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(71) Applicant: **SUNSTAR INC.**
Takatsuki-shi, Osaka 569-1195 (JP)

(72) Inventor: **IMAI Kieko**
Takatsuki-shi, Osaka 569-1195 (JP)

(74) Representative: **Vossius & Partner**
Patentanwälte Rechtsanwälte mbB
Siebertstraße 3
81675 München (DE)

(54) **TOOTHBRUSH**

(57) [Problem]

To provide a toothbrush that maintains resistance against loosing of a bristle bundle, prevents a crack in a base and a defect of appearance, and can further reduce a thickness of a head portion.

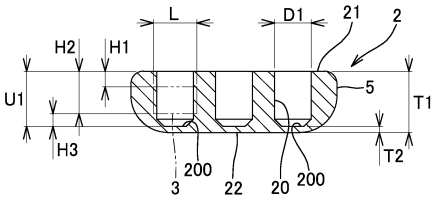
[Solution]

The toothbrush includes the head portion that is molded from a polyacetal resin having a weight-average molecular weight of 130000 or more. When the head portion is a thin head having a thickness of 3.0 mm or less, a base thickness that corresponds to a thickness of an implantation base is T1 (mm), a hole depth of an implantation hole is U1 (mm), a flat wire implantation depth that corresponds to a depth from an implantation face to an upper end of the flat wire implanted from the implantation face is H1 (mm), and a weight-average molecular weight of the polyacetal resin is Mw, a following equation (1) is satisfied.

[Formula 1]

$$(-18.5) + T1 \times 7.0 + U1 \times 3.5 + H1 \times (-10.0) + MW \times 0.78 \times 10^{-5} \geq 2.96 \qquad (1)$$

FIG. 2



EP 4 082 389 A1

Description

[Technical Field]

[0001] The present invention relates to a toothbrush that has a thin head portion and bristle bundles implanted respectively in a plurality of implantation holes in the head portion, using a flat wire.

[Background Art]

[0002] In a toothbrush, bristle bundles each having bristles are respectively implanted in implantation holes in an implantation base of a head portion. In order to enhance intraoral operability, approaches have been taken for reducing a thickness of the head portion and a neck portion of the toothbrush, by considering a quality of a resin material, specification of implantation, shapes of the head portion and the neck portion, and so on (see Patent Literature 1, for example). In Patent Literature 1, it is proposed to reduce the thickness of the head portion by adopting appropriate combination of a length and width of a flat wire, a diameter and depth of an implantation hole, a quality of a resin material, and so on.

[0003] However, as disclosed in Patent Literature 1, if a polyacetal resin (POM) is used for the resin material of the head portion, and bristle bundles are implanted in the thin head portion while resistance against loosing of the bristle bundles from the thin head portion being maintained by the flat wire, a defect including a crack (crack in a base) and bleaching occurs (see Patent Literature 1, Table 2, Example 8). In other words, if the POM is for the material of the head portion, stable production cannot be performed without setting the thickness of the head portion to be thick.

[Citation List]

[Patent Literature]

[0004] Patent Literature 1: Japanese Patent No. 5427486

[Summary of Invention]

[Technical Problem]

[0005] In view of the above, a purpose of the present invention is to provide a toothbrush in which resistance against loosing of bristle bundles is maintained, a crack in a base and a defect in appearance are prevented, and a thickness of a head portion can be further reduced.

[Solution to Problem]

[0006] The present invention covers an invention of:

[1] A toothbrush including: a head portion having an implantation base provided with implantation holes; and a bristle bundle implanted in each of the implantation holes of the implantation base by implantation of a flat wire, in which the head portion is a thin head that is molded from a polyacetal resin having a weight-average molecular weight of 130000 or more, and has a thickness of 3.0 mm or less, and when a base thickness that corresponds to a thickness of the implantation base is T1 (mm), a hole depth of the implantation hole is U1 (mm), a flat wire implantation depth that corresponds to a depth from an implantation face to an upper end of the flat wire implanted from the implantation face is H1 (mm), and a weight-average molecular weight of the polyacetal resin is Mw, a following equation (1) is satisfied.

[Formula 1]

$$(-18.5) + T1 \times 7.0 + U1 \times 3.5 + H1 \times (-10.0) + MW \times 0.78 \times 10^{-5} \geq 2.96 \qquad (1)$$

[2] A toothbrush including: a head portion having an implantation base provided with implantation holes; and a bristle bundle implanted in each of the implantation holes of the implantation base by implantation of a flat wire, in which

the head portion is a thin head that is molded from a polyacetal resin having a weight-average molecular weight of 130000 or more, and has a thickness of 3.0 mm or less, and when a base thickness that corresponds to a thickness of the implantation base is T1 (mm), a hole depth of the implantation hole is U1 (mm), a flat wire implantation depth that corresponds to a depth from an implantation face to an upper end of the flat wire implanted from the implantation face is H1 (mm), and a weight-average molecular weight of the polyacetal resin is Mw, a following equation (2) is satisfied.

