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(71) Applicant: **Aladdin Manufacturing Corporation**
Calhoun, GA 30701 (US)

(72) Inventors:
- **NORTH, Melissa**
  Calhoun, GA 30701 (US)
- **BEASON, Wayne**
  Dalton, GA 30721 (US)
- **CASCIO, Anthony**
  Calhoun, GA 30701 (US)

(74) Representative: **Schacht, Benny Marcel Corneel**
Flooring Industries Limited, SARL
Patent department
Ooigemstraat 3
8710 Wielsbeke (BE)

(54) **COMBINATION YARN**

(57) The present disclosure provides combination yarns and carpets formed therefrom, in particular combination yarns comprising a first single primarily PET yarn and a second single primarily PTT yarn, wherein at least one of the first single yarn or the second single yarn includes one or more additives which increases dye uptake.

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Description

TECHNICAL FIELD

[0001] This disclosure relates to combination yarns, and more particularly to polyester yarns and carpets using such yarns as pile yarn.

BACKGROUND

[0002] Carpets, rugs, and mats used in home or commercial applications are typically made from natural fibers (such as cotton or wool) or synthetic fibers (such as nylon, polyester, polyolefins, acrylics, rayon, and cellulose acetate). Synthetic fibers tend to be more favored in carpet manufacture as they are generally more commercially acceptable and can be used for a wider variety of applications.

[0003] Nylon is often used in carpet fiber since it is strong, easy to dye, and readily available. Nylon carpeting can be disadvantageous, however, as it generally requires various treatments in light of its susceptibility to developing static electric charges and its ease of staining. Carpets made from polyolefins, such as polypropylene, are very resistant to staining and are naturally antistatic; however, polypropylene is a more rigid and less resilient fiber and will not generally maintain its appearance or shape under prolonged or heavy use, or after repeated deformations.

[0004] Polyesters such a PET, PTT, and PBT are a favorable alternative to both nylon and polyolefins and are known to provide stain resistance and static resistance while also providing a "wool-like" feel with good physical performance.

SUMMARY

[0005] The present disclosure provides combination yarns, in particular combination yarns formed from two or more polyester yarns having different polymeric compositions yet having substantially the same color strength when dyed under the same dyeing conditions, for example when both yarns are dyed together. In other embodiments, the present disclosure provides combinations yarns formed from two or more polyester yarns having different polymeric compositions that provide substantially different color strength between the two yarns when dyed under the same dyeing conditions, for example when both yarns are dyed together.

[0006] Thus in one aspect, a combination yarn is provided comprising a first single yarn and a second single yarn, wherein the first single yarn and the second single yarn are linked to each other, wherein the first single yarn comprises at least 60% polyethylene terephthalate (PET), wherein the second single yarn comprises at least 60% polytrimethylene terephthalate (PTT), and wherein at least one of the first single yarn and the second single yarn includes one or more additives that increase dye uptake such that the color strength of the at least one of the first single yarn and the second single yarn is increased when compared to the same first single yarn and/or the same second single yarn which does not include the one or more additives.

[0007] In some embodiments, the first single yarn includes the one or more additives. In some embodiments where the first single yarn includes the one or more additives, the second single yarn does not include the one or more additives. In some embodiments where the first single yarn includes the one or more additives, the color strength of the first single yarn is within 20% or within 10% of the color strength of the second single yarn when both yarns are subjected to the same dyeing conditions, for example when both yarns are dyed together.

[0008] In some embodiments, the second single yarn includes the one or more additives. In some embodiments where the second single yarn includes the one or more additives, the first single yarn does not include the one or more additives. In other embodiments where the second single yarn includes the one or more additives, the first single yarn also includes the one or more additives. In some embodiments where both the first and the second single yarn include the one or more additives, the one or more additives included with the first single yarn are different from the one or more additives included with the second single yarn. In some embodiments where the second single yarn includes the one or more additives, the color strength of the second single yarn is at least 10% or at least 20% greater than the color strength of the first single yarn when both yarns are subjected to the same dyeing conditions, for example when both yarns are dyed together.

[0009] In one aspect, a combination yarn is provided comprising a first single yarn and a second single yarn, wherein the first single yarn and the second single yarn are linked to each other, wherein the first single yarn comprises polyethylene terephthalate (PET) and at least one or more additives which increase dye uptake, wherein the second single yarn comprises polytrimethylene terephthalate (PTT) and does not include one or more additives which increase dye uptake, and wherein the color strength of the first single yarn is within 20% or within 10% of the color strength of the second single yarn when both yarns are subjected to the same dyeing conditions, for example, when both yarns are dyed together. In some embodiments, the first single yarn comprises at least 75% PET. In some embodiments, the second single yarn comprises at least 75% PTT.

[0010] In another aspect, a combination yarn is provided comprising a first single yarn and a second single yarn, wherein the first single yarn and the second single yarn are linked to each other, wherein the first single yarn comprises PET, wherein the second single yarn comprises PTT and one or more additives which increase dye uptake, and wherein the color strength of the second single yarn is at least 10% or at least 20% greater than the color strength of the first single yarn when both yarns are

subjected to the same dyeing conditions, for example when both yarns are dyed together. In some embodiments, the first single yarn does not include one or more additives which increase dye uptake. In other embodiments, the first single yarn does include one or more additives which increase uptake, wherein the one or more additives for the first single yarn may be the same or different from the one or more additives for the second single yarn.

