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PROCESS OF PRODUCING A TEXTILE PRODUCT

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This invention relates to fibre preparation and in particular to the production of potentially adhesive artificial filaments and to textile products made therefrom.

In the prior U. S. Patents Nos. 2,247,308, 2,252,999; 2,253,000, 2,266,631, 2,289,039, 2,306,781, 2,313,058, 2,313,104, 2,316,824, 2,319,809, and 2,319,834, there are disclosed various textile products formed from a mixture of at least two types of fibres, one of the fibres being potentially adhesive, and processes of forming textile products from such mixture of fibres by rendering the potentially adhesive fibres in the mixture tacky to bind the fibres in the product. When the potentially adhesive fibres in such products are activated to render them tacky, for example, by the application of heat and pressure, the potentially adhesive fibres are deformed by the pressure, and if the heat is sufficient the fibres may in whole or in part lose their fibre shape and identity as fibres. This is due to the fact that the potentially adhesive fibres heretofore used in the products disclosed in the patents above-mentioned have been in every case of a homogeneous character. However, it is frequently desirable that the fibres be less susceptible to loss of shape and that they retain their identity as fibres in the product after activation, since the loss of the fibrous form results in a decrease in strength. Moreover, with homogeneous fibres it is difficult to control the extent of the activation whereby the fibres are rendered tacky but not destroyed. Another disadvantage of the prior potentially adhesive fibres lies in the fact that when formed of thermoplastic materials, such as thermoplastic cellulose derivatives and thermoplastic resins, the fibres are susceptible of activation each time the textile product is treated by heat and pressure, and if the fibres have a low thermotacking point, they will become activated each time the textile products are ironed. This is a distinct disadvantage since the repeated activation tends to stiffen the textile product and to render the fibres somewhat more brittle.

Therefore, it is an object of this invention to produce a filament which is activatable by heat to an adhesive condition and which is less susceptible to loss of shape and of its identity as a filament during activation.

It is a further object to provide such filaments that their activation by heat is very easily and reliably controlled. The invention also contemplates a filament which can be coalesced or distorted by pressure without danger of severing the filament.

A further object is to produce a textile product containing a thermoplastic filament which can undergo repeated activation without progressively deteriorating to such an extent as to lose its shape and identity as a filament.

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A specific object is to provide a textile product having heat-activatable filaments therein which, during an initial activation, are caused to be first activated, then permanently set and thereby become no longer subject to activation.

A further object is to provide an activatable filament having an exterior which is repeatedly activatable and having a core adapted to be permanently set during the first stage of activation.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

According to the present invention, there is provided a filament which is activatable by heat to an adhesive condition, the filament comprising at least two portions composed of different materials, one being exterior to the other and forming the filament surface, the exterior portion being an organic thermoplastic material more susceptible to activation than the other portion. In the now preferred embodiment the composite filament of the invention comprises a more and a sheath, the sheath being an organic thermoplastic material more susceptible to activation than the core. When both portions are activatable, they are so constituted as to be activatable under different conditions. The invention also provides an activatable fibre having a thermoplastic core and a thermosetting exterior in which the thermoplastic core is merely softened without becoming fluid at the temperature of activation of the thermosetting exterior, whereby the sheath produced during the initial activation serves to stabilize the textile permanently by adhesion during activation and thereafter serves to contain the thermoplastic interior regardless of later conditions of treatment of the fabric constituted thereof.

In the following detailed description and in the appended claims the word "filament" when referring to the potentially adhesive filaments, includes both continuous filaments and cut staple fibres; the expression "textile" includes yarns, fabrics, felts and papers, and the expression "activating" designates that operation by which the potentially adhesive filaments are caused to bind filaments in the product.

The boundary between core and sheath portions may be quite distinct and either of regular or irregular contour, or there may be a partial mixing or diffusion of one of such materials with the other at their juncture, or, again, there may be one or more layers of other materials between the interior core and the exterior portion of the fibre or filament. A core portion of composite character, as well as a sheath portion of composite character are within the purview of the invention.

