in textile fiber technology to bind silver to carrier materials, e.g. zeolite (U.S. Pat. No. 4,525,410, EP 275 047) and to disperse the thus doped zeolite in particle form in the polymer melt for the monofilament and extrude it with the latter. The fiber comprises a polymer core with a higher melting point and an outer layer of a polymer with a low melting point, which contains the silver-doped zeolite particles. It is also known (EP 116 865) to coextrude a fiber having a Nylon core and outer segments or layers, which contain silver-doped zeolite particles.

[0006] In all known systems the antimicrobial action is based on the fact that in a moist environment antimicrobially active cations diffuse out of the bristle or fiber and penetrate the thin cell wall of microorganisms, particularly bacteria and block their protein metabolism.

[0007] When used as bristles or in brushware monofilaments of the aforementioned type suffer from the disadvantage that if pure silver is used as the antimicrobial substance this necessarily leads to a correspondingly high filling of the bristle with the particulate silver. This leads to a reduction in the stability of the bristles and consequently to a deterioration of the use characteristics (flexibility, recovery capacity, etc.). Thus, such monofilaments have not been adopted in practice.

[0008] Other microbial substances, particularly in the form of metal salts or silver doped zeolite, due to the high ballast material percentage, also lead to a weakening of the bristle. This weakening can only be partly compensated by a diameter increase, which is highly undesired in the case of much brushware, particularly toothbrushes. This is often accompanied by an undesired, high bristle roughness. All the known proposals suffer from the further disadvantage that, even prior to use, particularly in a moist atmosphere, the antimicrobial substance is given off, so that the substance is used up prematurely.

SUMMARY OF THE INVENTION

[0009] On the basis of the prior art of EP 413 833, the problem of the present invention is to propose a bristle for brushware, e.g. for toothbrushes, body care, cosmetic and hygienic brushes or the like, which has an adequate antimicrobial action and at the same time unchanged, highly satisfactory use characteristics. The invention must also ensure that the antimicrobial action is not prematurely used up.

[0010] According to the invention this problem is solved in that the bristle is produced in a multicomponent extrusion process and has at least one first cross-sectional area determining the mechanical use characteristics of the bristle of a plastic component and at least one further cross-sectional area of the other plastic component, and that the further cross-sectional area or the sum of all further cross-sectional areas controls the diffusion rate of the antimicrobial substance.

[0011] As a result of the construction according to the invention the first cross-sectional area guarantees the use characteristics of the bristle, whereas the further cross-sectional area or areas are of minor significance for the use characteristics of the bristle. The doping with the antimicrobial substance takes place exclusively or preponderantly in one of the cross-sectional areas, whereas the other cross-sectional area or areas act in diffusion-controlling manner for the antimicrobial substance. The control of the diffusion rate of the microbial substance can take place by different doping of the cross sectional areas with the substance or in that a non-doped cross-sectional area acts as a diffusion brake or as a reflector for the ionized atoms or molecules. This makes it possible to simultaneously control the action period of the antimicrobial substance.

[0012] The use characteristics of the bristle on the one hand and the diffusion rate on the other can also be influenced in that the cross-sectional areas are made from different or differently finished plastics or have different cross-sectional surfaces and/or different cross-sectional contours.

[0013] Preferably the further and appropriately smaller cross-sectional area of the bristle is doped with the substance in high concentration, so that an adequate charge carrier quantity diffuses into the moist atmosphere. In this embodiment this can be further assisted in that the larger cross-sectional area acts as a diffusion brake, so that the substance mainly diffuses out at the surface of the highly doped cross-sectional area and only with a significant time lag at the surface of the large cross-sectional area.

