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PROCESS OF INDUCING A CREASE INTO CREASE-PROOFED CELLULOSE FABRICS BY TREATING WITH AN ACID CATALYST AND HOT PRESSING A CREASE IN THE TREATED AREA

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This invention relates to a method for creasing wrinkle-resistant treated cellulosic textiles and, more particularly, to a method for forming a crease or pleat on a cellulosic fabric which has undergone prior treatment with a chemical or resin and which has had imparted thereto the property of resisting the formation of wrinkles and creases.

Clothing which resists the formation of wrinkles and creases during service has long been preferred by consumers. Wool and silk, which have certain disadvantages, often are used simply because of their natural ability to recover from musing, creasing and wrinkling. This property of wrinkle recovery stems from the inherent resilience of the keratinous wool and proteinaceous silk fibers.

In addition to clothing uses, there are some household applications of textiles in which resistance to creasing, musing and wrinkling is a desirable characteristic. These include bedspreads, drapery and upholstery material, furniture slip-covers and other items. In clothing, wrinkle-resistance is generally more important in outer garments, where appearance is a significant factor.

In recent years, certain synthetic fibers have been developed with properties which make them adaptable for wrinkle-resistant fabrics. These fibers have good resilience properties; that is, when stretched or deformed, their elasticity causes them to return to their original dimensions, either quickly or slowly, depending on the nature of the fiber and the extent of deformation. This ability of the fiber to return to its original dimensions (generally length) after deformation (generally stretching) is the property which causes wrinkles to disappear from fabrics made from those fibers.

Cotton, linen, rayon and other cellulosic fabrics are inherently less resilient than wool, silk and some of the newer synthetic fibers. Thus, in service, fabrics of these cellulosic fibers become wrinkled, creased or mused in a more or less permanent fashion, and such wrinkles and creases remain in the fabrics, to a greater or lesser extent, until the fabrics are moistened and ironed.

To overcome the comparative disadvantage which the cellulosic fabrics have with respect to wool, silk, and some of the newer synthetic fibers, because of their greater susceptibility to crease and wrinkle formation, scientists have developed a type of treatment for cotton, linen (flax), and rayon fabrics which remarkably improve their resiliency and, therefore, their resistance to creasing and wrinkling. A wide range of materials, especially thermosetting synthetic resins, may be used to bring about this change in wrinkle-resisting properties, but it is believed that all of these function in substantially the same manner, namely, they act upon the cellulose molecules in the fibers, chemically linking together adjacent cellulose molecules or cellulosic and resin molecules to reduce creep or permanent set, conditions which occur when non-resilient fibers are placed under tension. The simplest cross-linking agent for cellulosic fibers is formaldehyde, but many other materials have been used, including gly-

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oxal and acrolein and materials which can polymerize to form resins, including urea-formaldehyde, melamine formaldehyde, and various modifications thereof, cyclic ethylene urea, epoxy compounds and the like.

The reaction of these materials with cellulose is usually brought about with the aid of catalysts, such as acid catalysts. Some of the more common types include ammonium chloride, magnesium chloride, zinc chloride and zinc nitrate. The most common commercial practice is to apply a monomeric resin-forming material to the cellulosic fabrics, frequently in mixture with other materials such as softeners and lubricants, and, with the use of catalysts and at elevated temperatures, to bring about condensation of the resin monomer into a polymer which is usually of the thermosetting type, at the same time forming the chemical bonds with the hydroxyl groups of cellulose molecules in the fiber, so that there is an effective cross-linking of these molecular chains.

The result, while basically a modification of the resilience properties of the cellulosic fiber, has been described as giving the fibers a "memory" for a particular shape or configuration. For example, when the resin is cured with the cellulosic fabric in a smooth, flattened form, the fibers tend to return the fabric to this form after it has been creased, wrinkled or mused. In like manner, if a fabric is put into the form of pleats and creases when the polymerization or cure takes place, the fibers will tend to retain in the fabric the pleats or creases in a more or less permanent fashion. Cellulose fabrics treated in this manner, therefore, may be given durable wrinkle-resisting properties in a smooth, flat form or may be given durable pleats, creases or other surface configurations. The fabrics, if properly treated, will continue to have such properties after repeated launderings or dry-cleanings, and, in general, fabrics of this type need little or no ironing after laundering. The wrinkle-resistant property of a treated cellulosic fabric may be completely lost by stripping the chemical or resinous cross-linking agent from the fabric with an acid.

Relatively large volumes of cotton fabrics have been processed with various forms of wrinkle-resistant finishes, trade estimates indicating that more than a billion yards were treated in this fashion in 1955. For the most part, these treated fabrics have been used in women's and children's dresses and slips, sports shirts for men and boys, and certain other apparel items.

