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(54) METHOD FOR IMPROVING FELTING PROPERTIES OF ANIMAL FIBRES BY PLASMA TREATMENT

VERFAHREN ZUR VERBESSERUNG DER FILZEIGENSCHAFTEN VON TIERFASERN MITTELS PLASMABEHANDLUNG

PROCÉDÉ POUR AMÉLIORER LES PROPRIÉTÉS DE FEUTRAGE DE FIBRES ANIMALES PAR UN TRAITEMENT AU PLASMA

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Description

Technical field

[0001] The invention relates to a method for improving felting properties of animal fibres using a nonthermal plasma process. The invention is particularly concerned with the manufacture of felt hat bodies.

Background Art

[0002] It is well known that a collection of animal fibres moved vigorously in water is subject to felting. Felting provides both desirable and undesirable properties to fibres; valuable in contexts where it is desirable to close up the texture and increase the bulkiness of the cloth (i.e., hats), but objectionable in woolen garments which are washed frequently and for which shrinkage would make the article less desirable or unusable.

[0003] It is generally accepted, see for example US patents USP 2,961,347, USP 7,090,701, USP 6,258,129, USP 6,140,109, US 6,099,588, P. Erra et al: Textile Research Journal 69(1999) 811-815, that a reduction in shrinkage implies a reduction in felting, and thus all methods that provide improved shrink-resistance also provide "anti-felting" properties.

[0004] In contrast to the undesirable felting in the laundering of fabrics made of animal fibres, the felting as a desirable process allows one to shape loose animal fibres into dense felt material which has desirable applications. According to T.J.Gillick: "Natural and Synthetic Fiber Felts" Ind. Eng. Chem. 51(1959) 904-907 the felt is defined as fabric made of matted fibres of wool, or wool and fur and hair fulled or wrought into a compact material by rolling or pressure, with lees or sizing, without spinning or weaving. In all cases felt materials result from interfiber friction or entangling without other nonfibrous additives.

[0005] Three main classes of animal fiber felts are in use today: fur, hair, and wool. Fur felt usage is confined mostly to the hat industry. Fur felt hats are chiefly made of rabbit fur. Some hare fur, preferably beaver fur, is used to make better hats, and is often mixed with rabbit fur to produce hats in various medium price grades. The prime factors in the quality of fur felt are the quality of the fur used and how tightly it is worked together in the felting process. The problem is that the felting qualities of untreated animal fibres are in general inadequate for such purposes as the production of hats. For example, rabbit fur that is usually used to make felt hats has been unsatisfactory as a material for making hats.

[0006] To produce desired felting characteristics the practice for many years has consequently been to subject the rabbit fur to a chemical treatment, see H.G. Froenlich:"The chemical action of carroting agents on fur" Journal of the Textile Institute Transactions 51(1960)T1237 - T1246 and USP 2,770,519 which is commonly termed carroting because of the orange color of the solution to produce desired felting characteristics. The carroting causes split ends and curling hairs which help in the felting process.

[0007] As described, for example, in GB695135 and GB573180, the standard carroting reagents are concentrated sulphuric and nitric acids, chloric acid, used either singly or in combination, to which may be added hydrogen peroxide and potassium permanganate as oxidizing agents.

[0008] Usually the carroting is done prior to separation of the fur from the skin by brushing a suitable carroting solution on the fur. After drying the rabbit pelts are then fed through a cutting machine, and the fur is sheared from the skin. Then the carroted fur is processes into felt by felting.

[0009] The described procedure typically requires hand operation and is a slow procedure. Moreover, carrot solutions are corrosive and irritate skin and lung. For a long time many attempts have been made to do away with the complicated, time consuming and expensive procedure of treating the hairs by brushing the solution on the fur, and to eliminate the manipulations required for this purpose by replacing said process by a pot-carroting process.

[0010] This latter process consists in cutting off the fur in the uncarroted state from the pelt, impregnating it by immersing the fur fibres in a loose condition into a carroting solution, then removing the excess moisture and drying the fur. Similarly as in the standard carroting prior to separation of the fur from the skin, the handling of aggressive carroting solutions during the pot-carroting and the subsequent fur drying create technical and environmental problems. Even more serious, however, is the fact that the fur fibres thus treated do not exhibit satisfactory felting properties and are not very suitable for the manufacture of hats. For this reason, such cut carroted fur fibres can generally be used only in mixture with a large percentage of fur fibres which have been carroted before shearing while still on the skin.

