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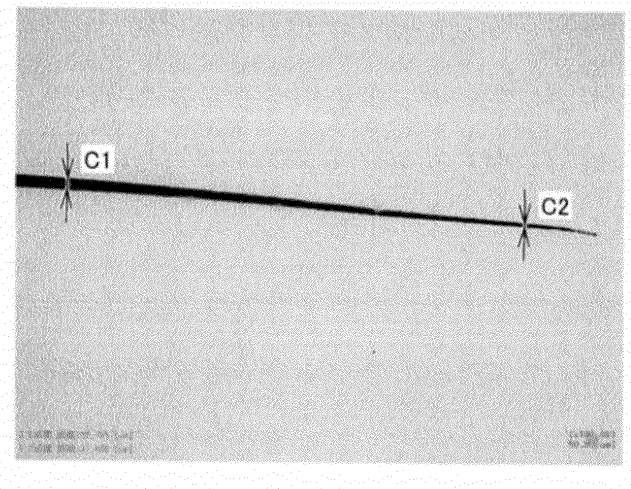
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(54) BRUSH FIBER, BRUSH USING BRUSH FIBER, AND METHOD FOR MANUFACTURING BRUSH FIBER

(57) A brush fiber and a method for manufacturing the brush fiber are provided. The brush fiber includes a fibrous core portion, a covering portion provided on a surface of the core portion. A leading end portion of the core portion has a tapered shape, and the covering portion is made of conductive material. The conductive material is a sulfide of at least one type of metal selected from the group consisting of Cu, Ag, and Pd.

FIG.3



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Description

TECHNICAL FIELD

[0001] The present invention relates to a brush fiber, a brush using the brush fiber, and a method for manufacturing a brush fiber.

BACKGROUND ART

[0002] Animal hair of a weasel, a squirrel, a goat, a pig, a horse, and the like provides a good texture being soft to the skin and contains cuticles, so that it tends to be high in abilities to retain fine particles such as powders and transfer the retained powders to the skin. Further, animal hair is thinner on one end, in other words, has a tapered shape, so that it tends to provide a good texture. Therefore, animal hair has been widely used as fibers for a brush such as a cosmetic brush. However, there have been problems of variation and limitation in the supply quantity of animal hair and a difficulty in completely removing animal-specific smell.

[0003] To address the problems described above, improved synthetic fibers achieving features close to animal hair have been used as alternatives to animal hair in recent years. For example, Japanese Patent Laying-Open No. 2008-109990 (PTL 1) discloses a method for manufacturing a filament having a surface structurally similar to cuticles of animal hair. According to the disclosed method, the filament is manufactured by mixing and melt-spinning inorganic powder and polyethylene terephthalate to prepare a filament and stretching the same. Further, PTL 1 discloses that one end of the stretched filament is immersed in an alkaline solution to obtain a tapered shape.

CITATION LIST

PATENT LITERATURE

[0004] PTL 1: Japanese Patent Laying-Open No. 2008-109990

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0005] A further demand for fibers as an alternative to animal hair is now increasing, and further development of technology is desired.

[0006] In light of the circumstance described above, an object of the present invention is to provide a brush fiber suitable for use as a fiber for a brush, a brush using the brush fiber, and a method for manufacturing a brush fiber.

SOLUTION TO PROBLEM

[0007] The first aspect of the present invention relates to a brush fiber. The brush fiber includes a fibrous core portion and a covering portion provided on a surface of the core portion. A leading end portion of the core portion has a tapered shape, and the covering portion is made of conductive material.

[0008] In the brush fiber described above, the core portion is preferably made of one type of synthetic fiber selected from the group consisting of a polyester synthetic fiber, an acrylic synthetic fiber, and a polyamide synthetic fiber.

[0009] In the brush fiber described above, the conductive material is preferably made of a sulfide of at least one type of metal selected from the group consisting of Cu, Ag, and Pd or plated metal of at least one type of metal selected from the group consisting of Cu, Ag, and Ni.

[0010] In the brush fiber described above, the core portion is preferably made of polybutylene terephthalate, and the conductive material is preferably made of a sulfide of Cu.

[0011] In the brush fiber described above, a surface electrical resistance value is preferably equal to or greater than 10^{-1} Ωcm and equal to or less than 10^{8} Ωcm.

[0012] The second aspect of the present invention relates to a brush using the brush fiber.

[0013] In the brush described above, equal to or greater than 1 volume % of a fiber bundle constituting the brush is preferably the brush fiber.

[0014] The third aspect of the present invention relates to a method for manufacturing a brush fiber. The method includes the steps of immersing a leading end portion of a fibrous core portion in an alkaline solution, washing the core portion after immersing, and forming a conductive portion made of conductive material on a surface of the core portion after washing.

ADVANTAGEOUS EFFECTS OF INVENTION

[0015] According to the present invention, a brush fiber suitable for use in a brush and a brush using the brush fiber, and a method for manufacturing a brush fiber in a convenient manner can be provided.

BRIEF DESCRIPTION OF DRAWINGS

[0016]

Fig. 1 represents a shape of a leading end portion of an untreated fiber of Example 1.
Fig. 2 represents a shape of the leading end portion of the fiber of Example 1 treated with an alkaline aqueous solution.
Fig. 3 represents a shape of the leading end portion of the brush fiber of Example 1 further formed with a covering portion after being treated with the alkaline aqueous solution.
Fig. 4 represents a shape of a leading end portion of a conductive fiber of Comparative Example 1 formed with a covering portion without treating an untreated fiber with an alkaline aqueous solution.
Fig. 5 represents a shape of a leading end portion of a brush fiber of Example 2 treated with an alkaline aqueous solution and thereafter further formed with a covering portion.
Fig. 6 represents a shape of a leading end portion of a brush fiber of Example 3 treated with an alkaline aqueous solution and thereafter further formed with a covering portion.

DESCRIPTION OF EMBODIMENTS

[0017] The inventors of the present invention considered that a synthetic fiber is likely to generate a static electric charge so that it causes a difficulty in detaching retained fine particles from the synthetic fiber and in turn causes a difficulty in transferring the fine particles to an object. Based on this study, the inventors conceived of providing conductivity to a synthetic fiber to have abilities to retain fine particles and transfer the retained fine particles to an object.

