(54) Titre : PROCESSUS POUR TEINdRE ET TRAITER UN FIL EN BCF
(54) Title: PROCESSES TO DYE AND TREAT BCF YARN

(57) Abrégé/Abstract:
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(57) Abrégé(suite)/Abstract(continued):
blocker and anti-soil compositions on BCF yarns prior to heat setting. The processes forego the need to dye and otherwise treat carpets and other textiles made from the BCF yarn using current methods. Also disclosed are systems, BCF yarns, and carpets made from the BCF yarn treated by the disclosed process.
Abstract

Disclosed are processes for applying dyes, stain blocker and anti-soil compositions on BCF yarns during cable or air twisting processes, or heat setting processes, prior to weaving, knitting or tufting. Further discloses are process for applying dyes, stain blocker and anti-soil compositions on BCF yarns prior to heat setting. The processes forego the need to dye and otherwise treat carpets and other textiles made from the BCF yarn using current methods. Also disclosed are systems, BCF yarns, and carpets made from the BCF yarn treated by the disclosed process.
PROCESSES TO DYE AND TREAT BCF YARN

FIELD OF THE INVENTION

[0001] The invention relates to treatment processes for bulk continuous filament (BCF) carpet and related textile fabrics, and specifically, to processes for applying dyes and topical treatment compositions on BCF yarns during twisting processes (cable or air) or heatsetting process prior to weaving, knitting or tufting. The process foregoes the need to dye and otherwise treat carpets and other textiles made from the BCF yarn using current methods. Thus, low inventory overhead is achieved and costly and environmentally unfavorable dyeing and low pH chemical treatment processes are eliminated. Also disclosed herein are systems used to apply the dye and performance enhancement formulations to the BCF yarn, and stain/soil repellent yarns, and carpets with improved anti-stain and anti-soil properties made from the BCF yarn of the disclosed process.

BACKGROUND OF THE TECHNOLOGY

[0002] Carpets and other fabrics made from synthetic yarns are currently colored using two well-established processes. The first process involves converting colorless white yarns into carpet, and dyeing the carpet in a dye bath. This process is referred to as the “acid dye process.” The acid dye process can be either a batch or a continuous dyeing operation. Each dyeing operation requires a large volume of water, steam to set the dyes, and heat to dry the carpet. In addition, collection and disposal of excess dye and acidified performance enhancing solutions add manufacturing cost and place additional burden on waste management and water treatment facilities. The
second process adds color pigments into the polymer during the melt spinning process. This process is referred to as the "solution dye process." The solution dye process is a low cost operation, but in comparison to the acid dye process it imposes undesirable inventory allocation measures on the fiber producer and the carpet mill. In order to meet consumer demand, then, the fiber producer and carpet mill may need to keep a costly inventory of colored yarns produced by the solution dye process. Variable production demands and large inventory costs can affect inventory flexibility with the result being the color availability of solution dyed carpets is undesirably limited.

[0003] Topical chemistries are used to treat carpets and other fabrics for improved stain resistance and/or soil resistance. For nylon carpets, both stain blocker (e.g. acid dye blocker) and anti-soil with fluorochemicals are traditionally used. For polyester carpets, such as 2GT and 3GT carpets, and polypropylene carpets, anti-soil chemistry may be applied topically to the tufted carpet as part of the carpet finishing process. Polyester and polypropylene carpets typically do not require a stain blocker treatment because of inherent stain resistance to acid dyes and stains owing to their lack of amine end groups that function as acid dye sites.