[0014] The large cross-sectional area of the monofilament can also be doped with the substance in a concentration not

impairing its mechanical use characteristics, the further, smaller cross-sectional area acting exclusively as a microbially inert diffusion brake and for regulating the active substance delivery from the larger cross-section. However, the smaller cross-section can also be highly doped with the antimicrobial substance and then there is also diffusion into the larger cross-sectional area, so that the ions diffusing out there on the surface are constantly replaced from the other cross-sectional area. However, at the same time the large cross-sectional area forms a diffusion brake, because the ions preferably pass out at the free surface of the smaller cross-sectional area, where the lower diffusion resistance exits.

[**0015**] According to a preferred development, the further cross-sectional area is located on the circumference of the large cross-sectional area and either forms part of the bristle surface or completely embraces the bristle. This on the one hand ensures a comparatively rapid delivery of the ions at the free surface of the smaller cross-sectional area and on the other hand the cross-sectional area decisive for the stability and bending behavior of the bristle is only slightly weakened, so that even very thin bristles can be adequately doped with antimicrobial substance. In the case of thin bristles, particularly with diameters smaller than 0,75 mm, the bristle can be completely surrounded by a thin layer acting as a diffusion brake.

[**0016**] The further, smaller cross-sectional area can form a sector in the larger cross-sectional area or also a layer on the surface thereof. In the first case said further cross-sectional area can be highly doped, whereas when constructed in the form of a layer it acts exclusively as a diffusion brake through a corresponding material choice. This layer can be extruded with the monofilament or can be subsequently applied.

[**0017**] In another embodiment the further, smaller cross-sectional area can be located in the interior of the large cross-sectional area, e.g. in the form of coextruded, thin monofilaments with a random cross-sectional shape (circular, polygonal, cruciform, etc.). The further cross-sectional area can also subdivide the large cross-sectional area into sectors, e.g. can be in the form of a star-shaped layer of limited thickness. In this embodiment the diffusion of the antimicrobial substance also takes place into the larger cross-sectional area. To the extent that the surface of the smaller cross-sectional area is exposed, an increased diffusing out takes place.

[**0018**] Preferably at least one further cross-sectional area has silver of oxidation level **0** as the antimicrobial substance. Instead of this or in addition thereto the large cross-sectional area can contain silver of oxidation level **0** and then preferably the further, smaller cross-sectional area has the same substance in a higher concentration.

[**0019**] An advantageous embodiment is characterized in that the large cross-sectional area has silver of oxidation level **0** with a content of $0<c<50{,}000$ ppm and the further cross-sectional area a content of $c<100\%$.

[**0020**] In a preferred development the further, smaller cross-sectional area has silver of oxidation level **0** with a content of $500<c<100{,}000$ ppm. Practical tests with such a bristle have shown that the combination of a high concentration in the further, smaller cross-sectional area and a lower concentration in the large cross-sectional area ensures a diffusion of the antimicrobial substance at an adequate speed and over an adequate period of time roughly corresponding to the use period of a toothbrush.

[**0021**] Another embodiment of the invention is characterized in that at least one cross-sectional area has silver of oxidation level **1** and it can be in the form of silver halides, sulphates, carbonates or organic silver salts, in which cation formation takes place as a function of the solubility product to a greater extent.

[**0022**] The aforementioned antimicrobial substances can also be combined with one another in such a way that one cross-sectional area has silver of oxidation level **0** and at least one further cross-sectional area silver of oxidation level **1**.

[**0023**] If silver of oxidation level **0** is used, it can be contained in the further, smaller cross-sectional area in the form of at least one thread, which, during the extrusion of the monofilament, also follows. Preferably the silver of oxidation level **0** or **1** is present in disperse form in the plastic matrix and is extruded together with the plastic melt. For this purpose it is possible to use a granulate, which already contains the particles. Instead of this silver-containing polymer particles can be extruded together with the polymer. Since as a result of the silver content the polymer particles have a better dimensional stability, they largely maintain their particle form. Bristles of this type without an antimicrobial finish and their production are e.g. described in WO 17/09906, the entire disclosure of which is hereby incorporated by reference.