While properly treated cellulosic fabrics, and in particular cotton fabrics, have wrinkle-resisting properties comparable to those of wool and silk, and the newer synthetic fibers, they have other important shortcomings in that they are hard to crease. When creases are desired in a made-up article or garment, cotton fabrics which have been wrinkle-resistant treated now resist crease formation in ironing. Wool and silk, however, because of their ability to take a temporary set when moist and hold it when dry, until remoistened, can be pressed into creases, as in trousers, and will hold these creases during normal service. Certain of the newer synthetic fibers, because of their thermoplastic nature, can be pressed into creases with a warm or hot iron, and will hold these creases during normal service or until pressed flat with an iron having a higher temperature, or until otherwise subjected to a temperature higher than that used in forming the crease.

In an attempt to make cotton suitable for apparel and other purposes, where creases are necessary or desirable, and where it is impractical to make such creases during manufacture of piece goods, garments or other articles manufactured from untreated cellulosic fabrics have been treated with wrinkle-resistant formulations, which were then polymerized or cured by heating and pressing with an iron, hot-head press, or other appropriate means so

that a crease could be formed in the finished garment where needed.

For example, a man's suit made from an untreated cotton fabric can be treated with a composition containing a cyclic ethylene urea-formaldehyde monomer, certain thermo-plastic materials as softeners, and an acid catalyst, and thereafter ironed in a hothead pressing device to produce a smooth, wrinkle-free surface in the garment as a whole, but with creases being pressed in the trousers in the usual places. The elevated temperature during the pressing operation causes the resins to polymerize or cure, and the fabric to acquire a more or less permanent shape. However, the treatment of a suit or other garment in this manner involves a number of problems. Because of the paddings and linings of tailored coats, it is difficult to apply sufficient heat to every area to bring about the proper cure of the resin. Furthermore, if the garment is improperly pressed so that a crease or wrinkle forms where it is not wanted, it may be difficult to remove it. Also, if the entire garment must be washed to remove unreacted resin monomer, catalysts, etc., linings and paddings may shrink or otherwise lose their shape.

Accordingly, it is an object of this invention to obviate the above disadvantages inherent in creasing and pleating cellulosic fabrics and garments which have previously undergone a wrinkle-resistant treatment.

Another object of this invention is to provide a process wherein crease-and-wrinkle-resistant treated cellulosic fabrics, which have previously been cured so that their wrinkle-resistant properties are set, may be given durable creases and pleats after such fabrics have been made into wearing apparel.

Still another object of this invention is to provide a method for quickly, easily and efficiently forming pleats or creases in cellulosic fabrics which have been treated with wrinkle-resistant compositions, and which ordinarily resist the formation of creases and wrinkles.

In attaining the objects of this invention, one feature resides in temporarily breaking the chemical bonds between the molecules of the cellulosic fibers or between the cellulose molecules and the resin polymers of the wrinkle-resistant materials, applying a crease to the cellulosic fabric, and simultaneously reforming the chemical bonds, as heat is applied to the creased area, thereby giving a fabric a "memory" for the formed crease.

Another feature resides in treating the wrinkle-resistant cellulosic fabrics with an acid solution, thus breaking the chemical linkage between the molecules of the cellulosic fibers or between the cellulose molecules and the wrinkle-resistant resin polymers, and creasing the cellulosic fabric with the application of heat and pressure wherein the same acidic solution acts as a catalyst in the reforming of the chemical linkage between the cellulose molecules of the fibers or between the cellulose molecules and the resin polymers with which the fabrics have been treated.

Other objects, features and advantages of the invention will become apparent from the following description of the invention.

Essentially, one means for accomplishing the creasing or pleating is to wet an area of the wrinkle-resistant fabric with an acidic solution, preferably in a .25% to approximately 10% concentration, depending upon the particular fabric and the chemical or resin cross-linking agents with which the fabric has been treated. The acidic solution breaks the chemical cross-links which impart the properties of wrinkle-resistance to the fabric. Thereafter, by folding the wetted fabric and applying heat and pressure along the fold, a crease is formed, while, at the same time, the cross-linking bonds between the cellulose molecules are reformed. The fibers now assume a "memory" for this deformed or pressed configuration, giving the fabric a durable crease. The acidic solution which was principally used to break the cross-linking

bonds, now, under the conditions of heat, acts as a catalyst for their reformation along the line of fold.

This process is applicable to all cellulose fabrics which have been previously treated with any of the classes of chemicals or polymerizable resins commercially used to produce wrinkle-resistant properties in such fabrics. These include formaldehyde, glyoxal, acrolein, various urea-formaldehydes including cyclic ethylene urea resins, melamine and modified melamine formaldehydes, epoxy resins and others of the general class of thermo-setting resins which can be condensed with aldehydes or which can be polymerized on cotton with reaction to the cellulose molecules, or which can react without polymerization to cross-link cellulose molecules.