[0004] Topical application at the carpet mill can be in the form of exhaust application and spray application. Exhaust application (i.e. flex-nip process at high (300 – 400 wt.%) wet pick-up), is known to provide an improvement in efficacy over spray-on applications at 10-20 wt.% wet pick-up of anti-soil. Exhaust applications typically use greater amounts of water and energy to dry and cure the carpet than do spray applications. Spray-on fluorochemical products are designed to use less water and energy than exhaust applications, but do not impart satisfactory anti-soil properties.
While various processes are in use in the carpet industry for the dyeing and finishing of carpets, some large scale and some small, most of the carpet made today is dyed and finished on a continuous dye range. This is done mainly in one of two ways: In one case, a two stage process is employed, where the carpet is steamed and dyed first, steamed, rinsed, and excess water extracted; then stain blocker (SB) is applied, the carpet is again steamed and washed, and then anti-soil fluorochemical (FC) is applied in the form of a foam or liquid spray and the carpet is finally dried. (See e.g. U.S. Patent Nos. 5,853,814; 5,948,480 and WO2000/000691). In the second, somewhat improved case, called the co-application process, the carpet is also steamed and dyed first, steamed again, rinsed and extracted; and then a blend of SB and FC is applied together at high wet pick up, after which the carpet and chemicals are exposed once again to steam to fix the treatment, followed by drying. (See e.g. U.S. Patent Nos. 6,197,378 and 5,520,962). In both cases, low pH solutions, excess water, and energy are required for the SB and FC to penetrate the carpet and achieve uniform coverage. In sum, the typical prior art process is as follows: BCF yarn →Twist → heat set → tufting → carpet → dye → stain block / anti-soil.

SUMMARY OF THE INVENTION

There is a desire to reduce the overall usage of dyeing solutions and stain blocker formulations for environmental and cost reasons. Further, there is also a desire to reduce the amount of water and low pH chemicals used to apply the dyeing and anti-stain formulations. Thus, processes which provide for low inventory needs while applying such beneficial compositions using less water, nominal pH chemicals, and less energy are in demand.
While the development of a process that eliminates the current carpet treatment systems for applying anti-stain and anti-soil compositions is desirable, current processes do exist for good reasons. First, because the appearance of carpet has historically depended on the ability to dye wool or nylon or even polyester tufted carpets to the desired shade, it would not be permissible to treat the carpet with compositions such as anti-stain or anti-soil chemistries beforehand that might interfere with the process of uniform dyeing. Further, the dyeing process would tend to remove the topical treatment chemistries, rendering them ineffective.

Second, as mentioned above, treatment of yarn or fabric with performance enhancement formulations for stain and soil resistance typically involves fixing with steam, and low pH may also be required especially for acid dyed fabrics. Therefore, it was deemed most practical to process carpets in the order described above, where carpet is formed, then steamed and dyed, steamed again, rinsed and extracted; and then SB and FC is applied, again involving steaming and/or rinsing in the various processes of the prior art.

Carpets have also long been constructed of dyed or pigmented yarns, which constructions are treated in numerous possible ways, including the options of further dyeing, and the application of stain and/or soil resistant compositions with the concomitant use of steam and rinse water, as in the processes described above.

The invention disclosed herein provides a process to make textile fabrics, especially tufted articles, without the requirements for dyeing and subsequent stain and soil resistant chemistry application, thus avoiding the costs associated with maintaining large inventories as well as waste generated by steam fixation and rinsing attendant
with such large-scale fabric applications. As disclosed herein, the process involves
application of dyes and topical chemistries to undyed yarns immediately after twisting or
cabling one or more such yarns together. The chemistries are then heat-set onto the
twisted yarn under dry conditions, and the twisted yarn subsequently weaved or tufted
into a finished fabric or carpet. Novel systems that enable the efficient application of
dye solutions and topical chemistries to yarn subsequent to twisting and prior to winding
and heat-setting are also disclosed.

[00011] Specifically, the disclosed process uses a dye solution or topical chemistry
composition applicator positioned within a mechanical twisting process downstream of
the twisted yarn take-up reel and upstream of the yarn winder. In sum, the disclosed
process moves the back end, large scale and wasteful stain blocker application step up
front during or after yarn twisting. Thus, the carpet manufacturing process now
becomes: BCF yarn → twist → dye → optional SB/FC → heat set (optionally dry heat
set) → tufting → carpet. Surprisingly, the disclosed process is as effective, or even
more effective, than processes of the prior art in terms of fabric soil resistance.
Additionally, neutral pH dye solutions (4-7.5 pH) can be used instead of the prior art low
pH dye solutions (1-3 pH). This reduces the environmental impact of prior art
processes.

