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PILL RESISTANT POLYESTER FABRICS

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ABSTRACT OF THE DISCLOSURE

A process for the preparation of pill resistant woven and knitted fabrics and the products produced thereby, said fabrics containing at least 25% by weight of non-fusible polyethylene terephthalate staple fibers having an intrinsic viscosity in excess of 0.46, pill resistance being achieved by incorporating fusible polyethylene terephthalate staple fibers into the blend and then heating the finished fabric to fusion temperatures.

This application is a continuation of Ser. No. 414,403 filed Nov. 27, 1964 and now abandoned.

This invention relates to fabrics resistant to pilling. More particularly, the invention is directed to fabrics made out of blends of wholly or substantial amounts of staple polyethylene terephthalate fibers which have improved pill resistant properties and to processing techniques to provide said fabrics.

As is well known, it is common in all fabrics which are made, yarns possessing a hairy or wooly surface form pills. Pilling results when loose fiber ends escape from yarns and the loose ends, especially at the points where the fabric is exposed to rubbing, collect on the surface of the material and ball up into rather unsightly fluffs. With woolen fabrics, pilling has presented no serious problems since the pills are very loosely held and either fall off or are unconsciously brushed off before there is a serious accumulation. The difficulty with fabrics made of substantial amounts of polyethylene terephthalate lies not in the fact that pills are formed but they cling tenaciously and cannot be brushed off but require pulling off with effort. These pills tend to accumulate and provide an unsightly appearance resulting in embarrassment to the wearer of the clothing.

In Belgian Patent 548,150, Eggleston et al., granted Nov. 20, 1956, and assigned to Imperial Chemical Industries Limited, London, England, a partial solution to the pilling problem for polyethylene terephthalate fabrics was proposed. It was suggested that fabrics be made from highly crystalline polyethylene terephthalate staple fibers having a low molecular weight and having an intrinsic viscosity in the range from about 0.28 to about 0.45. It was discovered that the tendency for pilling of polyethylene terephthalates having low molecular weights as described was eliminated or at least reduced considerably. However, the fabrics containing polyethylene terephthalate staple fibers having intrinsic viscosities in excess of about 0.46 still possessed the undesirable pilling problem. Chemical treatments and chemical additives are additional proposals recommended to overcome the pilling problems of the polyethylene terephthalate fabrics but a different hand of the fabrics are obtained over that of the untreated fabric which is generally not desirable.

It is the object of this invention to provide pill resistant textile fabrics containing substantial amounts of high molecular weight crystalline polyethylene terephthalate staple fibers without utilizing a chemical treatment or chemical additive to provide the desired result. A further object is to provide a unique process for providing pill resistant polyethylene terephthalate fabrics of the type described above. These and other objects will become apparent to those skilled in the art by the reading of the following detailed disclosure and claims.

The objects of the invention are attained by initially producing a blended yarn containing at least about 25 weight percent of polyethylene terephthalate staple fibers which are crystalline having an intrinsic viscosity in excess of 0.46, and non-crystalline, fusible polyethylene terephthalate staple fibers in amounts ranging from about 5 to about 25 weight percent of said blend. The blended yarns are woven or knitted into the desirable fabric-like construction and exposed to elevated temperatures which will not detrimentally affect the fiber content for a period of time to fuse the non-crystalline polyethylene terephthalate fibers. The resulting fabric obtained provides a dramatic improvement in pilling resistance and at the same time does not substantially alter the hand of the finished fabric when compared to the regular high pilling fabric.

The initial fabrics prepared for treatment to obtain the finished fabrics of this invention are woven or knitted from yarns made from blends of various staple fibers of polyethylene terephthalate fibers with other synthetic staple fibers, natural occurring staple fibers or combinations thereof.

One of the ingredients of the yarn used to prepare the initial fabric includes at least about 25 percent by weight of highly crystalline polyethylene terephthalate staple fibers having an intrinsic viscosity in excess of 0.46. These fibers and preparation thereof are well known in the art and are also known to provide undesirable pilling properties when used in fabrics. The polyethylene terephthalate fibers as used herein can include the homopolyester of ethylene glycol and terephthalic acid as well as the copolymers of polyethylene terephthalate which include additional components such as isophthalic acid, phthalic acid, naphthalic acids, bibenzoic acids, combinations thereof, sulfonated products thereof and the like.

