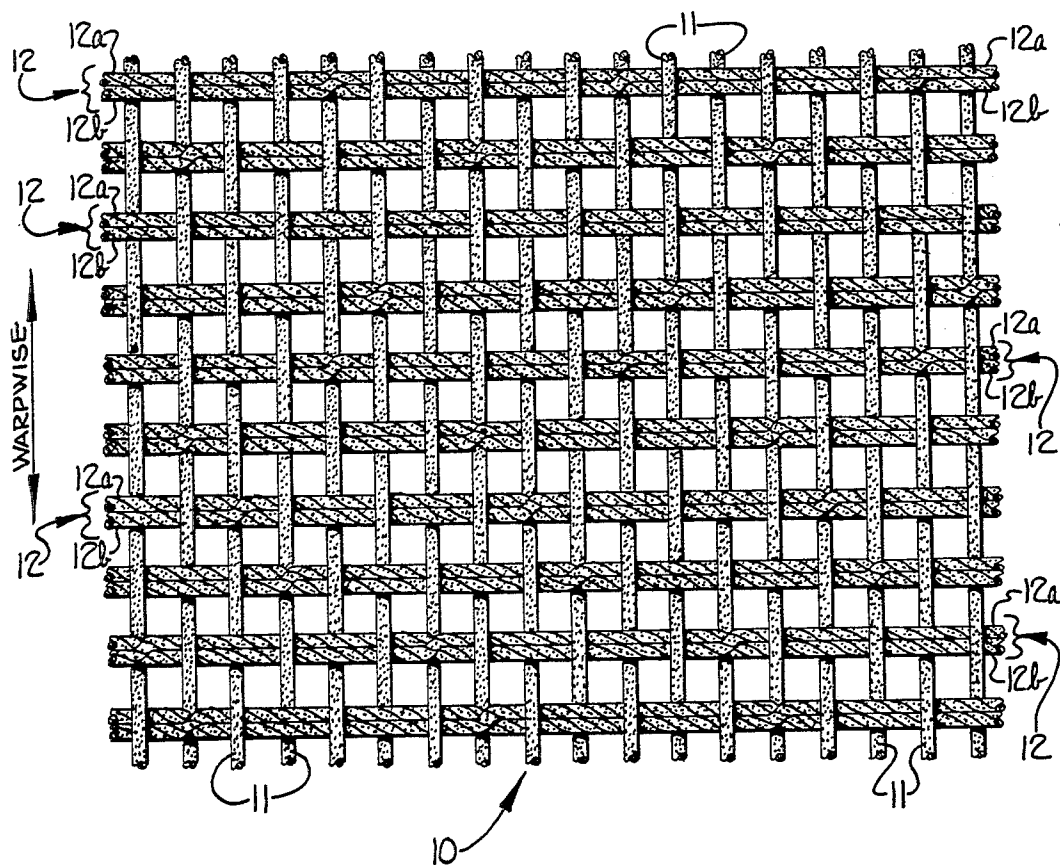


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STABILIZED DIRECTIONALLY STIFF WOVEN FABRIC
AND METHOD OF FORMING THE SAME
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STABILIZED DIRECTIONALLY STIFF WOVEN FABRIC AND METHOD OF FORMING THE SAME

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ABSTRACT OF THE DISCLOSURE

A woven fabric and method of making the same wherein one of the sets of yarns consists mainly of fused, cross-linked, regenerated cellulose of the high wet modulus type having a wet modulus of at least about 6 gm./d. to impart greater stiffness to the fabric in this direction and wherein the other set of yarns consist mainly of unfused fibers wherein the overall fabric is stable and has a maximum wet to dry difference of 3 percent in the direction of the fused yarns.

This invention relates to directionally stiff woven fabrics which have been chemically treated with a fusing agent, such as zinc chloride solution, to fuse one of the sets of warp or filling yarns, without any appreciable effect upon the other set of yarns for obtaining fabrics having materially greater stiffness in the direction of the fused yarns than in the other direction, and more particularly to such directionally stiff woven fabrics having increased dimensional stability and resistance to shrinkage and method of forming the same.

It is an object of the present invention to provide an improved directionally stiff woven fabric having fused cellulosic yarns in the stiffened direction and unfused yarns in the other direction, and having substantially increased dimensional stability over previously known directionally stiff woven fabrics employing fused cellulosic yarns and a novel method of forming such a fabric.

