United States Patent Office 3,053,609 Patented Sept. 11, 1962

3,053,609

TEXTILE

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No Drawing. Filed Feb. 24, 1959, Ser. No. 794,813
23 Claims. (Cl. 8—128)

This invention relates to new compositions and more particularly to a process for finishing synthetic fibrous material with said compositions to improve the aesthetic properties thereof.

Many methods have been proposed for bonding fibers within a network of woven or non-woven fabrics. None of these prior methods have been satisfactory for commercial application for several reasons. The bonded fabrics usually possessed too stiff a hand and were too boardy if sufficient bonding agent was used to improve the properties. Also the fabrics contained only temporary bonds between the fibers which upon wearing or other use and repeated laundering caused breaking of the bonds which resulted in the original fabric with essentially no improvements. Another problem was encountered in the application of the bonding or finishing agent to the fabric. In most cases the bonding between fibers occurred as a continuous adhesive film rather than isolated bond sites throughout the fabric.

It is an object of this invention to provide an improved composition and process of applying same to fabrics to bond the fibers within the fabrics at a series of small point bonded sites. Another object is to provide a composition and process for improving the pilling resistance, dimensional stability, body, and liveliness of synthetic fabrics without sacrificing the tactile hand and aesthetics of the fabrics, while retaining the strength and other advantageous properties contributed by the fibers in the fibrous material. Another object is to provide synthetic fabrics having improved properties without any foreign resinous finish remaining on the fabric. A further object is to provide improved fabrics wherein the fibers are bonded at a series of point sites, said bonds being permanently resistant to washing, laundering, and use. Other objects will be apparent from a description of the invention given below.

The above objects are accomplished by providing a one-phase liquid solution for bonding of fibers comprising a liquid medium or vehicle, a latent fiber solvent soluble or miscible with said liquid medium and an inert extender soluble or miscible in said liquid medium, said solution being capable of conversion to a multi-phase system upon insolubilization of said inert extender, one phase of said system being a latent solvent for the fiber. The invention also comprises a process for improving the aesthetics of fibrous material comprising the steps of applying to the fibrous material the one-phase liquid solution described above, insolubilizing the inert extender on the surface of the fibers, activating the latent solvent on the fibrous material sufficiently to bond the fibers at a number of point sites, then removing all of the remaining components of the liquid solution from the fibrous material.

A typical process for point bonding a fabric with the liquid solution is as follows:

(1) Prepare the one-phase liquid solution by combining a latent fiber solvent, an inert extender and a liquid medium.
(2) Pad the liquid solution on the fabric at room temperature.
(3) Insolubilize the extender, activate the solvent, dissolve a portion of fiber surface, and redeposit dissolved polymer to form fiber to fiber bonds preferably by drying the fabric.
(4) Wash away both the extender and the fiber solvent using suitable solvents to dissolve both of these.
(5) Dry the fabric.

By latent fiber solvent as used herein is meant any liquid or solid material or solution of same, soluble or miscible in the liquid medium, which is in the initial one-phase liquid solution a non-solvent for the fiber, but is capable of bonding (i.e., at least rendering the fiber surface tacky) the fiber after insolubilization of the inert extender. It is preferred to employ between 0.25% and 15% by weight of the 100% active fiber solvent, based on the total weight of one-phase solution, without using any more solvent than is necessary to bond the fibers. For special cases it may be desirable to use more than 15% active fiber solvent but in such cases the results are not as good and control of the bonding process is more difficult. The fiber solvent may be used herein by dissolving it in a separate liquid solvent for the same or by using it alone in the liquid medium specified.