[Formula 2]

$$(-13.3) + T1 \times 6.2 + U1 \times 2.1 + H1 \times (-8.05) + Mw \times 0.36 \times 10^{-5} \geq 3.33 \quad (2)$$

[Advantageous Effects of Invention]

[0007] According to the present invention as above, the resistance against loosing of the bristle bundles can be maintained, a crack in the base and a defect in the appearance can be prevented, and the thickness of the head portion can be further reduced. Specifically, the intraoral operability is enhanced by adopting a thin head having a thickness of 3.0 mm or less, as the head portion. Furthermore, the head portion is molded from a polyacetal resin having a weight-average molecular weight of 130000 or more, and when a base thickness that corresponds to a thickness of the implantation base is T1 (mm), a hole depth of the implantation hole is U1 (mm), a flat wire implantation depth that corresponds to a depth from an implantation face to an upper end of the flat wire implanted from the implantation face is H1 (mm), and a weight-average molecular weight of the polyacetal resin is Mw, a following equation (1) is satisfied. With this configuration, a crack in the base can be prevented.
[Formula 3]

$$(-18.5) + T1 \times 7.0 + U1 \times 3.5 + H1 \times (-10.0) + MW \times 0.78 \times 10^{-5} \geq 2.96 \quad (1)$$

[0008] Furthermore, the head portion is molded from a polyacetal resin having a weight-average molecular weight of 130000 or more, and when a base thickness that corresponds to a thickness of the implantation base is T1 (mm), a hole depth of the implantation hole is U1 (mm), a flat wire implantation depth that corresponds to a depth from an implantation face to an upper end of the flat wire implanted from the implantation face is H1 (mm), and a weight-average molecular weight of the polyacetal resin is Mw, a following equation (2) is satisfied. With this configuration, a crack in the base and a defect in the appearance (occurrence of unevenness) can be surely prevented.
[Formula 4]

$$(-13.3) + T1 \times 6.2 + U1 \times 2.1 + H1 \times (-8.05) + Mw \times 0.36 \times 10^{-5} \geq 3.33 \quad (2)$$

[Brief Description of Drawings]

[0009]

FIG. 1 is a transverse cross sectional view of a head portion of a toothbrush according to a representative embodiment of the present invention.
FIG. 2 is an explanatory view showing an implantation part of the head portion of the toothbrush according to the representative embodiment of the present invention.

[Description of Embodiments]

[0010] Next, embodiments of the present invention are described in detail with reference to the accompanying drawings.
[0011] A toothbrush 1 according to the present invention includes a thin head portion 2 that has an implantation base

5 provided with a plurality of implantation holes 20, and bristle bundles 4 that are implanted respectively in the plurality of implantation holes 20, using a flat wire. The toothbrush 1 in this example may be a manual toothbrush in which a head portion, a neck portion, and a handle portion are uniformly molded from a synthetic resin. The toothbrush 1 may be an electric toothbrush in which a toothbrush cleaning body having a head portion and a neck portion is connected to a distal end of a main body that serves as a grip portion and contains a driving mechanism. The toothbrush 1 may be certainly embodied by other embodiments.

[0012] The head portion 2 is molded from a polyacetal resin having a weight-average molecular weight of 130000 or more. The polyacetal resin may be a homopolymer or a copolymer, as long as the polyacetal resin contains a crystal part in addition to an amorphous part. As the weight-average molecular weight increases, a degree of crystallization becomes higher. Thus, the head portion 2 made of such a polyacetal resin is hardly cracked so as to have a good appearance. The head portion 2 includes the thin implantation base 5 having a thickness (base thickness) T1 of 3.0 mm or less. The head portion 2 is formed to be a thin head portion having a thickness preferably of 2.9 mm or less, more preferably of 2.6 mm or less, and further preferably of 2.5 mm or less. The lower limit of the base thickness T1 that is the thickness of the implantation base 5 is preferably 2 mm, and more preferably 2.2 mm or more. If the thickness is less than 2 mm, it is difficult to secure sufficient resistance against loosing of bristle bundles. The base thickness T1 corresponds to a thickness of at least a part of an implantation face, on which the bristle bundles 4 are implanted.

[0013] The head portion 2 (implantation base 5) has, in a ventral side thereof, an implantation face 21 to which the bristle bundles 4 are projectingly implanted. The implantation face 21 is provided with a plurality of implantation holes 20 each of which has a bottom and an approximately circle shape in the cross section. The number of the implantation holes 20, an arrangement form thereof, and so on are not limited to this example. A diameter and a depth of each of the holes, a shape thereof in the vertical cross section, the number of filaments for a single bristle bundle, a material of the filament, and so on, are selected from an appropriate range, depending on various conditions. For example, the diameter (inner diameter D1) of the hole is appropriately determined to be a level of 1.2 to 2.4 mm. Each of the implantation holes 20 according to the present example extends straight and has a circular shape in the cross section, basically. In a peripheral wall of the bottom of the hole, an inclined plane with a reduced diameter in a truncated cone shape is formed.

[0014] A hole depth U1 of each of the implantation holes 20 corresponds to a depth from an opening of the implantation hole 20 at the implantation face 21 to a bottom face 200 of the implantation hole 20. A thickness T2 of a bottom of the head portion (implantation base 5), i.e., a distance from the bottom face 200 of implantation hole to a rear face 22 of the head portion is referred to as a "distance from hole bottom to base bottom" in the present description. It should be noted that the implantation hole 20 may have another shape. It is preferable that the hole depth (U1) is set to 0.9 mm or more, in view of maintaining good resistance against loosing of the bristle bundles.