[00012] As described above, the process of the disclosed invention is
counterintuitive since treating the carpet yarn prior to heat setting and tufting is known to
affect the quality of the finished carpet, particularly during dyeing. Further, the inventive
process is also counter intuitive because soil resistant compositions tend to be very
difficult to apply uniformly to twisted yarn bundles at the usual line speed without
substantial waste [30 to 80 yards-per-minute (ypm)]. Moreover, the disclosed process is counter intuitive because the prior art yarn twisting apparatuses have not previously accepted topical chemistry applications to twisted yarn prior to winding. However, as shown below, nylon and polyester carpets manufactured with the treated BCF yarn show one or more of the following desirable characteristics:

- At least equivalent dyeing characteristics vs. the current state of the art processes.
- At least equivalent stain and soil repellant performance vs. the current state of the art processes.
- Desirable aesthetic attributes otherwise not generated by the current state of the art processes.

[00013] In one aspect, a process for treating twisted BCF yarn with one or more dye compositions is disclosed. The process comprises: (a) providing twisted BCF yarn; (b) winding said BCF yarn on a take-up reel; and (c) contacting said BCF yarn with said dye composition while said BCF yarn is in motion and prior to said BCF yarn contacting and winding up on said take-up reel. The dye composition can be comprised of an acid dye composition or a disperse dye composition.

[00014] In another aspect, a process for treating twisted BCF yarn with one or more dye compositions is disclosed. The process comprises: (a) providing twisted BCF yarn; (b) contacting said BCF yarn with said dye composition while said BCF yarn is in motion; and (c) heat setting said BCF yarn after contacting said BCF yarn with said dye
composition. The dye composition can be comprised of an acid dye composition or a disperse dye composition.

[00015] In a further aspect, a process for treating twisted BCF yarn with one or more dye compositions and performance enhancing compositions is disclosed. The process comprises: (a) providing twisted BCF yarn; (b) winding said BCF yarn on a take-up reel; (c) contacting said BCF yarn with said dye composition; (d) optionally contacting said BCF yarn with a first performance enhancing composition comprising a stain blocking composition; and (e) contacting said BCF yarn with a second performance enhancing composition comprising an anti-soil composition and prior to said BCF yarn contacting and winding up on said take-up reel, wherein said BCF yarn is in motion while contacted with said dye, said optional first performance enhancing composition, and said second performance enhancing composition. The dye composition can be comprised of an acid dye composition or a disperse dye composition. The stain blocking composition can be comprised of species having acidic moieties that associate with polymer amine end groups and protect them from staining by acidic dye stains. The general category of chemicals suitable to the process of the instant invention can comprise any chemical that blocks positively charged dye sites. The anti-soil composition can be comprised of a high specific surface energy chemical or other material, for example a fluorochemical that imparts high specific surface energy properties such as high contact angles for water and oil, or even a non-fluorochemical particulate material having similar properties. The anti-soil composition can further comprise an anti-stain component.
[00016] In even another aspect, a process for treating twisted BCF yarn with one or more dye compositions and performance enhancing compositions is disclosed. The process comprises: (a) providing twisted BCF yarn; (b) contacting said BCF yarn with said dye composition; (c) optionally contacting said BCF yarn with a first performance enhancing composition comprising a stain blocking composition; (d) contacting said BCF yarn with a second performance enhancing composition comprising an anti-soil composition, wherein said BCF yarn is in motion while contacted with said dye, said optional first performance enhancing composition, and said second performance enhancing composition and; (e) heat setting said BCF yarn after contacting said BCF yarn with said dye composition, said optional first performance enhancing composition, and said second performance enhancing composition. The dye compositions and performance enhancing compositions are disclosed above.