A further essential ingredient of the yarn used to prepare the initial fabric includes about 5 to 25 weight percent of the blend of non-crystalline, fusible polyethylene terephthalate homopolymer or copolymer stable fibers. For this fiber, the intrinsic viscosity is not essentially critical. It is well known in the art that polyethylene terephthalate fibers require a high degree of crystallinity to provide the desirable physical properties such as tenacity, elongation, etc. needed to produce the desired fabrics from said fibers. One method of producing a high degree of crystallinity is to stretch the fiber about 1.5 to about 8 times, or higher, its original length above the second order transition temperature. The resulting fiber will be essentially a non-fusible fiber up to the melting point of the polymer. For this invention, however, a specific amount of fusible polyethylene terephthalate staple fibers is required to obtain the desired result of improved pill resistance in the fabric. Fusible or non-crystalline polyethylene terephthalate fibers can be produced by merely spinning the polymer to form fibers. These fibers have a low crystallinity, low tenacity, high elongation, high dye uptake, low birefringence, among others, corresponding essentially to the opposite properties of the highly crystalline fibers used herein. These non-crystalline fibers can be produced by partially drawing or collecting directly from the melt spinning operation. In any event, it is essential that a portion of the fiber used in the blend to produce the fabrics of this invention must be fusible at elevated temperatures. The preferred amount of fusible polyethylene terephthalate staple fibers ranges from 10 to about 20 weight percent of the blend. It has been found that if the amount of fusible polyester fiber is increased to 30 weight percent of the yarn, the fabric made therefrom does not have the desired high pill resistance.

The yarns utilized herein cannot only consist of crystalline or non-fusible and non-crystalline or fusible polyethylene terephthalate staple fibers only to provide the desired fabric effects but can include additional components such as other synthetic fibers such as nylon, acrylics, acetate, and the like, as well as naturally occurring fibers such as cotton, wool and the like. These additional components are added in amounts so that an acceptable fabric can be obtained and can range from about 50 to about 70 percent by weight, preferably in the range from 30 to about 60 weight percent. The preferred components are wool and cotton in combination with polyethylene terephthalate which have been fibers found highly acceptable for fabric uses.

After the above-described yarns are prepared, they are woven or knitted into fabrics. These fabrics are then exposed to elevated temperatures in the range from about 200° F. to below the melting point of the lowest melting component of the fabric for a period of time sufficient to cause the non-crystalline polyethylene terephthalate staple fibers to fuse. Care is taken in the heating process to avoid damaging anyone of the components in the fabric. Although it is not definitely known, the fusion of the non-crystalline fibers is believed to anchor the individual fibers of polyethylene terephthalate or other components in the fabric in a binding manner thereby making the fabric less prone to pill with use.

The preferred method for fusing the non-crystalline polyethylene terephthalate in the fabric is to calender the fabric at temperatures in the range from about 200° F. to about 260° F. The calendering process is well known in the art and can be carried out by passing the fabric between rollers under pressure on the calender frame. The number of rollers may vary from two to seven depending on the desired finish of the fabric. The fabric can be passed over the rollers three or four times depending on the particular finish sought. The finish may be dull, flat, glazed, watered, or moiré smooth. The pressure and heat of the rollers are the important factor in obtaining the desired finish.