As is well known, directionally stiff fabrics have many uses, one very important use being in the garment industry as interliners for coat fronts to aid in imparting body, form and proper appearance to the finished coats. Relatively expensive haircloth has been employed for many years for this purpose, and while performing satisfactorily, the expensive nature thereof has resulted in a long and extensive search for less expensive substitutes therefor.

Chronologically, this search has resulted in the development of a first directionally stiff woven fabric, disclosed in United States Patent No. 2,409,089. This fabric has fused filling yarns of normal viscose rayon in the stiffened direction and unfused cotton warp yarns in the other direction, and has been commercialized for several years as a substitute for haircloth. While the economy of this fabric is very favorable as compared with haircloth and this fabric is successful for a variety of uses, the fused viscose rayon yarns are dimensionally unstable to laundering, i.e., a wet to dry dimensional difference materially in excess of seven percent (7%) in the direction of these fused yarns, and hence, this fabric has not been universally accepted.

The aforementioned search next resulted in the development of an improved directionally stiff woven fabric having substantially greater dimensional stability than the above described first directionally stiff woven fabric. This improved fabric has fused yarns of high wet modulus

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rayon yarns of the non-cross-linked type in the stiffened direction and unfused cotton yarns in the other direction as disclosed in United States Patent No. 3,163,185. Since this improved fabric has a lower wet to dry dimensional difference in the direction of the fused yarns than the first directionally stiff fabric having fused yarns or normal viscose rayon, it therefore has achieved a wider acceptance as a substitute for the more expensive haircloth and has been used with a substantial degree of success in both "wash and wear" type garments and in garments subjected to cold water shrinking operations during manufacture thereof. However, even with this greater dimensional stability, this has a certain degree of dimensional instability, i.e. a wet to dry dimensional difference materially in excess of the desired three percent (3%) maximum, which is sufficient to create problems in certain areas of use and particularly in the area of "wash and wear" garments which are subjected to repeated laundering operations in normal use.

In the development work leading up to this improved fabric of Patent No. 3,163,185, of which I am a co-inventor, it was determined that cross-linked high wet modulus yarns, which have very favorable characteristics, including water imbibition indices, which would apparently indicate good wet to dry dimensional stability, were too unstable after being fused to present a marketable product. This failure of the apparently more desirable cross-linked high wet modulus rayon yarns was apparently due to adverse effects of the fusing treatment on the cross-linked yarns and resulted in our finally using non-cross-linked types of high wet modulus yarns as the yarns to be fused, which fused yarns exhibited much more favorable wet to dry dimensional stability than the cross-linked yarns exhibited after fusing.

I have now determined that the wet to dry dimensional stability of the products of my previous invention can be markedly improved by cross-linking the initially non-cross-linked yarns after fusing, which I accomplish by subjecting the fused yarns in the fabric to a cross-linking agent treatment. Thus, in essence, I have found a technique of circumventing the adverse effects of the fusing treatment on cross-linked high wet modulus rayon yarns and achieving a directionally stiff fabric having fused cross-linked high wet modulus rayon yarns, as I had originally endeavored to do with my previous invention.

In the development of this technique, experiments were conducted with fabrics having fused filling yarns of initially non-cross-linked high wet modulus regenerated cellulose, with a large number of commercially available non-cross-linked high wet modulus regenerated cellulose fibers being tested. It was surprisingly learned from these experiments that a substantial number of these fabrics formed of certain commercially available high wet modulus viscose rayons would not accept the cross-linking treatment after they were fused without becoming excessively embrittled, and, therefore, unusable. Also, it was learned that some of these fabrics formed of other commercially available high wet modulus regenerated cellulose fibers, such as some viscose rayons and saponified acetates, would accept the cross-linking treatment after they were fused without excessive embrittlement.

However, while accepting the cross-linking treatment, some of these fabrics formed of certain high wet modulus viscose rayons, such as those presently being marketed under the trademarks Zantrel, Xena H, Vincel, and IRC, were not stabilized thereby to the point where they had sufficient dimensional stability, i.e. a maximum wet to

dry difference of 3% in the direction of the fused yarns, to be acceptable for substantially all uses of this type of fabric. On the contrary, other fabrics in this category were sufficiently stabilized by the cross-linking treatment to have excellent dimensional stability below the aforementioned maximum of 3% wet to dry difference.