[00017] In a further aspect, an untufted, twisted BCF yarn comprising a dye component is disclosed, wherein said dye component is present on said twisted BCF yarn prior to tufting the BCF yarn. The dye component is selected from acid and disperse dye ingredients. The yarn can comprise polyamide fiber and/or have polymer components selected from polyester. The yarn can be tufted and manufactured into carpet or fabrics.

[00018] In yet another aspect, an untufted, twisted BCF yarn comprising a dye component, an anti-soil component, and an optional anti-stain component is disclosed, wherein said dyeing component, anti-soil component and optional anti-stain component are present on said twisted BCF yarn prior to tufting the BCF yarn. The dye component is selected from acid and disperse dye ingredients. The anti-soil component and
optional anti-stain component can be selected from the compositions disclosed above. The stain blocking component is optionally present at an amount on weight of fiber of about 0.5 to about 40 ppm elemental sulfur content. The anti-soil component is present at an amount on weight of fiber from about 100 ppm to about 1000 ppm elemental fluorine content. The yarn can comprise polyamide fiber and/or have polymer components selected from polyester. The yarn can be tufted and manufactured into carpet or fabrics.

[00019] In yet a further aspect, a process for manufacturing carpet is disclosed comprising providing an untufted, twisted BCF yarn comprising a dye component, an optional stain blocker component, and an anti-soil component, tufting said BCF yarn, and weaving into said carpet. Because of the dye and performance enhancing components present on the BCF yarn prior to tufting and weaving, there is no need to process the finished carpet by dyeing or treating with an acidified stain blocker composition and an anti-soil composition under the current state of the art processes.

[00020] In yet even another aspect, a system for applying a dye composition to twisted BCF fiber is disclosed. The system comprises: (a) a first yarn take-up device that transmits a single yarn member made from at least two individual yarn members; (b) a dye composition applicator disposed downstream of said yarn take-up device that applies said dye composition to said single yarn member; and (c) a second yarn take-up device that receives a dyed single yarn member. The dyeing composition can be comprised of acid dye or disperse dye ingredients.

[00021] In yet even a further aspect, a system for applying a dye composition and at least one performance enhancing composition to twisted BCF fiber is disclosed. The
system comprises: (a) a first yarn take-up device that transmits a single yarn member made from at least two individual yarn members; (b) a dye composition applicator disposed downstream of said yarn take-up device that applies said dye composition to said single yarn member; (c) an optional anti-stain component applicator disposed downstream of said dye composition applicator that applies anti-stain composition to said single yarn member; (d) an anti-soil applicator disposed downstream of said dye composition applicator that applies anti-soil composition to said single yarn member; and (e) a second yarn take-up device that receives a dyed single yarn member. The dyeing composition can be comprised of acid dye or disperse dye ingredients. The anti-stain composition can be comprised of species having acidic moieties which associate with polymer amine end groups and protect them from staining by acidic dye stains. The anti-soil composition can be comprised of a high specific surface energy chemical or other material, for example a fluorochemical that imparts high specific surface energy properties such as high contact angles for water and oil, or even a non-fluorochemical particulate material having similar properties. The anti-soil composition can further comprise an anti-stain component.

**BRIEF DESCRIPTION OF THE FIGURES**

[00022] Figure 1 shows the current cable twisting process.

[00023] Figure 2 shows one aspect of the disclosed process.

[00024] Figure 3 shows another aspect of the disclosed process.

[00025] Figure 4 shows the current heat setting process.

[00026] Figure 5 shows a further aspect of the disclosed process.
DEFINITIONS

[00027] While mostly familiar to those versed in the art, the following definitions are provided in the interest of clarity.

[00028] OWF (On weight of fiber): The amount of chemistry that was applied as a % of weight of fiber.

[00029] WPU (Wet pick-up): The amount of water and solvent that was applied on carpet before drying off the carpet, expressed as a % of weight of fiber.

