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TEXTILE FIBER

Martin Eli Cupery, Wilmington, Del., assignor to E. I. du Pont de Nemours & Company, Wilmington, Del., a corporation of Delaware

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This invention is directed to the production of artificial textile fibers or filaments suitably coated, impregnated or otherwise treated with a material or materials adapted to impart to such fibers or filaments improved softness, resiliency, toughness, strength, and solvent resistance characteristics.

In a more particular embodiment, the invention is directed to the production of artificial fibers or filaments adapted to be employed as artificial bristles, and advantageous substitutes for natural fibers, such as pig bristles, horsehair, or vegetable fibers.

It has been customary, in prior practices, to produce artificial fibers or filaments by coating a suitable thread or filament with collodion or similar nitrated cellulose. Likewise, viscose and and varnish have been employed as coating agents for such threads or filaments. Similarly, attempts have been made to produce artificial fibers by coating threads or filaments with solutions of cellulose acetate of the type which is soluble in methyl acetate, acetone, etc.

The artificial textile fibers produced from such prior practices, however, are very unsatisfactory for use as natural bristle substitutes because they possess inherent deficiencies and disadvantages. Among other things, they are wholly unsuitable for use as artificial bristles since they are susceptible to and influenced by the action of such ordinary solvents as water and organic solvents with which solvents they may come in contact during use. These solvents effect an undue softening or warping of the synthetic fibers, causing them to become unfit and useless for further employment. Moreover, in instances where the artificial fibers have been coated with compositions employing ordinary cellulose acetate as an essential ingredient, and particularly where the coating composition contains twice as much plasticizer as acetate, the resultant fibers will be found useful only for the production of soft, pliable yarn, and wholly unsatisfactory as artificial bristles. Furthermore, the prior art fibers are lacking in sufficient toughness, rendering them susceptible on sharp bending to easy breaking, and are greatly deficient in that degree of resiliency and tensile strength which is necessary and requisite for artificial bristles which are to be satisfactorily employed in ordinary commercial uses.

It is among the objects of the present invention, therefore, to overcome the foregoing as well as other objections and disadvantages existent in the artificial fibers or filaments heretofore produced, and to provide an improved artificial fiber or bristle which possesses, among other desirable properties, a high resistance to solvents, particularly hot or cold water, and to such ordinary organic solvents as alcohols, esters, etc.; an equally effective resistance to hydrocarbon solvents of the type employed in paints and varnishes; improved resistance to animal, vegetable oils and fats; and improved resilience, toughness, and tensile strength properties. Furthermore, it is also among the objects of the present invention to provide a fiber element of a character such that it closely resembles bleached natural pig bristles.

The foregoing, as well as other, objects and advantages of the invention may be attained by treating, preferably, a variety of filaments or threads, such as multi-filament rayon yarn (regenerated cellulose yarn or cellulose acetate yarn), single filament viscose rayon straw, artificial horsehair rayon, or cotton, silk, linen, ramie, or wool thread, with a solution or solutions which contain as an essential ingredient or constituent cellulose triacetate alone or mixtures thereof with other materials. The term "cellulose triacetate" as employed herein is intended to refer to the cellulose acetates which contain about 2.7 to about 3 acetyl groups per glucose unit, and are characterized by being insoluble in acetone and soluble only in certain alcohol-halogenated hydrocarbon solvent mixtures, such as methylene chloride-methanol.

In the employment of cellulose triacetate as an ingredient of the coating or impregnating composition for the thread or filament, it will be found that the resultant product will possess all the desired attributes heretofore referred to, including high water-insensitivity, and increased resistance toward organic solvents, particularly the hydrocarbons, alcohols, esters, animal and vegetable oils and fats, etc. Having these properties, the resultant bristles, when fabricated into commercial articles, will obviously possess enhanced commercial utility, and in the instance of commercial paint brushes will have especial adaptability, since such types of brushes are constantly subjected during use to deleterious attack by hydrocarbon solvents present in the paint.

