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ANTISTATIC TEXTILE MATERIAL

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The present invention relates to blends of synthetic fibers having improved anti-static properties.

One common disadvantage of synthetic fibers, and particularly fabrics prepared from synthetic hydrophobic materials, is that they tend to develop static electrical charges. This feature is objectionable both during the manufacture of the textile and in the finished garment. During manufacturing, the static charge from the fibers or fabric interferes with the convenient handling during spinning, reeling, weaving, and like operations. Finished articles, which are desired to drape like cotton or wool, fail to do so properly due to their static charge and have a tendency to cling uncomfortably to the wearer. Furthermore, such textiles tend to collect dust and lint. In addition, the electric discharge itself is bothersome.

Many durable treating agents have been proposed to impart anti-static properties to textiles prepared from synthetic fibers. A large number of these agents are effective in reducing the static susceptibility of the material. However, most of them have a tendency to pick up dry cleaning agents, dirt and the like during use. This results in stiffening and discoloration of the fabric which reduces its aesthetic appeal. In addition, these agents tend to pick up soap micelles containing dirt during washing; stiffening and discoloration result. Also, when these agents are applied to dyed fabrics, discoloration or shade change frequently occurs.

It has now been found that by applying durable anti-static agents to staple fibers and blending these treated fibers in minor quantities with fibers which have not been treated with the anti-static agent, a fabric having highly improved anti-static qualities can be produced. Surprisingly, fabrics prepared from such a blend of treated and untreated fibers retain their anti-static property to a greater degree when subjected to cleaning operations than do fabrics in which 100% of the fibers are treated with an anti-static agent and do not become stiff and discolored. More surprising is the fact that these blends initially have less static susceptibility than do blends in which 100% of the fibers of the blend are treated with an anti-static agent. Furthermore, blends of the treated and untreated fibers have a higher durability when subjected to repeated cleaning operations than do the 100% treated materials.

It is, therefore, an object of this invention to prepare a blend of synthetic fibers having improved anti-static properties which are retained during the normal usage of the textile goods prepared therefrom. Another object is to prepare textile gods from blends of synthetic fibers having anti-static properties which are not lost during normal washing or dry-cleaning operations. Still another object is to prepare textile goods from anti-static blends of synthetic fibers having aesthetic properties equivalent to those of the untreated fibers themselves. Other objects will be apparent from the following discussion.

The objects of this invention are attained by providing a blend of synthetic fibers in which from about 10% to 50% of said fibers are treated with a durable anti-static agent. In a preferred embodiment of this invention the blend is comprised of from 20% to 25% of the treated fibers. In practicing this invention, the durable anti-static

agent is applied to staple fibers or fibers in the form of a tow. These treated fibers are then blended with untreated fibers in the proportions previously set forth. A relatively high loading, from about 0.2% to about 5.0%, of the anti-static agent is applied to the tow in a conventional manner such as that described in the copending application of Rimmer, U. S. application Serial No. 530,888, filed August 26, 1955, now Patent No. 2,839,431. Any of the many durable anti-static agents commonly known which can be applied at the loading rates described herein may be used. Application may be by cross-linking, application from special solvents, grafting to the fiber surface by chemical or physical means, and the like. The essential feature of the invention is that the anti-static agent be applied to the minor portion of the fibers, which is conventiontly accomplished by treating the fibers before they are converted into yarns, threads and fabrics.

The problem of static development exists for all fibers to a greater or lesser extent under conditions of extremely low relative humidity. However, the problem is most apparent in those fibers which are not based in any way on a natural product, such as cellulose. This invention is, therefore, directed to producing blends comprised of synthetic organic fibers prepared from fiber-forming addition and condensation polymers. Of particular interest are those fibers prepared from vinyl polymers, for example, acrylic fibers, polypropylene fibers, and the like, and fibers prepared from polymers of polyesters and polyamides.

The invention is further illustrated but not intended to be limited by the following examples.

Example I

The starting material for these tests was a 400,000-denier tow of continuous filaments which was dry spun from a dimethylformamide solution of an acrylonitrile copolymer and drawn to 450% of its original length. Samples of this tow were treated in various concentrations of an anti-static composition in a manner to give 100% pick-up of the solution itself. The anti-static material consisted of 70 parts of a linear polymer formed by the condensation of polyethylene glycol diamine and polyethylene glycol dihalide and 30 parts of polyethylene glycol diiodide as a cross-linking agent.