[0011] To avoid the dangers inherent in handling aggressive and corrosive liquids and also to avoid the energy consuming fur drying several attempts have been made to carrot fur by dry chemical processing as described, for example in Canadian patent CA425713, GB patent GB573180, US patents US2321775 and US2414955, but these have for various reasons not come into general use.

[0012] The known wet and dry carroting methods are based on the use of oxidizing, reducing, strongly acid or strongly basic chemicals, all of which are detrimental to the strength of fur fibres. There is therefore a continuing need for the development of more environmentally benign and cost-effective dry processes to improve felting qualities of animal fibres, without damaging the fibres and, consequently, reducing strength of the felt.

[0013] Nonthermal plasma treatment is a well known dry and environmentally benign technique that has been used in different manufacturing processes to improve surface characteristics of polymer materials including

surface modifications of animal fibres: According to the document E. I. Bureau: IPPC Reference Document on Best Available Techniques for the Textile Industry (European Commission, Directorate General JRC, Seville 2003) low temperature plasma is regarded as an emerging technique when used to achieve the effect of an anti-felt finishing in wool and it is one of the most studied applications of plasma technology in the textile sector. The current state of the art is reviewed in a detailed manner by R. Morent et al.: Surface & Coatings Technology 202 (2008) 3427-3449 on pp. 3443-3444.

[0014] The rationale for this extensive research is the generally accepted opinion that a plasma treatment considerably reduces the felting potential for any product obtained from the plasma treated wool, see H. Thomas: "Plasma modification of wool" in Plasma Technologies for Textiles, Woodhead Publishing Ltd., Cambridge 2007, pp. 228-246, A. Fridman: "Plasma Chemistry", Cambridge University Press 2008, pp. 647-648, and Rakowski in Journal of the Society of Dyers and Colourists 111(1998)250-255. Numerous examples of such anti-felting effects of the plasma treatment on animal hair materials include those in WO 2004070106, WO 9904083; USP, 6,258,129, USP 6,242,059, USP 6,103,068, USP 5,160,592, EP 1437437, EP 1010799, EP 1367172, EP 1437437, JP 2002180371, JP 2003278080, JP 1092483, JP 9170169, Japanese Patent Application Tokkai Hei 4-327274A, CN 101177915, CN 101153459, W.J. Thorsen: Textile Research Journal 38 (1968) 644-650, Hesse et al.: Textile Research Journal 65 (1995) 355-361, C. Canal et al.: Eur. Phys. J. Appl. Phys. 36, 35-41 (2006), Zaisheng Cai and Yiping Qiu: Journal of Applied Polymer Science 107(2007)1142 - 1146. According to M. Mori and N. Inagaki Textile Research Journal 76(2006) 687-694 the well-known anti-felting effects of the plasma treatment on animal hair materials are due to a cohesive force that is exerted between the plasma treated fiber surfaces. This result in a decrease of the unidirectional movement of individual wool fiber in fiber assemblage, and therefore, the anti-felting property is imparted into the fibres by plasma treatment.

[0015] Contrary to the above referred and many other published results concluding that the plasma treatment of animal fibres in general reduces the felting of animal fibres, there is no report in the open literature indicating an increasing the fiber felting properties using a plasma treatment as a step preparatory to felting.

[0016] In practicing the invention, the reference is made to the following:

> Discharge plasma sources applied for the treatment of animal fibres are reviewed, for example, in R. Morent et al.: Surface & Coatings Technology 202 (2008) 3427-3449 on pp. 3443-3444.

[0017] The plasma sources generating plasmas at near-atmospheric-pressures are reviewed, for example, in U. Kogelschatz: "Atmospheric-pressure plasma technology" Plasma Phys. Control. Fusion 46 (2004) B63-B75 and Yu. Akishev et. al:" Novel AC and DC Non-Thermal Plasma Sources for Cold Surface Treatment of Polymer Films and Fabrics at Atmospheric Pressure" Plasmas and Polymers 7(2002)261-289.