The following examples will demonstrate the present invention without limiting the same:

EXAMPLE 1

Yarns of a staple fiber blend containing varying amounts of fusible and non-crystalline polyethylene terephthalate and the remainder staple fibers made of non-fusible polyethylene terephthalate having an intrinsic viscosity of 0.6, were prepared. The yarns were used to construct Swiss piqué fabrics to promote pilling, i.e. short staple, low twist, loose knit. After the fabric was prepared, the fabric was calendered at 250° F. in order to fuse the non-crystalline polyethylene terephthalate fibers. The calendering must be effected before the fabric is subjected to temperatures above its second-order transition temperature (about 170° F.) under conditions which allow shrinkage (e.g. dyeing). After calendering, the fabrics are very stiff but the mechanical working during dyeing and finshing softens the fabrics considerably to provide a desirable hand of the finished product. The fabrics were then exposed to a Random Tumble Pilling Test which includes the placing of the fabrics in a tumbler with abrasive paper for a specified period of time and count the resulting pills. The following results were obtained in Table I below:

TABLE I

Yarn composition		Fabric—Random tumble pilling test	
Percent fusible polyethylene terephthalate	Percent non-fusible polyethylene terephthalate	10 minutes	20 minutes
0	100	3	1
10	90	5	4-5
30	70	3-4	2

The rating of the Random Tumble Pilling Test is on a basis of 1 to 5 where 5 is the best pilling resistant fabric and 1 represents the worst pilling properties while the intermediate numbers represent varying degrees of bad (2) to good (4). It should be noted from these results that when 10 percent fusible polyethylene terephthalate is used in the yarns to produce the fabrics, the pilling resistance is significantly higher than that of the fabrics made of yarns containing zero percent and 30 percent fusible polyethylene terephthalate fibers.

EXAMPLE 2

Fabrics were woven in a manner to incorporate a special blended yarn as described below in the filling portion and utilizing a yarn made of a blend of 55 percent by weight of non-fusible polyethylene terephthalate (intrinsic viscosity 0.58) and 45 percent wool staple of the worsted quality. All the yarns (1/36 wool-cotton yarn count) utilized had Z type twist of 13.7 turns per inch. After the fabric was woven, the fabric was calendered at 250° F. prior to dyeing and finishing in order to fuse the non-crystalline polyethylene terephthalate fibers. The fabric was then submitted to the various tests with the following results:

Tests	Pilling fiber composition: 55% non-fusible polyethylene terephthalate staple fiber and 45% wool staple	Pilling fiber composition: 20% fusible polyethylene terephthalate staple fiber, 35% non-fusible polyethylene terephthalate staple fiber, 45% wool staple
Grab tensile:		
Warp	194	204
Filling	173	140
Flex abrasion, cycles to finish	2,500+	2,500+
Flat abrasion, cycles to first thread break	512	1,007
Random tumble pilling: [1]		
30 minutes	2	5
60 minutes	1	5
Brush and sponge pilling: [1]		
10 minutes	1	4
20 minutes		4
Wash and wear rating [1]	4-5	4-5

[1] The ratings of these tests are on a basis of 1 to 5 where 5 is the best rating and 1 the poorest rating while the intermediate numbers represent varying degrees of bad (2) to good (4).

These results clearly indicate that the use of fusible polyethylene terephthalate in blends provides, under certain conditions, improved pill resistance as well as flat abrasion cycles to first thread break. In a similar manner as described above, cotton staple blended with polyethylene terephthalate in place of wool staple would provide similar results as utilized under the conditions of this invention.

EXAMPLE 3

Various yarns were blended to determine the effect of knitted fabrics in regard to pilling effects. Yarns were blended in the following manner:

(1) 55 percent non-fusible polyethylene terephthalate and 45 percent wool staple (worsted quality)

(2) 10 percent fusible polyethylene terephthalate, 45 percent non-fusible polyethylene terephthalate, 45 percent wool staple

The yarns (1) and (2) (1/20 wool-cotton yarn count) were individually knitted into fabrics. The fabric (2) was then exposed to calendering at 250° F. to fuse the fusible and non-crystalline polyethylene terephthalate fibers. The finished fabrics were then exposed to various tests with the following results:

	Fabric (1)	Fabric (2)
Random tumbling pilling:		
10 minutes	2	4–5
20 minutes	1–2	4
Random tumbling pilling 20 minutes:		
After 3 washings	1–2	4
After 6 washings	1	3–4
Wash and wear rating	4	4–5

The tests and ratings are identical to those described in Example 2. In the knitted fabrics, the fabrics of this invention (2) show improved results in pilling resistance over the blends of regular non-fusible polyethylene terephthalate fabrics.