[**0024**] Instead of this it is possible for the silver of oxidation level **0** to be applied to one of the cross-sectional areas in layer form.

[**0025**] All the cross-sectional areas of the bristle can comprise the same thermoplastic material. However, it is also possible to form the further, smaller cross-sectional area from a thermoplastic elastomer, which has a lower diffusion resistance to the antimicrobial substance.

[**0026**] In order to provide a use indication, the cross-sectional areas can also be differently surface or through-dyed, wherein increasing wear on the free bristle end or bristle jacket is indicated by a corresponding color change.

[**0027**] The preferred thermoplastic materials are those having a water absorptivity of at least 0.1 mass % and more particularly polyamides, polyesters and polyurethanes.

[**0028**] The diffusion rate can also be controlled in that the cross-sectional areas of the bristle or the polymers forming them have different water absorptivity, so that the cations are more rapidly formed in the cross-sectional area with the higher water absorptivity and more rapidly diffuse out than in the other cross-sectional area.

[**0029**] The cross-sectional areas of the bristle can also be formed by two or more combined monofilaments, whereof each forms one of the cross-sectional areas.

[**0030**] The invention also relates to brushware having a plastic bristle carrier and bristles constructed according to the invention. Such brushware is characterized in that also the bristle carrier is at least zonally antimicrobially finished. Thus, in the case of toothbrushes, the invention takes

account of the scientifically proven finding that as a result of the permanently moist atmosphere, as well as the cavities which have evolved in the bristle configuration area, a relatively high bacterial attack occurs on the bristle carrier.

[0031] If, as is usually the case, the bristle carrier is made from plastic, it preferably has particulate silver of oxidation level **0** or **1**.

[0032] If, as is also known, the bristle carrier is made from two different or different types of plastic, which are produced by multicomponent injection molding, at least one of the components is filled with particulate silver of oxidation level **0** or **1**.

[0033] In a preferred development the bristle carrier is solely or preponderantly filled in the vicinity of the fastening of the bristles with particulate silver of oxidation level **0** or **1**, i.e. in the area which is particularly endangered by bacterial attack and the establishment of bacteria.

[0034] Finally, in the case of such brushware, the bristles are preferably individually fastened to or in the bristle carrier, which compared with a bundle-like arrangement of the bristles aids free diffusion, because on the one hand moisture has uniformly rapid access to all the bristles and on the other the bristle configuration dries more rapidly after use, which prevents bacterial attack and blocks diffusion.

[0035] Moreover, either individually or in bundle form, the bristles are joined to the bristle carrier in gap-free manner by thermal processes in order to prevent the establishment of bacteria and in order to prevent excessively rapid consumption of the antimicrobial substance. Such processes more particularly include injecting in, welding or thermal bonding.

[0036] Bristles and brushware, particularly when used for hygienic purposes, such as toothbrushes, cosmetic brushes, etc., reach the processor or final consumer in packs. Frequently they are in the form of plastic packs or blister packs with a cardboard support and a transparent plastic blister. As packing cannot take place under sterile clean room conditions, it is also not possible to exclude that during packing germs can enter the pack. Despite the air-tight seal germ growth can occur if moisture is present in the pack, particularly if as a result of temperature changes the moisture condenses on the inside of the pack and which reacts more rapidly to temperature changes than the actual packed article.

[0037] To prevent contamination of the packed bristles or brushware with germs, according to the invention the pack is characterized in that it is finished with an antimicrobial substance. Said substance is preferably silver or silver salts and can be incorporated in disperse form into the material of the pack or can be applied in layer form to the inside of the pack.

[0038] The invention is described in greater detail hereinafter relative to embodiments represented in the drawings.