DETAILED DESCRIPTION OF THE INVENTION

[00030] A process for treating twisted BCF yarn is disclosed comprising contacting the BCF yarn with a dye composition while said yarn is in motion and prior to contacting and winding the yarn onto a take-up reel or winder to create a yarn package or cake. The process can also include contacting the BCF yarn with one or more performance enhancing compositions comprising stain blockers and anti-soil compositions. The dye composition comprises a dye component and is adapted to be continuously applied onto twisted BCF yarn at 10 to 100 ypm, preferably, 30 to 80 ypm. The stain blocker composition comprises an anti-stain component and is adapted to be continuously applied onto twisted BCF yarn at a wet pick-up of 10 to 50%, preferably 15 to 30%. The anti-soil composition comprises an anti-soil component and is adapted to be continuously applied onto twisted BCF yarn at a wet pick-up of between about 5 wt.% and about 50 wt.%, including between about 10 wt.% and about 30 wt%, about 20
wt.% to about 30 wt.%, and about 10 wt.% to about 20 wt.. The twisted BCF yarn can
be optionally heat set after contacting the yarn with the dye composition and the one or
more performance enhancing compositions. Heat setting temperatures can range from
about 125°C to about 200°C, including from about 160°C to about 195°C. Heat setting
dwell times can range from about 0.5 to about 4 minutes, including from about 0.5 to
about 3 minute and from about 0.5 to about 1 minute.

[00031] Dye components for use in the disclosed dye compositions are acid dyes
or disperse dyes. Acid dye components are well known to those skilled in the art and
are water-soluble ionic species containing one or more organic chromophore moieties.
Acid dyes are typically provided in powder form and different acid dyes can be used in
combinations to arrive at a precisely defined color choice depending on process
conditions such as the use rate of each selected dye component, the use rate of the
one or more acid auxiliaries employed, and the residence time of the substrate in the
dyeing zone. Examples of suitable acid dye compositions are Orange 3G, Red 2B and
Blue 4R. Disperse dye components are likewise well known to those skilled in the art
and are water-insoluble nonionic species containing one or more organic chromophore
moieties. Disperse dyes are either provided in paste form in combination with a
dispersing agent or in powder form. Different disperse dyes can be used in
combinations to arrive at a precisely defined color choice depending on process
conditions such as the use rate of each selected disperse dye component, the specific
dispersing agent or agents employed, and the residence time of the substrate in the
dyeing zone. Examples of suitable disperse dye compositions are Disperse Red 60,
Disperse Yellow 86 and Disperse Violet 33.
[00032] Anti-stain components for use in the disclosed stain blocker compositions have a component bearing an acidic moiety which associates with polymer amine end groups and protects them from staining by acidic dye stains. The general category of chemicals suitable to the process of the instant invention can comprise any chemical that blocks positively charged dye sites. Stain blockers are available in various forms such as syntans, sulfonated novolacs, sulfonated aromatic aldehyde condensation products (SACs) and/or reaction products of formaldehyde, phenolics, substituted phenolics, thiophenolics, sulfones, substituted sulfones, polymers or copolymers of olefins, branched olefins, cyclic olefins, sulfonated olefins, acrylates, methacrylates, maleic anhydride, and organosulfonic acids. They are usually made by reacting formaldehyde, phenol, polymethacrylic acid, maleic anhydride, and sulfonic acid depending on specific chemistry. Further, the stain blocker is typically water soluble and generally penetrates the fiber while the anti-soil, usually a fluorochemical, is a non-water soluble dispersion that coats the surface of fiber.