[0011] In some embodiments, the one or more additives that increase dye uptake may include polybutylene terephthalate (PBT), at least one ester modifier, or combinations thereof. In some embodiments, the ester modifier includes a copolymer formed by polymerization of a mixture comprising terephthalic acid or esters thereof, at least one dicarboxylic acid monomer, and at least one diol monomer. In other embodiments, the ester modifier includes a copolymer formed by polymerization of a mixture comprising terephthalic acid or esters thereof, at least one diol monomer, and at least one polyalkylene glycol. In some embodiments, the ester modifier includes ortho-phthalic acid, isophthalic acid, esters thereof, or mixtures thereof.

[0012] In some embodiments, the first single yarn and/or the second single yarn are continuous filament yarns. Each of the first single yarn and the second single yarn may comprise a given number of filaments per cross section, which number of filaments per cross section may be identical or different for the first single yarn and second single yarn.

[0013] In some embodiments, all filaments of the first single yarn may have a substantially equal cross section. In some embodiments, all filaments of the second single yarn may have a substantially equal cross section. In some embodiments, the cross sections of the filaments of the first single yarn and the second single yarn may be substantially identical (having cross-sectional areas within 10% of each other).

[0014] In some embodiments, the first single yarn or the second single yarn are bulked continuous filament (BCF) yarns. In other embodiments, the first single yarn or the second single yarn are spun yarns comprising staple fibers.

[0015] In some embodiments, the combination yarn may be a plied or twisted yarn. The combination yarn may be plied or twined in either the S- or Z-direction. The first single yarn, second single yarn, or further single yarns may be untwisted, particularly when the single yarns are BCF yarns, or may be twisted as well.

[0016] The use of the combination yarn as described herein as a pile yarn in a carpet is also provided. In some embodiments, the carpet is a tufted carpet.

[0017] Also provided is a tufted carpet comprising a pile yarn providing the pile of the carpet, wherein the pile yarn is the combination yarn described herein.

[0018] The details of one or more embodiments of the disclosure are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the disclosure will be apparent from the description and drawings, and from the claims.

DETAILED DESCRIPTION

[0019] The compositions and methods of the appended claims are not limited in scope by the specific compositions and methods described herein, which are intended as illustrations of a few aspects of the claims and any compositions and methods that are functionally equivalent are intended to fall within the scope of the claims. Various modifications of the compositions and methods in addition to those shown and described herein are intended to fall within the scope of the appended claims. Further, while only certain representative compositions and method steps disclosed herein are specifically described, other combinations of the compositions and method steps also are intended to fall within the scope of the appended claims, even if not specifically recited. Thus, a combination of steps, elements, components, or constituents may be explicitly mentioned herein; however, other combinations of steps, elements, components, and constituents are included, even though not explicitly stated.

[0020] The term "comprising" and variations thereof as used herein is used synonymously with the term "including" and variations thereof and are open, non-limiting terms. Although the terms "comprising" and "including" have been used herein to describe various embodiments, the terms "consisting essentially of' and "consisting of' can be used in place of "comprising" and "including" to provide for more specific embodiments of the invention and are also disclosed. Other than in the examples, or where otherwise noted, all numbers expressing quantities of ingredients, reaction conditions, and so forth used in the specification and claims are to be understood at the very least, and not as an attempt to limit the application of the doctrine of equivalents to the scope of the claims, to be construed in light of the number of significant digits and ordinary rounding approaches.

[0021] As used in the specification and the appended claims, the singular forms "a," "an" and "the" include plural referents unless the context clearly dictates otherwise. Ranges may be expressed herein as from "about" one particular value, and/or to "about" another particular value. When such a range is expressed, another embodiment includes¬ from the one particular value and/or to the other particular value. Similarly, when values are expressed as approximations, by use of the antecedent "about," it will be understood that the particular value forms another embodiment. It will be further understood that the endpoints of each of the ranges are significant both in relation to the other endpoint, and independently of the other endpoint.

[0022] "Optional" or "optionally" means that the subsequently described event or circumstance may or may not occur, and that the description includes instances where said event or circumstance occurs and instances

where it does not.

[0023] Disclosed are components that can be used to perform the disclosed methods and systems. These and other components are disclosed herein, and it is understood that when combinations, subsets, interactions, groups, etc. of these components are disclosed that while specific reference of each various individual and collective combinations and permutation of these may not be explicitly disclosed, each is specifically contemplated and described herein, for all methods and systems. This applies to all aspects of this application including, but not limited to, steps in disclosed methods. Thus, if there are a variety of additional steps that can be performed it is understood that each of these additional steps can be performed with any specific embodiment or combination of embodiments of the disclosed methods.