[0018] Therefore, the inventors attempted to fabricate a tapered fiber having conductivity by mixing carbon as a conductive substance and material of a synthetic fiber, melt-spinning the mixture, and allowing the fiber to undergo alkaline dissolution. However, as a result of this attempt, the inventors found that allowing the synthetic fiber kneaded with a conductive substance to undergo alkaline dissolution causes a dissolved part to curve so that the fiber is rendered to have an unsuitable shape as a brush fiber.

[0019] Therefore, the inventors conducted further study to find a method for providing conductivity to a fiber and shaping the fiber to be tapered, other than the method of kneading a conductive substance. As a result of diligent study, the inventors found that a tapered fiber having conductivity can be manufactured with a favorable yield by processing a fibrous core portion having a substantially equal diameter in the length direction to have a tapered shape and then forming a conductive covering portion on the surface of the core portion. Consequently, the inventors have completed the present invention.

[0020] In the following, a brush fiber, a brush, and a method for manufacturing a brush fiber according to the present invention will be described in detail with reference to an example of the embodiment.

<Brush Fiber>

[0021] An example of the embodiment of the brush fiber according to the present invention will be described.

[0022] In the present embodiment, the brush fiber includes a fibrous core portion and a covering portion made of conductive material and provided on a surface of the core portion. One end of the fiber has a tapered shape.

[0023] The covering portion made of conductive material is formed on the surface of the brush fiber, so that the brush fiber can have conductivity. Therefore, as compared to conventional synthetic fibers, generation of static electricity can be suppressed. Further, the brush fiber has a tapered shape. Therefore, for example, a favorable texture can be achieved when the brush fiber is used for a cosmetic brush. Further, for example, fine drawing can be achieved when drawings such as characters and pictures are depicted on a touch panel with the brush using the conductive fiber.

[0024] Further, as a result of diligent study, the inventors found that the brush fiber having a tapered shape improves the self-discharging feature of the brush fiber. Thus, as compared to conventional synthetic fibers, the brush fiber can further suppress generation of static electricity, and the improved self-discharging feature allows for removing the generated static electricity. Therefore, for example, when the brush fiber is used for a cosmetic brush, fine particles such as cosmetic powder can be retained and efficiently transferred to the skin.

[0025] In the brush fiber, a gradient of the tapered shape is not particularly limited, but it is preferable that the sectional area of the leading end portion of one tapered end is sufficiently small. A diameter of the brush fiber is also not specifically limited and can be suitably selected in accordance with a type of brush to be used. For example, the diameter of the

cross section of one end on the tapered leading end is preferably equal to or less than 10 μm in light of a favorable texture and an enhanced self-discharging feature, and more preferably the leading end is sharpened. Further, a length of the brush fiber is also not particularly limited and can be suitably selected in accordance with a type of brush to be used.

[0026] Further, the surface electricity resistance value of the brush fiber is preferably equal to or greater than 10^{-1} Ωcm and equal to or less than 10^{9} Ωcm. When the surface electricity resistance value is within the range described above, the self-discharging feature of the brush fiber tends to be further enhanced. Further, the surface electricity resistance value is preferably equal to or greater than 10^{1} Ωcm and equal to or less than 10^{8} Ωcm, and more preferably equal to or greater than 10^{2} Ωcm and equal to or less than 10^{6} Ωcm.

[0027] Next, respective configurations of the core portion and the covering portion constituting the brush fiber will be described in detail.

(Core Portion)

[0028] The core portion constituting the brush fiber is base material forming a shape of the brush fiber. Therefore, the core portion is fibrous and has one end with a tapered shape. Since the covering portion is formed thinly on the surface of the brush fiber, the shape of the brush fiber is not significantly different from the shape of core portion, and inherits the shape of the core portion. Thus, a favorable gradient, diameter, and length of the tapered shape of the core portion are substantially the same as those of the brush fiber.

[0029] The core portion is made of a non-conductive synthetic fiber and is specifically made of one type of synthetic fiber selected from the group consisting of a polyester synthetic fiber, an acrylic synthetic fiber, and a polyamide synthetic fiber. As a polyester synthetic fiber, it is preferable to employ polybutylene terephthalate and polyethylene terephthalate. As an acrylic synthetic fiber, it is preferable to employ acrylonitrile and a modacrylic fiber manufactured by Kaneka Corporation. Further, as a polyamide synthetic fiber, it is preferable to employ nylon 6, nylon 66, and nylon 612. Among these fibers, polybutylene terephthalate is preferable in that it has a sufficient resilience.

(Covering Portion)

[0030] The covering portion constituting the brush fiber is provided on the surface of the core portion. To obtain high conductivity with a stability and a favorable yield, it is preferable to cover the entire region of the surface of the core portion. As described above, since the covering portion is formed thinly on the surface of core portion, it does not affect the shape of the core portion.

[0031] The covering portion is made of conductive material, and more specifically made of a sulfide of at least one type of metal selected from the group consisting of Cu, Ag, and Pd, or plated metal of at least one type of metal selected from the group consisting of Cu, Ag and Ni. Among these materials, it is preferable to select a copper sulfide, which is a sulfide of Cu, in light of a difficulty in peeling off and a low reactivity with oxygen after being formed. Having such a covering portion enhances an additional antibiotic feature of the brush fiber.

(Other)

[0032] Further, the brush fiber may include bonding material such as a silane coupling agent. For example, placing the silane coupling agent between the core portion and the covering portion produces strong bonding between the core portion and the silane coupling agent and between the covering portion and the silane coupling agent. Therefore, peeling of the covering portion can be suppressed efficiently, thus durability of the brush fiber can be improved.

[0033] The brush fiber according to the present embodiment described above in detail may have conductivity and a tapered shape. Therefore, as compared to the conventional synthetic fibers, generation of static electricity can be suppressed, and a favorable texture can be achieved. Thus, for example, the brush fiber can be used in place of animal hair for a cosmetic brush. Further, for example, when characters and pictures are depicted on a touch panel with the brush using the conductive fiber, a fine drawing can be achieved. Thus, for example, the brush fiber can be used as a conductive brush pen capable of achieving a fine brush-like touch to the touch panel and the like.