Typical fiber solvents for acrylonitrile polymer fibers include aqueous solutions of sodium thiocyanate, lithium thiocyanate, lithium iodide, sodium iodide, calcium thiocyanate, potassium thiocyanate, calcium bromide, zinc chloride, lithium bromide, magnesium thiocyanate, cupric chloride, magnesium chloride, ferric chloride, ferrous bromide, cadium iodide, barium chloride, and cobaltous iodide. Suitable fiber solvents also include propylene carbonate, ethylene carbonate, dimethyl sulfone, tetramethylene sulfone, dimethyl formamide, dimethyl acetamide, gamma-butyrolactone, trimethylene carbonate, and the like. These may be dissolved in water, or many of them may be dissolved in alcohol, ethylene glycol, benzene or the like. Typical fiber solvents for polyamide fibers include aqueous solutions of the inorganic salts listed above for acrylonitrile polymer fibers, as well as materials such as nitric acid, formic acid, phenol, meta-cresol, and the like. These may be dissolved in water, ethanol, methanol, benzene, and the like depending upon the fiber solvent used. Typical fiber solvents for polyester fibers include benzyl alcohol, benzoic acid, dichloro acetic acid, trichloro acetic acid, trifluoro acetic acid, dichloro phenol, and aqueous solutions of calcium and magnesium thiocyanates. Similarly, known solvents for other polymers listed below may be used when such polymers are present. In the case of natural fibers, etc., any known solvent may be used. Typical solvents suitable for wool include alkali metal salts of thioglycolic acid, and sodium sulfide. Dilute aqueous solutions of ferric chloride, etc., are suitable for rayon.

The liquid medium employed in the preparation of the one-phase liquid solution of this invention may be the same liquid as used for dissolving the fiber solvent when desired, as illustrated above in the lists of fiber solvents, or the liquid medium may be a different liquid which is miscible with the liquid employed to dissolve the fiber solvent. The liquid medium may be aqueous or organic or a mixture of two or more liquids which are miscible with one another. The liquid medium will normally comprise 70% to 99.5% by weight of the total one-phase liquid solution. In each case the liquid medium should be capable initially of dissolving both the fiber solvent and the inert extender to form the one-phase liquid solution.

By inert extender as used herein is meant a substance of sufficiently high molecular weight or of such a complex structure that the substance is initially soluble or miscible with the liquid medium in a one-phase solution, but is subsequently capable of being insolubilized. A number of methods may be employed to achieve insolubilization of the inert extender including, for example,

heating to insolubilize the inert extender when it has inverse solubility, heating to evaporate liquid medium which will result in insolubilization of the inert extender by precipitation, adding salts or precipitating ions to the one-phase liquid solution to precipitate the extender, concentrating salts within the liquid solution to precipitate the extender, adding acid or alkali to the liquid solution to change the pH or to neutralize the extender to cause precipitation thereof, or any other well known method of causing insolubilization of high molecular weight substances in the liquid solution.

It is preferred to employ between 0.25% and 15% by weight of the extender, based on the total weight of one-phase liquid solution. It is also preferred to employ an extender which is insoluble in the fiber solvent. Typical inert extenders which may be employed in preparation of the one-phase liquid solution, regardless of the fibers to be bonded, include liquid and solid polyethylene oxides, polydioxolane, and polyalkylene ether glycols (commercially available for example as "Polyox" WSR–205, "Polyox" WSR–301, and polyethylene glycol 200, made by Union Carbide Corp.), sodium carboxymethyl cellulose, sodium alginate, potassium alginate, methyl cellulose, polyvinyl alcohol, polyacrylic and polymethacrylic acids, the sodium salt of polyacrylic acid, sodium oleate, and the like. The inert extender may be either liquid or solid so long as it is initially soluble or miscible in the liquid medium.

Although the composition of the one-phase liquid solution of this invention will normally be limited to three ingredients (i.e., fiber solvent, inert extender, and liquid medium), it may be advantageous in treating certain fibers or fabrics to employ in the one-phase liquid solution small amounts of softeners, antistats, slickening agents, and other modifying agents to achieve particular results. However, these additional modifying agents must be carefully chosen in amount and composition so as not to disrupt the cooperating functions of the three main ingredients of the solution during application and processing on the fibrous material. Fiber solvent may be composed of two or more separate solvents, one for each of the fibers being bonded.

The fibrous material to be treated in accordance with this invention may be in a number of forms. The material may consist of or comprise staple fibers, monofilaments, tow, sliver, spun yarns or continuous filament yarns, bulked yarns, or woven, knitted or non-woven fabrics. The woven fabrics may be woolen, or worsted spun flannels, cheviots, tweeds, Shetlands, blankets, pile fabrics, etc. The knitted fabrics may be warp knit or circular knit jerseys, sweaters, pile fabrics, socks, suitings, gloves, scarfs, and the like. The non-woven fabrics may include batts, felts, pile fabrics, carpets, stuffing materials and the like.