[0024] In one aspect, a combination yarn is providing comprising a first single yarn and a second single yarn, wherein the first single yarn and second single yarn are linked to each other, wherein the first single yarn comprises primarily polyethylene terephthalate (PET), and wherein the second single yarn comprises primarily polytrimethylene terephthalate (PTT). In some embodiments, the color strength of the first single yarn is within 20%, within 15%, within 10%, or within 5% of the color strength of the second single yarn when both yarns are subjected to the same dyeing conditions. In other embodiments, the color strength of the second single yarn is at least 10%, at least 20%, at least 30%, or at least 20% greater than the color strength of the first single yarn when both yarns are subjected to the same dyeing conditions. In some embodiments, the first single yarn and second single yarn are subjected to dyeing together.

[0025] The first single yarn may comprise filaments or fibers, which filaments or fibers are made primarily from polyethylene terephthalate (PET) and hence comprise at least 60% PET, and may further include common additives like process enhancers, stabilizers, fillers, and the like. In some embodiments, the PET as used in the first single yarn may originate from recycled PET products such as recycled PET bottles, also referred to as rPET. In some embodiments, the first single yarn includes at least 60%, at least 70%, at least 75%, at least 80%, at least 90%, at least 95%, or at least 99% PET.

[0026] The second single yarn may comprise filaments or fibers, which filaments or fibers are made primarily from polytrimethylene terephthalate (PTT) and hence comprise at least 60% PTT as the majority of the material, and may further include common additives like process enhancers, stabilizers, fillers and the like. In some embodiments, the PTT as used in the second single yarn may originate from recycled PTT products, also referred to as rPTT. In some embodiments, the second single yarn includes at least 60%, at least 70%, at least 75%, at least 80%, at least 90%, at least 95%, or at least 99% PTT.

[0027] The combination yarn may have a linear weight, expressed in denier, in the range of 1000 to 1600 denier, more preferably 1100 to 1500 denier. A 'denier' equals one gram per 9000 meters of yarn. Either the first single yarn or the second single yarn may have a linear weight, expressed in denier, in the range of 500 to 800 denier, more preferably 550 to 750 denier. In some embodiments, the first single yarn and the second single yarn, and if present also any further single yarn, have substantially equal linear weights (within 10% of each other).

[0028] In some embodiments, the first single yarn and/or the second single yarn are continuous filament yarns. Each of the first single yarn and the second single yarn may comprise a given number of filaments per cross section, which number of filaments per cross section may be identical or different for the first single yarn and second single yarn. The number of filaments may be between 120 and 160, preferably between 123 and 150. Each filament has a thickness, in function as an element of the yarn, typically expressed as "denier per filament" or "dpf." The filaments of the first single and/or second single yarn may have a thickness in the range of 10 to 12 dpf, more preferably in the range of 10.4 to 11.2 dpf. Thus, each filament of the first single yarn and the second single yarn may have a thickness in the range of 10 to 12 denier, more preferably in the range of 10.4 to 11.2 denier.

[0029] Each filament of the first and second single yarn has a cross section which may be circular, oval, triangular, trilobal, or square. Optionally, the filaments may be hollow, comprising one or a plurality of hollow channels. These one or more channels may be coaxial with the axis of the filament.

[0030] In some embodiments, all filaments of the first single yarn may have a substantially equal cross section with a cross-sectional area within 10% of the mean cross-section. In some embodiments, all filaments of the second single yarn may have a substantially equal cross section with a cross-sectional area within 10% of the mean cross-section. In some embodiments, the mean cross-section of the filaments of the first single yarn and the mean cross-section of the filaments in the second single yarn are substantially identical, i.e., within 10% of each other.

[0031] In some embodiments, the first single yarn or the second single yarn are bulked continuous filament (BCF) yarns. In other embodiments, the first single yarn or the second single yarn are spun yarns comprising staple fibers.

[0032] In some embodiments, the first single yarn is a primarily PET single yarn as discussed herein including one or more additives that increase dye uptake. In other embodiments, the second single yarn is a primarily PTT single yarn as described herein including one or more additives that increase dye uptake. In yet other embodiments, both the first single yarn and the second single yarn as described herein include one or more additives that increase dye uptake. In some embodiments, an increase in dye uptake is defined by an increase in color strength for the first single yarn or the second single yarn, as measured by colorimetry, of 20% or more as com-

pared to a control first single yarn or a control second single yarn respectively that does not contain the one or more additives that increase dye uptake when exposed to the same dyeing conditions. In some embodiments, the first single yarn or the second single yarn shows a greater than 20%, greater than 40%, greater than 60%, greater than 80%, greater than 100%, greater than 150%, greater than 200%, greater than 250%, greater than 300%, or greater than 400% increase in color strength, as compared to a control first single yarn or a control second single yarn that does not contain the one or more additives that increase dye uptake, when exposed to the same dyeing conditions.