[0034] Further, since the tapered shape of the brush fiber produces a high self-discharging feature, fine particles retained by the brush fiber can be readily detached. Thus, for example, when the fiber is used for a cosmetic brush, the ability to transfer fine particles such as powder to the skin is improved. Further, as described above, there has been a problem that the fiber is curved when the synthetic fiber kneaded with a conductive substance undergoes alkaline dissolution. However, according to the brush fiber of the present embodiment, a tapered shape with a constant gradient can be achieved without any curve formed in the fiber. Thus, a sufficient resilience can be maintained.

<Method for Manufacturing a Brush Fiber>

[0035] An example of the embodiment of a method for producing a brush fiber according to the present invention will be described.

(Step of Preparing a Core Portion)

[0036] Firstly, a fibrous core portion is prepared. The core portion is made of a non-conductive synthetic fiber. The fibrous core portion made of a synthetic fiber is formed by, for example, melt-spinning.

[0037] As a synthetic fiber, one type selected from the group consisting of a polyester synthetic fiber, an acrylic synthetic fiber, and a polyamide synthetic fiber is used. Specifically, as a polyester synthetic fiber, it is preferable to employ polybutylene terephthalate and polyethylene terephthalate. As an acrylic synthetic fiber, it is preferable to employ acrylonitrile and a modacrylic fiber of Kaneka Corporation. As a polyamide synthetic fiber, it is preferable to use nylon 6, nylon 66, and nylon 612. Among these fibers, it is preferable to employ polybutylene terephthalate capable of being dissolved promptly and forming a tapered shape having a constant gradient.

[0038] The length of the core portion is not particularly limited, and the length can be suitably set in accordance with the type of brush to be used. Further, the diameter of the core portion is preferably equal to or less than 500 μm, and more preferably equal to or less than 200 μm in light of a texture and fineness. Further, in light of easiness in handling, it is preferable that the diameter is equal to or greater than 50 μm.

[0039] Further, the method for forming a core portion is not limited to the melt-spinning. For example, the core portion may be formed by fabricating a polyester film and cutting the same finely.

(Step of Immersing in Alkaline Solution)

[0040] Next, the leading end portion on one end of the core portion is immersed in an alkaline solution.

[0041] The alkaline solution may be an alkaline aqueous solution, an organic solvent, and the like. For example, when an alkaline aqueous solution is used, the leading portion on one end of the core portion is immersed in a sodium hydroxide solution of 30 mass % with a liquid temperature of approximately 60°C for 6-12 hours. Further, heated dimethylformamide (DMF) and heated phenolic solvent may be used favorably as an organic solvent in the case of a polyester synthetic fiber. Acetone and DMF can be used favorably in the case of an acrylic synthetic fiber. A phenolic solvent can be used in the case of a polyamide synthetic fiber.

[0042] In this step, a capillary action causes the alkaline solution to rise from the one end of the immersed core portion to the other end along the surface of the core portion. This causes the surface of the core portion along which the alkaline solution moves to be dissolved by the alkaline solution. At this time, greater amount of alkaline solution is moved as it comes closer to the leading end on one end of the immersed fiber. Therefore, the fiber is dissolved in such a manner that the diameter of the cross section of leading end portion on one end of immersed fiber becomes smaller (in other words, thinner), and the diameter of the cross section becomes larger (in other words, more thicker) as it moves toward the other end. Consequently, the tapered core portion can be formed.

[0043] In this step, the leading end of the tapered shape can be sharper as the immersing time is longer. Further, as the liquid temperature of the alkaline solution is higher, or as the density of the alkaline solution is higher, the core portion can be dissolved more promptly. The diameter of the cross section of the tapered leading end is preferably equal to or less than 10 μm in light of the texture and fineness, and it is more preferable that the cross section is not present, in other words, it has the shape with a sharpened leading end portion.

(Step of Washing)

[0044] Next, the core portion is washed after immersing.

[0045] For example, the core portion can be washed by being immersed in a washing liquid. Alternatively, the washing liquid may be poured on the core portion. The washing liquid may be an acid aqueous solution containing water, citric acid, acetic acid, formic acid, and sulfuric acid. Further, after the washing, it is preferable to dry the core portion.

[0046] With this step, the alkaline solution adhered to the surface of core portion can be removed by washing. Therefore, dissolution of the core portion can be stopped promptly. The degree of dissolution can be controlled by adjusting the density, the temperature, and the immersing time of the alkaline solution. Furthermore, for example, the degree of dissolution can be controlled also by performing this step after taking the core portion out from alkaline solution and leaving the core portion for a predetermined time period.

(Step of Forming a Conductive Portion)

[0047] Next, a conductive portion made of conductive material is formed on the surface of the core portion.

[0048] For example, this step can be conducted by immersing the core portion in a treatment bath accommodating a treatment liquid of a water solution containing copper salt and thiosulfate. It is preferable that the density of copper salt in the treatment liquid is equal to or greater than 5 mass % and equal to or less than 15 mass % with respect to the mass of the core portion, and the density of the thiosulfate is preferably equal to or greater than 5 mass % and equal to or less than 15 mass % with respect to the mass of the core portion. The temperature of the treatment liquid and the immersing time are not particularly limited and can be changed suitably.

[0049] Further, for example, the core portion may be immersed in a treatment bath accommodating a treatment liquid of a water solution containing a copper sulfide and a reductant agent. The density of copper sulfide in the treatment liquid is preferably equal to or greater than 10 mass % and equal to or less than 13 mass % with respect to the mass of the core portion, and the density of the reductant agent in the treatment liquid is preferably equal to or greater than 10 mass % and equal to or less than 13 mass % with respect to the mass of the core portion. The temperature of the treatment liquid and the immersing time is not particularly limited and can be changed suitably. Further, the reductant agent can be sodium thiosulfate ($Na_2S_2O_3$).

[0050] With this step, a covering portion made of a copper sulfide can be formed on the surface of the core portion immersed in the treatment liquid. The conductive material is not limited to the copper sulfide. For example, a sulfide of Ag (silver sulfide) and a sulfide of Pd (palladium sulfide) can be used, and also plated metal of at least one type of metal selected from the group consisting of Cu, Ag and Ni can be used. The covering portion of plated metal can be formed by known plating methods. However, in light of difficulty in peeling and low reactivity with respect to oxygen after being formed, it is preferable to use a copper sulfide.