The reasons why these certain fabrics were successfully stabilized and others failed are not known with certainty, but it is believed that one of these reasons is the wet modulus. It was determined that the high wet modulus regenerated cellulose in those successfully stabilized fabrics had a wet modulus above 6.0 gm./d. when fused and still at least about 6.0 gm./d. when cross-linked, whereas the high wet modulus regenerated cellulose in those fabrics that could not be successfully stabilized had a wet modulus below 3.5 gm./d. when fused and still lower when cross-linked.

An unexpected benefit was derived from this technique of stabilizing the fused yarns in that for a number of years the other set of yarns had, for practical reasons, been formed of cotton fibers and the cotton yarns necessitated a high degree of compressive shrinkage to impart sufficient dimensional stability to the fabric in the direction of the cotton yarns. This high degree of compressive shrinkage resulted in undesirable elongation of the fabric when it was subjected to laundering and/or cold water shrinking operations. During the development of this invention, it was determined that the degree of compressive shrinkage could be substantially reduced due to the fact that the cross-linking agent substantially enhanced the dimensional stability of the cotton yarns and resulted in the cotton yarns having a wet to dry difference of less than 1%, without undesirable elongation of the fabric when wetted.

A more specific object of the invention is to provide an improved directionally stiff woven fabric of the character described and method of forming the same wherein one set of warp and filling yarns consists mainly of fused, cross-linked regenerated cellulose of the high wet modulus type having a wet modulus of at least about 6.0 gm./d., wherein the other set of yarns consists mainly of unfused fibers, and wherein the fabric is dimensionally stable and has a maximum wet to dry difference of 3% in the direction of the fused yarns.

It is a further object of the invention to provide a directionally stiff woven fabric of the character described wherein the fabric is dimensionally stable and has a maximum wet to dry difference of 3% in the direction of the fused yarns, and of substantially less than 3% without undesirable elongation in the direction of the unfused yarn.

Some of the objects of the invention having been stated, other objects will appear as the description proceeds, when taken in connection with the accompanying drawing, in which the figure of the drawing is a greatly magnified view of a portion of a fabric constructed in accordance with the present invention.

Referring now more particularly to the drawing, there is shown a portion of fabric, generally indicated as 10, constructed and finished to embody the features of the present invention. Fabric 10 is formed of interwoven sets of warp and filling yarns 11 and 12, respectively.

As woven into fabric 10, one of these sets of yarns, preferably the set of warp yarns 11, is formed of a textile fibrous material which is non-reactive to fusing treatment by a fusing agent of appropriate concentration, such as a zinc chloride solution of 62% to 71% concentration. More preferably, warp yarns 11 are formed of cotton which may be in either the raw or bleached state as desired, but preferably raw, it being understood that the use of bleached cotton yarns as warp yarns 11 adds materially to the cost of manufacture of the fabric 10 and that unbleached warp yarns are less susceptible to fusing by a zinc chloride solution of the above-noted concentrations.

Additionally, warp yarns 11 may vary in size or count and in the number of yarns per inch in accordance with end use requirements. For example, warp yarns 11 may be 20/1 (cotton count) and 48 warp yarns per inch may be provided in fabric 10.

Filling yarns 12 are preferably formed by plying two yarns 12a and 12b together. Yarns 12a and 12b are preferably twisted in the same direction with the same amount of twist therein and are then plied in the opposite direction to the twist therein to balance or overcome any tendency of fabric 10 to curl after being subjected to fusing treatment. This curling tendency and the above-described manner of overcoming the same are described in detail in the aforementioned U.S. Patent No. 2,409,089.

As with warp yarns 11, filling yarns 12 may vary in size or count and in the number of yarns per inch in accordance with end use requirements, particularly in regard to the degree of stiffness required. An exemplary fabric construction in this respect would be 48 filling yarns per inch, each of these yarns being 20/2 count and having 20 turns per inch of Z twist therein, and being plied together by 8 turns per inch of S ply twist.