[00033] Examples of stain blockers include, but are not limited to: phenol formaldehyde polymers or copolymers such as CEASESTAIN and STAINAWAY (from American Emulsions Company, Inc., Dalton, Ga.), MESITOL (from Bayer Corporation, Rock Hill, N.C.), ERIONAL (from Ciba Corporation, Greensboro, N.C.), INTRATEX (from Crompton & Knowles Colors, Inc., Charlotte, N.C.), STAINKLEER (from Dyetech, Inc., Dalton, Ga.), LANOSTAIN (from Lenmar Chemical Corporation, Dalton, Ga.), and SR-300, SR-400, and SR-500 (from E. I. du Pont de Nemours and Company, Wilmington, Del.); polymers of methacrylic acid such as the SCOTCHGARD FX series carpet protectors (from 3M Company, St. Paul Minn.); sulfonated fatty acids from
Rockland React-Rite, Inc., Rockmart, Ga); and stain resist chemistries from ArrowStar LLC, Dalton and Tri-Tex, Canada.

[00034] Anti-soil components for use in the disclosed anti-soil compositions impart high specific surface energy properties such as high contact angles for water and oil (e.g. water and oil "beads up" on surfaces treated by it). The anti-soil component can comprise a fluorochemical dispersion, which dispersion may be predominantly either cationic or anionic, including those selected from the group consisting of fluorochemical allophanates, fluorochemical polyacrylates, fluorochemical urethanes, fluorochemical carbodiimides, fluorochemical guanidines, non-telomeric fluorochemicals, and fluorochemicals incorporating C2 to C8 chemistries. Alternatively, the fluorochemical can have one or more monomeric repeat units having less than or equal to eight fluorinated carbons, including less than or equal to six fluorinated carbons. Example fluorochemical anti-soil components include: DuPont TLF 10816 and 10894; Daikin TG 2511, and DuPont Capstone® RCP. Non-fluorinated anti-soil components can include: silicones, silsesquioxanes and silane-modified particulates, organosilane-modified particulates and alkylated particulates, anionic non-fluorinated surfactants and anionic hydrotrope non-fluorinated surfactants, including sulfonates, sulfates, phosphates and carboxylates. (See U.S. Patent No. 6,824,854, herein incorporated by reference).

[00035] The dye composition is adapted to contact the twisted BCF yarn while it is in motion and prior to contacting the take-up reel or winder. Further, the dye composition can be at a neutral pH (e.g. 4 to 9, including 5.5 to 7.5) because the yarn can be optionally heat set after application of the composition. The process foregoes the
need for harsh low pH chemicals; deionized water is suitable for use in the disclosed process.

[00036] The stain blocker composition is adapted to contact the twisted BCF yarn while it is in motion and prior to contacting the take-up reel or winder. Further, the stain blocker composition can be at a neutral pH (e.g. 6 to 8) because the yarn can be optionally heat set after application of the composition. The process foregoes the need for harsh low pH chemicals.

[00037] The anti-soil composition is adapted to contact the twisted BCF yarn while it is in motion and prior to contacting the take-up reel or winder. Further, the anti-soil composition can be at a neutral pH (e.g. 6 to 8) because the yarn can be optionally heat set after application of the composition. The process foregoes the need for harsh low pH chemicals.

[00038] The contacting can be performed by any suitable device that applies wet ingredients to a dry substrate, including, but not limited to: applicator pad, nip rollers, wet-wick, dip-tank, sprayer, and mister.

[00039] For example, cotton wicks can be stacked together to form the desired thickness (e.g. $\frac{1}{2}$" – 3") and submersed in the dye bath for transporting dye solution to the moving yarn at a constant flow-rate. The wick thickness selection was based on the optimum wick and yarn contacting time needed to achieve the desired color depth and color consistency. A further option is to use multiple sets of wicking applicator stations. The first wicking applicator station applies the primary color onto the yarn and the second wicking applicator station applies a second color or performance enhancing
chemical onto the yarn. Each wicking applicator station can be made up of one or more wicks.

[00040] Another option is to transport dye solution to the yarn using two rotating rolls covered with wicks. Here, the yarn passes between the two rotating rolls. Further, multiple rolls can be used in series. For example, one roll can apply a first color onto one side of the moving yarn and another roll to apply a second color onto the other side of the yarn to create a unique two color yarn. Further, two sets of nip rolls can be used. The first set can apply the primary color and the second set can apply a second color or performance enhancing chemical onto the yarn. Any combination of the above options can be used to make yarn with multiple colors, color depth and with various performance chemicals.

