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TREATMENT OF TEXTILE MATERIALS WITH ANTISTATIC MATERIAL PRODUCT OBTAINED THEREBY

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The present invention relates to the treatment of textile materials for the purpose, among others, of providing a durable, anti-static finish on such materials, and to the textile materials so treated, and it more particularly relates to the treatment of synthetic textile materials especially nylon fabrics, for the purpose of providing a durable, anti-static finish thereon.

It is one object of this invention to provide processes for the treatment of textile materials, particularly synthetic textile materials, whereby the textile materials are provided with a soft, efficiently anti-static finish or dressing which has good resistance to washing or laundering or dry cleaning.

It is a further object of this invention to provide textile materials particularly synthetic textile materials, which have a soft, anti-static finish which is characterized by good resistance to washing or laundering or dry cleaning.

It is a further object of this invention to provide textile finishing agents which provide a durable, anti-static finish on textile materials.

Still further objects and advantages of this invention will appear in the following description and appended claims.

The objects of this invention are attained, in general, by applying a water-insoluble amine salt of sulfonated polystyrene to a textile material. Such salt is applied to the textile material in various ways as, for example, by treating the textile material with an aqueous solution of sulfonated polystyrene or a water-soluble salt of sulfonated polystyrene, such as the sodium salt, and thereafter treating the material with a liquid amine or with a water dispersion of an amine or a water-soluble salt of an amine, which amine is capable of reacting with the sulfonated polystyrene or the water-soluble salt of the sulfonated polystyrene to form a water-insoluble amine salt of sulfonated polystyrene. The resulting material is then dried. The water-insoluble amine salt of sulfonated polystyrene is also applied to textile materials in accordance with the present invention by first treating the textile material with a liquid amine or with an aqueous dispersion thereof or with an aqueous solution of an amine salt, which amine is capable of reacting with sulfonated polystyrene or an alkali salt of sulfonated polystyrene to form a water-insoluble amine salt of a sulfonated polystyrene, and thereafter treating the material with an aqueous solution of a sulfonated polystyrene or a water-soluble salt of sulfonated polystyrene. The treated material is then dried.

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From the standpoint of practical considerations as, for example, economy in application, it is preferred to apply the water-insoluble amine salt of sulfonated polystyrene from a single bath. This is accomplished, for example, by treating the textile material with an aqueous dispersion of a water-insoluble amine salt of a sulfonated polystyrene and thereafter drying the material. This treatment is somewhat restricted in the amount of the water-insoluble amine salt of a sulfonated polystyrene which is applied to the textile material since normally the aqueous dispersions of the water-insoluble amine salts of sulfonated polystyrene cannot be readily prepared containing more than 3% by weight of the water-insoluble amine salts of sulfonated polystyrene. In those instances, where it is desired to apply more than 3% by weight of the water-insoluble amine salt of sulfonated polystyrene, based on the textile material, it is preferred to treat the textile material separately with the amine or a water-soluble amine salt and the sulfonated polystyrene or a water-soluble alkali salt thereof, as hereinbefore described.

The water-insoluble amine salts of sulfonated polystyrene may also be applied to the textile material by coating one or more sides of the textile material with the water-insoluble amine salt of sulfonated polystyrene in powdered or finely divided form and then fusing or melting such salt on the material in the form of a thin film or continuous or substantially continuous coating by passing the textile material over one or more heated rolls.

The term "textile material" as employed herein is intended to include unspun fibers, both natural and synthetic staple fibers, yarns or continuous filaments and woven and knitted fabrics.

The term "textile material" as employed herein is also intended to include natural and artificial textile fibers, yarns and fabrics comprising cotton, linen and other natural cellluose textile materials; viscose and cuprammonium and other regenerated cellulose textile materials; wool, casein, alpaca and other natural or synthetic protein textile materials; cellulose acetate and other cellulose derivative textile materials; and nylon, vinyl chloride-vinyl acetate copolymers, polyvinylidene polymers, acrylonitrile polymers and other synthetic polymer or condensation product textile materials. The present invention is particularly directed to the treatment of woven and knitted fabrics comprising a major portion of yarns of textile materials which readily acquire a static charge and which do not have good drap-

ing qualities when such static charge is present, especially in the case of apparel fabrics. Best results are obtained in accordance with the present invention on woven or knitted fabrics comprising a major portion of nylon, that is, polyhexamethylene amine-adipamide condensation product, yarns or filaments. Accordingly, nylon fabrics are the preferred textile materials for the purposes of this invention.