[0015] The distance from hole bottom to base bottom (T2) is preferably 0.15 mm or more, more preferably 0.2 mm or more, and still more preferably 0.25 mm or more. If the distance from hole bottom to base bottom is 0.5 mm or more, the resistance against loosing of the bristle bundles cannot be maintained by the thin head of the present invention. Accordingly, the distance from hole bottom to base bottom is preferably kept to less than 0.5 mm, more preferably to 0.45 mm or less.

[0016] In each of the implantation holes 20, a bristle bundle prepared by bundling a plurality of filaments and folding the bundled filaments into halves is implanted using a flat wire 3. A material of the flat wire 3 is not particularly limited, and may be a well-known material used in typical toothbrushes, such as a metal and a hard synthetic resin. The thickness of the flat wire 3 may be set to 0.1 mm or more and 0.2 mm or less, and preferably set to 0.15 mm or more and 0.185 mm or less. If the thickness is less than 0.1 mm, the flat wire is deformed at the time of implanting the flat wire. This prevents the resistance against loosing of the bristle bundles from being maintained. If the thickness of the flat wire is 0.21 mm or more and the head portion is, in particular, a thin head, the head portion may be bleached or the base may be cracked.

[0017] An overlap margin of the flat wire 3 onto the implantation hole 20 (a difference between the hole diameter D1 of the implantation hole 20 and a transverse length L of the flat wire 3, which is orthogonal to an implantation direction of the flat wire) is preferably set to + 0.35 mm or more and + 0.6 mm or less, and more preferably set to +0.45 mm or more and + 0.6 mm or less. If the overlap margin is less than + 0.35 mm, an engagement dimension is small, preventing the resistance against loosing of the bristle bundles from being maintained. If the overlap margin exceeds + 0.6 mm, the flat wire may be deformed. This causes the resistance against loosing of the bristle bundle or a single filament to be lowered. The flat wire may be implanted so that both end portions thereof in the length direction are engaged in the same dimension. With this configuration, each end portion is engaged in the peripheral wall of the implantation hole 20 with a preferable amount of 0.175 mm or more and 0.3 mm or less.

[0018] A cross sectional area obtained by cutting the flat wire 3 at a face perpendicular to the transverse direction is set to 0.1 mm^2 or more and less than 0.3 mm^2, and is preferably set to 0.12 mm^2 or more and 0.3 mm^2 or less. If the cross sectional area is less than 0.1 mm^2, the flat wire may be bent, resulting in lowering the resistance against loosing of the bristle bundle or a single filament. A shape of the cross section is exemplified by an elliptical shape in this example, so as to have curve faces at a proximal end and a distal end in the implantation direction. Thus, it is considered that

load is prevented from being imposed to the bristle bundle 4. A thickness t of the flat wire 3 in this example corresponds to the thickness of a straight area of the flat wire 3, which excepts the curved portions at both end portions thereof.

[0019] The implanted flat wire 3 is shown by virtual lines in FIG. 2. In the present description, a distance H1 from the implantation face 21 at which implantation holes are opened to an upper end of the flat wire 3 implanted from the implantation face 21 is referred to as a "flat wire implantation depth". In addition, a distance H2 from the implantation face 21 to a lower end of the flat wire 3 implanted from the implantation face 21 is referred to as a "plus flat wire" as an implantation depth covering a vertical size of the flat wire 3. Furthermore, a distance H3 from the lower end of the flat wire to the bottom face 200 of the implantation hole is referred to as a "distance from flat wire to hole bottom". It is preferable to set the flat wire implantation depth (H1) to a value from 0.07 mm to 0.5 mm, in view of preventing the base from cracking and maintaining both an excellent appearance and the resistance against loosing of the bristle bundles. Regarding the distance from flat wire to hole bottom (H3), it is preferable to secure 0.5 mm or more, and more preferably to secure 0.58 mm or more, in view of preventing the base from cracking and of maintaining a good appearance.

[0020] A material of the filament is not limited in particular, and may be artificial bristles made of a resin material, such as nylon, polyester, polyolefin, and so on, or may be natural bristles, such as pig bristles. These may be combined. In addition to the above, well-known embodiments can be widely adopted in terms of a cross sectional shape, a dimension of the cross section, length, presence/absence of a tapered shape, and so on.

[0021] Such a head portion 2 of the toothbrush 1 according to the present invention is formed so that a value of X1 in the below-shown equation (3) is 2.96 or more. In the equation (3), a thickness of the base is T1 (mm); a hole depth of the implantation hole is U1 (mm); an implantation depth of the flat wire is H1 (mm); and a weight-average molecular weight of the polyacetal resin is Mw. If the value X1 is less than 2.96, a crack may occur in the base.

[Formula 5]

$$(-18.5) + T1 \times 7.0 + U1 \times 3.5 + H1 \times (-10.0) + MW \times 0.78 \times 10^{-5} = X1 \quad (3)$$

[0022] Furthermore, the head portion 2 of the toothbrush 1 according to the present invention is formed so that a value of X2 in the below-shown equation (4) is 3.33 or more. In the equation (4), the thickness of the base is T1 (mm); the hole depth of the implantation hole is U1 (mm); the implantation depth of the flat wire is H1 (mm); and the weight-average molecular weight of the polyacetal resin is Mw. If the value X2 is less than 3.33, a crack in the base or defection of the appearance (occurrence of unevenness) may occur. If the value of X2 is more than 3.33, a crack in the base and the defection of the appearance (occurrence of unevenness) can be prevented without fail.