[0018] The Diffuse Surface Dielectric Barrier Discharge (DCSBD) is described, for example, in EP 1 387 901 and M. Simor et. al.:"Atmospheric-pressure diffuse coplanar surface discharge for surface treatments" Appl. Phys. Lett., 81(2002) 2716-2718.

[0019] Surface Dielectric Barrier Discharge (SDBD) is described, for example, in US patent US 5,792,517 and L. Cernakova et al.:" Surface Modification of Polypropylene Non-Woven Fabrics by Atmospheric-Pressure Plasma Activation Followed by Acrylic Acid Grafting" Plasma Chemistry and Plasma Processing 25(2005) 427-437.

[0020] Volume Dielectric Barrier Discharge (VDBD) is described, for example, in EP1938907, S.N. Abolmasov et al.: IEEE Trans. On Plasma Science 33 (2005) 941-948.

Disclosure of the invention

[0021] In the following context of the present application, the term felting is used when reference is made to the art or process of making felt. The invention is particularly concerned with the manufacture of felt hat bodies.

[0022] It is an object of this invention to provide a method to produce desired felting characteristics of animal fibres in order to solve the above-mentioned problems of the conventional wet fur carroting.

[0023] The method of the invention provides a felted fabric having a feel and tensile strength superior to those of a felted fabric made entirely from carroted rabbit fur and having the feel approximately equal to a bear fur, but containing no bear fur.

[0024] Since the carroting reaction by its very nature causes damage to fur fibres, the object of the invention was also to increase the fur fiber felting characteristics without damaging the fibres and, consequently, reducing strength of the felt.

[0025] The present inventors have found that the disadvantages of using the aggressive carroting chemicals can be overcome using a dry gas discharge plasma treatment of the animal fibres, which results in an improvement of their felting qualities.

[0026] In the context of this invention "improvement of the felting qualities" means an improvement in the ability of the animal fibres to felting when processed under conditions conducive to making felt fabrics.

[0027] The improvement of the felting qualities of animal fibres by the effect of the plasma treatment before making felt fabrics is a surprising result, which was not previously identified or explored in the art. This observation is contrary to the many previous studies which conclude that the plasma treatment of animal fibres in general results in reduction of the felting qualities corresponding to an improved shrink-resistance.

[0028] Advantages of the present ion include dry plasma treatment without the use of aggressive water solutions of acids. As such, the energy and cost-intensive drying of the fibers is thereby avoided.

[0029] It has been found that a large variety of plasma treatment conditions can result in improving felting qualities of animal fibres by the effect of the plasma treatment before making felt fabrics. In practicing the invention, any type of gas discharge plasma source may be used that generates non-thermal plasmas, including a combination of two or more such plasma sources (the reference is made above).

[0030] Preferred plasma sources are the plasma sources generating non-thermal plasmas at near-atmospheric pressure.

[0031] In a more preferred embodiment, the dielectric barrier discharge used to generate the plasma is the co-called Diffuse Surface Dielectric Barrier Discharge (DCS-BD).

[0032] Another preferred type of dielectric barrier discharge is the so-called Surface Dielectric Barrier Discharge (SDBD).

[0033] Another preferred type of dielectric barrier discharge is the so-called Volume Dielectric Barrier Discharge (VDBD).

[0034] The invention consists in treating animal fibres in situ on the skin using the plasma in such a way that only the tip portion of the fibres are exposed to the action of the plasma, which makes possible to improvement of the felting qualities without the undue and energy consuming plasma treatment of the rest fiber portion.

[0035] It is also possible to treat a layer of loose animal fibers of the thickness from 0.3 mm to 5 mm using the plasma, which makes possible to treat the fur cutted off from the pelt. The layer of loose animal fibers with the preferred density from 0.2 g/cc to 0.05 g/cc may be formed from the fur fibers by pressing them to the desired thickness.

[0036] Although an extensive study was made, over a considerable period of time, no single determining characteristic was found by which the feltability of fibres could be easily and universally determined. Because animal fibres are of biological origin, they may vary greatly in chemical composition and morphological structure, depending on the living conditions and health of the animal. Accordingly, the effects obtained by subjecting animal fibres to the methods of

[0037] the present invention may vary in accordance with the properties of the starting material.