The water-insoluble amine salts of sulfonated polystyrene of this invention perform several functions as a finish on the textile material. In the first place they eliminate or minimize the formation of a static charge on the textile material. Secondly, they soften and lubricate the textile material and thus act as textile softening agents. Moreover, since they are resistant to leaching with water at temperatures of 100 to 110° F. and are also resistant to washing or laundering or dry cleaning at such temperatures, they provide a durable or semi-permanent finish which is of considerable importance in apparel fabrics.

The amount of water-insoluble amine salt of sulfonated polystyrene applied to the textile material may be varied considerably and is largely governed by the efficiency of the particular amine salt selected as an anti-static agent and also the nature of the textile material and the type of hand, etc. desired. In general, the water-insoluble amine salts of sulfonated polystyrene are applied in amounts sufficient to provide a finish which has anti-static properties, that is, the property of substantially preventing the build-up of static charges on the textile material. This is accomplished ordinarily by applying at least 0.1% by weight of the water-insoluble amine salt of sulfonated polystyrene, based on the weight of the textile material. Usually there is no need to apply more than 5% by weight of the water-insoluble amine salt of sulfonated polystyrene, based on the weight of the textile material, but larger amounts of such salts may be applied if desired.

Best results are usually obtained by applying from about 0.5 to 3% by weight of the water-insoluble amine salt of the sulfonated polystyrene and these amounts are accordingly preferred.

The above amounts of the water-insoluble amine salt of sulfonated polystyrene are readily applied to the textile material by any of the procedures hereinbefore described. Thus, in those instances where the insoluble amine salt is applied by first treating the textile material with an aqueous solution of sulfonated polystyrene or a water-soluble salt thereof and thereafter with an amine or an amine salt, the textile material is first generally immersed in, dipped in, or sprayed with or roll coated with an aqueous solution containing from about 0.1 to 5% by weight, preferably from about 0.5 to 3% by weight, of sulfonated polystyrene or a water-soluble salt thereof. The material is then preferably extracted as by padding, centrifuging or the like to deposit from about 0.1 to 5% by weight of the sulfonated polystyrene or water-soluble salt thereof. The textile material is thereafter treated as by immersion, dipping or spraying or roll coating with a liquid amine or an aqueous dispersion thereof or an aqueous solution of a water-soluble salt of the amine, and this is preferably followed by a squeezing operation such as padding wherein excess liquid is removed. The amount of amine or its water-soluble salt thus applied to the textile material is preferably sufficient to react with all of the sulfonic acid groups or sulfonate groups of the sulfonated polystyrene or water-soluble salt of sulfonated polystyrene, although larger amounts of the amine or its water-soluble salt may be used, if desired. Thus, it is preferred to apply substantially 1 molecular proportion or more of the amine or the amine salt for each sulfonic acid group or sulfonate group of the sulfonated polystyrene or water-soluble salt thereof.

When the amine or water-soluble salt thereof is applied to the textile material first and the sulfonated polystyrene or the water-soluble salt thereof is applied last, the same concentrations of these ingredients are applied as is described immediately above.

When either of the above procedures are followed it is preferred to dry the textile material after the application of the first ingredient, but before the application of the second ingredient. In either case the amine or the amine salt reacts with the sulfonated polystyrene or the water-soluble salt of the sulfonated polystyrene on the material to form the water-insoluble amine salt of the sulfonated polystyrene which provides a soft, durable, anti-static finish on the material. No special drying temperatures are required and the material may be dried at normal room temperatures, that is, temperatures of about 70 to 90° F., and temperatures as high as 350° F. are used successfully depending upon the resistance of the particular textile material to the drying temperature used.

In those instances where the water-soluble amine salt of sulfonated polystyrene is applied to the textile material by treating the material directly with an aqueous dispersion of such salt, it is usually not possible to employ an aqueous dispersion containing more than 3% by weight of the dispersed salt since at higher concentrations the salt tends to separate from the aqueous phase. However, it is possible when using such dispersions to apply from 0.1 to 3.0% by weight of the water-insoluble amine salt of the sulfonated polystyrene, based on the textile material, depending on whether or not the treated material is also extracted, and such amounts are normally adequate to provide the textile material with an anti-static finish which is soft and durable.