BRIEF DESCRIPTION OF THE DRAWING

[0039] **FIG. 1** shows a cross section through a bristle in a first embodiment of the invention;

[0040] **FIG. 2** shows a perspective view of the bristle of **FIG. 1**;

[0041] **FIG. 3** shows a cross section through a bristle in a second embodiment of the invention;

[0042] **FIG. 4** shows a cross section through a bristle in a third embodiment of the invention;

[0043] **FIG. 5** shows a cross section through a bristle in a fourth embodiment of the invention;

[0044] **FIG. 6** shows a cross section through a bristle in a fifth embodiment of the invention;

[0045] **FIG. 7** shows a cross section through a bristle in a sixth embodiment of the invention;

[0046] **FIG. 8** shows a cross section through a bristle in a seventh embodiment of the invention;

[0047] **FIG. 9** shows a cross section through a bristle in an eighth embodiment of the invention;

[0048] **FIG. 10** shows a cross section through a bristle in a ninth embodiment of the invention;

[0049] **FIG. 11** shows a cross section through a bristle in a tenth embodiment of the invention; and

[0050] **FIG. 12** shows a cross section through a bristle in an eleventh embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0051] **FIG. 1** is a cross section through a bristle **1**, whose first, larger cross-sectional area **2** comprises a thermoplastic material, e.g. polyamide, polyester or polyurethane and which has a further cross-sectional area **3** with a much smaller cross-section and which forms a partly cylindrical sector of the overall cross-section. The cross-sectional area **2** has the use characteristics necessary for a bristle with respect to the bending behavior and recovery capacity and at least to a limited extent this is aided by cross-sectional area **3**. Cross-sectional area **3** can be made from a different plastic, particularly a different thermoplastic or an elastomer.

[0052] As can be gathered from **FIG. 2**, the smaller cross-sectional area **3** passes over the entire length of the bristle **1** and production preferably takes place by the extrusion of both material components for cross-sectional areas **2** and **3**. The smaller cross-sectional area **3** is filled with an antimicrobial substance in particle form, preferably silver of oxidation level **0** or **1**. A high doping of the antimicrobial substance takes place. The larger cross-sectional area **2** can also be filled with an antimicrobial substance **5** in particle form. The thermoplastic material of the larger cross-sectional area **2** forms in this embodiment a diffusion brake for the highly doped, antimicrobial substance in the smaller cross-sectional area **3** and which diffuses out more rapidly on its free surface, whereas the substance from the larger cross-sectional area diffuses out at a lower speed and more slowly due to the longer diffusion paths.

[0053] The bristle **1** according to **FIG. 3** once again has a large cross-sectional area **2**, which determines the use characteristics thereof. In said cross-sectional area **2** the small cross-sectional area **3** is present as a core and is produced, optionally together with the larger cross-sectional area **2**, by coextrusion. It can once again comprise a different plastic and is in this case highly doped with the antimicrobial

substance **4**. In this case the larger cross-sectional area **2** acts as a diffusion brake or conversely the smaller cross-sectional area **3** forms a slow and continuously flowing source of antimicrobial substance.

[**0054**] In the embodiment according to **FIG. 4** the larger cross-sectional area **2** determining the bristle use characteristics contains three smaller cross-sectional areas **3** in the form of strands and which are once again highly doped with the antimicrobial substance. Once again the larger cross-sectional area **2** acts as a diffusion brake.

[**0055**] In the embodiment according to **FIG. 5** the further, smaller cross-sectional area **3** is incorporated in the form of a cruciform cross-section in the larger cross-sectional area **2**. In this embodiment the cruciform cross-sectional area **3** is highly doped and the larger cross-sectional area **2** less highly doped with the antimicrobial substance.

[**0056**] **FIG. 6** shows an embodiment in which the larger cross-sectional area **2** is subdivided in star-like manner into sectors by the smaller cross-sectional area **3** and only the smaller cross-sectional area **3** is highly doped with the antimicrobial substance.