While the process is intended for and applies to cellulosic fabrics, such as cotton, rayon, linen (flax) and the like, fabrics composed of mixtures or blends of these fibers or mixtures or blends of one or more of these fibers with other natural fibers or synthetic fibers may be utilized, provided they have undergone a previous treatment with a chemical cross-linking material such as the aforementioned chemicals and resins, whereby the fabrics have wrinkle-resistant properties.

Among the solutions having acidic characteristics suitable for breaking the chemical bonds which the wrinkle-resistant material forms between the cellulose molecules of the fibers, and for catalyzing the reformation of other bonds upon the application of heat and pressure on the wetted area along the line of fold, are included mineral acids such as hydrochloric acid, nitric acid, sulphuric acid, and the like; various salts of strong acids, including ammonium salts, such as ammonium chloride primary amine salts, secondary amine salts and alkanol amine salts; metallic salts of strong acids and weak bases, including zinc and magnesium chlorides and nitrates; and certain of the stronger organic acids, including formic acid, oxalic acid, the chloracetic acids and lactic acid. Salts of some of these acids with materials which form weak bases may also be used.

A buffering material may be employed with the acidic solutions to reduce or prevent any hydrolysis of the cellulose and consequent weakening of the fabric, by the acidic material. These buffers may include various amines such as urea, melamine, ethanolamine, diethanolamine, triethanolamine and the like, and may be present in approximately 1 to 10 parts per one part of acidic material. Also, additional resin-forming material may be incorporated in the solution in proportions of 1 to 30 parts per each part of acid catalyst, the material being either similar to that originally applied to make the fabric wrinkle-resistant or being of some other type. These resin-forming materials act in part as buffers for the acidic material and, in part, give additional durability to the new crease which is formed. Softeners, lubricants and other ingredients which modify the properties of the new crease in much the same manner that such ingredients are used in the original wrinkle-resistant formulation which was applied to the fabric, may also be used.

Generally, the weaker acids require a longer time than the stronger mineral acids to break the bonds with which the wrinkle-resistant chemical materials link the cellulose molecules together. However, these mineral acids are more likely to damage the fabric during the heating and pressing operation, or in subsequent use, if they are not removed completely by washing. Where amine containing crease-proofing resins are used, however, they in themselves buffer the acid and reduce any damage to the fabric.

Mixtures of acid catalysts may also be used for the acidic solution. For example, formic acid, which is volatile at 100° C. may be used with a non-volatile acid catalyst such as zinc nitrate. The formic acid helps release the bonds between the cellulose molecules or between the cellulose molecules and the resin polymers and the small amount of the non-volatile zinc nitrate catalyzes the

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reformation of the bonds at temperatures above the volatilizing point of the formic acid.

The following is an example of one embodiment of the invention and is merely illustrative of the process without in any way limiting the scope thereof. A crease resistant cotton fabric which had this characteristic imparted thereto by treatment with a cyclic ethylene urea formaldehyde resin was moistened with a 2% solution of zinc nitrate heated to a temperature between 120° and 180° F. along the area in which the crease was to be made. After a short waiting period, which varies from a few seconds to a few minutes, depending on the length of time necessary for the solution to soak into the fabric, a crease was formed along the wetted area, using a hand-iron heated to a temperature within the range of 300° to 350° F. Optimum time for this pressing was about one minute or until the fabric was dry. A substantially permanent sharply defined crease was formed in the fabric. The fabric was subsequently washed and dried and the sharply-defined crease was retained by the fabric.

A similar wrinkle-resistant cellulosic fabric, treated in the above manner, was subsequently dry cleaned in accordance with commercial methods and the crease was still sharply-defined.

A wrinkle-resistant cellulose fabric similar to those above, but which was not treated with the acid catalyst was pressed with a hand-iron in an effort to apply a crease thereto. While a crease was temporarily formed, it was not as sharply defined and, upon washing and drying, the crease was completely removed from the fabric.

While the concentration of the acid catalyst may vary from an 0.25% solution to approximately a 10% solution or even stronger, a range of 1% to 5% is preferred with most catalysts. However, when strong acids are used, a concentration as low as 0.1% will be sufficient to break the links between the cellulose molecules and to catalyze the reformation of these links upon the application of heat and pressure to the folded area of the cellulosic fabric. When weak acids are used, a concentration as high as 50% will work satisfactorily and will have no deleterious effect on the fabric.

The choice of the particular catalyst which is to be used in preparing the acidic solution is dictated to some extent by the particular cellulosic fabric, the particular crease-proofing material with which the fabric has been treated, whether or not it is convenient to wash the fabric after it has been creased, etc.

In place of the zinc nitrate solution of the above example, the following solutions containing acid catalysts may be utilized to break the chemical bonds of the wrinkle-resistant cellulosic fabric and re-form them after the fabric has been creased or pleated. To speed up the breaking of the linkage system and, then, the reforming of the molecule links, it is preferred to use the acid catalysts in heated form.