In producing the artificial fibers or bristles of the present invention, a single but preferably a plurality of coatings of solutions containing cellulose triacetate as the essential ingredient, may be successively and independently applied to a thin, supporting base or filament. While preferably each coating application may con-

tain the cellulose triacetate ingredient alone, the invention contemplates the employment of cellulose triacetate in admixture with other well-known film-forming substances, whereby a laminated filament structure effect is obtained which may comprise a plurality of coatings of either cellulose triacetate alone or in combination with other well-known film-forming substances. If desired, however, the coating structure and application may also be varied to produce a composite effect whereby a plurality of film-forming coatings are applied to a base material, one of which coatings may comprise cellulose triacetate alone, cellulose triacetate in admixture with other film-forming substances, or a non-cellulose triacetate coating, all of which may be alternately and successively applied in any desired relationship to the base material to produce the desired laminated effect. In the latter instance, however, it is preferable, in view of the essential attributes which cellulose triacetate imparts to the resulting filament or bristle, that the cellulose triacetate coating comprise the outer or external film in the laminated structure.

In carrying the invention into effect, any well-known method and/or apparatus for applying the coating solutions to the thread or filament may be employed. For example, the filament may be initially drawn from a retaining spool into and through one or more solutions containing cellulose triacetate. Thereafter, the coated thread may be passed through an orifice nozzle, or similar means, ranging in diameter, for example, from 0.2 to 1 mm., or higher as desired, adapted to scrape off and remove any excess coating from the thread, and maintain its diameter uniform throughout. Thereupon, the coated thread may be passed through a conventional drying tower or oven to remove volatile solvents present in the coating composition, and after the drying operation, the coated thread may again be passed through the same or a different coating solution of cellulose triacetate, as desired, and the entire method repeated. After each application of coating, of course, a proportionate increase in nozzle diameter must be employed, and this must be commensurate with and in conformity to the resultant desired increase in the diameter of the coated thread. The coating operation may be repeated any number of times, whereby coated filaments of any desired diameter and any number or plurality of coatings result.

Each of the successive and independently applied coating solutions of cellulose triacetate may vary in percentage composition, making it possible to vary the film thickness of the individually applied coatings as desired. By suitable variations in either the concentration of the coating solution, or its composition, it will obviously be possible to produce fibers exhibiting widely varying characteristics. Additionally suitable pigments, colors, etc., may, if desired, be incorporated in one or all of the various coating compositions, whereby many novel and useful effects may be produced. Furthermore, by proper regulation of the coating composition and its method of application to the threads, fibers of continuous length and of uniform size may be produced, and may be either substantially circular, or in suitably shaped cross-section.

In order that the invention may be more fully understood, the following specific examples are given, each of which, it is understood, is to be taken in no wise limiting, but as merely exemplifying the invention:—

Example 1

A 40 filament viscose rayon yarn of 100 denier and having four turns per inch was passed through a solution comprising 15% cellulose triacetate, 3% plasticizer, 8% methanol, and 74% methylene chloride, in the usual conventional manner. The excess coating solution was removed by drawing the coated thread through a small nozzle orifice. After passage through a drying chamber, which was maintained at 45–50° C., the coated thread was subjected to repeated treatment with the same solution until four coatings had been applied thereto, the nozzle orifice during each treatment being, respectively, 0.3, 0.4, 0.5 and 0.6 mm. in diameter. The last coating solution also contains about 4% by weight of titanium oxide based on the cellulose triacetate present. The thread was drawn through the several coating solutions at an approximate rate of 20 feet per minute, and the finished fiber collected on wood panels and subsequently dried for ½ hour at 100° C., immersed in water at 50° C., for 15 minutes, followed by a final drying at 100° C. for 3 hours. The fibers were then removed from the panels and cut into the desired lengths. The fibers thus obtained were 0.28 to 0.31 mm. in diameter, of approximately 900 denier, and had a substantially circular cross-section. They had a creamy, translucent, glossy white appearance which closely resembled natural pig bristles. They showed practically no softening or warping upon immersion in water at room temperature for 24 hours. These fibers did not break on bending sharply, showed good resiliency, toughness, and tensile strength, and hair brushes fabricated therefrom compared favorably in quality with similar brushes fabricated from high grade natural bristles.