[0038] In praxis the felt fabric quality is assessed by the handle of felt. The handle of felt refers to the sensation of feel of a felt fabric. Typically, the handle is evaluated using a rating of 1-3 (worst to best). The quality of the felt hats is often designated by a number of X's, an arbitrary value differing between manufacturers. These commercial tests, as well as the handle test, are subjective and, consequently, the results are useful only when comparing results measured by the same operator.

[0039] The method for improving felting properties of animal fibres as a step preparatory to felting, according to present invention, comprises of bringing only the tip portion of the fur-coated side of an animal pelt in contact with electrical plasma, treating only the tip portion of the fur-coated side of an animal pelt by the plasma and separating the plasma-treated fur from the pelt skin.

[0040] Another way of improving felting properties of animal fibres comprises of forming a layer from the loose animal fibres, bringing the layer of the loose animal fibres in contact with electrical plasma and treating the layer of the loose animal fibres by the plasma.

[0041] During the process, the plasma treatment is performed at a pressure of approximately 1 atm (0,1MPa) with the plasma process gas containing oxygen. Advantageously, the plasma treatment is performed at a pressure of approximately 1 atm (0.1MPa) with the plasma process gas containing water vapor.

[0042] As a result of this method, such animal fibres have increased fiber felting properties.

[0043] An apparatus for carrying out this method of improving felting properties of animal fibres displayed on Fig. 1 is described as follows. It comprises the layer of the loose animal fibres or the fur-bearing animal pelt and a diffuse coplanar surface dielectric barrier discharge plasma source including: at least two systems of electrically conductive electrodes and that are situated inside of the dielectric body and are situated on the same side of the layer of the loose animal fibres or the fur-bearing side of the animal pelt affected by the plasma layer generated above the portion of the surface of the dielectric body that is in contact or situated in a distance less than 1 mm from the layer of the loose animal fibres or the fur-bearing side of the animal pelt, where an electrodes and are situated inside of the dielectric body without any contact with the plasma layer.

[0044] An apparatus for improving felting properties of animal fibres displayed on Fig. 2 comprises the layer of the loose animal fibres or the fur-bearing animal pelt and a surface dielectric barrier discharge plasma source including: two systems of surface electrically conductive electrodes that are situated opposite to each other on opposite surfaces of a solid dielectric layer that is in contact or in a distance less than 1 mm from the layer of the loose animal fibres or the fur-bearing side of the animal pelt affected by the plasma layer generated above the portion of the surface of the solid dielectric layer.

[0045] An apparatus for improving felting properties of animal fibres displayed on Fig. 3 comprises the layer of the loose animal fibres and volume dielectric barrier discharge plasma source including: a discharge space between at least a pair of electrodes and arranged for generating the filamentary plasma

[0046] volume in the discharge space, at least one of the electrodes having a layered structure including a conductive layer covered by a dielectric layer, the dielectric layer having a boundary surface with said discharge space, wherein said discharge space contains the layer

of the loose animal fibres.

[0047] For the above presented apparatus, the voltage of a frequency from 50 Hz to 1 MHz is applied between the electrodes.

[0048] The voltage of a magnitude from 0.5 kV to 100 kV is applied between the electrodes and the plasma is generated the gas pressure from 1 kPa to 500 kPa.

Brief Description of Drawings

[0049] Examples of the apparatus are described schematically in the attached figures.

Figures 1 and 2 are schematic-sectional view illustrating essential parts of the apparatus for the treatment of a layer of loose animal fibres or fur-bearing animal pelt using the Diffuse Coplanar Surface Dielectric Barrier Discharge and Surface Dielectric barrier Discharge, respectively.

Figure 3 is a schematic-sectional view illustrating essential parts of the apparatus for the treatment of a layer of loose animal fibres using the Volume Dielectric Barrier Discharge.