[0051] Further, the surface electric resistance value of the brush fiber according to the present embodiment is preferably equal to or greater than 10^{-1} Ωcm and equal to or less than 10^{9} Ωcm. When the surface electric resistance value is within the range described above, the self-discharging feature of the brush fiber tends to be high. Thus, it is preferable to adjust the density and the thickness of the covering portion so that the surface electric resistance value of the brush fiber falls within the range described above. Further, the surface electric resistance value is preferably equal to or greater than 10^{1} Ωcm and equal to or less than 10^{8} Ωcm, and more preferably equal to or greater than 10^{2} Ωcm and equal to or less than 10^{6} Ωcm.

[0052] In any of the methods described above, an additional adjuvant such as a pH adjuster can be added to the treatment liquid. The pH adjuster may be, for example, an organic acid such as an acetic acid and a citric acid. Further, to retain the reducing condition in the treatment liquid, a weak reductant agent such as bisulfite soda, sulfite soda, and hypophosphorus soda can be used. Further, the additional adjuvant may be added to a bath other than the treatment bath accommodating the treatment liquid to immerse the core portion in each bath sequentially.

[0053] With the step described above, the brush fiber including a fibrous core portion and a covering portion made of conductive material and provided on the surface of the core portion and having a tapered shape on one end side can be manufactured conveniently with a favorable yield.

[0054] According to the method for manufacturing a brush fiber of the present embodiment as described above, the covering portion having conductivity is formed on the surface of the core portion formed to have a tapered shape. In this case, for example, a homogeneous tapered shape can be formed without causing a curve in a fiber generated when the synthetic fiber kneaded with the conductive substance is applied with the alkaline dissolution. Further, the core portion as the base material has a homogeneous tapered shape, so that the covering portion formed on the surface can be also homogeneous. Thus, according to the manufacturing method of the present embodiment, the brush fiber suitable for the fiber of a brush can be manufactured conveniently with a favorable yield.

<Brush>

[0055] An example of the embodiment of the brush according to the present invention will be described.

[0056] In the present embodiment, the brush uses the brush fiber according to the present invention. Specifically, it is preferable that 1 or more volume % of the fiber bundle constituting the brush is the above-described brush fiber. Since at least 1 volume % of the fiber bundle constituting the brush is the above-described brush fiber described above, sufficient conductivity and self-discharging feature can be obtained. Further, since the above-described brush fiber has a tapered shape, the brush of the present embodiment can have a resilience and a favorable texture and enables a finer touch.

[0057] The remaining 99 volume % or less of the fiber bundle may be, for example, animal hair. Animal hair have disadvantages that they are unsanitary, not suitable for repeated washing, and difficult to collect. However, with the brush using the brush fiber described above, such disadvantageous can be suppressed. Further, the remaining 99 volume % or less of the fiber bundle may be, for example, conventional synthetic fibers. The conventional synthetic

fibers are disadvantageous in that they are likely to generate static electricity and have low resilience due to the curve. On the other hand, the brush using the brush fiber described above can suppress the generation of static electricity and strengthen the resilience.

[0058] Further, the remaining 99 volume % or less of the fiber bundle may be constituted by tapered core portions produced on the course of manufacturing the brush fiber and not formed with a covering portion. In other words, the remaining fiber bundle may be constituted by tapered non-conductive fibers. The brush, also in this case, may have sufficient conductivity and self-discharging feature. Further, in this case, all of the fibers constituting the fiber bundle are configured to have homogeneous tapered shape, so that texture can be further improved, and a finer touch is possible, and the resilience can be further strengthened.

[0059] As described above, the brush has conductivity and a tapered shape, so that it provides a good texture and fineness, and can have enhanced self-discharging feature. Thus, the brush according to the present embodiment, for example, can be preferably used as a cosmetic brush. Further, fine depiction on a touch panel can be achieved.

EXAMPLES

[0060] In the following, the present invention will be described in more detail with examples, but the present invention is not limited to the examples.

<Study 1>

[0061] In Study 1, the study was conducted using untreated fibers of polybutylene terephthalate having various diameters. In the following, the untreated fibers correspond to melt-spun fibers which have not been applied with treatment by the alkaline solution and not formed with a covering portion.

(Example 1)

[0062] First, untreated fibers each having the diameter of 0.15 mm and the length of 50 mm and made of polybutylene terephthalate were provided, and the leading end portion on one end of the fiber was immersed in sodium hydroxide of 30 mass % for 6 hours, where the liquid temperature adjusted to be 60°C. Then, the fiber taken out from the sodium hydroxide water solution was immersed and washed in a water bath and then dried with hot air of 60-100°C. Accordingly, a non-conductive fiber having a tapered shape and made of polybutylene terephthalate was fabricated.

[0063] Next, the fiber described above was immersed in a treatment bath accommodating a water solution containing a copper sulfide and a thiosulfate sodium as a reductant agent to form a conductive covering portion on the surface of the fiber. The density of the copper sulfide in the water solution was 12 mass % with respect to the mass of the fiber, and the density of the reductant agent in the water solution was 13 mass % with respect to the mass of fiber. Then, the fiber was taken out from the treatment bath and dried with hot air of 80°C. With the treatment above, the brush fiber having a tapered shape was fabricated.

[0064] Then, 0.45g of untreated fibers and 0.05g of the fabricated brush fibers having a tapered shape are mixed while aligning the tapered leading end portions to form a fiber bundle of 0.5g, and the other ends were bundled to form a brush. In other words, on the leading end portions not bundled of the brush mixedly included one non-tapered end of untreated fiber (non-conductive) and one tapered end of the brush fiber having a tapered shape.

(Comparative Example 1)

[0065] Without immersing the untreated fibers described above in the sodium hydroxide water solution, the untreated fiber was immersed in the treatment bath described above and dried to fabricate linear, in other words, non-tapered conductive fibers. The composition and the drying processing of the aqueous solution in the treatment bath were similar to those of Example 1. Then, 0.45g of untreated fibers and 0.05g of fabricated non-tapered conductive fibers were used to fabricate the brush in accordance with the method similar to the Example 1.

(Electrical Neutralization Test)

[0066] The electrical neutralization test was conducted using the fabricated brush.