Example 2

Artificial fibers were prepared according to the method of the preceding example, except that the pigment was omitted from the last coating composition, and a small quantity of soluble blue dyestuff substituted therefor. The finished fibers had a delicate blue color which was highly attractive owing to the glossy nature of the fiber surface. The physical properties of the resultant fibers closely resembled those of the product set out in the preceding example.

Example 3

A 40 filament 150 denier viscose rayon thread having three turns per inch was successively coated with the following five compositions in the order given, using nozzle orifices of the sizes designated for each application.

Coat #1.—Cellulose triacetate 15%, plasticizer 3%, methanol 8%, methylene chloride 74%; nozzle orifice 0.27 mm. in diameter.

Coat #2.—10-second nitrocellulose (11.9% nitrogen) 21%, alcohol 16%, acetone 63%; nozzle orifice 0.30 mm. in diameter.

Coat #3.—Cellulose triacetate, same composition as No. 1 above, with 5% by weight titanium oxide added, based on cellulose acetate; nozzle orifice 0.35 mm. in diameter.

Coat #4.—Nitrocellulose, composition same as No. 2 above; nozzle orifice 0.40 mm. diameter.

Coat #5.—Cellulose triacetate, composition same as No. 1 above; nozzle orifice 0.50 mm. in diameter.

During the coating procedure the solutions were maintained at 30–33° C., while the drying chamber was kept at 50° C. The supporting thread was passed through the coating solution at a rate of about 25 feet per minute. The product was collected on wood panels, dried for one hour at 100° C., immersed in water at 60° C. for 15 minutes, dried at 100° C. for 1½ hours, then at 65° C. for 16 hours.

The product was removed from the wood panels by cutting the fiber at the end of the panels. After the ends were trimmed off straight fibers ranging from 0.25 to 0.31 mm. in diameter and having a nearly uniform circular cross-section were obtained. Such fibers had a denier of approximately 800, and were glossy white in appearance. Upon immersion in either cold or hot water such fibers showed practically no softening or warping. The resistance toward softening in water heated at 90–100° C. was superior to that of the fibers produced by Example 1. These fibers also showed improved toughness and resiliency, and were employed as bristles in the fabrication of clothes brushes and hair brushes with good results.

Example 4

Artificial fibers of about 800 denier were prepared according to the method described in Example 3, except that the nitrocellulose compositions used for the second and fourth coatings were replaced by a composition comprising methyl methacrylate polymer 12%, benzene 53%, methanol 8%, and methylene chloride 27%.

The product had an opaque glossy white appearance, similar to the fibers previously described. These fibers showed better stiffness than the products produced by Examples 1 and 3.

Example 5

A 40 filament viscose rayon thread of 150 denier and having three turns per inch was successively coated with the following four compositions in the order given, and using nozzle orifices of the size designated for each application.

Coat #1.—Cellulose triacetate 15%, plasticizer 3%, methanol 8%, methylene chloride 74%; nozzle orifice 0.3 mm. diameter.

Coat #2.—Methyl methacrylate polymer 15%, benzene 50%, ethyl alcohol 10%, methylene chloride 25%, nozzle orifice 0.4 mm. diameter.

Coat #3.—10-second nitrocellulose (11.9% nitrogen) 21%, ethyl alcohol 16%, acetone 63%; nozzle orifice 0.45 mm. diameter.

Coat #4.—Cellulose triacetate, composition same as coating #1 with 3% by weight of titanium oxide, based on cellulose triacetate, added; nozzle orifice 0.50 mm. diameter.

The various coating compositions were maintained at 30–35° C. during the process and the drying chamber was kept at 50–52° C. The rayon thread was drawn through the coating solution at a rate of about 38 ft. per minute. After collecting the finished fiber on wooden panels, the product was immersed in warm water and dried as described in Example 1.

The fibers obtained had a uniform circular cross-section of 0.23 to 0.25 mm. diameter, and in appearance and properties resembled the fibers described in Example 1. Upon immersion in water the product showed practically no tendency to warp.