Example 2

HCl	1.5
Urea	5
Water	98.5

Example 3

H ₃ PO ₄	1.5
Urea	5.0
Water	93.5

Example 4

Chloracetic acid	5.0
Water	95.0

Example 5

Zinc nitrate	4.0
Cyclic ethylene urea-formaldehyde monomer	12.0
Water	96.0

Example 6

Magnesium chloride	3.0
Water	97.0

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Example 7

H ₂ SO ₄	1.0
Urea	5.0
Water	99.0

Example 8

Lactic acid	10.0
Water	90.0

Example 9

Formic acid	2.0
Zinc nitrate	2.5
Water	100.0

Example 10

Ammonium chloride	2.0
Water	98.0

Example 11

Diethanolamine hydrochloride	5.0
Water	95.0

Example 12

HCl	0.25
Water	99.75

While only several embodiments of this invention have been described, these examples are merely illustrative of the invention and are not to be considered as a limitation thereof. It is intended in the appended claims to include all such processes as fall within the scope of this invention.

Having fully disclosed the invention, what is claimed

1. The method of forming a durable crease in a cotton fabric made crease-resistant by treatment with an acidic catalyst and a chemical agent selected from the group consisting of urea-formaldehyde, melamine-formaldehyde and cyclic ethylene urea-formaldehyde, which agent reacts with the cellulose molecules of the fabric to form a chemical bond therewith comprising wetting the area of said fabric along which said crease is to be formed with an aqueous acidic catalyst solution under treatment conditions which break the chemical bonds between said fabric and said agent to destroy the crease-resistance of said fabric in said wetted area, folding said fabric along said wetted area to form a fold and applying heat and pressure to said fold until said wetted area is dry and the chemical bonds between the cellulose and said chemical agent are reformed, said acid catalyst in said aqueous solution catalyzing the reaction to form the aforesaid chemical bonds.

2. The method of forming a durable crease in a cotton fabric as defined in claim 1 wherein said aqueous acidic solution contains a buffering agent for the acidic component in said solution, said buffering agent reducing any damaging effect of the acidic solution on said cotton-fabric.

3. The method of forming a durable crease in a cotton fabric as defined in claim 1 wherein said aqueous acidic solution contains from 1 to 30 parts by weight of said solution of a crease-resistance imparting chemical agent selected from the group consisting of urea-formaldehyde, melamine-formaldehyde, and cyclic ethylene urea-formaldehyde.

4. The method of forming a durable crease in a cotton fabric made crease-resistant by treatment with an acidic catalyst and a chemical agent selected from the group consisting of urea-formaldehyde, melamine-formaldehyde, and cyclic ethylene urea-formaldehyde which reacts with the cellulose molecules of the fabric to form chemical bonds therewith comprising wetting the area of said fabric along which said crease is to be formed with an aqueous solution of .25% to 10% zinc nitrate under treatment conditions which break the chemical bonds between said fabric and said agent to destroy the crease-resistance of said fabric in said wetted area, folding said fabric along said wetted area to form a fold and applying heat and pressure to said fold until said wetted area is dry and the chemical bonds between the cellulose and said chemical agent are reformed.

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5. The method of forming a durable crease in a cotton fabric having crease-resistant properties, said fabric made crease-resistant by treatment with an acidic catalyst and a cyclic ethylene urea-formaldehyde which reacts with the cellulose molecules of the fabric to form chemical bonds therewith comprising wetting the area of said fabric along which said crease is to be formed with an acidic solution comprising, by weight, 4 parts of zinc nitrate, 12 parts of cyclic ethylene urea-formaldehyde and 96 parts of water under treatment conditions which break the chemical bonds between said fabric and said agent to destroy the crease-resistance of said fabric in said wetted area, folding said fabric along said wetted area to form a fold and applying heat and pressure to said fold until said wetted area is dry and the chemical bonds between the cellulose and said chemical agent are reformed.

6. The method of forming a durable crease in a cotton fabric made crease-resistant by treatment with an acidic catalyst and a member selected from the group consisting

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of urea-formaldehyde, melamine-formaldehyde, and cyclic ethylene urea-formaldehyde which reacts with the cellulose molecules of the cotton fabric to form chemical bonds therewith comprising wetting the area of said fabric along which said crease is to be formed with an acidic solution comprising 2 parts by weight of formic acid, 2.5 parts by weight of zinc nitrate, and 100 parts by weight of water under treatment conditions which break the chemical bonds between said fabric and said member to destroy the crease-resistance of said fabric in said wetted area, folding said fabric along said wetted area to form a fold and applying heat and pressure to said fold until said wetted area is dry and the chemical bonds between the cellulose and said chemical agent are reformed.

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