The aqueous dispersions of the water-insoluble amine salt of sulfonated polystyrene may be prepared in various ways. One suitable method of preparing such dispersions comprises adding an amine or a water-soluble salt thereof, either of which is capable with reacting with sulfonated polystyrene or the water-soluble salt thereof to form a water-insoluble amine salt of sulfonated polystyrene, to an aqueous solution containing from about 0.1 to 3% by weight of sulfonated polystyrene or an alkali salt thereof, the amine or water-soluble salt thereof being added in an amount sufficient to provide about 1 molecular proportion or more of amine or amine salt (calculated as amine) for each sulfonic acid or sulfonate group of the sulfonated polystyrene or water-soluble salt thereof. If the above amounts are used it is generally possible to obtain a bluish, aqueous colloidal solution or dispersion of the water-insoluble amine salt of sulfonated polystyrene. This dispersion or colloidal solution is readily applied to the textile material by spraying it on the material or by dipping or immersing the material therein. The material may then be

extracted or dried, or extracted and then dried as desired. The resulting material has a soft, durable, anti-static finish which is substantially the same as the finish provided by applying the amine and sulfonated polystyrene separately.

As examples of amines which are useful in forming the water-insoluble amine salts of sulfonated polystyrene according to the procedures hereinbefore described may be mentioned the unsubstituted straight and branch chained aliphatic mono-amines, that is, the alkylamines including the primary, secondary and tertiary alkylamines, for example, lauryl amine, cetyl amine, decyl amine, octadecyl amine, dibutyl amine, diamyl amine, tripropyl amine, tributylamine, triamyl amine, trihexylamine and the like; alkylene polyamines as, for example, ethylene diamine, propylene diamine, diethylene triamine, triethylene tetramine, trimethylene diamine, tetraethylene pentamine and the like; dialicyclic monoamines such as dicyclohexyl amine and the like; and aryl and aralkylamines such as diphenyl amine, dinaphthyl amine, dibenzyl amine and the like. In the case of alkyl monoamines best results are obtained by using amines containing at least 8 carbon atoms, and preferably from 10 to 20 carbon atoms. This also applies to di-alicyclic amines. In the case of alkylene polyamines there is no restriction on the number of carbon atoms in the amine molecule but best results are usually obtained when the amine contains from 2 to 5 carbon atoms. When alkyl mono-amines, including the primary, secondary and tertiary alkyl mono-amines having one straight chain containing at least 10 carbon atoms are used it is possible to obtain water-insoluble amine salts of sulfonated polystyrene which not only provide a soft, durable, anti-static finish on textile materials but which also provide a water-repellent finish which is highly desirable in certain apparel applications.

The water-soluble amines of those described above are normally employed in a water solution. However, when the amine is water-insoluble or only slightly soluble in water, it is preferred to form a water-soluble salt of the amine before reacting the amine with the sulfonated polystyrene or water-soluble salt thereof to form the water-insoluble amine salt of the sulfonated polystyrene. Such water-soluble salts of the water-insoluble amine are suitably prepared by reacting the amine in water with an equimolecular quantity of an acid, preferably an organic acid such as formic acid, acetic acid, glycollic acid, acetic anhydride and the like. Such procedure is also useful when it is desired to prepare a dilute dispersion of the water-insoluble amine salt of the sulfonated polystyrene, as hereinbefore described.

The sulfonated polystyrene or water-soluble salts thereof as used in the processes of this invention, as hereinbefore described, may be prepared in various ways. For example, such sulfonated polystyrene may be prepared by first dissolving powdered polystyrene (obtained by the mass or emulsion polymerization of monomeric styrene in the presence of a polymerization catalyst) in concentrated sulfuric acid until the product is soluble in water in concentrations up to 5%, after which the solution is diluted to precipitate the sulfonated polystyrene. The resulting sulfonated polystyrene is then preferably purified by separating it from the acid solution as by decantation, after which it is dissolved in water, neutralized with an alkali such as caustic soda and then dialyzed to remove dissolved inorganic salts. The final product is an aqueous solution of the sodium salt of sulfonated polystyrene. The dissolved sulfonated polystyrene may be neutralized with other bases such as quaternary ammonium hydroxides, ammonia, alkali metal hydroxides and carbonates and the like, in which case the corresponding quaternary ammonium, ammonium or alkali metal salt of the sulfonated polystyrene is obtained.

The sulfonated polystyrenes used herein are also suitably prepared by dissolving polystyrene in a chlorinated, aliphatic solvent therefor and reacting the dissolved polystyrene at a temperature of from −15° C. to +5° C. with a complex of sulfur trioxide and bis-(beta-chlor ethyl) ether containing from 1.5 to 3 mols of the ether per mol of sulfur trioxide. This method is described in greater detail in the patent to Massimo Baer No. 2,533,210. Instead of using the complex described above, it is also possible to use a complex of sulfur trioxide and dioxane containing from 0.5 to 2 mols of dioxane per mol of sulfur trioxide as is described in greater detail in the patent to Massimo Baer No. 2,533,211.

Instead of sulfonated polystyrene or water-soluble salts thereof, it is also possible to use sulfonated polymers of alpha methyl styrene or water-soluble salts thereof in the processes of this invention.