[Formula 6]

$$(-13.3) + T1 \times 6.2 + U1 \times 2.1 + H1 \times (-8.05) + Mw \times 0.36 \times 10^{-5} = X2 \quad (4)$$

[0023] Although the embodiments of the present invention are described, the present invention is not limited to the above-mentioned embodiments, and can be appropriately embodied through various embodiments without departing from the scope of the present invention.

[Example]

<Evaluation of crack in base and appearance>

[0024] Subsequently, samples of the thin head portion, which were molded from the polyacetal resin and had a base thickness of 3.0 mm or less, were prepared by changing each of the base thickness T1, the hole depth U1, the flat wire implantation depth H1, the distance T2 from hole bottom to base bottom, and the weight-average molecular weight Mw of the polyacetal resin. Evaluations as shown in Tables 1 to 8 were obtained in terms of a crack in the base and appearance (unevenness) of the head portion.

(Sample)

[0025] The samples were prepared with values shown in Tables 1 to 4 in terms of the base thickness T1, the hole

depth U1, the flat wire implantation depth H1, the distance T2 from hole bottom to base bottom, the weight-average molecular weight Mw of the polyacetal resin, a value of X1 calculated by the above equation (3), and types of the polyacetal resin "P1" to "P6". The inner diameter of the implantation hole (opening) was set to 1.5 mm.

[0026] The polyacetal resin "P1" is a polyacetal copolymer (the number average molecular weight (Mn): 24900, the weight-average molecular weight (Mw): 122000, a Z-average molecular weight (Mz): 247000, MFR: 27 g/10 min, tensile modulus of elasticity: 2800 Mpa, and flexural modulus: 2550 Mpa).

[0027] The polyacetal resin "P2" is a polyacetal homopolymer (the number average molecular weight (Mn): 55400, the weight-average molecular weight (Mw): 130000, the Z-average molecular weight (Mz): 261000, MFR: 25 g/10 min, the tensile modulus of elasticity: 3300 Mpa, and the flexural modulus: 3000 Mpa). The polyacetal resin "P3" is a polyacetal homopolymer (the number average molecular weight (Mn): 58200, the weight-average molecular weight (Mw): 143000, the Z-average molecular weight (Mz): 301000, MFR: 15 g/10 min, the tensile modulus of elasticity: 3100 Mpa, and the flexural modulus: 3000 Mpa).

[0028] The polyacetal resin "P4" is a polyacetal homopolymer (the number average molecular weight (Mn): 67100, the weight-average molecular weight (Mw): 184000, the Z-average molecular weight (Mz): 471000, MFR: 7 g/10 min, the tensile modulus of elasticity: 3300 Mpa, and the flexural modulus: 3100 Mpa). The polyacetal resin "P5" is a polyacetal homopolymer (the number average molecular weight (Mn): 85000, the weight-average molecular weight (Mw): 227000, the Z-average molecular weight (Mz): 549000, MFR: 2.5 g/10 min, the tensile modulus of elasticity: 3200 Mpa, and the flexural modulus: 3000 Mpa). Polyacetal resin "P6" is a polyacetal copolymer (the number average molecular weight (Mn): 24800, the weight-average molecular weight (Mw): 141000, the Z-average molecular weight (Mz): 302000, the tensile modulus of elasticity: 2850 Mpa, and the flexural modulus: 2700 Mpa).

[0029] The number of filaments in a single bristle bundle to be implanted was set to 21 to 23 (average: 22), and a single filament had a diameter of 0.19 mm and a length of 29 mm, and was made of nylon. The flat wire to be used for implantation of the bristle bundles was set to have a vertical length of 1.2 mm, and a transverse length, which was perpendicular to the vertical length, of 2.0 to 2.05 mm (average: 2.03 mm), and a thickness of 0.185 mm.

(Method of evaluating crack in base)

[0030] A crack in the base is visually evaluated based on the following five-grade criteria. "5": there is no crack, "4": there is a hole in which a slight crack can be recognized, "3": there are many holes in each of which a slight crack can be recognized, but holes are not connected, "2": there are many holes in each of which a slight crack can be recognized, and holes are connected, and "1": cleavage is recognized (there is a gap between cracks), or there is a crack across a plurality of holes.