[0033] "Color Strength" as used herein refers to the ability of a pigment or dye to change the color of an otherwise colorless material. Color strength may be measured, for example, by comparing the K/S value (where K represents the absorbance and S represents the scatter of the material) of a material, such as the first single yarn or the second single yarn described herein, to a known standard, for example a control first single yarn or a control second single yarn respectively that does not contain one or more additives that increase dye uptake, when exposed to the same dyeing conditions. In some embodiments, the K/S value may be measured from the reflectance of the dyed material as determined by Kubelka-Monk theory using the following formula: $K/S = [\{(1-R)^2/2R\}]$. Thus, in some embodiments, the first single yarn or the second single yarn as described herein shows an increase in its K/S value of 20% or more as compared to the K/S value of the control first single yarn or the control second single yarn, respectively. In some embodiments, the first single yarn or the second single yarn as described herein shows a 20% or greater, 40% or greater, 60% or greater, 80% or greater, 100% of greater, 150% or greater, 150% or greater, 200% or greater, 250% or greater, 300% or greater, or 400% or greater increase in its K/S value as compared to the K/S value of the control first single yarn or the control second single yarn, respectively. K/S values may be measured using any number of commercially available spectrophotometers, for example, the Datacolor® 800 spectrophotometer.

[0034] Whether the first single yarn, the second single yarn, or both further include one or more additives that increase dye uptake depends on the desired color strength difference between the two single yarns for the particular desired application. In some embodiments, the color strength of the first single yarn is desired to be within 20% or within 10% of the color strength of the second single yarn when both are subjected to the same dyeing conditions. In these embodiments, the first single yarn may comprise primarily PET and one or more additives that increase dye uptake and the second single yarn may comprise primarily PTT and does not include any additives that increase dye uptake. Such embodiments typically are directed to applications where uniformity of color is desired, such as unicolor carpets. In other embodiments, the color strength of the second single yarn is instead desired to be at least 10% or at least 20% greater than the color strength of the first single yarn when both yarns are subjected to the same dyeing conditions. In these embodiments, both the first single yarn and the second single yarn may further comprise one or more additives to increase dye uptake, or the second single yarn may further comprise one or more additives to increase dye uptake while the first single yarn does not include one or more of such additives.

[0035] In some embodiments, the one or more additives that increase dye uptake may include polybutylene terephthalate (PBT), at least one ester modifier, or combinations thereof. In some embodiments, the one or more additives that increase dye uptake include polybutylene terephthalate (PBT). In some embodiments, the one or more additives that increase dye uptake include at least one ester modifier. In other embodiments, the one or more additives that increase dye uptake include both polybutylene terephthalate (PBT) and at least one ester modifier. In some embodiments, polybutylene terephthalate (PBT) can be present in an amount from 2.5 wt. % to 12 wt. %, from 3 wt. % to 12 wt. %, from 4 wt. % to 11 wt. %, from 5 wt. % to 10 wt. %, from 5.5 wt. % to 9.5 wt. %, or from 6 wt. % to 8 wt. % based on the total polymer weight of the first or second single yarn. In some embodiments, PBT can be present at 2.5 wt. %, 3 wt. %, 4 wt. %, 5 wt. %, 6 wt. %, 7 wt. %, 8 wt. %, 9 wt. %, 10 wt. %, 11 wt. %, or 12 wt. % based on the total polymer weight of the first or second single yarn. In one embodiment, PBT is present at 7.5 wt. % based on the total polymer weight of the first or second single yarn. In some embodiments, the ester modifier can be present in an amount ranging from 2.5 wt. % to 12 wt. %, from 3 wt. % to 10 wt. %, from 4 wt. % to 8 wt. %, from 5 wt. % to 7 wt. %, or from 5.5 wt. % to 6.5 wt. % based on the total polymer weight of the first or second single yarn. In some embodiments, the ester modifier can be present at 2.5 wt. %, 3 wt. %, 4 wt. %, 5 wt. %, 6 wt. %, 7 wt. %, 8 wt. %, 9 wt. %, 10 wt. %, 11 wt. %, or 12 wt. % based on the total polymer weight of the first or second single yarn. In one embodiment, the ester modifier is present at 6 wt. % based on the total polymer weight of the first or second single yarn. In another embodiment, the ester modifier is present at 8 wt. % based on the total polymer weight of the first or second single yarn.

[0036] Ester modifiers may typically comprise compounds that chemically modify the polyester such that it has decreased crystallinity. This decrease in crystallinity provides more space for the dye to penetrate the polymer matrix formed from the polyester, resulting in an increase in dye uptake.

[0037] In some embodiments, the ester modifier comprises a copolymer formed by polymerization of a mixture comprising terephthalic acid or esters thereof, at least one dicarboxylic acid monomer, and at least one diol monomer. In other embodiments, the ester modifier comprises a copolymer formed by polymerization of a mixture comprising terephthalic acid or esters thereof, at least

one diol monomer, and at least one polyalkylene glycol. In one embodiment, the mixture comprises terephthalic acid or an ester thereof, a diol monomer, and a dicarboxylic acid monomer in a ratio of 1:2:1. In one embodiment, the mixture includes terephthalic acid. In one embodiment, the mixture includes dimethyl terephthalate.