A. In the first test the anti-static composition was applied to a sample of tow to give a weight increase of 0.2% after the tow had been cut and dried at 270° F. for 10 minutes. The resulting cut staple was converted into spun yarn and this yarn used to prepare a sample of knit fabric.

B. In the second test a higher concentration of the anti-static composition was used, with the result that the cut, dried staple contained 0.5% of the material on a dry basis. This staple was likewise converted into knit fabric of identical construction to that of part A.

C. In the third test a sample of tow was treated with the anti-static composition at still higher concentration such that after cutting and drying for 10 minutes at 270° F. the staple contained 1.0% of the agent. Twenty (20) parts of this treated staple was blended with 80 parts of staple prepared by cutting a portion of the original tow and drying at 270° F. for 10 minutes. This portion of the staple blend contained no anti-static agent. The two portions of staple were well blended, and the blend was then converted into spun yarn and the yarn used to prepare a sample of knit fabric of identical construction to that of A and B above.

D. In the fourth test the anti-static composition was applied to the tow from a solution of sufficient concentra-

tion that after cutting the tow and drying it at 270° F. for 10 minutes it contained 2.5% of the anti-static composition on a dry basis. Twenty (20) parts of this treated staple was carefully blended with 80 parts of untreated staple as described in part C and the resulting blend was then used to prepare yarn which in turn was used to prepare knit fabric of identical construction to the above items.

The various knit fabrics described above were tested for static development both by a subjective method and by a resistivity measurement. The measurements were repeated after multiple washings of the fabrics.

For the subjective rating of static a subject took several samples of fabric into a room conditioned to 20% relative humidity and after a delay of 2 hours to bring the samples to equilibrium rubbed each sample in turn against his skin and then noted the static tendencies as indicated by clinging of the fabric to the skin.

The measurements of resistivity were made by using a Beckman Micro-micro Ammeter (Beckman Instruments Company, Pasadena, California) to measure the resistance between two stainless-steel probes placed on the fabric surface. The probes were placed so that each had an edge three inches in length parallel to the other probe and spaced three inches from it.

Washing tests were carried out as described in U.S. Patent 2,767,107.

Comparison of the details given for the preparation of samples A and C will show that the same average composition of anti-static material was present in the final knit fabric in each case. However, the log of resistivity for sample C was found to be 12.0 and for sample A was found to be 12.4 prior to washing and was found to be 13.1 for sample C and 13.7 for sample A after 10 washings. Subjectively, sample C showed no static at the start of the test and again after 10 washings. Sample A, however, though it showed no static at the start of the test, showed moderate static after the tenth wash. An additional five washes in each case brought sample C to a log resistivity reading of 13.6 and a subjective rating of moderate static, while the same additional washings brought sample A to a condition of severe static with a log resistivity reading of 14.0.

Thus, it is clear that the same amount of anti-static agent produced better results in terms of prevention of static development in fabric when this amount was applied to a portion of the staple to be used in fabric preparation with this treated material later being blended with fiber having no anti-static application than when the anti-static agent was distributed over the entire sample of staple being used.

Samples B and D likewise contained identical amounts of anti-static agent when considered on the basis of the total amount of fiber present in the fabric. With the higher level of application used in these samples as compared to samples A and C, each of the fabrics (B and D) showed no static development after 10 washes. After 15 washes, sample D showed only slight static while sample B showed moderate static. The respective log resistivity readings were 13.2 and 13.5.

A subject comparison between sample B and sample D with regard to fabric softness made it quite evident that sample B was noticeably stiff in hand. This effect was even more noticeable after samples prepared in identical fashion to B and D were dry-cleaned five times in a typical commercial dry-cleaning solution consisting of 4% of a sulfonated petroleum oil soap dissolved in Stoddard solvent.

In addition to being considerably stiffer than sample D after dry cleaning, sample B also showed a high degree of discoloration at this point as compared to sample D which was only slightly darker than a sample which had not been dry cleaned.

Similar though smaller effects were noted in comparison of dry-cleaned samples made according to A and C above.

Thus, the application of anti-static agent to only a portion of staple to be used in the preparation of yarns and fabrics as opposed to application of this same amount distributed over the entire lot of staple results not only in improved protection of the ultimate fabric against static development, but also in improved softness, particularly after normal dry cleaning, and in lack of discoloration after such dry cleaning. The application of the agent to only a portion of the staple allows a greater amount to be applied based on total fiber weight and hence, results in greater protection against static development before stiffening and discoloration become apparent.