[Table 1]

A01 to A30: Evaluation of crack in base									
Sample	Base thickness T1 (mm)	Hole depth U1 (mm)	Flat wire implantation depth H1 (mm)	Distance T2 from hole bottom to base bottom (mm)	Distance H3 from flat wire to hole bottom (mm)	Weight average molecular weight Mw	Polyacetal	X1	Evaluation of crack in base
A01	2.20	2.05	0.27	0.15	0.58	122000	P1	2.33	1
A02						130000	P2	2.39	2
A03						143000	P3	2.49	2
A04						184000	P4	2.81	2
A05						227000	P5	3.15	3
A06			0.32		0.53	122000	P1	1.83	1
A07						130000	P2	1.89	1
A08						143000	P3	1.99	1
A09						184000	P4	2.31	1
A10						227000	P5	2.65	1
A11		1.95	0.17	0.25	0.58	122000	P1	2.98	1
A12						130000	P2	3.04	4
A13						143000	P3	3.14	4
A14						184000	P4	3.46	4
A15						227000	P5	3.80	4
A16			0.22		0.53	122000	P1	2.48	1
A17						130000	P2	2.54	1
A18						143000	P3	2.64	1
A19						184000	P4	2.96	3
A20						227000	P5	3.30	3
A21		1.85	0.07	0.35	0.58	122000	P1	3.63	5
A22						130000	P2	3.69	5
A23						143000	P3	3.79	5
A24						184000	P4	4.11	5
A25						227000	P5	4.45	5
A26			0.12		0.53	122000	P1	3.13	1
A27						130000	P2	3.19	4
A28						143000	P3	3.29	4
A29						184000	P4	3.61	4
A30						227000	P5	3.95	4

[Table 2]

B01 to B10: Evaluation of crack in base									
Sample	Base thickness T1 (mm)	Hole depth U1 (mm)	Flat wire implantation depth H1 (mm)	Distance T2 from hole bottom to base bottom (mm)	Distance H3 from flat wire to hole bottom (mm)	Weight average molecular weight Mw	Polyacetal	X1	Evaluation of crack in base
B01	2.30	1.95	0.17	0.35	0.58	122000	P1	3.68	5
B02						130000	P2	3.74	5
B03						143000	P3	3.84	5
B04						184000	P4	4.16	5
B05						227000	P5	4.50	5
B06			0.22		0.53	122000	P1	3.18	1
B07						130000	P2	3.24	4
B08						143000	P3	3.34	4
B09						184000	P4	3.66	5
B10						227000	P5	4.00	5

[Table 3]

C01 to C33 Evaluation of crack in base									
Sample	Base thickness T1 (mm)	Hole depth U1 (mm)	Flat wire implantation depth H1 (mm)	Distance T2 from hole bottom to base bottom (mm)	Distance H3 from flat wire to hole bottom (mm)	Weight average molecular weight Mw	Polyacetal	X1	Evaluation of crack in base
C01						122000	P1	4.38	5
C02						130000	P2	4.44	5
C03			0.17		0.68	143000	P3	4.54	5
C04						184000	P4	4.86	5
C05						227000	P5	5.20	5
C06						122000	P1	3.38	5
C07						130000	P2	3.44	5
C08		2.05	0.27	0.30	0.58	143000	P3	3.54	5
C09						184000	P4	3.86	5
C10						227000	P5	4.20	5
C11						122000	P1	2.88	1
C12						130000	P2	2.94	3
C13			0.32		0.53	143000	P3	3.04	3
C14						184000	P4	3.36	3
C15						227000	P5	3.70	3

(continued)

C01 to C33 Evaluation of crack in base									
Sample	Base thickness T1 (mm)	Hole depth U1 (mm)	Flat wire implantation depth H1 (mm)	Distance T2 from hole bottom to base bottom (mm)	Distance H3 from flat wire to hole bottom (mm)	Weight average molecular weight Mw	Polyacetal	X1	Evaluation of crack in base
C16	2.35	1.95	0.17	0.40	0.58	122000	P1	4.03	5
C17						130000	P2	4.09	5
C18						143000	P3	4.19	5
C19						184000	P4	4.51	5
C20						227000	P5	4.85	5
C21			0.22		0.53	122000	P1	3.53	1
C22						130000	P2	3.59	5
C23						143000	P3	3.69	5
C24						184000	P4	4.01	5
C25						227000	P5	4.35	5
C26		1.85	0.07	0.50	0.58	130000	P2	4.74	5
C27						143000	P3	4.84	5
C28						184000	P4	5.16	5
C29						227000	P5	5.50	5
C30			0.12		0.53	130000	P2	4.24	5
C31						143000	P3	4.34	5
C32						184000	P4	4.66	5
C33						227000	P5	5.00	5

[Table 4]

D01 to D48						Evaluation of crack in base			
Sample	Base thickness T1 (mm)	Hole depth U1 (mm)	Flat wire implantation depth H1 (mm)	Distance T2 from hole bottom to base bottom (mm)	Distance H3 from flat wire to hole bottom (mm)	Weight average molecular weight Mw	Polyacetal	X1	Evaluation of crack in base
D01			0.26		0.79	122000	P1	5.23	5
D02						130000	P2	5.29	5
D03						14300D	P3	5.39	5
D04						184000	P4	5.71	5
D05						227000	P5	6.05	5
D06						141000	P6	5.37	5
D07			0.37		0.68	122000	P1	4.13	5
D08						130000	P2	4.19	5
D09						143000	P3	4.29	5
D10						184000	P4	4.61	5
D11						227000	P5	4.95	5
D12		2.25		0.25		141000	P6	4.27	5
D13			0.47		0.58	122000	P1	3.13	1
D14						130000	P2	3.19	5
D15						143000	P3	3.29	5
D16						184000	P4	3.61	5
D17						227000	P5	3.95	5
D18						141000	P6	3.27	5
D19			0.52		0.53	122000	P1	2.63	1
D20						130000	P2	2.69	1
D21						143000	P3	2.79	1
D22						184000	P4	3.11	5
D23						227000	P5	3.45	4