Example 6

Artificial fibers were prepared according to the procedure of Example 1 by using a coating composition comprising cellulose triacetate 16%, plasticizer 4%, methanol 8%, methylene chloride 72%, for each of the four coatings applied to a 40 filament viscose rayon thread of 150 denier and having three turns per inch. The fibers obtained showed greater pliability than the fibers produced by any of the foregoing examples. These fibers also showed improved toughness and elasticity.

Example 7

Artificial fibers of about 900 denier were prepared according to Example 1 except that the last or fourth coating composition contained about 20% by weight of bronze metal powder based on cellulose triacetate, in place of the titanium oxide pigment. These fibers showed a golden metallic luster which gave a brilliant reflection when held in sunlight. In physical character and properties these fibers greatly resembled those of Example 1.

Example 8

Two, three, or four coatings of a solution comprising cellulose triacetate 15%, plasticizer (phthalic acid esters of the mixed primary and secondary aliphatic branch chain alcohols containing from 6 to 15 carbon atoms, such alcohols as are obtained as a by-product in the hydrogenation of carbon oxides) 3%, carbon black pigment (well dispersed) 0.5%, methylene chloride 72.5%, methanol 9%, were applied to 150 denier, 40 filament, 3 turns per inch viscose rayon thread which was drawn at a linear rate of 37 to 60 feet per minute. The drying chamber was maintained at 60–70° C. Nozzle orifices having a diameter of 0.30, 0.35, 0.40, 0.45 mm. were used in the order given for the application of four coatings, or the first two nozzle sizes listed for the application of two coatings, or the first three nozzle sizes listed for the application of three coatings of the above composition. The products were collected and dried as in Example 1.

Fibers prepared by applying two coats of the above composition had a diameter of 0.20 mm. while fibers obtained by applying three coats were about 0.25 mm. in diameter, and the fibers having four coats were about 0.30 mm. in diameter. All of the fibers were of substantially circular cross-section and showed a glossy, uniform black color, and closely resembled natural horsehair in appearance, stiffness, resiliency, and toughness. Paint brushes fabricated from such fibers showed no softening in gasoline, aromatic hydrocarbons, turpentine, or oils.

The foregoing description and examples define a process for the preparation of artificial fibers which comprises applying to a supporting filament a plurality of coats from the same or different coating compositions and drying the coated thread following each application.

It is obvious that the supporting filament or thread is in general of less importance in developing the required characteristics of an artificial fiber than the coating material which is applied. Hence, a variety of filaments or threads may be used without appreciably altering or affecting the quality of the resultant fibers. For example, in addition to the types of threads or filaments heretofore enumerated, small wires may also be employed as the supporting filament, and are especially suited for the preparation of fibers or bristles where a high degree of toughness or resiliency is requisite.

In carrying out the invention it has been found

preferable and desirable in all cases to avoid as far as possible any undue stretching of the supporting filament during the coating operation. It has also been found preferable to employ coating solutions having a viscosity of from 15 to 25 poises at 25° C. However, these conditions are not invariable for in certain modifications it will be found possible to employ solutions of varied concentrations having a viscosity range of 5–100 poises at 25° C. Again, it is advantageous, and therefore preferable, to employ solvents or solvent mixtures having low-boiling characteristics, such as within a range of 40–70° C., since these produce optimum results. It is to be understood, however, that higher boiling solvents may, if desired, be employed, but these generally require resort to higher drying temperatures.

In most of the specific examples a warm water immersion treatment was given the fibers. This serves to remove residual strains within the fibers so that the final product has little or no tendency to warp upon subsequent prolonged immersion in water. The same results may, if desired, be accomplished by steaming the dried fibers or subjecting them to a high temperature for a short period of time.