[0038] In some embodiments, the at least one dicarboxylic acid monomer can be selected from an aliphatic and/or aromatic acid. In some embodiments, the at least one dicarboxylic acid monomer can be selected from isophthalic acid, 2,6-naphthalene dicarboxylic acid, 3,4'-diphenyl ether dicarboxylic acid, hexahydrophthalic acid, 2,7-naphthalenedicarboxylic acid, phthalic acid, 4,4'-methylenebis(benzoic acid), oxalic acid, malonic acid, succinic acid, methyl succinic acid, glutaric acid, adipic acid, 3-methyladipic acid, pimelic acid, suberic acid, azelaic acid, sebacic acid, 1,11-undecanedicarboxylic acid, 1,10-dodecanedicarboxylic acid, undecanedioic acid, 1,12-dodecanedicarboxylic acid, hexadecanedioic acid, docosanedioic acid, tetracosanedioic acid, 1,4-cyclohexanedicarboxylic acid, 1,3-cyclohexanedicarboxylic acid, 1,2-cyclohexanediacetic acid, fumaric acid, maleic acid, or combinations thereof. In some embodiments, the at least one dicarboxylic acid is selected from succinic acid, glutaric acid, adipic acid, sebacic acid, or combinations thereof. In one embodiment, the dicarboxylic acid monomer is adipic acid.

[0039] In some embodiments, the at least one diol monomer can be selected from an aliphatic diol, a cyclic diol, and/or an aromatic diol. In some embodiments, the at least one diol can be selected from monoethylene glycol, diethylene glycol, triethyleneglycol, poly(ethylene ether)glycols, 1,3-propanediol, 1,4-butanediol, poly(butylene ether)glycols, 1,6-hexanediol, 1,8-octanediol, 1,10-decanediol, 1,12-dodecanediol, 1,14-tetradecanediol, 1,16-hexadecanediol, and cis- or trans-1,4-cyclohexanedimethanol. In some embodiments, the diol is selected from ethylene glycol, 1,3-propanediol, and 1,4-butanediol. In other embodiments, the diol ca be selected from 1,4-butanediol, 1,5-pentanediol, or 1,6-hexanediol. In one embodiment, the diol includes 1,4-butanediol.

[0040] In some embodiments, the polyalkylene glycol can be selected from the group consisting of polyethylene glycol, polypropylene glycol, ethylene oxide-propylene oxide copolymers, or combinations thereof. In some embodiments, the polyalkylene glycol includes polyethylene glycol. In some embodiments, the polyethylene glycol has a molecular weight from 200 to 5000 g/mol.

[0041] In some embodiments, the mixture further comprises sodium dimethyl-5-sulfoisophthalate (DMSIP), 5-sulfoisophthalic acid (SIPA), or combinations thereof. In some embodiments, the mixture includes dimethyl-5-sulfoisophthalate (DMSIP). In some embodiments, the mixture includes 5-sulfoisophthalic acid.

[0042] In some embodiments, the ester modifier comprises polybutylene adipate terephthalate (PBAT).

[0043] In some embodiments, the mixture further comprises a chain extender. In some embodiments, the chain extender can be selected from compounds comprising at least three groups capable of ester formation, for example but not limited to: tartaric acid, citric acid, malic acid, trimethylolpropane, trimethylolethane, pentaerythritol, polyether triols, glycerol, trimesic acid, trimellitic acid, trimellitic anhydride, pyromellitic acid, pyromellitic dianhydride and hydroxyisophthalic acid. In other embodiments, the chain extender is selected from compound comprising at least two isocyanate groups, for example but not limited to: aromatic isocyanates including tolylene 2,4-diisocyanate, tolylene 2,6-diisocyanate, 2,2'-diphenylmethane diisocyanate, 2,4'-diphenylmethane diisocyanate, 4,4'-diphenylmethane diisocyanate, naphthylene 1,5-diisocyanate, or xylylene diisocyanate; aliphatic diisocyanates such as 1,6-hexamethylene diisocyanate, isophorone diisocyanate, and methylenebis(4-isocyanatocyclohexane); trinuclear isocyanates such as tri(4-isocyanophenyl)methane; and isocyanurates derived from aliphatic isocyanates such as isophorone diisocyanate or methylenebis(4-isocyanatocyclohexane).

[0044] In other embodiments, the ester modifier may be selected from a phthalate plasticizer. Representative examples of phthalate plasticizers as can be used in the present invention include, but are not limited to, bis(2-ethylhexyl)phthalate (DEHP), bis(2-propylheptyl)phthalate (DPHP), diisononyl phthalate (DINP), di-n-butyl phthalate (DnBP), butyl benzyl phthalate (BBzP), diisodecyl phthalate (DIDP), dioctyl phthalate (DOP), diisooctyl phthalate (DIOP), diethyl phthalate (DEP), diisobutyl phthalate (DIBP), and di-n-hexyl phthalate. In some embodiments, the ester modifier may be selected from ortho-phthalic acid, isophthalic acid, or esters thereof.

[0045] In some embodiments, the PET as used in the first single yarn described herein can further comprise one or more additional monomeric or polymeric units. In one particular embodiment, the one or more additional monomeric units comprises cyclohexane dimethanol (CHDM), wherein a PET polymer including a percentage of CHDM may also be known as PETG. In some embodiments, the one or more additional units can comprise one or more isophthalic acids, including sulfonated isophthalic acids. In some embodiments, the one or more additional units can be selected from diethylene glycol, polyethylene glycol, butylene glycol, polystyrene, vinyltoluene, halostyrene, dihalostyrene, styrene-butadiene copolymers, styrene-acrylonitrile copolymers, styrene-acrylonitrile-butadiene copolymers, styrene-butadiene-styrene terpolymers, styrene-isoprene copolymers, aromatic dicarboxylic acids such a 5-sodium sulfoisophthalic acid, aliphatic dicarboxylic acids such as adipic acid and itaconic acid, glutaric acid, azelaic acid, sebacic acid, and combinations thereof. In some embodiments, the one or more additional units can comprise branching agents such as trimesic acid, pyromellitic acid, trimethylolpropane, trimethylolethane, and pentaerythritol.