As woven into fabric 10, filling yarns 12 are formed mainly of non-cross-linked high wet modulus regenerated cellulose having a wet modulus at least about 6.0 gm./d. This modulus is defined by ASTM Standards on Textile Materials, ASTM, Committee D-13, Philadelphia, Pa., 1964, as: "The ratio of change in stress to the change in strain in the initial straight line portion of a stress-strain curve following the removal of any crimp." This ratio is calculated from the stress expressed in grams per denier and the strain expressed in percent elongation and with the yarn samples having been soaked in cold tap water for no less than two (2) minutes. Filling yarns 12 are reactive to a fusing treatment by a fusing agent, preferably a zinc chloride solution of 62% to 71% concentration, but other known fusing agents as, for example, those disclosed in the aforementioned U.S. Patent No. 2,409,089, may be used. Also, these filling yarns are capable of stabilization after fusing by a cross-linking agent without excessive embrittlement to provide a durable and resilient fabric which is dimensionally stable and has a maximum wet to dry difference of three percent (3%) in the direction of these yarns. Examples of such non-cross-linked high wet modulus regenerated cellulose fibers are a viscose rayon presently being marketed by Courtaulds, Ltd., under the trademark Lirelle, and a saponified acetate presently being marketed by Celanese Corporation under the trademark Fortisan. These fibers have a wet modulus above 6.0 gm./d. when fused by a zinc chloride solution, and a wet modulus of at least about 6.0 gm./d. when stabilized by a cross-linking agent in accordance with the present invention. From tests to date, it has been determined that the aforementioned high wet modulus viscose rayon and saponified acetate after fusing and cross-linking have a wet modulus within the range of about 6.4 gm./d. to about 11.2 gm./d. In addition, fused and cross-linked yarns formed of these fibers have a wet to dry dimensional difference in the fabric of less than three percent (3%) and therefore have excellent dimensional stability sufficient for substantially all end use requirements.

In accordance with the method of the present invention, the woven fabric having such warp and filling yarns therein is rendered materially stiffer in the direction of the initially non-cross-linked high wet modulus regenerated cellulose yarns, preferably the fillingwise direction, by a fusing treatment, i.e. by a zinc chloride solution of 62% to 71% concentration. Following the fusing treatment, the fabric 10 is stabilized in the direction of the fused yarns by the cross-linking of these fused yarns. This cross-linking treatment of the fabric to cross-link the fused yarns also results in a substantial amount of cross-linking stabilization of the other set of unfused cotton

yarns and this cross-linking stabilization is preferably combined with compressive shrinkage of the unfused cotton yarns to provide a maximum wet to dry to wet dimensional difference of 1% in the direction of these yarns. It is noted that all of the stabilization of the unfused yarns has heretofore been achieved by compressive shrinkage and this compressive shrinkage has been of such a degree that substantial crimp has been imparted to the unfused yarns which resulted in an undesirable dry to wet elongation of more than 3% during a cold water shrinking operation on a garment including this fabric. This high degree of compressive shrinkage is not required with the present invention in view of the cross-linking stabilization of the unfused cotton yarns along with the fused yarns.

It has been determined from tests to date that either substantially non-polymer forming cross-linking fiber reactants or polymer forming cross-linking resins may be used as the cross-linking stabilizing agent to cross-link the fused yarns if the fusing treatment is performed by a zinc chloride solution having a concentration within the range of about 62% to 68%, but that only substantially non-polymer forming cross-linking fiber reactants may be used as the cross-linking stabilizing agent if a zinc chloride solution with a concentration of over about 68% is used in the fusing treatment. Also, with the use of a zinc chloride solution having a concentration within the range of about 62% to 68% in the fusing treatment, a wet holding period between the application of the cross-linking stabilizing agent and the drying and catalysis thereof is not required, but may be desirable in certain instances and with certain cross-linking agents. However, with the use of a zinc chloride solution of over 68% concentration, a wet holding period of from five (5) minutes to thirty-six (36) hours is required. Such a wet holding period and the reasons therefor and results achieved are described in detail in U.S. Patent No. 2,709,141.

The following general types of substantially non-polymer forming cross-linking fiber reactants are examples of reactants which may be used in accordance with this invention: tetramethylol acetylene, glyoxal, buffered formaldehyde, dichloropropanol, polyfunctional sulfone systems, methyl or ethyl carbamate, glycerol dichlorohydrin, carbamoyl ethyl amines, and acrolein formaldehyde. Likewise, the following general types of polymer forming cross-linking resins are examples of resins which may be used as stabilizing agents: dimethyl ethylene urea, dimethyl propylene urea, cyclic ethylene urea, triazone formaldehyde, acetal condensation products, triazine formaldehyde, trimethylol melamine, and dimethyl uron.