Again, in most of these examples no particular plasticizer for the cellulose triacetate has been specifically designated. It will be found preferable, however, to employ such plasticizers as the carbamates of the mixed branched chain primary and secondary aliphatic alcohols containing 6–15 carbon atoms (such alcohols as are obtained as by-products of the hydrogenation of carbon oxides). While these are preferred, other plasticizers comprising the phthalic acid esters of such alcohols, diacetin or triacetin, camphor, beta-naphthanone, dibutyl phthalate, dicyclohexyl phthalate, isobornyl phthalate and the like, ethyl or butyl naphthenates, and the like, dibutyl sebacate, glyceryl sebacate and the like, or the mono alkyl or aryl ethers of glycol, etc., may be utilized.

In addition, a variety of pigments, extenders or similar materials may be added to the coating compositions in order to produce in the product useful and novel effects. In lieu of titanium oxide employed in the examples, such materials as zinc oxide, barium sulphate, carbon black, chrome yellow, Prussian blue, antimony sulphides, or the like, may be employed. In lieu of bronze powders other metallic powders or pearl essence, powdered glass or fine sand and the like, may be used. These may be applied to the filaments by being dusted or impinged on the surface of the coating materials before the surfaces become dry. Additional coating material may then be applied in order to thoroughly cement the adhering substance to the fiber or supporting filament.

In lieu of, or in addition to, the nitrocellulose utilized in Examples 3 and 4, other organic cellulose derivatives, e. g., ethyl cellulose, benzyl cellulose, etc., may be employed. In place of, or in addition to, the methyl methacrylate of Example 5, other materials may be used, and as examples of such materials may be mentioned polyacrylic acid and its esters, polymethacrylic acid and its esters (other than the methyl ester), polyvinyl derivatives, e. g., the acetate, chloride, and chloroacetate, polyvinyl alcohol, phenol-formaldehyde and urea-formaldehyde resins, etc., ester gum, rosin, etc., casein, gelatin, glue, etc.

The synthetic fibers of the present invention have particular adaptability for employment as artificial bristles in the fabrication of hair brushes, clothes brushes, tooth brushes, paint brushes, or brooms of various types. Obviously, by obvious modifications coated textile fibers, suitable for use in the manufacture of clothing, stiffened fabrics, rugs, draperies, table mattings, tapestries, filter cloth, and the like, may be produced, wherein the treated fiber may be used alone or interwoven with other threads or fiber materials. Similarly they may be employed as fibers for weaving into coarse cloth of varied colored metallic or design effect; as fibers for braiding or twisting into heavy cord or bundle form; in the manufacture of lamp shades and novelty products of various kinds; as decorative fiber materials in sheaf or tassel form for use in the preparation of artificial flower displays and the like, or for decorative purposes on hats and the like, caps (military uniforms) and the like. Similarly the addition of powdered glass or aluminum powder to a coating material will yield valuable fibers adaptable in the fabrication of moving picture screens.

I claim as my invention:

1. A method of producing artificial fibers relatively stiff and resilient in character comprising treating a filamentous material with a solution the essential ingredient of which is acetone-insoluble cellulose triacetate containing about 2.7 to about 3 acetyl groups per glucose unit.

2. A method of producing artificial fibers relatively stiff and resilient in character comprising passing a filament through successive coating solutions, at least one of which solutions contains as an essential ingredient thereof acetone-insoluble cellulose triacetate containing about 2.7 to about 3 acetyl groups per glucose unit.

3. An artificial fiber relatively stiff and resilient in character comprising a filamentous core of permeable material having a plurality of coatings of acetone-insoluble cellulose triacetate containing about 2.7 to about 3 acetyl groups per glucose unit.

4. An artificial fiber relatively stiff and resilient in character comprising a filamentous base having a coating comprising essentially acetone-insoluble cellulose triacetate containing about 2.7 to about 3 acetyl groups per glucose unit.

5. An artificial fiber relatively stiff and resilient in character comprising a filamentous base having a plurality of coatings applied thereto, at least one of which coatings comprises essentially acetone-insoluble cellulose triacetate containing about 2.7 to about 3 acetyl groups per glucose unit.

6. An artificial bristle comprising a viscose rayon filament coated with acetone-insoluble cellulose triacetate containing about 2.7 to about 3 acetyl groups per glucose unit.

MARTIN ELI CUPERY.