The composition of the fibers or filaments making up the fibrous material should be at least 25% by weight of organic, fibrous material capable of being point bonded in order to achieve benefit from the one-phase liquid bonding solution of this invention. Blends of synthetic and/or natural fibers may be advantageously treated where all the fibers are to be bonded, or the solutions may be carefully chosen so that they are inert with respect to the fibers present that are not to be bonded.

Typical of the synthetic organic fibers and filaments which may be treated according to this invention include those prepared from polyamides such as poly(hexamethylene adipamide), poly(hexamethylene sebacamide), polycaproamide, and copolyamides, polyesters, and copolyesters such as condensation products of ethylene glycol with terephthalic acid, ethylene glycol with a 90/10 mixture of terephthalic/isophthalic acids, ethylene glycol with a 98/2 mixture of terephthalic/5-(sodium sulfo)-isophthalic acids, and trans-p-hexahydroxlyylene glycol with terephthalic acid, polyacrylonitrile, copolymers of acrylonitrile with other monomers such as vinyl acetate, vinyl chloride, methyl acrylate, vinyl pyridine, sodium styrene sulfonate terpolymers of acrylonitrile/methyl acrylate/sodium styrene sulfonate made in accordance with U.S. Patent 2,837,501, vinyl and vinylidene polymers and copolymers, polycarbonates, polyurethanes, polyesteramides, polyethylenes, polypropylenes, fluorinated ethylene polymers and copolymers, cellulose derivatives, such as cellulose acetate, cellulose triacetate, rayon, viscose, etc., composite filaments such as, for example, a sheath of polyamides around a core of polyester as described in the copending application of Breen, S.N. 621,443, filed November 9, 1956, now abandoned, of which S.N. 771,676, filed November 3, 1958, is a continuation-in-part and issued as U.S. 3,038,236 and two acrylonitrile polymers differing in ionizable group content spun as a sheath and core as described in the copending application of Taylor, S.N. 640,722, filed February 18, 1957, now abandoned, of which S.N. 771,677, filed November 3, 1958, is a continuation-in-part and issued as U.S. 3,038,237, and the like. The fibers and filaments may be crimped or uncrimped, drawn or undrawn, and/or bulked or unbulked. Two or more synthetic fibers with or without natural fibers may be blended before bonding with the solutions of this invention.

Natural fibers which may be treated according to the invention include wool, cotton, and silk.

The new one-phase liquid bonding solutions of this invention are normally applied to the fabric as the last or essentially the last step in fabric finishing. The fabric is first prepared by weaving, knitting or any other conventional constructions, then it is dyed and finished by conventional means. Then the one-phase bonding solution is applied to the fabric with a take-up weight of about 50% to 250% by weight based on the weight of the fabric. However, standard textile finishes may be applied to the fabric before or after bonding such as softeners, antistats, and the like. However, these other finishes should not leave an impermeable film on the fibers that would prevent the bonding solution from penetrating the fibers. In addition to employing standard chemical finishing agents, there may also be employed mechanical finishing treatments before or after the point bonding in accordance with this invention. Such memechanical finishing treatments may include napping, brushing, teasling, shearing, fulling, semi-decating, scouring, palmering, rotary pressing, calendering, and the like.

In addition to finishing fabrics in accordance with this invention, the solutions may also be applied to yarns prior to weaving or knitting. Such application to warp yarns acts as a warp size and aids in handling the yarns during weaving. The solutions applied to knitting yarns improves the knitting efficiency and leads to knitted fabrics having better aesthetics and less pilling.

The following test procedures were used in obtaining the data reported in the examples. For determining dimensional stability, swatches of fabric two feet square are cut from a sample fabric. The corners of an 18-inch square are marked on the 2 x 2 fabric, after lining up the marking square parallel to the warp and fill. The fabrics are then commercially dry-cleaned five times or laundered on a domestic washing machine and tumble dried five times. After dry cleaning or laundering the change in dimensions of the hatch marks is measured and reported as percent shrinkage (—) or percent elongation (+), calculated as follows:

$$\text{Percent change in dims.} = \frac{\text{length after testing} - \text{orig. length}}{\text{original length}} \times 100$$

The stiffness is determined by first conditioning the fabric samples for at least 12 hours in air at room temperature. The test employs a modified Monsanto wrinkle recovery tester. A 9/16" wide strip of fabric is suspended one inch beyond the clamp in a horizontal position and the vertical sagging deflection at the free end of the fabric

is noted. This deflection is measured and reported in millimeters, the lower the deflection value, the higher the stiffness or body of the fabric.