Example II

A two-gram sample of 3-denier per filament staple prepared from polyethylene terephthalate was wet to 100% pickup with a 1% solution of the anti-static composition described in Example I. The staple was then dried at 270° F. for 10 minutes after which it was put through a small cotton card with 8 grams of polyethylene terephthalate staple which was given no anti-static treatment. The blended material was formed into a pad 3 inches square which was measured for resistivity before and after several washings of the type described in Example I.

After one washing, the sample showed no static by subjective tests and showed a log resistivity of 12.9. After 5 washings the log resistivity was only 13.5 and the subjective rating showed only slight static. By comparison, a sample of the original staple which was given no anti-static treatment had log resistivity readings greater than 15 after 1 washing and after 5 washings, and showed severe static in each case.

Example III

A copolymer of 94% acrylonitrile and 6% methyl acrylate was dry spun from dimethylformamide to produce a 9-denier per filament product. A sample of this undrawn yarn was soaked in a solution of sodium styrenesulfonate and irradiated with electrons from a Van de Graaff generator to attach the sodium styrenesulfonate to the fiber, and was then drawn to 400% of its original length in hot water. A second and larger portion of the undrawn staple was similarly drawn but without the treatment with the styrenesulfonate. A 5-gram sample of the treated fiber was blended with 20 grams of untreated fiber in a cotton card. After one washing, this sample was found to have a log resistivity of 11.5 and to show no static according to subjective rating.

Example IV

A sample of one pound of 2-denier per filament drawn fiber from a terpolymer of acrylonitrile, methyl acrylate, and sodium styrenesulfonate was cut to 2-inch length, dipped in a solution of the anti-static agent described in the copending U.S. application of Rimmer, Serial No. 530,888, filed August 26, 1955, and cured by heat as described in that application. Weight gain after drying showed that 2% of the agent was attached. This treated staple was blended with three pounds of untreated staple and the resulting blend was spun to yarn and converted to knit fabric.

This fabric showed no static by subjective tests even after 5 washings. It showed no discoloration or stiffening after 5 dry cleanings. By comparison, fabric made from staple to which the same agent had been applied at the 0.5% level showed stiffening and discoloration after 5 dry cleanings.

Similar results were found when the same experiments were repeated on fibers prepared from polyethylene terephthalate and from poly(hexamethylene adipamide).

The foregoing examples illustrate the practice of this invention but, as previously stated, are not intended to be limitative since other fibers and treating agents such as

described herein may be substituted directly for those in the examples.

As demonstrated in the foregoing examples, the greatly improved anti-static quality of products of this invention is only obtained by applying the anti-static material to a portion of the fiber before it is spun into yarn and knitted or woven into a fabric. It is also indicated and will be apparent that the amount of material applied to the treated portion of the blend represents a relatively high loading of the fibers with the material. It is indeed surprising that the anti-static effect obtained by a relatively high loading of a minor portion of the fibers which are then blended with untreated fibers is much greater than when the fibers are uniformly treated with an anti-static agent.

Included among the various synthetic organic fibers which may be used in practicing this invention are those prepared from fiber-forming addition polymers such as polyvinyl chloride and other vinyl polymerization products such as polypropylene, polymers of acrylonitrile, and particularly those containing at least 70% acrylonitrile in the polymeric form. Fibers prepared from fiber-forming condensation polymers such as polyester, polyamides, polyacetals, and polyurethanes may likewise be used.

In addition, the anti-static property of blends of the aforementioned synthetic fibers may be improved by the teachings of the present invention. For example, a fiber blend consisting of 20% acrylonitrile polymer fibers treated with anti-static agent, 30% untreated acrylonitrile, and 50% untreated polyethylene terephthalate fiber may be prepared. Other suitable blends will be obvious to those skilled in the art.

As previously indicated, that portion of the blend which is to be rendered anti-static may be prepared in a number of ways. Of greatest interest is the method whereby the fiber is treated with an anti-static composition which may be attached to the fiber in durable fashion. The amount applied is normally greater than that applied when there is no blending of the treated staple with staple not containing such a material. For this reason, it is important that the agent can be applied in relatively large amounts without showing any tendency toward easy removal during subsequent processing operations such as the mechanical operations of carding and spinning, or operations involving liquids such as dyeing, washing, or dry cleaning.