[0050] List of the reference symbols used:

1 - Layer of the loose animal fibres or fur-bearing animal pelt
2 - First system of electrically conductive electrodes
3 - Second system of electrically conductive electrodes
4 - Dielectric body
5 - Plasma layer
6 - Surface portion of dielectric body 4 where plasma layer 5 is generated
7 - First system of surface electrically conductive electrodes
8 - Second system of surface electrically conductive electrodes
9 - Solid dielectric layer
10 - Portion of surface of solid dielectric layer 9 where plasma layer 5 is generated
11 - Layer of loose animal fibres
12 - Discharge space
13 - First electrode
14 - Second electrode
15 - Filamentary plasma volume
16 - Conductive layer
17 - Dielectric layer

Examples of Execution

Example 1

[0051] The apparatus for performing the method and the method according to the present invention were used to improve feltability of rabbit fur fibres, where the fur was treated by the DCSBD plasma source in situ on the skin in such a way that only the tip portions of the fibres were exposed to the action of the DCSBD plasma.

[0052] The thin layer of DCSBD plasma was generated in ambient air at the power density of 2.5 W/cm^2. The thickness of the plasma layer was approximately 0.5 mm and the plasma covered an area of 40 cm by 30 cm. The plasma was generated using two systems of parallel strip like electrodes (~1 mm wide, 50 mm thick, 0.5 mm strip to strip; molybdenum) embedded in 96% alumina. The thickness of the alumina ceramic layer between the plasma and electrodes was 0.4 mm. A sinusoidal high frequency high-voltage (15 kHz, and 11.5 kV peak to peak was applied between the electrodes).

[0053] The fur-coated side of a rabbit pelt was brought into contact with the plasma by pressing it to the alumina surface of the DCSBD plasma source by an average pressure of approximately 2 Pa for a treatment time t/2. After, the pelt fibres tips were reversed by a brush and exposed to the plasma again for in the same way for the same treatment time t/2.

[0054] Subsequently, two hundred of such plasma treated pelts were subjected to the following standard process of making fur felt: The pelts were stretched over a bar in a cutting machine and the skin sliced off in thin shreds, the fleece coming away entirely. The fur was passed through a blowing machine to remove guard hairs and skin fragments. The fibres were blown onto a cone-shaped colander and treated with hot water to consolidate them. The cone was peeled off and undergone the felting by being 30 times subjected to mechanical forces in two planes while traveling on rubber aprons between rollers in water at about 90°C. Water was adjusted to ph 2 using sulphuric acid. Then the felt cones were dyed using revolving care-type equipment and dried.

[0055] The tensile strength and elongation tests, which are well known in the art, were used to evaluate felting quality and damage to fur felt, whether resulting from carroting or the plasma treatment. The tensile strength and elongation-to-break were measured using a tensiometer on 5 cm wide and 15 cm long felt strips cut from the felt cones.

[0056] The tensile strength and elongation values of felts made using the standard number of 30 passes of felting roller from the conventionally carroted and felted fur were 420 N and 38% respectively.

[0057] It was found that, using the same felting process and the same number of felting roller passes, the plasma treatment time necessary to reach approximately the same tensile strength and elongation values of the felt made from the DCSBD plasma treated fur was t = 8 s.

[0058] The non-objective measurement was done by the feeling of softness on the human skin (handle). It was found that the felts made from the fur treated according to the above described treatment procedure using the DCSBD plasma are of superior handle to felts made from the conventionally carroted fur of similar quality. In fact, such felts posses a feel approximately equal with the feel

of beaver fur felts. However, the cost of producing a hat from such a plasma treated rabbit fur is only a small fraction of the production cost of a beaver hat.

Example 2

[0059] Two hundred rabbit pelts were treated using the DCSBD plasma as in Example 1, coupled together in pairs the fur sides touching, and stored under ambient air conditions of temperature and humidity for 90 days. After the storage the plasma treated pelts were subjected to the sequence of the felting process and the subsequent testing of felt properties as described in Example 1. It was found that the storage of the plasma treated pelts did not affect the felt properties and it is possible to store such plasma treated pelts without loss of feltability.