The preferred sulfonated polystyrenes or the water-soluble salts thereof for use in the processes of this invention are those which contain from about 0.7 to 2 sulfonic acid or sulfonate groups per styrene unit and which are prepared from polystyrene having a molecular weight between about 5,000 and 500,000.

A further understanding of the processes and textile materials of this invention will be obtained from the following specific examples which are intended to illustrate the invention but not to limit the scope thereof, parts and percentages being by weight unless otherwise specified.

Example I

A sodium salt of sulfonated polystyrene was first prepared as described in Example I of U. S. Patent No. 2,533,210, and then dissolved in water in an amount sufficient to provide a 2% solution. A cellulose acetate fabric was padded through this solution with the pad rolls adjusted to pick up 100% of the solution, based on the fabric, thus depositing 2% of the sodium salt of the sulfonated polystyrene, based on the weight of the fabric. The fabric was then dried at 180° F. The dried fabric was next padded through a 2% water solution of lauryl amine acetate (prepared by reacting lauryl amine and acetic acid in equimolecular proportions) with the pad rolls adjusted to obtain a 100% pick up of the lauryl amine acetate solution. The sodium salt of sulfonated polystyrene and the lauryl amine acetate reacted substantially instantaneously on the fabric to form sodium acetate and the water-insoluble lauryl amine salt of the sulfonated polystyrene. The fabric was then dried. The dried fabric had a soft hand and also had good resistance to static charge accumulation when rubbed with a polystyrene rod. The anti-static finish thus imparted to the fabric was resistant to dry cleaning, and to at least three rayon launderings at 100° F. The treated fabric was also water-repellent and this water-repellency was resistant to laundering and dry cleaning.

Example II

A sodium salt of sulfonated polystyrene containing 1.2 sodium sulfonate groups per styrene unit was first prepared as described in Example I of U. S. Patent No. 2,533,210, and was then dissolved in water in an amount sufficient to form a 1.5% solution. A 1.5% aqueous solution of tetra-alkylene pentamine was slowly added to the sodium salt of sulfonated polystyrene solution. The resulting solution or dispersion was colloidal in nature and contained about 3% of the water-insoluble tetraethylene pentamine salt of sulfonated polystyrene. A nylon (polyhexamethylene amine-adipamide polymer) fabric was padded through the above dispersion with the squeeze rolls adjusted to pick up 100% by weight of the dispersion, based on the fabric weight. This resulted in the deposition of 3% by weight, based on the fabric, of the water-insoluble tetraethylene pentamine salt of sulfonated polystyrene. The fabric was then dried at 180° F. The dried fabric had excellent resistance to static accumulation when rubbed with a polystyrene rod and also had a soft hand. The anti-static properties of the fabric still remained after the fabric was dry cleaned, or was given 3 rayon washes at 100° F.

Example III

A sulfonated polystyrene containing 1.2 sulfonic acid groups per styrene unit was first prepared as described in Example I of U. S. Patent No. 2,533,210, and was dissolved in sufficient water to provide a 2% solution. A nylon (polyhexamethylene amine-adipamide) fabric was padded through this solution to obtain a pick-up of 90% of the solution on the fabric weight thus depositing about 1.8% of the sulfonated polystyrene, based on the weight of the fabric. The fabric was then dried, after which it was padded through a 5% aqueous solution of the acid formate of ethylene diamine with the pad rolls set to obtain a pick-up of 100% on the fabric weight thus depositing about 5% of the acid formate of ethylene diamine, based on the fabric weight. The fabric was then dried. The resulting fabric had a soft hand and did not exhibit any appreciable static charge when rubbed with a polystyrene rod. The anti-static properties of the fabric were not appreciably altered by a dry cleaning, or by a rayon wash at 110° F.

Example IV

A sodium salt of sulfonated polystyrene containing 1.2 sodium sulfonate groups per styrene unit was first prepared as described in Example I of U. S. Patent No. 2,533,211, and was dissolved in sufficient water to provide a 1% solution. A 1% aqueous dispersion of triamyl amine was slowly added to the solution of the sodium salt of sulfonated polystyrene to form a colloid solution or dispersion containing about 2% of the water-insoluble triamyl amine salt of the sulfonated polystyrene. Polyvinylidine yarns were immersed in the dispersion and then dried. The resulting yarns contained about 1.5% of the water-insoluble triamyl amine salt of sulfonated polystyrene. The yarns were softer than the untreated yarns and resisted the accumulation of a static charge when rubbed with a polystyrene rod. The finish thereon was resistant to dry cleaning, or to water leaching at temperatures of 100 to 110° F.