[0046] In some embodiments, the PTT as used in the second single yarn described herein can further comprise one or more additional monomeric units. Representative

examples of the additional monomeric units include 5-sodium sulfoisophthalic acid, 5-potassium sulfoisophthalic acid, 4-sodium sulfo-2,6-naphthalenedicarboxylate, tetramethylphosphonium-3,5-dicarboxybenzenesulfonate, tetrabutylphosphonium 3,5-dicarboxybenzenesulfonate, tributylmethylphosphonium 3,5-dicarboxybenzenesulfonate, tetrabutylphosphonium 2,6-dicarboxynaphthalene-4-sulfonate, tetramethylphosphonium 2,6-dicarboxynaphthalene-4-sulfonate, ammonium 3,5-dicarboxybenzenesulfonate, 1,2-butanediol, 1,3-butanediol, 1,4-butanediol, neopentyl glycol, 1,5-pentamethylene glycol, 1,6-hexamethylene glycol, heptamethylene glycol, octamethylene glycol, decamethylene glycol, dodecamethylene glycol, 1,4-cyclohexanediol, 1,3-cyclohexanediol, 1,2-cyclohexanediol, 1,4-cyclohexanedimethanol, 1,3-cyclohexanedimethanol, 1,2-cyclohexanedimethanol, oxalic acid, malonic acid, succinic acid, glutaric acid, adipic acid, heptanedioic acid, octanedioic acid, sebacic acid, dodecanedioic acid, 2-methylglutaric acid, 2-methyladipic acid, fumaric acid, maleic acid, itaconic acid, 1,4-cyclohexanedicarboxylic acid, 1,3-cyclohexanedicarboxylic acid, and 1,2-cyclohexanedicarboxylic acid.

[0047] In some embodiments, the yarns as described herein may comprise one or more further additives, including but not limited to: flame retardant additives, for example decabromodiphenyl ether and triaryl phosphates such as triphenyl phosphate; reinforcing agents such as glass fibers; thermal stabilizers, for example thermal conductivity improves such as zinc oxide and titanium oxide; ultraviolet light stabilizers such as resorcinol monobenzoates, phenyl salicyclate and 2-hydroxybenzophenones; hindered amine stabilizers such as benzotriazole, benzophenone, oxalanilide, and cerium oxide; impact modifiers; flow enhancing additives; ionomers; liquid crystal polymers; fluoropolymers; olefins including cyclic olefins; polyamides; ethylene vinyl acetate copolymers; stabilizing agents such as ortho-phosphoric acid, trimethyl phosphate, triphenylphosphate, and triethylphosphino acetate; delustering agents such as titanium oxide; carriers such as o-phenylphenol, p-phenylphenol, o-dichlorobenzene, trichlorobenzene, monochlorobenzene, biphenyl, methyl salicyclate, butyl benzoate, benzyl benzoate, benzoic acid, benzalacetone, and methyl cinnamate; leveling agents such as asbishydroxymethyloxazoline, diaryl ethers, ditolyl ether, sodium di-naphthylmethane-B,B disulfonate, ammonium dodecylbenzene sulfonate, sodium tetrapropylbenzene sulfonate, homopolymers or oligomers of N-vinyl pyrrolidone or poly tetrahydrofuran; and porosity additives such as metal oxalate complexes, organic sulfonate salts, jade powder, or zeolite powder.

[0048] In one aspect, a combination yarn is provided comprising a first single yarn and a second single yarn,
wherein the first single yarn and the second single yarn are linked to each other,
wherein the first single yarn comprises at least 60% (for example, at least 75%) PET and an additive that includes at least one ester modifier,
wherein the second single yarn comprises at least 60% (for example, at least 75%) PTT and does not include any additives that increase dye uptake, and
wherein the color strength of the first single yarn is within 20% (for example, within 10%) of the color strength of the second single yarn when both yarns are subject to the same dyeing conditions, for example, when both yarns are dyed together.

[0049] In another aspect, a combination yarn is provided comprising a first single yarn and a second single yarn,
wherein the first single yarn and the second single yarn are linked to each other,
wherein the first single yarn comprises at least 60% (for example, at least 75%) PET and does not include any additives that increase dye uptake,
wherein the second single yarn comprises at least 60% (for example, at least 95%) PTT and an additive that includes PBT and at least one ester modifier, and
wherein the color strength of the second single yarn is at least 10% (for example, at least 20%) greater than the color strength of the first single yarn when both yarns are subject to the same dyeing conditions, for example when both yarns are dyed together.

[0050] A disperse dye may be used to color the first single yarn and/or the second single yarn. In some embodiments, the same disperse dye may be used to color the first single yarn and the second single yarn. For example, the first single yarn and the second single yarn may be dyed together. In other embodiments, the first single yarn and the second single yarn may be dyed to the same or to a different dye tone using the same disperse dye.