[0067] Specifically, a charging device (manufactured by Kasuga Electric Works Ltd.: KTB-15) was used to apply the voltage of 9 kV to an acrylic resin plate to charge the surface of the acrylic plate with negative static electricity. Then, a static electricity measuring instrument (SIMCO JAPAN Kabushiki Kaisha: FMX-002) was arranged at a position separate by 2 cm in perpendicular from the back surface of the acrylic resin plate, and the surface of the acrylic resin plate was brushed 3 times with each brush of Example 1 and Comparative Example 1. Then, the static electricity on the surface

of the acrylic resin plate before and after brushing with each brush was measured by the static electricity measuring instrument. The measurement of the static electricity was conducted under the environment of 25°C and 45% relative humidity.

[0068] Further, the charging device was used to apply the voltage of 9 kV to the vinyl chloride plate to charge the surface of the vinyl chloride plate with the positive static electricity. Then, the static electricity measuring instrument was arranged at a position separated by 2 cm in perpendicular from the back surface of the vinyl chloride plate, and then the surface of the vinyl chloride plate was brushed three times by each brush of the Example 1 and Comparative Example 1. Then, the static electricity on the surface of the vinyl chloride plate before and after brushing with each brush was measured by the static electricity measuring instrument.

(Result of the Study)

[0069] Fig. 1 shows a shape of the leading end portion of the untreated fiber in Example 1. Fig. 2 shows a shape of the leading end portion of the tapered fiber in Example 1 after being treated with the alkaline aqueous solution. Fig. 3 shows a shape of the leading end portion of the brush fiber in Example 1 treated with the alkaline aqueous solution and formed with the covering portion. Further, Fig. 4 shows a shape of the leading end portion of the conductive fiber formed with the covering portion without applying with the treatment of alkaline aqueous solution with respect to a treated fiber in Comparative Example 1. Each of Figs. 1-4 shows the end portion of each fiber with enlargement by a factor of 300 with use of a microscope.

[0070] With reference to Fig. 1, in the leading end portion of the untreated fiber, A1 was 144 μm, and A2 was 148 μm. As described above, the leading end portion of the untreated fiber was not tapered. On the other hand, at the leading end portion of the tapered fiber after being treated with the alkaline aqueous solution of Fig. 2, B1 was 33 μm, and B2 was 11 μm. Therefore, it was confirmed that the treatment with use of the alkaline aqueous solution changes the leading end of the fiber to be tapered. Further, with reference to Fig. 3, in the brush fiber, it was confirmed from the change of color that the covering portion was formed on an entire region of the surface of the fiber. Further, it was also confirmed that C1 was 70 μm, C2 was 22 μm, and the tapered shape of fiber (core portion) was inherited.

[0071] Table 1 shows the type and composition amount (%) of the fiber used in Example 1 and Comparative Example 1 and the result of electrical neutralization test (the cases of positive charging and t negative charging). Further, Table 1 shows the result of similar electrical neutralization test using the brush of untreated fiber 100% used in Example 1 as a Reference Example 1. The unit of static electricity is kV.

Table 1

	Type of Fiber			Negative Charging		Positive Charging	
	Untreated Fiber (non-tapered/ non-conductive)	Brush Fiber (tapered/ conductive)	Conductive Fiber (non-tapered/ conductive)	Before Treatment	After Treatment	Before Treatment	After Treatment
Example 1	90%	10%	-	-9.1	-0.2	9.0	0.3
Comparative Example 1	90%	-	10%	-9.7	-1.4	10.2	0.7
Reference Example 1	100%	-	-	-9.5	-4.7	9.7	4.2

[0072] With reference to Table 1, in the brush of Example 1, a high neutralization effect could be obtained. Further, it was confirmed that the brush of Example 1 had a better texture and a finer touch as compared to the brush of Example 1.

(Example 2 and Comparative Example 2)

[0073] Except for using the untreated fiber of polybutylene terephthalate having the diameter of 0.10 mm and the length of 50 mm in place of the untreated fiber of polybutylene terephthalate having the diameter of 0.15 mm and the length of 50 mm, the brushes of Example 2 and Comparative Example 2 were fabricated with the same method as the Example 1 and the Comparative Example 1. Then, the electrical neutralization test was conducted using each brush.

(Example 3 and Comparative Example 3)

[0074] Except for using the untreated fiber of polybutylene terephthalate having the diameter of 0.07 mm and the length of 50 mm in place of the untreated fiber of the polybutylene terephthalate having the diameter of 0.15 mm and the length of 50 mm, the brushes of Example 3 and the Comparative Example 3 were fabricated with the same method as the Example 1 and Comparative Example 1. Then, the electrical neutralization test was conducted using each brush.

(Study Result)

[0075] Fig. 5 shows a shape of the leading end of the brush fiber in Example 2 processed with the alkaline aqueous solution and thereafter formed with the covering portion. Further, Fig. 6 shows a shape of the leading end portion of the brush fiber in Example 3 treated with the alkaline aqueous solution and thereafter formed with the covering portion. Fig. 5 and Fig. 6, similarly to Figs. 1-4, are enlarged views of the leading end portions of the fiber by a factor of 300 using a microscope.

[0076] Referring to Fig. 5 and Fig. 6, in the brush fiber formed with the covering portion, it is confirmed from the change of color that the covering portion was formed on an entire region of the surface of the fiber. Further, D1 was 23 μm, D2 was 8 μm, F1 was 23 μm and F2 was 8 μm. Thus, in the brush fiber, the tapered shape of the fiber (core portion) was inherited.

[0077] Further, Table 2 shows the type and composition amount (%) of the fiber used in Example 2 and Comparative Example 2 and the result of electrical neutralization test (in the case of the positive charging and the case of negative charging). Further, as Reference Example 2, Table 2 shows the result of the similar electrical neutralization test using the brush composed of 100% untreated fiber used in Example 2. Further, Table 3 shows the type and composition amount (%) of the fiber used in Example 3 and Comparative Example 3 and the result of electrical neutralization test (the case of positive charging and the case of negative charging). Further, as Reference Example 3, Table 3 shows the result of the similar electrical neutralization test using the brush of 100% treated fiber used in Example 3.