Examples of thermoplastic materials which may be used in the core or the sheath are thermoplastic cellulose esters as a class, such as

cellulose acetate; cellulose butyrate and propionate, suitably plasticized to a thermoplastic condition; thermoplastic cellulose ethers as a class, such, for example, as ethyl cellulose; propionyl cellulose; butyl cellulose and benzyl cellulose; also thermoplastic mixed esters and mixed ethers and ether-esters of cellulose; thermoplastic synthetic resins, including polyvinyl resins and polyacrylic resins as well as derivatives thereof, such as polyvinyl chlorides; polyvinylidene chlorides; polyvinyl acetates; polymers of methyl or ethyl acrylates or methacrylates; polystyrene; copolymers of two or more polymerizable unsaturated compounds, such as the copolymer of vinyl chloride and vinyl acetate; of vinyl chloride and acrylonitrile; of vinyl chloride and ethyl methacrylate; also after-chlorinated polyvinyl chlorides; and after-chlorinated copolymers of vinyl acetate and vinyl chloride; and natural and synthetic rubber.

For the thermosetting materials which are used initially in the thermoplastic state and therefore capable of use in the present invention, there may be employed, for example phenol-aldehyde resins, urea-aldehyde resins, phenolfurfural resins, urea-aldehyde-alcohol ether resins, melamine-aldehyde resins and other amine-aldehyde resins; sulfonamide-aldehyde resins, alkyd resins, drying-oil-modified alkyd resins, and the like.

If desired, a mixture of two or more of the thermoplastic materials, or a mixture of two or more thermo-setting (initially thermoplastic) materials or a mixture of thermoplastic and thermosetting materials may be used for either the core or sheath of the filaments and fibres.

In one embodiment, the core may be composed of a non-thermoplastic material such, for example, as regenerated cellulose, gelatine, casein, chitin, and the like, and may be provided with a sheath composed of or comprising a thermoplastic material or a thermosetting material which is initially in a thermoplastic state.

It is only necessary that one of the structural elements, i. e., the core or the sheath, be formed of a material which is filament-forming. Thus, if the core is made of a filament-forming material, the sheath may be made of a material which is of such a low degree of polymerization or has other inherent characteristics which render the material incapable of being formed into filaments. Alternatively, the sheath may be formed of a filament-forming material, while the core may be of a material incapable of forming filaments. Advantageously, both core and sheath are formed of filament-forming materials.

The composite thermoplastic filaments of the present invention may be produced by any suitable process, for example, by (a) applying a coating or sheath about a central core portion, or by (b) extruding one material about a pre-formed core of the other, or by (c) simultaneously extruding the core and the sheath into a common coagulating medium.

Filaments of special characteristics may be obtained by associating two different materials as the core and sheath thereof, both of which are activatable but at different temperatures or under different conditions. Thus, a thermosetting core may be associated with a thermoplastic or thermosetting sheath, while a thermoplastic core may be associated with a thermoplastic or thermosetting sheath. Preferably the sheath is more susceptible to the desired activation treatment. With activation by heat, the sheath becomes adhesive at a temperature lower than the

material constituting the core of the filament. Filaments and fibres so constituted hold their shape and retain their identity as filaments during activation of the sheath by virtue of the fact that the core is relatively unaffected by the activation treatment.

The filaments of the present invention may take other specific forms than those mentioned above. The activatable filaments may be so constituted as to make use of a material for the core which would ordinarily be susceptible to swelling and shrinkage tendencies, but which are entirely overcome by the application of a thermoplastic or thermosetting material as a sheath about the core. Thus, a regenerated cellulose filament or fibre which is highly hydrophilic and susceptible to swelling and shrinkage tendencies in the presence of high humidity or when wet, may be waterproofed by a sheath of a thermoplastic resin, such as a copolymer of vinyl chloride and vinyl acetate, which at the same time serves to make the filament activatable. The same core material of regenerated cellulose may be waterproofed also and rendered activatable by the application of a thermosetting resin material, such as a partially condensed phenol-aldehyde resin in the thermoplastic state. In the former case, the composite filament is activatable repeatedly, whereas in the latter case it is permanently set by the first activation.