The random tumble pill test described by E. M. Baird, L. C. Legere and H. E. Stanley, Textile Research Journal, 26, 701–735, 1956, is used to determine the pilling resistance of fabric samples. Six fabric test pieces 4 3/16" x 4 3/16" are cut on a 45-degree bias across the full width of the fabric. The edges of the cut pieces are sealed with diluted "Uba-bond" cement. The test pieces are examined after each 30 minuites of tumbling and given a pill rating of 1 to 5, where 1 shows no pilling and 5 has severe and unacceptable pilling.

For determining liveliness (i.e., tensile work recovery) of fabrics, ten specimen pieces each 4" x 8" are cut from a sample fabric. Five of the specimens are cut with the long dimension parallel to the warp and five are cut with the long dimension parallel to the filling yarns. No specimen in the warp direction contains the same warp yarns, and no specimen in the filling direction contains the same filling yarns. A sample is placed in an Instron tensile tester with 3" x 11" jaws (3" jaw dimension being perpendicular to the direction of loading) at a 3-inch gauge length, so that a slight amount of slack is left in the specimen. The fabric is then elongated at a rate of 10%/minute to a load of 1000 grams. After elongation the load is removed at the same rate (10%) and the fabric is allowed to recover. The work recovery is calculated according to the formula shown below:

$$\text{Work recov. (percent)} = \frac{\text{integrator count after removal of load}}{\text{integrator count after reaching 1000 } g. \text{ load}} \times 100$$

This percent work recovery is a measure of the liveliness of the fabric.

This percent work recovery is a measure of the lievli- of this invention. The parts are by weight unless otherwise specified. It is to be understood however that any combination of fibers or fabric prepared from the polymers mentioned above may be substituted in the examples by using appropriate solvents for the polymers selected.

EXAMPLE I

A flannel fabric was woven from worsted yarns spun from 3 denier, 4.25 inches staple composite fiber made in accordance with copending application to R. B. Taylor, U.S. Ser. No. 771,677, filed November 3, 1958, where one polymer component was 100% polyacrylonitrile and the other component was made from 97% by weight acrylonitrile and 3% sodium styrenesulfonate. The fabric was finished conventionally by Beck scouring, dyeing, napping, brushing and shearing, and semi-decating. A finishing solution was made by dissolving 4 grams of polyethylene oxide having an intrinsic viscosity 17 (Polyox WSR–301) and 4¼ grams of sodium thiocyanate in 300 ml. of water. 100 grams of the above-described fabric was padded with the single phase solution to a wet pick-up of 100%. The fabric was then dried in an oven at 120° C. for 20 minutes. The fabric after drying was stiff and boardy. The stiff and boardy fabric was scoured thoroughly in warm tap water to remove all the polymeric extender and salt. The fabric was then air dried and ironed smooth with a cool iron. The finished fabric had outstanding liveliness, body and resistance to pilling. The treated fabric had a random tumble pill test rating after 30 minutes of 2.0. The control fabric not treated with the special finishing solution had a random tumble pill test rating of 5.0 after 30 minutes. The untreated fabric was dead and lean.

EXAMPLE II

A solution of 12.8 grams of sodium thiocyanate and 3 grams of polyethyleneoxide ("Polyox" WSR–205) was made by dissolving these two materials in 84.2 grams of water. The above solution was padded on to 50 grams of a warp knit fabric made from a blend of 75% by weight staple fiber (made of a terpolymer 94% acrylonitrile, 5.6% methyl acrylate and 0.4% sodium styrenesulfonate) with 25% of regenerated cellulose staple fiber. The fabric picked up 170% of its weight in the solution. The padded fabric was dried in an oven at 100° C. for 15 minutes. After drying the fabric was stiff and boardy. The fabric was rinsed in water at 50° C. until all the extender and salt were removed. The fabric was then air dried and ironed smooth using a cool iron. The dried fabric was appreciably more lively and full bodied than an untreated control and exhibited marked improvement in stretch resistance.