Table 2

	Type of Fiber			Negative Charging		Positive Charging	
	Untreated Fiber (non-tapered/ non-conductive)	Brush Fiber (tapered/ conductive)	Conductive Fiber (non-tapered/ conductive)	Before Treatment	After Treatment	Before Treatment	After Treatment
Example 2	90%	10%	-	-9.6	-0.3	9.2	0.1
Comparative Example 2	90%	-	10%	-9.0	-0.5	9.1	0.2
Reference Example 2	100%	-	-	-9.0	-8.1	9.7	4.5

Table 3

	Type of Fiber			Negative Charging		Positive Charging	
	Untreated Fiber (non-tapered/ non-conductive)	Brush Fiber (tapered/ conductive)	Conductive Fiber (non-tapered/ conductive)	Before Treatment	After Treatment	Before Treatment	After Treatment
Example 3	90%	10%	-	-9.6	-0.4	9.4	0.9
Comparative Example 3	90%	-	10%	-9.7	-0.7	9.6	1.6
Reference Example 3	100%	-	-	-9.1	-8.1	8.8	7.9

[0078] With reference to Table 2 and Table 3, in the brushes of Example 2 and Example 3, high neutralization effect could be obtained. Further, it was confirmed that the brush of each example had better texture and finer touch as compared to the brushes of Comparative Examples.

[0079] Further, with reference to Table 1 - Table 3, it was found that Examples 1-3 could obtain higher neutralization effect than Comparative Examples 1-3. From this, it could be understood that the neutralization characteristic is improved by the brush fiber having a tapered shape.

<Study 2>

[0080] In the Study 2, the study was conducted using the brush with a tapered shape having varied composition amount (%).

(Examples 4-8)

[0081] In Examples 4-8, firstly, a untreated fiber of polybutylene terephthalate with the diameter of 0.07 mm and the length of 50 mm was prepared, and then the brush fiber with a tapered shape was fabricated by the method similar to the Example 1. Then, the untreated fiber and the fabricated brush fiber with the tapered shape were used to fabricate each brush. In Examples 4-8, the amount (g) of used untreated fibers and the amount (g) of the brush fibers having at the mixing ratio as follows. Then using each brush, the electrical neutralization test was conducted.

Example 4: untreated fiber 0.495g, brush fiber 0.005g

Example 5: untreated fiber 0.40g, brush fiber 0.10g

Example 6: untreated fiber 0.35g, brush fiber 0.15g

Example 7: untreated fiber 0.25g, brush fiber 0.25g

Example 8: untreated fiber 0g (not used), brush fiber 0.5g

(Comparative Examples 4-8)

[0082] In the Comparative Examples 4-8, untreated fiber of polybutylene terephthalate having the diameter of 0.07 mm, and the length of 50 mm was provided and conductive fiber was fabricated with non-tapered shape by the method similar to Example 1. Then, the untreated fiber and the fabricated conductive fiber of non-tapered shape were used to fabricate each brush. In Comparative Examples 4-8, the amount (g) of used untreated fiber and the amount (g) of fabricated conductive fiber of non-tapered shape had the following mixing ratio, and it corresponds to the mixing ratio of the Examples 4-8. Then, using each brush, the electrical neutralization test was conducted.

Comparative Example 4: untreated fiber 0.495g. conductive fiber 0.005g

Comparative Example 5: untreated fiber 0.40g, conductive fiber 0.10g

Comparative Example 6: untreated fiber 0.35g, conductive fiber 0.15g

Comparative Example 7: untreated fiber 0.25g, conductive fiber 0.25g

Comparative Example 8: untreated fiber 0g (not used), conductive fiber 0.5g

(Study Result)

[0083] The type and composition amount (%) of the fiber used in Examples 4-8 and Comparative Examples 4-8, and the result of electrical neutralization test (in the case of positive charging and the case of negative charging) are shown in Table 4. Further, as Reference Examples 4-8, Table 4 shows the result of the similar electrical neutralization test using brush of untreated fiber 100% of polybutylene terephthalate of having the diameter of 0.07 mm and the length of 50 mm are shown.

Table 4

	Type of Fiber			Negative Charging		Positive Charging	
	Untreated Fiber (non-tapered/ non-conductive)	Brush Fiber (tapered/ conductive)	Conductive Fiber (non-tapered/ conductive	Before Treatment	After Treatment	Before Treatment	After Treatment
Example 4	99%	1%	-	-9.3	-0.6	8.9	1.3
Comparative Example 4	99%	-	1%	-9.0	-1.0	9.8	1.8
Reference Example 4	100%	-	-	-9.0	-5.6	8.5	6.9
Example 5	80%	20%	-	-9.8	-0.6	9.6	0.7
Comparative Example 5	80%	-	20%	-10.1	-0.8	10.4	1.0
Reference Example 5	100%	-	-	-10.2	-7.6	8.9	8.1
Example 6	70%	30%	-	-9.8	-0.4	10.8	0.4
Comparative Example 6	70%	-	30%	-9.4	-0.7	10.5	0.7
Reference Example 6	100%	-	-	-9.6	-9.4	10.2	7.8
Example 7	50%	50%	-	-8.7	-0.2	9.4	1.5
Comparative Example 7	50%	-	50%	-8.7	-0.9	9.1	2.2
Reference Example 7	100%	-	-	-9.0	-5.8	9.7	5.3
Example 8	-	100%	-	-9.6	-0.1	9.8	0.2
Comparative Example 8	-	-	100%	-9.9	-0.2	9.0	1.1
Reference Example 8	100%	-	-	-9.1	-6.1	9.4	4.4

[0084] Referring to Table 4, based on the results of Examples 4-8, it was found out that the brush has a high self-discharging feature if the brush has at least equal to or greater than 1 mass % of brush fiber as conductive fiber with the tapered shape.

[0085] The embodiments and the examples disclosed herein are examples and should be considered not limiting. The scope of the present invention was shown not in the description above but in the claims of the invention, and it is intended to include all the modifications within the claims and equivalent meaning.

INDUSTRIAL APPLICABILITY

[0086] The present invention can be used for brushes of cosmetics and depiction on touch panel.

Claims

1. A brush fiber, comprising:

   a fibrous core portion;
   a covering portion provided on a surface of said core portion, wherein
   a leading end portion of said core portion has a tapered shape, and said covering portion is made of conductive material.