The fibrous product may be subjected to various means for activating the potentially adhesive fibre including, for example, (1) subjecting the fibrous product to the application of dry heat, with or without pressure, as by passing dry hot air through the products, or by passing the products through heated calender rolls or pressing them between heated plates; (2) by treating the fabric, with or without pressure, with moist heat as by the use of hot water or steam. The use of steam in accordance with the procedure described and claimed in my copending application Serial No. 444,438, filed May 25, 1942, is particularly advantageous when it is desired to produce soft or thick products; (3) by the application of radiation, with or without pressure, for example, by exposing the products to infra-red radiation of such intensity and duration as to activate the thermoplastic fibres; (4) by subjecting the fibrous products to high frequency induction field, with or without pressure, whereby the relatively non-activating thermoplastic fibres are activated by the heat generated therein, and to promote such high frequency induction heating of the potentially adhesive fibres, a minor proportion of an electrically conducting substance, such as metallic powder, graphite, and the like, may be incorporated in the potentially adhesive fibre; (5) by the application, with or without pressure, to the fibrous product of a liquid which is a solvent or a softening agent for the potentially adhesive fibre and simultaneously or thereafter heating the product, whereupon the potentially adhesive fibres are softened and rendered tacky after which the liquid agent may be removed if desired.

Activation of the yarns or fabrics may be accompanied by the application of pressure which has the effect of increasing the number of points and areas of contact between the activatable fibres and themselves, or between themselves and the non-activatable fibres in the articles whatever the case may be. The total number of the individual points of adhesion and the total area constituted thereof in a given fabric may be predetermined by adjusting the proportion of fibre

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which is activatable in the initial fibre mixture to be spun, or the proportion of activatable continuous filaments in the initial continuous filament yarn. Further variations and further opportunities to control the extent of the connection between the points of intercrossing of the yarns in the fabric are obtainable by alternating one or more activatable yarns with one or more non-activatable yarns in the weft or in the warp of a woven fabric, or on the successive courses of a knitted fabric. Similarly, in doubling, netting, braiding and knitting, one or more activatable yarns may be combined with one or more non-activatable yarns.

Depending upon the particular desideratum in the final fabric to be produced, the percentage of activatable fibres or filaments therein may be varied widely. For simple stabilization of the fabric, a range of activatable fibres between 5 to 25% of the entire weight of the fabric is generally adequate, the balance being non-activatable. Where considerable stiffening of the fabric is also desired, higher percentages up to 100% of activatable fibre may be present in the fabric.

The activatable filaments, either in the form of continuous filaments or staple fibres, may be associated with non-activatable fibres or continuous filaments of any sort, such as regenerated cellulose from viscose or cuprammonium cellulose, cotton, silk, wool, flax, kapok, casein, mineral fibres including asbestos, glass fibres, rock wool and the like, for the production of textiles in accordance with the present invention.

The composite filaments thus formed are capable of employment as continuous filaments or cut staple fibres to advantage in the textile arts in numerous ways. In the making of textile yarns and fabrics, staple fibres cut from the thermoplastic filaments of the present invention may be used alone or in admixture with other activatable and/or non-activatable fibres, in the production of textiles of all kinds, such as yarns, fabrics and felts. The twist, hand and bulk characteristics of the yarns so formed may be set and stabilized by activation of the thermoplastic filaments. Such yarn, either before or after activation, may be woven, knitted or braided into fabrics, and the fabric will be stabilized by the adhesion between fibres in the yarns and/or between yarns. Similarly, such yarns, either before or after activation, may be plied together or with other yarns whether activatable or not, into cords and the plying may be followed by activation or reactivation to set the twist and structure in the cord. Similarly, yarns which are formed of the continuous composite filaments may be formed of, or contain, the composite activatable continuous filaments of this invention, and these continuous filament yarns may be fabricated into cords by plying, into textile fabrics by weaving, knitting, braiding, netting or felting, after which the fabrics may be activated to stabilize the structure.