EXAMPLE III

A woolen-type skirting fabric was made from 100% of the same terpolymer staple fiber as that described in Example II. The yarns were spun from a mixture of 3 d.p.f., 2.5-inch staple of two different shrinkage capacities, 65% by weight being staple having a residual shrinkage of 0–3% of its length, and 35% being staple having a residual lengthwise shrinkage in boiling water of 17%. The yarns were woven using a loom construction of 32 x 26. The fabric was finished conventionally by Beck scouring at the boil ½ hr., dyeing, drying, napping, brushing and shearing, semi-decating and palmering. The finished fabric had a construction of 48 x 34. A solution was made by dissolving 2 grams of sodium carboxymethyl cellulose (Hercules Powder Co., "CMC" 70, medium viscosity grade) and 3 grams of sodium thiocyanate in 300 ml. of water. 100 grams of the fabric described above was padded with the single phase solution to 100% wet pick-up. The padded fabric was dried in an oven at 120° C. for 15 minutes. When the fabric was removed from the oven it was stiff and boardy. The stiff and boardy fabric was rinsed with water at 50° C. until all the extender and salt were removed. The fabric was air dried and ironed smooth using a cool iron. The treated fabric was appreciably livelier and more full bodied than the untreated control. The treated fabric showed less tendency to scuff and pill and was more dimensionally stable to laundering.

EXAMPLE IV

A solution was made by dissolving 0.7 gram of polyethylene oxide ("Polyox" WSR 301) and 0.25 gram of sodium thiocyanate in 100 ml. of water. 50 grams of the same fabric that was described in Example III was padded with the single-phase solution to a wet pick-up of 198%. The fabric was dried in an oven at 120° C. for 15 minutes. The fabric as removed from the oven was stiff and boardy. In this condition the fabric was scoured in water at 50° C. until all the extender and salt were removed. The fabric was then dried and ironed smooth with a cool iron. The treated fabric was appreciably more lively and full bodied than the untreated control. The stiffness of the treated fabric showed 7.3 mm. deflection and that of the untreated control fabric 12.8 mm. deflection.

EXAMPLE V

A solution was made by dissolving 3 grams of the same polyethylene oxide as used in Example IV and 5 grams of zinc chloride in 300 ml. of water. A piece of carpet made from 15 denier, 3-inch staple fiber (polyhexamethylene adipamide) was woolen spun to 4 Z singles, 2.5 S ply, 3/45s (6200 total denier). The yarn was woven into a carpet to 198 pitch (7⅓ warp face ends/inch), 8 rows/inch, 0.375-inch wire height. The face yarn weight (take-up) was approximately 35 oz./yd.^{2}. A sample of this carpet weighing 200 grams was impregnated with the above solution so that a wet pick-up of 100° is achieved. The treated carpet was dried in an oven at 120° C. for ½ hour. Upon removal from the oven the carpet was stiff and boardy. The stiff and boardy carpet was rinsed in water at 50° C. until all the extender and salt were removed. The carpet was dried in an oven with air cir-

culating at 120° C. for 1 hour. The treated carpet was more firm and resilient than the untreated control and exhibited less tendency to soil. The treated carpet showed a greater resistance to scuffing and pilling than the untreated control. The random tumble pill test rating for a sample of the treated control carpet was only 3.9 compared with a rating of 5.0 for the untreated control sample, both tested under the same conditions.

EXAMPLE VI

A solution was made by dissolving 4 grams of the same polyethylene oxide as that used in Example V and 4 grams of zinc chloride in 300 ml. of water. The above solution was padded on to 100 grams of a broadcloth fabric woven from yarns composed of 100% polyhexamethylene adipamide staple fibers which were spun on the cotton system. The padded fabric had a wet pick-up of 100%. The padded fabric was dried in an oven at 120° C. for 15 minutes. Upon removal from the oven the fabric was stiff and boardy. The stiff and boardy fabric was scoured in water at 50° C. until all the extender and salt were removed. The fabric was then air dried and ironed smooth using a cool iron. The treated fabric had markedly improved body and liveliness and better resistance to pilling compared to the untreated control fabric.