[0051] In some embodiments, a combination yarn is provided comprising at least a first single yarn and a second single yarn, wherein the first single yarn is a polyethylene terephthalate (PET) single yarn, wherein the second single yarn is a polytrimethylene terephthalate (PTT) single yarn, and wherein the first single yarn and/or the second single yarn have been solution dyed. For example, the first single yarn and the second single yarn may be dyed together.

[0052] The combination yarn as described herein may be dyed using a piece dyeing process. In a piece dyeing process, the undyed combination yarn is first assembled as a component of the final object, for example as pile fibers in a carpet. The assembled final object, for example a carpet, is then immersed in a dye bath at an elevated temperature. Depending upon the composition of the first single yarn and the second single yarn of the combination yarn described herein, the final object such as a carpet may be unicolor or may be subject to a differential or tonal effect due to different dyeing levels for the first and second single yarns. In some embodiments, the piece dyeing process may be a continuous dyeing process, where the final objected is passed under dyeing equipment that flows dye solution through the object instead of requiring immersion within a dye bath.

[0053] In some embodiments, the first single yarn and the second single yarn are dyed at the same temperature. For example, the first single yarn and the second single yarn can be dyed at a temperature less than 135 °C, for example at a temperature of from 100°C to 130°C.

[0054] In some embodiments, the first single yarn and the second single yarn may be linked by being formed into a plied or twisted yarn. The combination yarn may be plied or twined in either the S- or Z-direction. The number of turns per inch may be in the range of 4.10 to 4.30 turns. In some embodiments, the number of turns per inch may be in the range of 4.20 to 4.25 turns.

[0055] The first single yarn, second single yarn, or further single yarns may be untwisted, particularly when the single yarns are BCF yarns, or may be twisted as well. In some embodiments, the twisted single yarn is twisted in a direction (S- or Z-direction) which is opposite to the twining or plying direction. In some embodiments, the twisted single yarn may be twisted in the range of 4.10 to 4.30 turns per inch. In some embodiments, the twisted single yarn may be twisted by 4.25 turns per inch.

[0056] In some embodiments, the first single yarn and the second single yarn are linked to each other by air entanglement.

[0057] In some embodiments, the combination yarn may comprise more than two single yarns, such as 3, 4, 5 or more single yarns all linked to each other as described herein. In embodiments containing 3 or more single yarns, the additional single yarns may be PET single yarns or PTT single yarns. Depending upon the number of single yarns the properties of the filaments or fibers used to provide the single yarns, the weight ratio of PET to PTT in the combination yarn may vary. In some embodiments, the combination yarn may have a weight ratio of PET to PTT between 4:1 to 1:4. In some embodiments, the combination yarn may have a weight ratio of PET to PTT of 1:1.

[0058] In some embodiments, the combination yarn is heat set. In some embodiments, the combined yarn is heat set through, e.g., a Suessen or Superba heat set tunnel, thereby imposing at least to some extent memory, strength and wearability to the yarn.

[0059] The combination yarns described herein have several advantages over prior PET-based yarns, particularly when used to provide the pile of a woven or tufted carpet. The addition of PTT yarns to PET-based carpet brings durability, wear and stain resistance with only a portion of the PET yarns being replaced by PTT.

[0060] Thus, use of the combination yarn as a pile yarn in a carpet is also provided. In some embodiments, the carpet is a tufted carpet.

[0061] Also provided is a tufted carpet comprising a pile yarn providing the pile of the carpet, wherein the pile yarn is the combination yarn described herein. In some embodiments, the tufted carpet may be provided from solely polyester material, i.e., all parts of the carpet, such as pile yarn, primary backing in which the pile is tufted, the adhesion layer to lock the pile in the primary backing, the secondary backing and the like are provided from a polyester material. In some embodiments, the polyester material is only PET or PTT.

[0062] In some embodiments, the carpet is a unicolor carpet. A unicolor carpet is defined by having all the yarns providing the pile of the carpet having a substantially uniform color over the surface of the carpet.

[0063] In other embodiments, the carpets may instead have a tonal effect to differing coloration of the first single yarn and the second single yarn. In some embodiments, the carpet is initially assembled as a greige roll, i.e. a roll of the tufted undyed combination yarn without a secondary backing. This greige roll may then be subjected to a piece dyeing process as described herein by immersion into a dye bath or by a continuous dyeing process.

[0064] In some embodiments, the carpet may be a loop pile carpet. In other embodiments, the carpet may be a cut pile carpet. In yet other embodiments, the carpet may comprise both cut piles and loop piles.

[0065] In some embodiments, the surface weight of the carpet may vary between 25 and 60 ounces per square yard. The height of the pile of the carpet may be between 6/32 inches and 2.5 inches, for example between 1/4 to 1/2 inches or between 1/2 to ¾ inches. The thickness of the carpet may be between 12/32 of an inch and 1 inch. The number of tufts or pile units per surface unit may be between 250,000 and 25,000 per square meter. The number of piles or tufts in the production direct per inch may be in the range of 6 to 13. The distance between two adjacent tufts (or gauge) may range from 3/16 of an inch to 1/10 of an inch.