Textile fabrics, whether knitted or woven, braided or plied, can thus be produced which are substantially free of any tendency of the component yarns and filaments therein to slip with respect to the others, and particularly in regard to knitted fabrics, free of any tendency to run or "ladder" upon the breakage of one of the loops therein. It is also possible to control slippage and laddering to any predetermined extent by adjusting the extent of activation. Fabrics thus stabilized may be characterized by the same high porosity and fullness of hand as such fabrics before stabilization by activation of the yarns

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thereof. If desired, activation may be so effected as to impart to the fabric a stiffness which may be of special advantage in the production of fabric-stiffening materials, particularly for collars, cuffs and the like. Also, the activation may be effected in such a manner as to control the porosity of the fabric, and may be so extensive as to impart a smooth glossy surface to the fabrics.

The activatable filaments of this invention may be employed for the production of felts, either by the dry-laying or wet-laying processes. As in the applications mentioned above, the percentage of activatable fibres may vary from a very low proportion, such as 5%, up to 100% of the product, and the extent of activation may be varied as desired to obtain a predetermined amount of porosity stiffness and density in the felt product. The activatable filaments of the present invention may be associated with non-activatable filaments to produce numerous fibrous products applicable to various textile uses, such as hats and other clothing, and also to industrial uses. For example, they may be applied in the form of braids, felts, threads or cords, for use as packing material and gasket material for sealing relatively moving or stationary parts of machinery of any kind, or in similar form as wicks for transmitting liquids to elements or surfaces to be lubricated or otherwise coated. The activatable fibres of this invention, with or without non-activatable fibres, may be fabricated into such articles as battery separators, heat-insulation material, sound-insulation material, cushioning, padding, filtering materials either for gaseous or liquid suspension, etc.

By way of illustration, but not by way of limiting the invention, there will be given the following specific examples:

Example 1

There is formed a composite potentially adhesive filament having a thermoplastic core and a thermosetting sheath. For the core there is employed a filament-forming copolymer of vinyl chloride and vinyl acetate which has been after-chlorinated until its softening point is about 125° C. Such a core is then provided with a sheath comprising a urea-formaldehyde butanol ether resin in the thermoplastic state, the resin containing 5% of a suitable plasticizer and a small percentage of an ammonium salt as a curing catalyst. Fabrics made in whole or in part of such filaments are activated at temperatures below 125° C. with pressure, at which temperature the sheath becomes tacky but the core does not lose its filamentary form. During activation the urea-formaldehyde butanol resin is polymerized to the infusible state so that thereafter the fabrics may be ironed even at temperatures above the softening point of the core without reactivation of the composite filaments.

Example 2

There is prepared a potentially adhesive filament comprising a thermosetting core and a thermoplastic sheath by forming the core of a urea-formaldehyde butanol ether resin in the fusible state containing 5% of a suitable plasticizer and a small percentage of a catalyst as in Example 1, and forming a sheath thereon of the copolymer of vinyl chloride and vinyl acetate which was used for the core in Example 1. Upon activation of articles containing such composite filaments at temperatures above 125° C. the sheath is rendered tacky and the core is converted to the in-

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fusible state. After the initial activation the core is no longer fusible so that the sheath may be rendered repeatedly tacky without softening the core, thus avoiding repeated shrinkage of the composite filament.