EXAMPLE VII

A solution was made by dissolving 3 grams of the same polyethylene oxide as that used in Example V and 20 grams of trichloroacetic acid in a mixture of 240 ml. of isopropyl alcohol and 60 ml. of water. The above one phase finishing solution was padded onto 100 gms. of a woven shirting fabric made from yarns spun from a blend of 65% polyethylene terephthalate fibers by weight and 35% cotton fibers so that a wet pick-up of 100% was obtained on the fabric. The fabric was dried in an oven at 120° C. for 15 minutes. Upon removal of the fabric from the oven, it was stiff and boardy. The stiff and boardy fabric was scoured in water at 50° C. until all the extender and trichloroacetic acid were removed. The fabric was air dried and then ironed smooth with a cool iron. The treated fabric had markedly improved body and liveliness and dimensional stability after laundering over the untreated control fabric.

EXAMPLE VIII

A 50-gram swatch of circular knit jersey fabric made from yarns spun from staple fiber composed of at least 85% by weight acrylonitrile fiber was padded with a solution made by dissolving 3 grams of the same polyethylene oxide as that used in Example II and 4 grams of sodium thiocyanate in 300 ml. of water. The pressure on the squeeze rolls of the pad was adjustable so that the fabric picked up 110% of its own weight of solution. The treated fabric was dried in an oven at 120° C. for 15 minutes. At the end of this time, the fabric was stiff and boardy. The stiff and boardy fabric was rinsed in water at 50° C. until all of the extender and salt were removed. The fabric was then air dried and ironed smooth with a cool iron. The treated fabric had improved body and liveliness over the untreated control. The treated fabric had a stiffness rating of 9.9 mm., while the untreated control fabric had a stiffness rating of 12.4 mm.

EXAMPLE IX

A plain woven fabric was prepared from yarns spun on the woolen system. Each yarn was a blend of 65% by weight of staple fiber, made from a terpolymer of 94% acrylonitrile, 5.6% methyl acrylate and 0.4% sodium styrenesulfonate, and 35% wool. Half the yarn was dyed black and used in the warp and the other half brown used in the filling. The fabric was then conventionally scoured, dried, then brushed and sheared. Next a solution was prepared by dissolving 3.5 pounds of sodium thiocyanate in 95.2 lbs. of water at room temperature. The salt solution was placed in a baffled tank and agitated by means of a propeller type mixing blade. To this turbulent mixture was added 1.3 lbs. of the same polyethyleneoxide as that used in Example II. (This high molecular weight polyethyleneoxide, sold by Union Carbide Corp. as "Polyox" WSR–205, had an intrinsic viscosity of about 4.5 measured in water.) Agitation was maintained until solution was complete. Fifty pounds of fabric was fed through a padding bath of 100 lbs. of the one-phase finishing solution at room temperature. The treated fabric was then led through the padding rolls to squeeze out excess solution and to adjust the wet fabric pick up to 135% of its own weight (dry basis). The fabric was dried on a pin tenter frame wet width with no overfeed at a rate of one yard/minute at 115° C. frame temperature. This required 3 minutes exposure time. The dry fabric was then stiff and boardy. The selvedges were tacked together to form a continuous tube of fabric, which was then Beck scoured at 43° C. for 30 minutes to remove all of the extender and salt. The fabric was dried on the pin tenter at 115° C. for 30 minutes. The fabric was brushed and sheared once on each side, then rotary pressed, and finally warm blanket decated with wet steam for one minute. The completely finished fabric was much more lively and more full bodied than a control fabric without the finishing solution. The improvements in properties of the fabric finished according to this invention compared with a control fabric not so treated are shown in Table I. This table shows the superior pilling resistance and dimensional stability of the treated fabric over the control fabric, the latter property being maintained even after repeated launderings. Also for comparison a third sample of the same initial fabric was finished with a solution of 1 gram of sodium thiocyanate in 100 grams of water so that a 104% wet pick up on the fabric was achieved. This third fabric treated in the absence of any extender showed a stiffness rating of 6.4 mm. before laundering and 10.4 mm. after ten launderings, indicating the poor bond stability achieved on this sample.