(continued)

D01 to D48						Evaluation of crack in base			
Sample	Base thickness T1 (mm)	Hole depth U1 (mm)	Flat wire implantation depth H1 (mm)	Distance T2 from hole bottom to base bottom (mm)	Distance H3 from flat wire to hole bottom (mm)	Weight average molecular weight Mw	Polyacetal	X1	Evaluation of crack in base
D24	2.50	2.05	0.17	0.45	0.68	122000	P1	5.43	5
D25						130000	P2	5.49	5
D26						143000	P3	5.59	5
D27						184000	P4	5.91	5
D28						227000	P5	6.25	5
D29			0.27		0.58	122000	P1	4.43	5
D30						130000	P2	4.49	5
D31						143000	P3	4.59	5
D32						184000	P4	4.91	5
D33						227000	P5	5.25	5
D34			0.32		0.53	122000	P1	3.93	5
D35						130000	P2	3.99	5
D36						143000	P3	4.09	5
D37						184000	P4	4.41	5
D38						227000	P5	4.75	5
D39		1.85	0.07	0.65	0.58	122000	P1	5.73	5
D40						130000	P2	5.79	5
D41						143000	P3	5.89	5
D42						184000	P4	6.21	5
D43						227000	P5	6.55	5
D44			0.12		0.53	122000	P1	5.23	5
D45						130000	P2	5.29	5
D46						143000	P3	5.39	5
D47						184000	P4	5.71	5
D48						227000	P5	6.05	5

[0031] As shown in Tables 1 to 4, if a value of X1 is 2.96 or more, the evaluation of a crack in the base can be maintained "3" or more, except for the sample P1 in which the weight-average molecular weight Mw of the polyacetal resin is less than 130000.

[0032] Table 5 to Table 8 shows values of X2 obtained by the equation (4) above, instead of the values of X1, for the same sample. In Tables 5 to 8, results of the evaluation of an appearance (unevenness) are shown in addition to the evaluation of a crack in the base.

(Method of evaluating appearance)

[0033] The appearance is evaluated by evaluating the rear face of the head portion based on the following five-grade criteria. "5": there is no unevenness, "4": slight unevenness can be recognized, "3": slight unevenness can be felt by

being touched with a finger, "2": unevenness can be felt by being touched with a finger, and "1": there is unevenness at a level of a claw being felt by touch with a finger.

[Table 5]

A01 to A30: Evaluation of unevenness							
Sample	Base thickness T1 (mm)	Hole depth U1 (mm)	Flat wire implantation depth H1 (mm)	Weight average molecular weight Mw	X2	Evaluation of crack in base	Evaluation of unevenness
A01	2.20	2.05	0.27	122000	2.91	1	3
A02				130000	2.94	2	3
A03				143000	2.99	2	3
A04				184000	3.13	2	3
A05				227000	3.29	3	3
A06			0.32	122000	2.51	1	1
A07				130000	2.54	1	1
A08				143000	2.56	1	1
A09				184000	2.73	1	1
A10				227000	2.89	1	1
A11		1.95	0.17	122000	3.51	1	2
A12				130000	3.53	4	3
A13				143000	3.58	4	3
A14				184000	3.73	4	3
A15				227000	3.88	4	3
A16			0.22	122000	3.10	1	1
A17				130000	3.13	1	2
A18				143000	3.18	1	2
A19				184000	3.33	3	3
A20				227000	3.48	3	3
A21		1.85	0.07	122000	4.10	5	5
A22				130000	4.13	5	5
A23				143000	4.16	5	5
A24				184000	4.32	5	5
A25				227000	4.48	5	5
A26			0.12	122000	3.70	1	4
A 27				130000	3.73	4	5
A28				143000	3.77	4	5
A29				184000	3.92	4	5
A30				227000	4.08	4	5

[Table 6]

B01 to B10			Evaluation of crack in base & unevenness				
Sample	Base thickness T1 (mm)	Hole depth U1 (mm)	Flat wire implantation depth H1 (mm)	Weight average molecular weight Mw	X2	Evaluation of crack in base	Evaluation of unevenness
B01	2.30	1.95	0.17	122000	4.13	5	5
B02				130000	4.15	5	5
B03				143000	4.20	5	5
B04				184000	4.35	5	5
B05				227000	4.50	5	5
B06			0.22	122000	3.72	1	3
B07				130000	3.75	4	4
B08				143000	3.80	4	4
B09				184000	3.95	5	5
B10				227000	4.10	5	5

[Table 7]