With the foregoing in mind, an example of the method of the instant invention will now be described utilizing an exemplary fabric having filling yarns of 100% Lirelle high wet modulus rayon of 20/2 yarn size (cotton count) and having the aforementioned twist characteristics and being woven 20 picks per inch with unbleached warp yarns of 100% cotton of 14.5/1 yarn size and a standard twist multiple and arranged 48 ends per inch. In accordance with this method, a zinc chloride solution of a concentration within the range of 62% to 68% is padded on the fabric and the fabric is held wet for at least one (1) hour up to 24 hours, put preferably about 2½ hours. The zinc chloride is then leached out by washing the fabric in running cold water and the fabric is tenter-dried to the desired width.

A cross-linking stabilizing agent (1% to 12% active fiber reaction products) is padded on and the fabric is tenter-dried. The cross-linking stabilizing agent is then catalyzed by passing the fabric through a hot curing oven and the fabric is open-width washed to remove any residual unreacted chemicals and is then can-dried.

The fabric is then lightly top sized with lubricants, a wetting agent and an adhesive to effect some bonding between the warp and filling yarns at the cross-over points and tenter-dried to about one-quarter inch (¼") above

the desired final width for optimum shrinkage resistance. Finally, the fabric is mechanically compressively shrunk to a small degree in the warp direction, to complete the stabilization of the warp yarns.

It is, therefore, believed apparent that the present invention provides an improved directionally stiff woven fabric having fused, cross-linked high wet modulus regenerated cellulose yarns in the stiffened direction to provide substantially increased dimensional stability over previous directionally stiff fabric constructions and a novel method of forming this fabric.

In the drawing and specification there has been set forth a preferred embodiment of the invention and, although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention being defined in the claims.

I claim:

1. A dimensionally stable, woven fabric having substantially greater stiffness in one direction than the other direction comprising sets of warp and filling yarns interwoven with each other, one of said sets of yarns consisting mainly of fused, cross-linked regenerated cellulose of the high wet modulus type having a wet modulus of at least about 6.0 gm./d. and being sufficient in number and size to provide said greater stiffness in their longitudinal direction, the other set of yarns consisting mainly of unfused fibers, and said fabric being dimensionally stable and having a maximum wet to dry difference of three percent (3%) in the directions of said sets of yarns.

2. A dimensionally stable, woven fabric according to claim 1 wherein said fused, cross-linked yarns are the filling yarns.

3. A dimensionally stable, woven fabric according to claim 1 wherein said other set of yarns consist mainly of cotton fibers and wherein the fabric has a maximum wet to dry difference of one percent (1%) in the direction of this set of yarns.

4. A dimensionally stable, woven fabric according to claim 3 wherein said cotton fibers are unbleached.

5. A dimensionally stable, woven fabric according to claim 1 wherein said regenerated cellulose is viscose rayon.

6. A dimensionally stable, woven fabric according to claim 1 wherein said regenerated cellulose is saponified acetate.

7. A method of treating a fabric formed of interwoven sets of warp and filling yarns to render the same substantially stiffer in one direction than in the other direction and to provide dimensional stability therein, one set of said yarns consisting mainly of regenerated cellulose yarns of the non-cross-linked, high wet modulus type having a wet modulus of at least about 6.0 gm./d. in fused state and the other set of said yarns consisting mainly of cotton yarns, said method comprising the steps of subjecting the fabric to a fusing treatment to fuse the one set of yarns without affecting the other set of yarns and to render the fabric materially stiffer in the longitudinal direction of the fused yarns than in the other direction, and thereafter treating the fabric with a cross-linking stabilizing agent to cross-link the fused yarns and to impart additional dimensional stability to at least the fused yarns and a maximum wet to dry difference of three per cent (3%) in the direction of the fused yarns.

8. A method according to claim 7 wherein the one set of yarns is fused by a zinc chloride solution of 62% to 68% concentration.

9. A method according to claim 7 wherein the cross-linking stabilizing agent has active fiber reaction products within the range of 1% to 12%.

10. A method according to claim 7 wherein the one set of yarns is fused by a zinc chloride solution of 62% to 71% concentration with the fused yarns being cross-linked by a substantially non-polymer forming cross-linking fiber reactant.

11. A method according to claim 7 wherein the one set of yarns is fused by a zinc chloride solution of 62% to 68% concentration with the fused yarns being cross-linked by a polymer forming cross-linking resin.

12. A method according to claim 7 wherein the cross-linking stabilizing agent also stabilizes the other set of unfused yarns and including compressively shrinking the fabric in the direction of the other set of yarns to additionally stabilize the fabric in this direction.

No references cited.

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