Example 3

There is prepared a potentially adhesive filament comprising a non-thermoplastic core and a thermoplastic sheath by forming the core of viscose rayon and the sheath of suitably plasticized cellulose acetate. Fibrous products made from such composite filaments may be activated at any temperature which renders the cellulose acetate sheath tacky without causing a softening of the core. Thus, the fibre form of the filament is retained during activation and shrinkage of the filaments and articles is retarded.

Example 4

There is prepared a composite potentially adhesive filament in which both the core and the sheath are thermoplastic but have different thermal softening points, preferably the sheath softening at a lower temperature than the core. Thus, the core may be formed of unplasticized cellulose acetate softening at 120° C. and the sheath of polyvinyl acetate having a thermal tacking point of 100° C. Thus, articles formed from such filaments may be activated to bind fibres therein by heating to a temperature at which the sheath is rendered tacky but at which the core is not softened, thus preserving the fibre form of the filament and preventing breakage and distortion of the filament.

Example 5

A fabric for use as a cover for ironing boards, for heat insulation, or for other purposes where it is exposed to high temperatures is formed of composite filaments having a core consisting of a single glass filament and a sheath of a plasticized phenol-formaldehyde resin containing an acid catalyst, the resin being initially in the fusible, thermoplastic state. Such filaments are formed in the yarns, and the yarns, before or after fabrication into a fabric, are activated to bind fibres in the product and to convert the phenol-formaldehyde resin to the infusible state whereupon the fabric will subsequently resist temperatures up to about 400° C. without causing distortion of the fabric by re-activation of the sheath of the composite fibres.

Example 6

A composite potentially adhesive filament is formed using a single nylon mono-filament as the core and having a sheath formed from a mixture of a thermoplastic resin and a thermosetting resin; for example, a mixture of three parts of "Bakelite" phenol-formaldehyde resin and one part of a "Vinylite" polyvinyl butyral resin, the "Bakelite" resin being in the organic solvent soluble fusible state and containing a small percentage of a latent acid catalyst and one-half part of a plasticizer such as "Flexol" plasticizer. Such composite filaments have the property of being activatable repeatedly at moderate temperature, but upon prolonged heating or heating at more elevated temperatures the filaments can be cured so that they are no longer activatable.

The composite filaments of the present invention and the textile products produced therewith

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are characterized by many unforeseen advantages. The filaments are less susceptible to loss of the shape and identity of the filaments during activation, and the extent of activation by heat can be more easily controlled than with homogeneous potentially adhesive filaments. A greater pressure or less control of pressure is required with the present filaments and products since there is less danger of the composite filament being severed during activation as a result of being pressed against an adjacent filament. The filaments and articles produced therewith are capable of being permanently set and thereby, no longer subject to activation, which is an advantage when it is desired to maintain the shape and structure of an article even at elevated temperatures.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A process of producing a textile product comprising forming a structure of composite, potentially adhesive filaments comprising at least two integral portions, one of said portions being a core portion and the other being a sheath portion, exterior to and encasing said core portion and forming a smooth longitudinally continuous and homogeneous filament surface, the core portion being formed of organic material of non-cellular structure, and the sheath portion being formed of a thermosetting resin in the thermoplastic state, heating said structure to cause the sheath portions of adjacent filaments to soften and adhere to each other, and to cause interpolymerization of the thermosetting resin comprising said sheath portions so adhered to each other, and continuing polymerization of said thermosetting resin to the infusible state, whereby the filaments of the structure are bonded to each other at the points of intercrossing, and the bonds between said filaments rendered resistant to heat.

2. A process of producing a textile product in accordance with claim 1 in which the core portion is formed of a thermoplastic synthetic resin.

3. A process of producing a textile product in accordance with claim 1 in which the core portion is formed of a non-thermoplastic organic material.

4. A process of producing a textile product in accordance with claim 1 in which the core portion is initially formed of a thermosetting resin in the thermoplastic state, the resin forming the core portion and the resin forming the sheath portion being polymerized to the infusible state.

WORTH WADE.

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