C01 to C33			Evaluation of crack in base & unevenness				
Sample	Base thickness T1 (mm)	Hole depth U1 (mm)	Flat wire implantation depth H1 (mm)	Weight average molecular weight Mw	X2	Evaluation of crack in base	Evaluation of unevenness
C01	2.35	2.05	0.17	122000	4.65	5	5
C02				130000	4.67	5	5
C03				143000	4.72	5	5
C04				184000	4.87	5	5
C05				227000	5.02	5	5
C06			0.27	122000	3.84	5	3
C07				130000	3.87	5	5
C08				143000	3.92	5	5
C09				184000	4.06	5	5
C10				227000	4.22	5	5
C11			0.32	122000	3.44	1	3
C12				130000	3.47	3	3
C13				143000	3.51	3	3
C14				184000	3.66	3	3
C15				227000	3.82	3	3
C16		1.95	0.17	122000	4.44	5	5
C17				130000	4.46	5	5
C18				143000	4.51	5	5
C19				184000	4.66	5	5
C20				227000	4.81	5	5
C21			0.22	122000	4.03	1	4
C22				130000	4.06	5	5
C23				143000	4.11	5	5
C24				184000	4.26	5	5
C25				227000	4.41	5	5
C26		1.85	0.07	130000	5.06	5	5
C27				143000	5.11	5	5
C28				184000	5.25	5	5
C29				227000	5.41	5	5
C30			0.12	130000	4.66	5	5
C31				143000	4.70	5	5
C32				184000	4.85	5	5
C33				227000	5.01	5	5

[Table 8]

D01 to D48			Evaluation of crack in base & unevenness				
Sample	Base thickness T1 (mm)	Hole depth U1 (mm)	Flat wire implantation depth H1 (mm)	Weight average molecular weight Mw	X2	Evaluation of crack in base	Evaluation of unevennes
D01				122000	5.27	5	5
D02				130000	5.30	5	5
D03			0.26	143000	5.35	5	5
D04				184000	5.49	5	5
D05				227000	5.65	5	5
D06				141000	5.34	5	5
D07				122000	4.39	5	4
D08				130000	4.41	5	5
D09			0.37	143000	4.46	5	5
D10				184000	4.61	5	5
D11				227000	4.76	5	5
D12		2.25		141000	4.45	5	5
D13				122000	3.58	1	4
D14				130000	3.61	5	5
D15			0.47	143000	3.66	5	5
D16				184000	3.80	5	5
D17				227000	3.96	5	5
D18				141000	3.65	5	5
D19				122000	3.18	1	2
D20				130000	3.21	1	2
D21			0.52	143000	3.25	1	2
D22				184000	3.40	5	4
D23				227000	3.56	4	3

(continued)

D01 to D48			Evaluation of crack in base & unevenness				
Sample	Base thickness T1 (mm)	Hole depth U1 (mm)	Flat wire implantation depth H1 (mm)	Weight average molecular weight Mw	X2	Evaluation of crack in base	Evaluation of unevennes
D24	2.50	2.05	0.17	122000	5.58	5	5
D25				130000	5.60	5	5
D26				143000	5.65	5	5
D27				184000	5.80	5	5
D28				227000	5.95	5	5
D29			0.27	122000	4.77	5	5
D30				130000	4.80	5	5
D31				143000	4.85	5	5
D32				184000	4.99	5	5
D33				227000	5.15	5	5
D34			0.32	122000	4.37	5	5
D35				130000	4.40	5	5
D36				143000	4.44	5	5
D37				184000	4.59	5	5
D38				227000	4.75	5	5
D39		1.85	0.07	122000	5.96	5	5
D40				130000	5.99	5	5
D41				143000	6.04	5	5
D42				184000	6.18	5	5
D43				227000	6.34	5	5
D44			0.12	122000	5.56	5	5
D45				130000	5.59	5	5
D46				143000	5.63	5	5
D47				184000	5.78	5	5
D48				227000	5.94	5	5

[0034] As shown in Tables 5 to 8, if a value of X2 is 3.33 or more, the evaluation of a crack in the base and an appearance (unevenness) can be maintained "3" or more, except for the sample P1 in which the weight-average molecular weight Mw of the polyacetal resin is less than 130000.

[Reference Signs List]

[0035]

1 Toothbrush
2 Head portion
3 Flat wire
4 Bristle bundle
5 Implantation base
20 Implantation hole

21 Implantation face
22 Rear face
D1 Hole diameter of implantation hole
H1 Depth from implantation face to upper end of flat wire ("flat wire implantation depth")
H2 Depth from implantation face to lower end of flat wire ("plus flat wire")
H3 Distance from lower end of flat wire to bottom face of implantation hole "distance from flat wire to hole bottom"
T1 Thickness of head portion (implantation base) ("base thickness")
T2 Thickness of bottom portion of implantation hole (distance from hole bottom to base bottom)
U1 Hole depth of implantation hole
L Length of flat wire in transverse direction

Claims

1. A toothbrush comprising:

a head portion having an implantation base provided with implantation holes; and
a bristle bundle implanted in each of the implantation holes of the implantation base by implantation of a flat wire, wherein
the head portion is a thin head that is molded from a polyacetal resin having a weight-average molecular weight of 130000 or more, and has a thickness of 3.0 mm or less, and
when a base thickness that corresponds to a thickness of the implantation base is T1 (mm), a hole depth of the implantation hole is U1 (mm), a flat wire implantation depth that corresponds to a depth from an implantation face to an upper end of the flat wire implanted from the implantation face is H1 (mm), and a weight-average molecular weight of the polyacetal resin is Mw, a following equation (1) is satisfied.
[Formula 1]

$$(-18.5) + T1 \times 7.0 + U1 \times 3.5 + H1 \times (-10.0) + MW \times 0.78 \times 10^{-5} \geq 2.96 \qquad (1)$$