[**0057**] **FIG. 7** shows a bristle **6** with a polygonal, namely square cross-section leading to a higher mechanical cleaning action than with a circular bristle. The bristle **6** once again has a larger cross-sectional area **2** of a thermoplastic material and a smaller cross-sectional area **3** in the form of a segment, which is more highly doped with the antimicrobial substance than the large cross-sectional area **2**. The bristle **7** according to **FIG. 8** differs from that of **FIG. 7** only in that it has two segmental, smaller cross-sectional areas **3** at diagonally positioned corners. In both cases the antimicrobially acting cations are mainly delivered at the free surface of the smaller cross-sectional area **3**. However, part thereof is diffused into the larger cross-sectional area **2** and to this extent a diffusion brake is formed, because the cations must firstly migrate through this cross-sectional area in order to arrive at the free surface thereof.

[**0058**] In the embodiment according to **FIG. 9** the smaller cross-sectional area **3** forms a layer on the larger cross-sectional area **2** only extending over a small part of the circumference. The cross-sectional area **3** is preferably diffusion-tight with respect to the antimicrobial substance **4** in the large cross-sectional area **2**, so that the inherently slow diffusion on the larger, free surface of cross-sectional area **2** is intensified. According to **FIG. 10** this can optionally take place in locally oriented form, in that the outer layer **3** forming the diffusion brake covers a larger part of the circumference of the large cross-sectional area **2** or, as in the embodiment of **FIG. 11**, the entire circumference. In both cases the antimicrobial substance is exclusively housed in the large cross-sectional area **2**.

[**0059**] **FIG. 12** shows a star-shaped bristle **8**, whose bearing cross-sectional area **2** has a four-arm construction. At the ends of each arm are located the smaller cross-sectional areas **3**, which are highly doped with the antimicrobial substance **4**, whereas the cross-sectional area **2** is less highly doped.

1. A bristle comprising:

a first cross sectional region made from a first plastic component, said first cross sectional region defining mechanical use characteristics of the bristle, said first cross sectional region forming a portion of an outer surface of the bristle; and

at least one second cross sectional region made from a second plastic component, said at least one second cross sectional region containing an antimicrobial substance doped into said second plastic component, said at least one second cross sectional region forming a remaining portion of said outer surface of the bristle.

2. The bristle of claim 1, wherein said second cross sectional region is disposed substantially within said first cross sectional region.

3. The bristle of claim 1, wherein said second cross sectional region is Y-shaped, X-shaped, cross-shaped, or star-shaped.

4. The bristle of claim 1, wherein said first cross sectional region defines a jacket which substantially surrounds said second cross sectional region.

5. The bristle of claim 1, wherein said first cross sectional region retards diffusion of said antimicrobial substance toward said outer surface of the bristle during use.

6. The bristle of claim 1, wherein said at least one second cross sectional region is located on a cirumference of said first cross sectional region.

7. The bristle of claim 1, wherein said first cross sectional region is doped with said antimicrobial substance and said at least one second cross sectional region retards diffusion of said antimicrobial substance from said first cross sectional region.

8. The bristle of claim 1, wherein said at least one second cross sectional region is doped with said antimicrobial substance to control said diffusion of said antimicrobial substance and said first cross sectional region retards said diffusion of said antimicrobial substance from said at least one second cross sectional region.

9. The bristle of claim 1, wherein said first and said second cross-sectional regions are made from different materials or differently finished materials.

10. The bristle of claim 1, wherein said first and said second cross-sectional regions have different cross sectional areas.

11. The bristle of claim 1, wherein only said at least one second cross-sectional region is doped with said antimicrobial substance in high concentration.

12. The bristle of claim 1, wherein said first cross-sectional region is doped with the antimicrobial substance in a concentration not impairing mechanical use characteristics thereof.

13. The bristle of claim 1, wherein said second cross-sectional region forms a sector of said first cross-sectional region.

14. The bristle of claim 1, wherein said second cross-sectional region forms a layer on a surface of said first cross-sectional region.