Comparative example 1

[0060] The apparatus for performing the method and the method according to the present invention were used to improve feltability of loose rabbit fur fibres by the DCSBD plasma treatment, where a 0.5 mm thick layer of loose fur fibres was treated by DCSBD plasma on its both sides. The layer of slightly pressed fur fibres was prepared from the fur cutted of from rabbit pelts and passed through a blowing machine to remove guard hairs and skin fragments. Subsequently, the layer of loose fibres was plasma treated under the same plasma conditions as in Example 1 at various plasma treatment times t.

[0061] Subsequently, the treated loose fur fibres were felted using the same felting process as in Example 1. The felts samples were prepared and tested using the same felting and testing methods as described in Example 1. It was found that even using the plasma treatment times longer than 60 seconds the tensile strength and elongation values of such felts made from plasma treated layer of loose fibres were approximately 40% less than those of the felts made from conventionally carroted fur. However, the standard tensile strength and elongation values of 420 N and 38% were obtained by increasing the number of felting roll passes from standard 30 to 45 passes. In such a case the standard tensile strength and elongation values were obtained at plasma treatment time values ranging from 25 to 60 seconds. The treatment times longer than 60 seconds resulted in decay of the felt mechanical properties, apparently due to damage caused to fur fibres by the plasma over-treatment.

Example 4

[0062] The apparatus for performing the method and the method according to the present invention were used to improve feltability of rabbit fur fibres, where the fur was treated by the SDBD plasma source in situ on the skin in such a way that only the tip portions of the fibres were exposed to the action of the SDBD plasma.

[0063] The thin layer of SDBD plasma was generated in ambient air at the power density of 1 W/cm^2. The discharge system consists of two electrodes separated by $400 \times 300 \times 0.6$ mm^3 alumina plate. The discharge electrode (1.5 μm-thick) consists of interconnected strips 1-mm-wide and 3 mm strip-to-strip distance. The inductive electrode is square-shaped (390 x 290 mm^2), 1.5 μm-thick. Both electrodes were made of molybdenum. A sinusoidal high voltage with a frequency of typically 12 kHz and peak-to-peak value 9 kV was applied between the electrodes. This produced a thin filamentary plasma layer covering uniformly the ceramic surface between the discharge electrode strips.

[0064] The fur-coated side of a rabbit pelt was brought into contact with the SDBD plasma and treated by the plasma in a way analogous to the DCSBD plasma treatment described in detail in Example 1. The felt was prepared, and the effects of the plasma treatment on the felt properties were evaluated in the same ways as described in Example 1.

[0065] It was found that, using the same felting process and the same number of felting roller passes as described in Example 1, the SDBD plasma treatment time necessary to reach the standard tensile strength and elongation values was t = 22 s. The results indicate that the energy efficiency of the SDBD plasma treatment is slightly lower than that of the DCSBD plasma treatment, and the handle, as in the case of DCSBD treatment, is superior to the handle of felts prepared using the conventional carroting treatment.

Comparative example 2

[0066] The apparatus for performing the method and the method according to the present invention were used to improve feltability of loose rabbit fur fibres by the VDBD plasma treatment, where a 1.5 mm thick layer of loose fur fibres was treated using a VDBD discharge burning in ambient air. The layer of slightly pressed fur fibres was prepared from the fur cutted of from rabbit pelts and passed through a blowing machine to remove guard hairs and skin fragments. Subsequently, the layer of loose fibres was placed into the 1.5-mm wide discharge space between the VDBD electrodes.

[0067] The filamentary VDBD plasma filling the discharge space was generated in ambient air at the surface power density of 3 W/cm^2. The discharge system consists of two electrodes 20 cm in diameter and coated with a 0.5 mm thick alumina layers. A sinusoidal high voltage with a frequency of 10 kHz and peak-to-peak value 15 kV was applied between the electrodes. This produced a filamentary plasma volume filling the discharge space with the volume power density of approximately 20 W/cm^3.

[0068] Subsequently, the VDBD air plasma treated loose fur fibres were felted using the same felting process as in Example 1. The felts samples were prepared and tested using the same felting and testing methods as described in Example 1. Similarly as in the case of Ex-

ample 3 it was found that to reach the standard mechanical properties of the carroted fur, for the plasma treated loose fibres it was necessary to increase the number of felting roller passes. Thus to reach the standard tensile strength and elongation values of 420 N and 38% at 50 felting roller passes, it was necessary to treat fur fibres by the VDBD plasma for more than 60 seconds. The handle of such felt was found to be superior to the handle of felts prepared using the conventional carroting treatment.