2. A toothbrush comprising:

a head portion having an implantation base provided with implantation holes; and
a bristle bundle implanted in each of the implantation holes of the implantation base by implantation of a flat wire, wherein
the head portion is a thin head that is molded from a polyacetal resin having a weight-average molecular weight of 130000 or more, and has a thickness of 3.0 mm or less, and
when a base thickness that corresponds to a thickness of the implantation base is T1 (mm), a hole depth of the implantation hole is U1 (mm), a flat wire implantation depth that corresponds to a depth from an implantation face to an upper end of the flat wire implanted from the implantation face is H1 (mm), and a weight-average molecular weight of the polyacetal resin is Mw, a following equation (2) is satisfied.
[Formula 2]

$$(-13.3) + T1 \times 6.2 + U1 \times 2.1 + H1 \times (-8.05) + Mw \times 0.36 \times 10^{-5} \geq 3.33 \quad (2)$$

FIG. 1

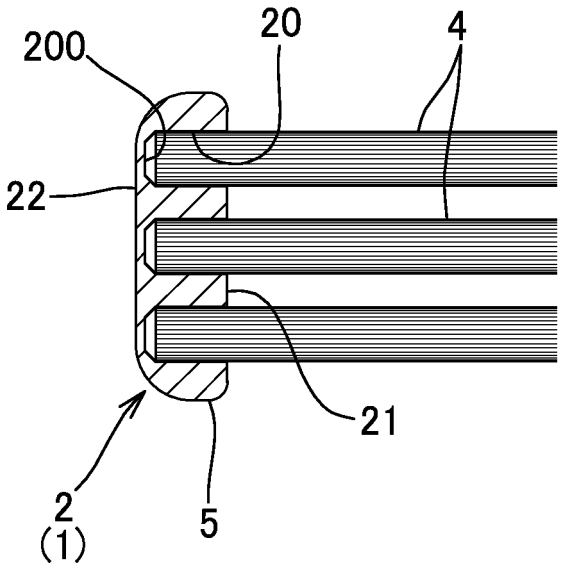
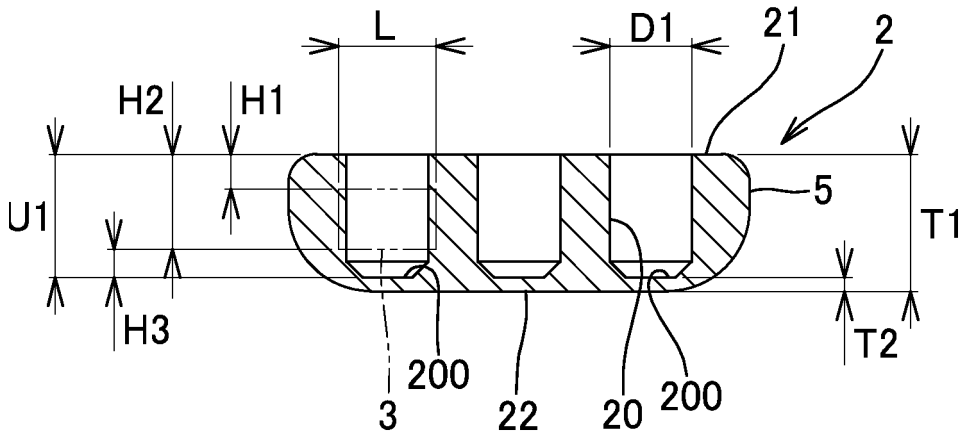


FIG. 2



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/048297

A. CLASSIFICATION OF SUBJECT MATTER
A46B 5/00(2006.01)i; A46B 3/16(2006.01)i; A46B 9/04(2006.01)i
FI: A46B5/00 A; A46B3/16; A46B9/04
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A46B5/00; A46B3/16; A46B9/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2021
Registered utility model specifications of Japan	1996-2021
Published registered utility model applications of Japan	1994-2021

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2016-63912 A (SUNSTAR INC.) 28 April 2016 (2016-04-28) paragraphs [0005], [0020]-[0021], [0030]-[0035], fig. 1-3	1-2
Y	WO 2018/198772 A1 (LION CORP.) 01 November 2018 (2018-11-01) paragraphs [0016]-[0019], [0025]-[0029], [0053]-[0054], fig. 4, 6B	1-2
Y	WO 2014/084160 A1 (ASAHI KASEI CORPORATION) 05 June 2014 (2014-06-05) paragraphs [0023], [0107], [0109]-[0110]	1-2
Y	JP 2015-3954 A (ASAHI KASEI CHEMICALS CORP.) 08 January 2015 (2015-01-08) paragraph [0014]	1-2
A	JP 5427486 B2 (LION CORP.) 26 February 2014 (2014-02-26) entire text, all drawings	1-2

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Date of the actual completion of the international search	Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2020/048297

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
JP 2016-63912 A	28 Apr. 2016	(Family: none)	
WO 2018/198772 A1	01 Nov. 2018	CN 110573043 A KR 10-2019-0134606 A	
WO 2014/084160 A1	05 Jun. 2014	US 2015/0294750 A1 paragraphs [0034], [0133], [0137], [0139] CN 104812835 A KR 10-2015-0076221 A	
JP 2015-3954 A	08 Jan. 2015	(Family: none)	
JP 5427486 B2	26 Feb. 2014	JP 2011-4852 A	

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Patent documents cited in the description

- JP 5427486 B **[0004]**