2. The brush fiber according to claim 1, wherein said core portion is made of one type of synthetic fiber selected from the group consisting of a polyester synthetic fiber, an acrylic synthetic fiber, and a polyamide synthetic fiber.

3. The brush fiber according to claim 1, wherein said conductive material is made of a sulfide of at least one type of metal selected from the group consisting of Cu, Ag, and Pd or plated metal of at least one type of metal selected from the group consisting of Cu, Ag, and Ni.

4. The brush fiber according to claim 1, wherein said core portion is made of polybutylene terephthalate, and said conductive material is made of a sulfide of Cu.

5. The brush fiber according to claim 1, wherein a surface electricity resistance value of said brush fiber is equal to or greater than 10^{-1} Ωcm and equal to or less than 10^{9} Ωcm.

6. A brush using the brush fiber according to claim 1.

7. The brush according to claim 6, wherein equal to or greater than 1 volume % of a fiber bundle constituting said brush is said brush fiber.

8. A method for manufacturing a brush fiber, comprising the steps of:

   immersing a leading end portion of a fibrous core portion in an alkaline solution;
   washing said core portion after immersing; and
   forming a conductive portion made of conductive material on a surface of said core portion after washing.

FIG.1

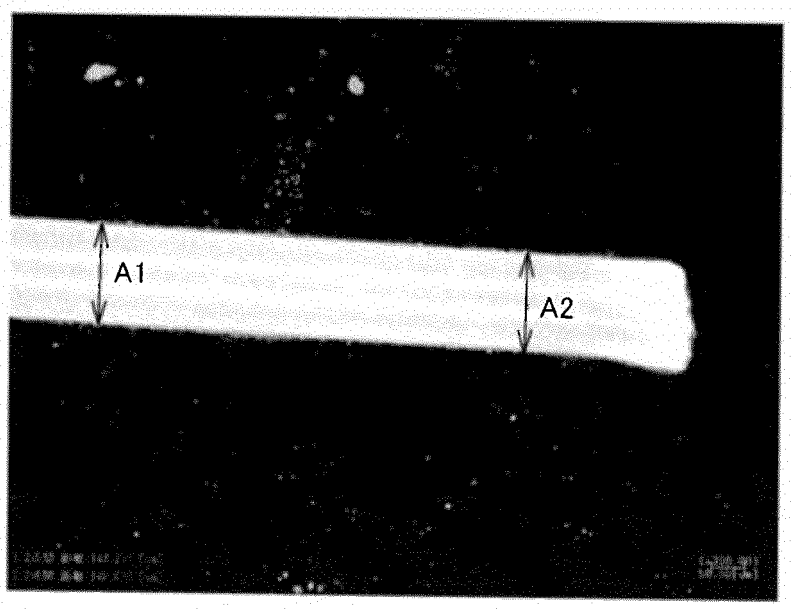


FIG.2

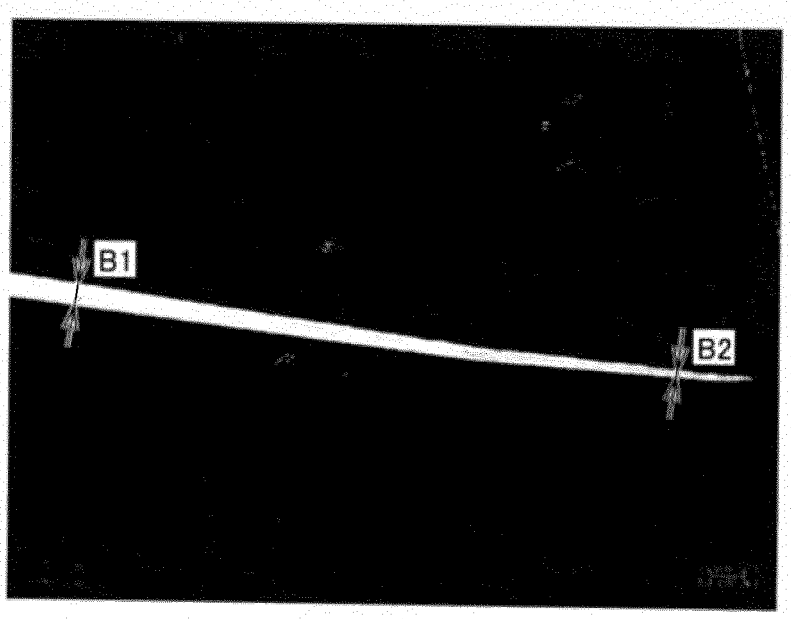


FIG.3

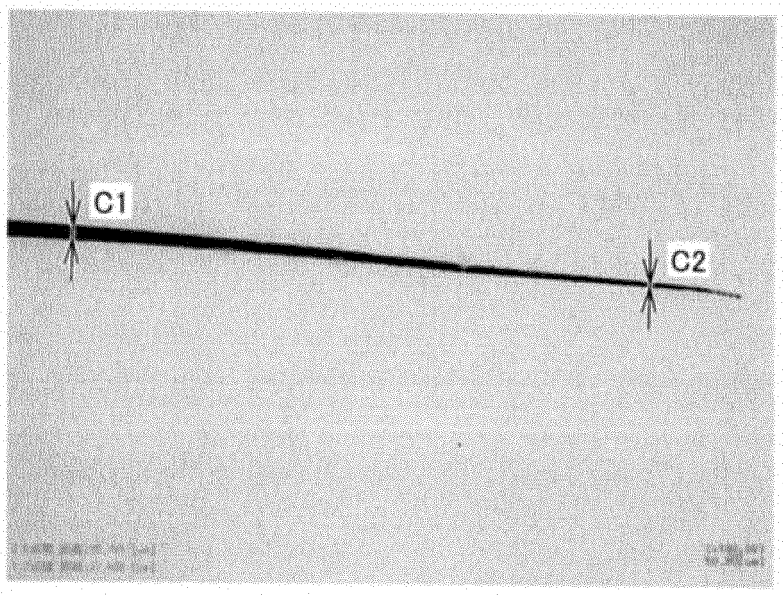


FIG.4

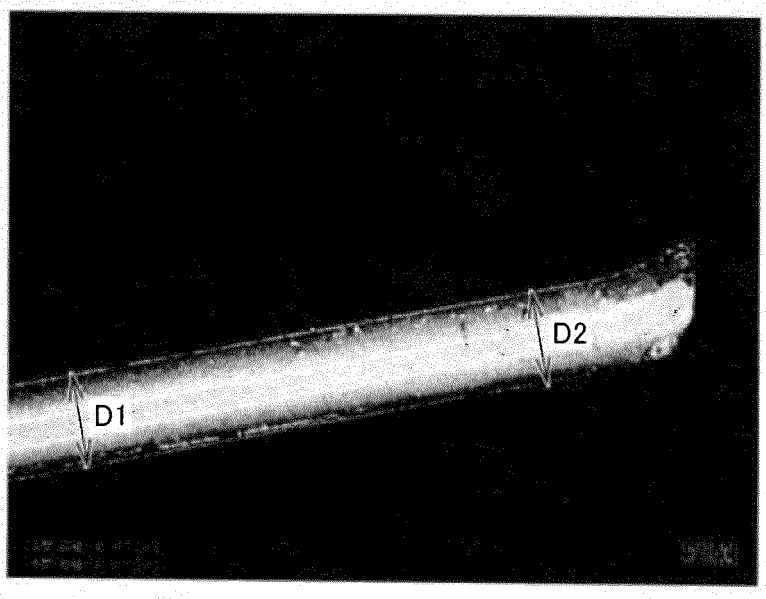


FIG.5