Table I

	Control	Treated
Weight (oz./yd.²)	6.1	5.9
Stiffness (mm. deflection):		
Initial	10.8	5.6
After 10 launderings	11.6	5.9
After 5 Dry Cleanings	10.4	5.8
Pilling:		
30 min	2.1	1.3
60 min	3.6	1.7
Liveliness—Tensile Work Recovery (Percent)	64	82
Dimensional Stability (Percent change in dimensions):		
5 Home Machine Launderings	−2.1	−1.4
5 Commercial Dry Cleanings	−1.3	−1.3

EXAMPLE X

This example illustrates the advantages of treating yarn with the solutions of this invention. The yarn used was made of the same composite staple acrylic fiber as that of Example I and was 2/32s worsted count with a twist of 14 Z t.p.i. singles and 7 S t.p i. plied. The yarn was treated by passage through a solution of 1.33% of the same polyethylene oxide as that of Example II and 0.67% sodium thiocyanate in water. The yarn was dried by passing over a heated drum at 54° C. at 10 yards/minute and then through a copper tube which was heated to 121° C. The yarn was taken up on a take-up roll at 70° C. at a speed of 12 yards/minute. To insure complete drying, an electrically-heated hot air blower was spaced between the take-up roll and a wind-up bobbin. This hot air was at a temperature of 149° C. A control yarn was prepared in the same manner with a 2% aqueous solution of the same polyethylene oxide, but no sodium thiocyanate. The treated yarn was knitted on a 24 gauge Komet knitting machine at 10 courses/inch. The knit tubing was mock dyed to remove all

the extender and salt. The fabric was then tested in the random tumble pill tester. Pill ratings after 20 minutes were as follows.

Fabric:	Pill rating
Control (untreated yarn)	5.0
Control (polyethyleneoxide only)	5.0
Treated (extender plus salt)	4.5

EXAMPLE XI

A fabric was knit on a 22-cut Supreme ROF circular knitting machine from 20/1 cc. yarn (15.3 turns/in. Z twist) containing a mixed shrinkage blend of two acrylic fibers and wool. The two acrylic fibers are made of the same terpolymer composition as that used in Example II. The fiber blend consisted of 35% of high shrinkage acrylic fiber (17% residual lengthwise shrinkage, 4.5 d.p.f., 2.5-inch staple), 35% of low shrinkage acrylic fiber (0–3% residual shrinkage, 2 d.p.f., 2.5-inch staple), and 30% wool (64/70s grade). This yarn was spun from a stock blend of fibers on a modified cotton spinning system. The yarn in skein form had a lengthwise shrinkage of 12.2%. A stabilized structure was knit at a construction of 34 courses and 22 wales/inch in a knit design consisting of alternating (in single succession) courses of plain stitches and courses of missed and tuck stitches. The fabric was finished by a process of fulling. Beck dyeing at the boil during which the fabric shrinks (9% in length and 25% in width), drying open width on a pin-tenter frame, napping, shearing and semi-decating. The fabric was then padded with an aqueous solution of 1% of the same polyethylene oxide used in Example I and 2.5% sodium thiocyanate to give a wet pick up of 161%. It was next Beck scoured to remove the chemicals, dried on a pin-tenter frame and given a final semi-decating.

The resulting fabric, even though knitted, closely resembled a woven flannel-type fabric in cover and handle. It had the following properties:

	Treated Fabric	Untreated Fabric
Weight (oz./sq. yd.)	7.5	7.5
Stiffness (mm.)	8.4	14.5
Percent Elongation (1,000 g. load on Instron tester):		
Wale direction	2.1	3.1
Course direction	7.1	14.9
Dimensional Stability (percent shrinkage after 5 automatic machine launderings and 5 automatic tumble dryings):		
Wale direction	−3.3	−3.7
Course direction	+0.9	+0.9

The percent elongation as measured is an indication of the stretchiness of the fabric. It is desirable for this type of fabric to have a low amount of stretch.