It is to be understood that the foregoing description is merely illustrative of preferred embodiments of the invention of which many variations may be made by those skilled in the art within the scope of the following claims without departing from the spirit thereof.

Having thus disclosed the invention, what is claimed is:

1. A woven or knitted textile fabric having a high resistance to pilling prepared from a yarn comprising a blend of at least about 25 percent by weight of said blend of non-fusible polyethylene terephthalate staple fibers having an intrinsic viscosity in excess of 0.46, about 10 to about 20 percent by weight of said blend of fusible polyethylene terephthalate staple fibers and the remainder of said blend of staple fibers selected from the group of synthetic fibers and natural fibers, wherein said fusible polyethylene terephthalate staple fibers are fused in fabric form.

2. The textile fabric of claim **1** wherein the natural fiber is wool.

3. The textile fabric of claim **1** wherein the natural fiber is cotton.

4. A woven or knitted textile fabric having a high resistance to pilling prepared from a yarn comprising a blend of about 75 to 95 percent by weight of said blend of non-fusible polyethylene terephthalate staple fibers having an intrinsic viscosity in excess of 0.46 and about 10 to about 20 percent by weight of said blend of fusible polyethylene terephthalate staple fibers wherein said fusible polyethylene terephthalate staple fibers are fused in fabric form.

5. A woven or knitted textile fabric having a high resistance to pilling prepared from a yarn comprising a blend of about 80 to about 90 percent by weight of said blend of non-fusible polyethylene terephthalate staple fibers having an intrinsic viscosity in excess of 0.46 and about 10 to about 20 percent by weight of said blend of fusible polyethylene terephthalate staple fibers wherein said fusible polyethylene terephthalate staple fibers are fused in fabric form.

6. A woven or knitted textile fabric having a high resistance to pilling prepared from a yarn comprising a blend of about 30 to about 50 percent by weight of said blend of non-fusible polyethylene terephthalate staple fibers having an intrinsic viscosity in excess of 0.46, about 10 to about 20 percent by weight of said blend of fusible polyethylene terephthalate staple fibers, and about 30

to about 60 percent by weight of said blend of wool staple fibers wherein said fusible polyethylene terephthalate staple fibers are fused in fabric form.

7. A process for increasing the pill resistance of a woven or knitted textile fabric prepared from a yarn comprising a blend of at least 25 percent by weight of said blend of non-fusible polyethylene terephthalate staple fibers having an intrinsic viscosity in excess of 0.46, about 10 to about 20 percent by weight of said blend of fusible polyethylene terephthalate staple fibers and the remainder of said blend of staple fibers selected from the group of synthetic fibers and natural fibers, comprising heating said fabric at temperatures in the range from about 200° F. to below the melting point of the lowest melting component of said fabric for a period of time sufficient to cause fusion of said fusible polyethylene terephthalate fibers.

8. A process for increasing the pill resistance of a woven or knitted textile fabric prepared from a yarn comprising a blend of at least 25 percent by weight of said blend of non-fusible polyethylene terephthalate staple fibers having an intrinsic viscosity in excess of 0.46, about 10 to about 20 percent by weight of said blend of fusible polyethylene terephthalate staple fibers and the remainder of said blend of staple fibers selected from the group of synthetic fibers and natural fibers, comprising heating said fabric at temperatures in the range from about 200° F. to 260° F. for a sufficient period of time to cause fusion of said fusible polyethylene terephthalate fibers.

9. The process of claim **8** wherein the natural staple fiber in the blend is wool.

10. The process of claim **8** wherein the natural staple fiber in the blend is cotton.

11. The process of claim **8** wherein the yarn blend is composed of about 80 to 90 percent of non-fusible polyethylene terephthalate staple fibers having an intrinsic viscosity in excess of 0.46.

12. The process of claim **8** wherein the yarn blend contains about 30 to 50 percent by weight of non-fusible polyethylene terephthalate staple fibers having an intrinsic viscosity in excess of 0.46, about 10 to 20 percent by weight of fusible polyethylene terephthalate staple fibers and about 30 to about 60 percent by weight of wool staple fibers.

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