Compounds involving the attachment of numerous hydrophilic groups to the fiber surface are generally desirable as anti-static agents. Of particular interest are products formed from polyethylene glycol such as the condensation product of polyethylene glycol diamine and polyethylene glycol dihalide which may be attached to a fiber surface through heating with polyethylene glycol diiodide. One agent of particular value which is believed to be of this type is a product sold by Onyx Oil and Chemical Company under the name "Aston" 108.

The proportions of anti-static treated and untreated fiber to be used in the blends from which the fabrics of this invention are prepared will depend somewhat on the fiber used and the material used to impart an anti-static quality. In most instances, blends containing as little as 10% of treated fiber will show the necessary good anti-static properties. As much as 50% of treated fiber may generally be used before the resulting blend and fabric made from it begin to exhibit problems of discoloration and stiffening, particularly during dry cleaning. It is preferred to blend from about 20% to about 25% of the treated fiber with about 80% to 75% of fiber containing no added anti-static composition.

Likewise, the rate of application of the anti-static material on the portion of the fiber to be treated will depend on both the agent and the fiber. It will likewise depend on the proportions of treated and untreated fiber to be used in the blend. For the preferred blending ratio of 1 part of treated fiber to 3 or 4 parts of untreated fiber and for the preferred agent, the percentage application should be from about 0.2% to about 5.0%, and preferably from about 0.5% to about 2.5% based on the portion of fiber to which the agent is applied. If a smaller ratio of treated fiber is used, the percentage of anti-static agent applied should be increased proportionately.

It will be apparent from the foregoing discussion that many advantages are obtained from the present invention. The major advantage lies in the fact that textile materials having highly desirable wearability can be prepared. Specifically, these textiles have improved anti-static properties. Furthermore, these properties are obtained by applying a relatively small amount of the anti-static material to a minor portion of the fibers. The textiles so prepared do not become stiff after washing and dry cleaning as do those in which 100% of the fibers are treated with an anti-static material. In addition, the textiles of this invention do not become discolored due to adsorption of materials from cleaning solutions. A further advantage lies in the fact that the textiles have a pleasing hand. And a still further advantage lies in the fact that textiles prepared from the fiber blends of this invention have a greater durability to repeated cleaning operations than do the materials in which 100% of the fibers are treated with an anti-static agent. The fibers of this invention are useful in the preparation of non-woven goods such as felts and the like as well as woven and knitted goods.

Although the invention has been described in terms of treatment for imparting anti-static properties to fiber blends, it will be apparent to those skilled in the art that the same blending principles may be used for the application of other materials such as anti-soiling agents. In addition, if desired, other finishes such as crease- or wrinkle-resistant resin finishes may be used. Depending on the type of fiber being used, the other finishes may be advantageously applied to all the fibers with a subsequent application of the anti-static agent to a portion of the fibers as described herein.

Throughout the specification and claims, any reference to parts, proportions and percentages refers to parts, proportions and percentages by weight unless otherwise specified.

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.

What is claimed is:

1. A blend of hydrophobic synthetic fibers having improved anti-static properties comprised of a major and a minor portion of fibers, the minor portion having incorporated therein a durable anti-static agent and comprising from about 10% to about 50% of the total fibers in the blend, the major portion of said fibers being substantially free of said anti-static agent.

2. The product of claim 1 in which said anti-static agent is present in an amount from about 0.2% to about 5.0% of the total weight of the fibers in the minor portion.

3. The product of claim 2 in which the minor portion of the fiber comprises from about 20% to about 25% of the blend.

4. The product of claim 3 in which said anti-static material is comprised of a linear polymer formed by the condensation of polyethylene glycol diamine and polyethylene glycol dihalide and is present in an amount from about 0.5% to about 2.5% of the total weight of the fibers in the minor portion.

5. The product of claim 1 wherein said blend of fibers is in the form of a textile yarn.

6. The product of claim 2 wherein said blend of fibers is in the form of a textile yarn.

7. Textile goods comprised of a blend of hydrophobic synthetic fibers having improved anti-static properties,

said blend consisting of a major and a minor portion of said synthetic fibers, the minor portion having incorporated therein a durable anti-static agent and comprising from about 10% to about 50% of the total fibers, the major portion of said fibers being substantially free of said anti-static agent.

8. The product of claim 7 in which said anti-static agent is present in an amount from about 0.2% to about 5.0% of the total weight of the fibers in the minor portion.

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