Claims

1. A method for improving felting properties of animal fibers, **characterized by** the fact that the way of improving felting properties involves following consequential steps:

    - bringing only the tip portion of fibers situated on fur-coated side of an animal pelt in contact with an electrical plasma;
    - treating only the tip portion of fibers situated on fur-coated side of an animal pelt by the plasma performed at the gas pressure from 1 kPa to 500 kPa with the plasma process gas containing oxygen;
    - separating the plasma-treated fur from the pelt skin.

Patentansprüche

1. Verfahren zur Verbesserung der Filzfähigkeiten der Tierfasern, **dadurch gekennzeichnet, dass** die Weise der Verbesserung der Filzfähigkeiten folgende konsequente Schritte umfasst:

    - nur die Spitzenteile der Fasern, die sich auf der Fellseite von Tierleder befinden, in Kontakt mit elektrischem Plasma zu bringen;
    - nur die Spitzenteile der Fasern, die sich auf der Fellseite von Tierleder befinden, mit dem Plasma zu behandeln, und zwar unter dem Gasdruck von 1 kPa bis 500 kPa mit dem Sauerstoff beinhaltenden Plasmaprozessgas;
    - das mit Plasma behandelte Fell vom Leder abzuteilen.

Revendications

1. Procédé pour améliorer les propriétés de feutrage des fibres animales, **caractérisé par le fait que** le moyen d'améliorer les propriétés de feutrage implique des étapes consécutives:

    - portant uniquement la partie de fibres situées sur le côté furcoated d'une peau animale en contact avec un plasma électrique;
    - traiter uniquement la partie d'extrémité de fibres situé sur le côté furcoated d'une fourrure de l'animal par le plasma effectué à la pression du gaz à partir de 1 kPa à 500 kPa avec le gaz de traitement au plasma contenant de l'oxygène;
    - séparer de la fourrure traitée au plasma de la peau de fourrure.