15. The bristle of claim 1, wherein said second cross-sectional region subdivides said first cross-sectional region into sectors.

16. The bristle of claim 1, wherein at least one of said first and said cross-sectional region has silver of oxidation level **0** as the antimicrobial substance.

17. The bristle of claim 1, wherein said first cross-sectional region has an antimicrobial substance comprising

silver of oxidation level **0** and said at least one second cross-sectional region has a same antimicrobial substance of higher concentration.

18. The bristle of claim 17, wherein said first cross-sectional region has silver of oxidation level **0** with a content of 500<c<100,000 ppm and said further cross-sectional region has a content of c<100%.

19. The bristle of claim 17, wherein said at least one second cross-sectional region has silver of oxidation level **0** with a content of 500<c<100,000 ppm.

20. The bristle of claim 1, wherein at least one of said first and said second cross-sectional regions has antimicrobial substance comprising silver of oxidation level **1**.

21. The bristle of claim 20, wherein the antimicrobial substance is selected from the group consisting of silver halides, silver sulphates, silver carbonates and organic silver salts.

22. The bristle of claim 1, wherein at least one of said first and said at least one second cross-sectional region contains silver of oxidation level **0** and an other one of said first and said at least one second cross-sectional region contains silver of oxidation level **1**.

23. The bristle of claim 1, wherein said second cross-sectional region contains silver of oxidation level **0** in a form of at least one thread.

24. The bristle of claim 1, wherein silver of oxidation level **0** or **1** is present in disperse form in a plastic matrix of the bristle.

25. The bristle of claim 1, wherein silver of oxidation level **0** is applied as a layer to at least one of said first and said second cross-sectional regions.

26. The bristle of claim 1, wherein said at least one second cross-sectional region comprises a thermoplastic elastomer.

27. The bristle of claim 1, wherein said first cross-sectional region has one of a first surface color and a first body color which differs from one of a second surface color and a second body color of said at least one second cross-sectional region.

28. The bristle of claim 1, wherein the thermoplastic material has a water absorptivity of at least 0.1 mass %.

29. The bristle of claim 28, wherein the thermoplastic material is one of polyamide, polyester and polyurethane.

30. The bristle of claim 1, wherein said first cross-sectional region has a first water absorptivity which differs from a second water absorptivity of said second cross-sectional region.

31. The bristle of claim 1, wherein each of at least two combined monofilaments forms one of said first and said at least one second cross sectional region.

32. Brushware having a plastic bristle carrier and bristles according to claim 1, wherein at least portions of said bristle carrier are antimicrobially treated.

33. The brushware of claim 32, wherein said bristle carrier is made from plastic and contains particulate silver of oxidation level **0** and/or **1**.

34. The brushware of claim 32, wherein said bristle carrier is made from two different or different types of plastics in multicomponent injection molding, at least one component being filled with particulate silver of oxidation level **0** and/or **1**.

35. The brushware of claim 32, wherein the bristle carrier is filled with particulate silver of oxidation level **0** and/or **1** in a region of attachment of the bristles.

36. The brushware of claim 32, wherein the bristles are individually fastened on or in the bristle carrier.

37. The brushware of claim 32, wherein the bristles are joined in a gap-free manner to said bristle carrier by thermal processes.

38. A pack for the brushware of claim 32, wherein the pack is finished with an antimicrobial substance.

39. The pack of claim 38, wherein pack material contains antimicrobial substance in disperse form.

40. The pack of claim 38, wherein a side forming an inside of the pack is coated with the antimicrobial substance.

41. A method for producing the bristle of claim 1, the method comprising the steps of:

a) preparing a first plastic component for extrusion;

b) doping a second plastic component with an antimicrobial substance;

c) co-extruding, following step b), said first plastic component together with said second plastic component in a multi-component extrusion process to form a bristle having an outer surface with a portion thereof occupied by said second plastic component and with a remaining portion thereof occupied by said first plastic component.

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