[0066] A number of embodiments of the disclosure have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the invention. Accordingly, other embodiments are within the scope of the following claims.

EXAMPLES

[0067] By way of non-limiting illustration, examples of certain embodiments of the present disclosure are given below.

Example 1 - Combination Yarn I

[0068] A first example of a combination yarn according to the present disclosure was provided by plying a first single yarn and a second single yarn, the first single yarn being a polyethylene terephthalate (PET) single yarn comprising 8% of BASF 3S ester modifier and the second single yarn being a polytrimethylene terephthalate (PTT) single yarn.

[0069] The first single yarn was a bulk continuous filament yarn formed from 150 PET filaments. Each filament has a denier of 10.4 and has a trilobal cross section, providing a single yarn with 1560 denier. The PET used includes 92 wt. % PET and 8% BASF 3S Modifier.

[0070] The second single yarn was a bulk continuous filament yarn formed from 123 PTT filaments. Each filament has a denier of 10.4 and a trilobal cross section, providing a single yarn with 1279 denier.

[0071] The two single yarns were plied with 4.25 turns per inch in the S-direction, providing a two-ply combination yarn. The two-ply yarn was heat set using a Superba textured heat set tunnel.

[0072] A solid dyeable two-ply combination yarn was provided by the above process with little to no tonal aspect visible to the naked eye upon dyeing. This yarn was used to create a solid color fabric that shows better performance than 100% PET fabrics made of the same construction.

Claims

1. A combination yarn comprising a first single yarn and a second single yarn,
   wherein the first single yarn and the second single yarn are linked to each other,
   wherein the first single yarn comprises at least 60% polyethylene terephthalate (PET),
   wherein the second single yarn comprises at least 60% polytrimethylene terephthalate (PTT), and
   wherein at least one of the first single yarn and the second single yarn includes one or more additives that increase dye uptake such that the color strength of the at least one of the first single yarn and the second single yarn is increased when compared to the same first single yarn and/or the same second single yarn which does not include the one or more additives.

2. The combination yarn of claim 1, wherein the one or more additives includes polybutylene terephthalate (PBT), at least one ester modifier, or combinations thereof.

3. The combination yarn of any one of claims 1-2, wherein the one or more additives includes polybutylene terephthalate (PBT).

4. The combination yarn of any one of claims 1-3, wherein the one or more additives includes at least one ester modifier.

5. The combination yarn of claim 4, wherein the ester modifier comprises

   • a copolymer formed by polymerization of a mixture comprising terephthalic acid or esters thereof, at least one dicarboxylic acid monomer, and at least one diol monomer; or
   • a copolymer formed by polymerization of a mixture comprising terephthalic acid or esters thereof, at least one diol monomer, and at least one polyalkylene glycol.

6. The combination yarn of claim 4, wherein the ester modifier is selected from the group consisting of ortho-phthalic acid, isophthalic acid, or esters thereof.

7. The combination yarn of any one of claims 1-6, wherein the first single yarn comprises at least 75% PET.

8. The combination yarn of any one of claims 1-7, wherein the second single yarn comprises at least 75% PTT.

9. The combination yarn of any one of claims 1-8, wherein the first single yarn and/or the second single yarn is a bulked continuous filament yarn.

10. The combination yarn of any one of claims 1-9, wherein the first single yarn and the second single yarn are plied to each other.

11. The combination yarn of any one of claims 1-10, wherein the weight ratio of PET to PTT in the combination yarn is 1:1 to 1:4.

12. The use of the combination yarn of any one of claims 1-11 in the manufacture of a carpet, preferably a tufted carpet.

13. A tufted carpet comprising a pile yarn providing the pile of the carpet, the pile yarn being a combination yarn of any one of claims 1-12.

14. A combination yarn comprising a first single yarn and a second single yarn,

    wherein the first single yarn and the second single yarn are linked to each other,
    wherein the first single yarn comprises at least 75% PET and an additive that includes at least one ester modifier,
    wherein the second single yarn comprises at least 75% PTT and does not include any additives that increase dye uptake, and
    wherein the color strength of the first single yarn is within 10% of the color strength of the second single yarn when both yarns are subject to the same dyeing conditions.

15. A combination yarn comprising a first single yarn and a second single yarn,

    wherein the first single yarn and the second single yarn are linked to each other,
    wherein the first single yarn comprising at least 75% PET and does not include any additives that increase dye uptake,

wherein the second single yarn comprises at least 75% PTT and an additive that includes PBT and at least one ester modifier, and
wherein the color strength of the second single yarn is at least 20% greater than the color strength of the first single yarn when both yarns are subject to the same dyeing conditions.

16. A combination yarn comprising a first single yarn and a second single yarn,
wherein the first single yarn and the second single yarn are linked to each other,
wherein the first single yarn comprises at least 75% PET,
wherein the second single yarn comprises at least 95% PTT,
wherein both the first single yarn and the second single yarn further comprise an additive that includes PBT, at least one ester modifier, or combinations thereof, and
wherein the color strength of the second single yarn is at least 20% greater than the color strength of the first single yarn when both yarns are subject to the same dyeing conditions.

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EUROPEAN SEARCH REPORT

Application Number
EP 20 15 4782

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