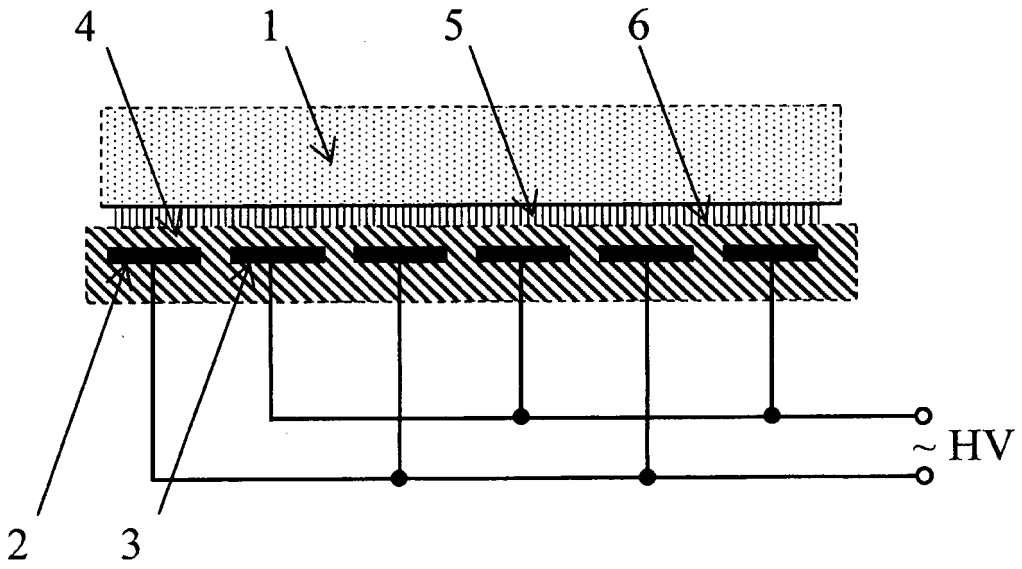


Fig.1

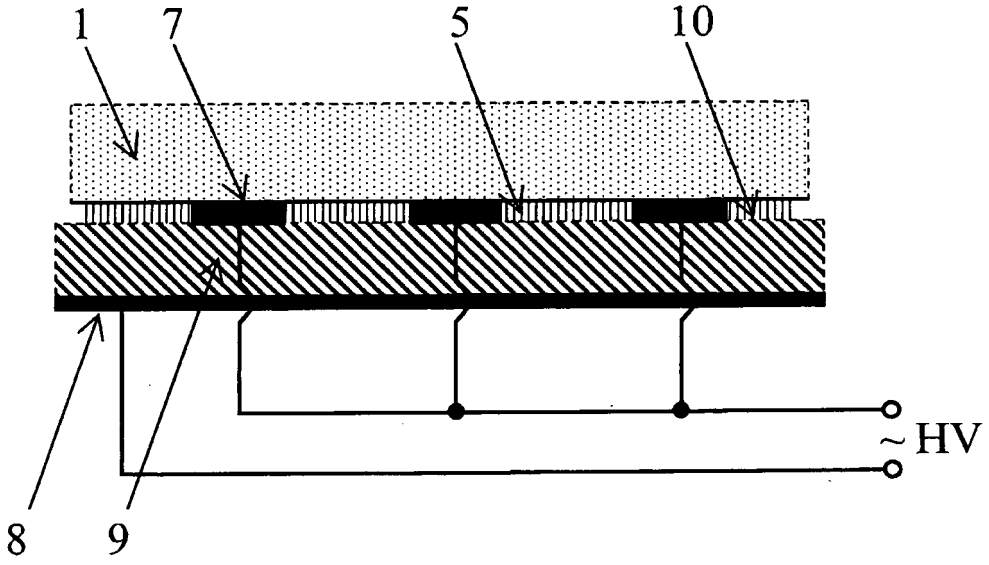


Fig.2

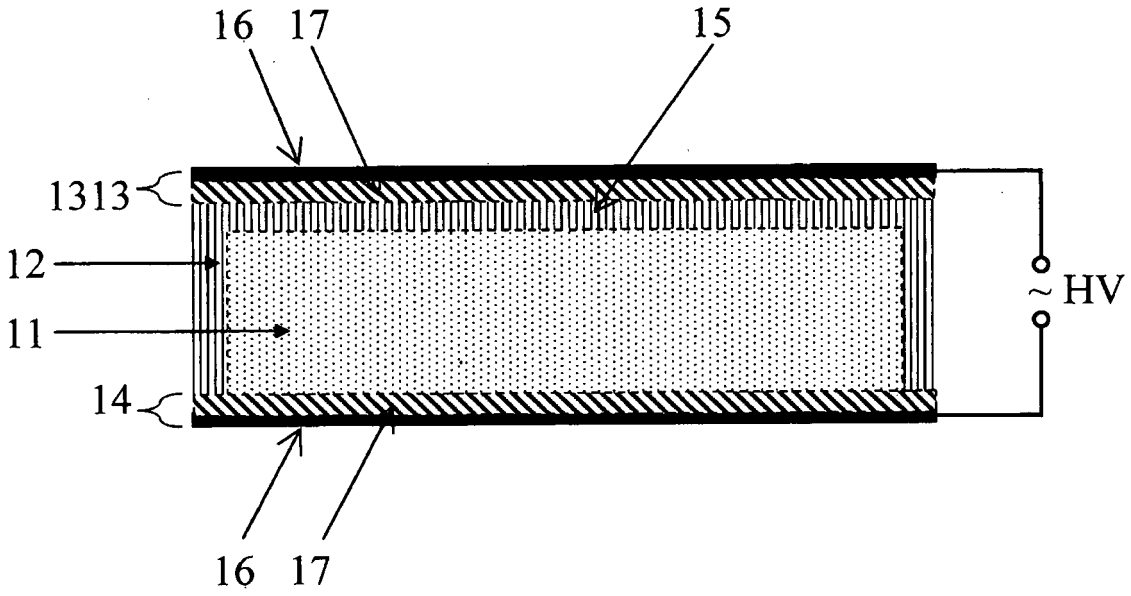


Fig.3

REFERENCES CITED IN THE DESCRIPTION

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