EXAMPLE XII

A thirty gram sample of a 100% wool woven fabric 12" x 12" was padded at 27° C. and 30 lbs. pad pressure with a solution of 470 grams water containing 25 grams of potassium thioglycolate and 5 grams of polyethylene oxide ("Polyox" WSR–35). The pH of the solution was adjusted to 11.0 before padding. Fabric pickup was 100% of its own weight. The padded fabric was laid flat on a tray and dried at 110–120° C. After drying the fabric was rinsed in an excess of a 1% solution of acetic acid in water, then rinsed thoroughly with water and dried. A control fabric was treated identically using a similar padding solution containing no polyethylene oxide. The preferred fabric treated according to this invention was noticeably livelier than the control fabric. Also the control fabric was stiffened and boardly and was noticeably weakened by the treatment.

The chief advantage of this invention is the provision of synthetic fibers and fabrics having a combination of improved pilling resistance, dimensional stability, body, and liveliness, without sacrifice to the fabric aesthetics and tactile hand of the fabric, while retaining the strength and other satisfactory properties inherent in synthetic fibers. Another advantage of the composition and process of this invention is that they yield when applied to synthetic fabrics all of the advantages of a typical resin treatment of the fabric without the disadvantages inherent in resin finishes.

The composition and process of this invention may be used to improve the properties of all forms of organic fibrous materials including blends of synthetic and natural fibrous materials for a variety of apparel and industrial textile applications.

This application is a continuation-in-part of my copending application Ser. No. 782,412, filed December 23, 1958, now abandoned.

It will be apparent that many widely different embodiments of this invention may be made without departing from the spirit and scope thereof, and therefore it is not intended to be limited except as indicated in the appended claims.

I claim:

1. The process of bonding fibers of fibrous textile material at isolated points only on contiguous fibers, without significant shrinkage or impairment of hand, which comprises applying to fibrous textile material a single-phase solution which consists essentially of a liquid medium vehicle inert to the said fibers, a latent solvent for the fibers in amount insufficient to be an active solvent while in the single-phase solution, and an inert insolubilizable extender which is a non-adhesive for the fiber; separating the said single-phase solution into a plurality of phases by insolubilizing the inert extender, one of which plurality of phases contains the inert extender in contact with the textile material as a discontinuous coating; and rendering the latent solvent active to the extent that it softens the surface of the fibers of the textile material and renders them adhesive to each other at isolated points only, these isolated points being those at which fibers become contiguous; the surfaces of the fibers of the said textile material other than at the said isolated points having the inert extender therebetween rendering such surfaces non-adhesive to each other.

2. The process of claim 1 in which the fibrous material contains fibers composed of an acrylonitrile polymer.

3. The process of claim 1 in which the fibrous material contains fibers composed of a polyester.

4. The process of claim 1 in which the fibrous material contains fibers composed of a polyamide.

5. The process of claim 1 in which the fibrous material contains wool fibers.

6. The process of claim 1 in which the latent solvent is present in the amount of from 0.25% to 15%, based on the total weight of the said single-phase solution.

7. The process of claim 1 in which the liquid medium is present in the amount of from about 70% to about 99.5%, based on the total weight of the single-phase solution.

8. The process of claim 1 in which the inert extender is a polymer.

9. The process of claim 1 in which the extender is insolubilized by removal of the liquid medium.

10. The process of claim 1 in which the extender is present in the amount of from 0.25% to 15%, based on the weight of the said single-phase solution.

11. The process of claim 1 in which the extender is a polyalkylene oxide.

12. The process of claim 1 in which the take-up weight of the said single-phase solution by the fibrous material is from about 50% to 250% by weight of the fibrous material.

13. The process of claim 1 in which the fibrous material is a yarn.

14. The process of claim 1 in which the fibrous material is a fabric.

15. The process of claim 1 in which the latent solvent is activated by removal of the liquid medium.

16. The process of claim 1 in which the latent solvent is activated and the fibers are point bonded by drying.

17. The product obtained by the process of claim 1.

18. The product of claim 17 in which the fibrous material is non-woven.

19. The product of claim 17 in which the fibrous material is woven.

20. The product of claim 17 in which the fibrous material is knitted.

21. The process of claim 1 in which the said fibrous textile material contains at least 25% of organic polymeric fibers.

22. The process of claim 1 in which the said fibrous textile material is in the form of a non-woven fabric.

23. The process of claim 1 in which the said inert extender is removed from the said fibrous textile material after bonding the fibers at the said isolated points.

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