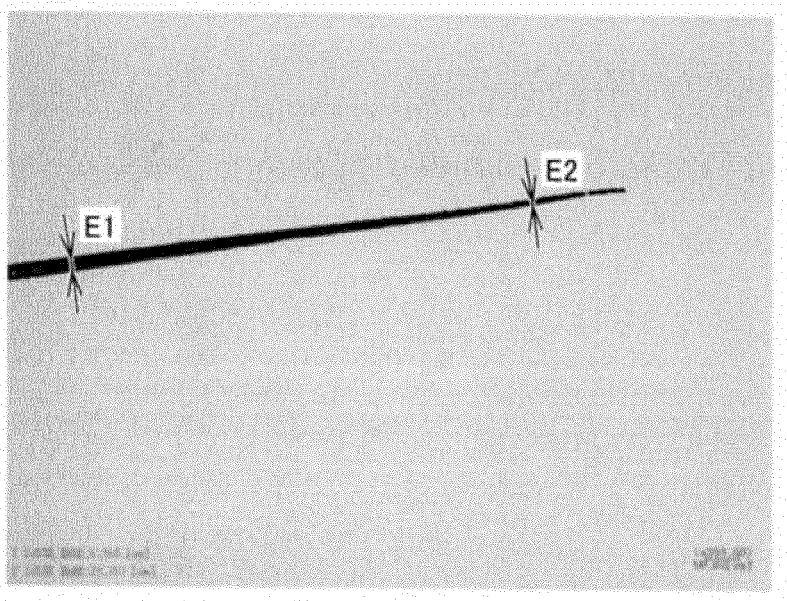
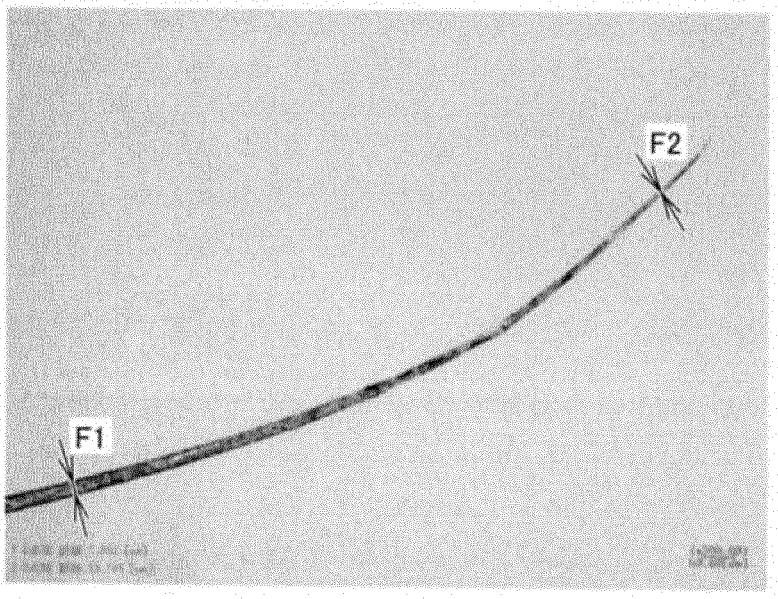


FIG.6



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/066019

A. CLASSIFICATION OF SUBJECT MATTER
A46D1/05(2006.01)i, *A46D1/00*(2006.01)i, *D06M11/00*(2006.01)i, *D06M11/38*(2006.01)i, *D06M11/51*(2006.01)i, *D06M11/83*(2006.01)i, *D06M101/26*(2006.01)n, *D06M101/32*(2006.01)n, *D06M101/34*(2006.01)n
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)
A46D1/00-99/00, A46B1/00-17/08, D06M11/83

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2012
Kokai Jitsuyo Shinan Koho	1971-2012	Toroku Jitsuyo Shinan Koho	1994-2012

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 11-235230 A (Kenji NAKAMURA), 31 August 1999 (31.08.1999), paragraphs [0024] to [0025] (Family: none)	1-8
Y	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 80757/1992(Laid-open No. 44428/1994) (Nihon Sanmo Dyeing Co., Ltd.), 14 June 1994 (14.06.1994), paragraphs [0004], [0010] (Family: none)	1-8

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
20 July, 2012 (20.07.12)	07 August, 2012 (07.08.12)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/066019

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 62-299566 A (Kuraray Co., Ltd.), 26 December 1987 (26.12.1987), page 2, lower left column, line 20 to page 3, upper left column, line 10; table 1 (Family: none)	4-8
A	JP 2-41140 A (Nihon Sanmo Dyeing Co., Ltd.), 09 February 1990 (09.02.1990), page 2, upper right column, line 13 to lower right column, line 20 (Family: none)	1-8

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2008109990 A **[0003] [0004]**