The resistance of the treated textile materials to the accumulation of static charges was measured in an apparatus consisting of a tetrode, a neon glow lamp connected in the plate circuit of the tetrode and a condenser for transmitting a static charge to the grid of the tetrode. The condenser consisted of two concentrically mounted steel beakers. A small transformer operating on a 110 volt, 60 cycle current was used to heat the filament of the tetrode. This apparatus operates on the principle that when a negative charge is transmitted to the grid the charge will prevent filament electrons from reaching the plate with the result that the neon glow lamp will not light. When the treated textile material is rubbed with a polystyrene rod and then put in contact with the condenser the neon glow lamp will only go off for a short time or may only flicker momentarily which indicates that the static charge accumulation on the material is not appreciable. The untreated textile material when rubbed with a polystyrene rod and then put into contact with the condenser will cause the neon glow lamp to go off for a comparatively long period of time, depending on the particular textile material employed, indicating that a considerable static charge has accumulated on the material.

Various changes and modifications in the processes and textile materials described herein may be made as will be apparent to those skilled in the art to which the present invention appertains without departing from the spirit and intent of this invention. It is to be understood therefore that the present invention is not to be limited except by the scope of the appended claims.

What is claimed is:

1. A process of providing textile materials comprising a major portion of a synthetic polymer textile material with an anti-static finish which comprises applying to said textile materials an aqueous solution of a substance selected from the group consisting of water-soluble sulfonated polystyrene and water-soluble salts thereof, thereafter treating said textile materials with an aqueous medium comprising an amine which is capable of reacting with said substance to form a water-insoluble amine salt, said amine being selected from the group consisting of alkyl monoamines containing at least 10 carbon atoms, alkylene polyamines, di-alicyclic mono-amines, aryl amines and aralkylamines, whereby a water-insoluble amine salt of sulfonated polystyrene is formed in situ on said textile materials, and drying said textile materials.

2. A process of providing nylon textile materials with an anti-static finish which comprises applying to said textile materials an aqueous solution of from about 0.1 to 5% by weight of a sodium salt of sulfonated polystyrene, drying said textile materials, treating said textile materials with an aqueous medium comprising an amine which is capable of reacting with said salt to form a water-insoluble amine salt, said amine being selected from the group consisting of alkyl monoamines containing at least 10 carbon atoms, alkylene polyamines, di-alicyclic mono-amines, aryl amines and aralkylamines and being present in the aqueous medium in an amount sufficient to provide substantially 1 molecular proportion of amine for each sulfonate group in said sodium salt of sulfonated polystyrene, whereby a water-insoluble amine salt of sulfonated polystyrene is formed in situ on the textile materials, and drying said textile materials.

3. A process substantially according to claim 2, but further characterized in that the amine is laurylamine.

4. A process substantially according to claim

2, but further characterized in that the amine is octadecylamine.

5. Textile materials comprising a major portion of nylon textile materials, and coated with a substantially continuous film of a water-insoluble amine salt of sulfonated polystyrene, said amine being selected from the group consisting of alkyl mono-amines containing at least 10 carbon atoms, alkylene polyamines, di-alicyclic mono-amines, aryl amines and aralkylamines, said salt being present in amounts between about 0.1 and 5% by weight, based on the weight of said textile materials.

6. Textile materials substantially according to claim 5, but further characterized in that the salt is a laurylamine salt of sulfonated polystyrene.

7. Textile materials substantially according to claim 5, but further characterized in that the salt is an ethylene diamine salt of sulfonated polystyrene.

8. Textile materials substantially according to claim 5, but further characterized in that the salt is an octadecylamine salt of sulfonated polystyrene.

9. Textile materials substantially according to claim 5, but further characterized in that the salt is a triamylamine salt of sulfonated polystyrene.

10. A process of providing textile materials comprising a major portion of a synthetic polymer textile material with an anti-static finish which comprises applying to said textile materials an aqueous solution of a substance selected from the group consisting of water-soluble sulfonated polystyrene and water-soluble salts thereof, thereafter treating said textile materials with an aqueous medium comprising laurylamine, whereby a water-insoluble laurylamine salt of sulfonated polystyrene is formed in situ on said textile materials, and drying said textile materials.

11. A process of providing textile materials comprising a major portion of a synthetic polymer textile material with an anti-static finish which comprises applying to said textile materials an aqueous solution of a substance selected from the group consisting of water-soluble sulfonated polystyrene and water-soluble salts thereof, thereafter treating said textile materials with an aqueous medium comprising octadecylamine, whereby a water-insoluble octadecylamine salt of sulfonated polystyrene is formed in situ on said textile materials, and drying said textile materials.

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