[00041] The wet pick-up of the anti-soil composition is between about 5 wt.% and about 50 wt.%, including between about 10 wt.% and about 30 wt%, about 20 wt.% to about 30 wt.%, and about 10 wt.% to about 20 wt.%. The resulting twisted BCF yarn, if a fluorine based anti-soil component is used, can have an on weight of fiber from about 100 ppm to about 1000 ppm elemental fluorine, including from about 100 to about 500 ppm elemental fluorine, from about 200 to about 400 ppm, and from about 100 ppm to about 300 ppm elemental fluorine.

[00042] The wet pick-up of the stain blocker composition is present on weight of fiber from about 500 ppm to about 4%, including from about 1000 ppm to about 3%, from about 0.5% to about 2%, and from about 0.5% to about 1%. Common stain blockers use sulfonated moieties as part of the chemistry, which results in the presence of sulfur on the treated fiber. The sulfur content can range from about 50 ppm with 5%
stain blocker to about 1 ppm with 0.1% stain blocker on weight of fiber. Thus, based on
the above stain blocker concentrations, the sulfur content on weight of fiber will range
from about 0.5 ppm to about 40 ppm, including from about 1 ppm to about 30 ppm, from
about 5 ppm to about 20 ppm, and from about 5 ppm to about 10 ppm. Sulfur content
can be determined by x-ray diffraction or other methods.

[00043] The performance enhancing compositions can further comprise one or
more components selected from the group consisting of: odor control agents, anti-
microbial agents, anti-fungal agents, fragrance agents, bleach resist agents, softeners,
and UV stabilizers.

[00044] The twisted BCF yarn can be made from polyamide fibers, such as those
made from nylon 6,6, nylon 6, nylon 4,6, nylon 6,10, nylon 10,10, nylon 12, its
copolymers, and blends thereof. Further, the twisted BCF yarn can also have additional
polymer components, such as polyester. The additional polymer components can be
incorporated with the polyamide (by melt-blend or co-polymerization) prior to making a
polyamide fiber (e.g. a polyamide/polyester fiber), or can be stand-alone fibers that are
twisted with the polyamide fibers to make the twisted BCF yarn.

[00045] As stated above, the BCF yarn can be manufactured with polyamide and /
or polyester polymer components. An unexpected benefit of the disclosed process has
been discovered in that, whereas a small amount of anti-soil composition is applied
compared to known exhaust processes, a high anti-soil component content, such as
fluorine, is achieved on the surface of the yarn. Further, the anti-soil composition
applied in the process of the disclosed invention can be either fluorochemical or non-
fluorochemical based, or a mixture of fluorochemical or fluoropolymer material with non-fluorinated soil resistant materials.

[00046] The disclosed process may be used with yarns that do not require subsequent dyeing or performance enhancing chemical treatments, having been dyed and optionally treated with one or more performance enhancing compositions prior to twisting. The yarns can be made by acid dyed as well as disperse dyed fibers. Yarns suitable for use in the process may further comprise inherent stain resistance, whether by base composition as in the case of polyester, or by the inclusion of strong acid functionality in the polymer composition of the yarn, as in the case of nylon. Use of a dye applicator with the disclosed process eliminates the need for subsequent dyeing and enables the creation of colored carpets that improve inventory flexibility, improve color options, are stain resistant, and are soil resistant without the need for dyeing and performance enhancing chemical applications as practiced under the current state of the art.

[00047] The twisted BCF yarn made with the various aspects of the disclosed process, by itself or blended with non-treated fibers and yarns, can be tufted and manufactured into carpets or fabrics.

[00048] The disclosed process can also be advantageously applied in certain processes where a styling advantage might be derived from differential dyeing and finishing after carpet formation. For example, a soil resistant or stain resistant twisted yarn of the disclosed invention could optionally be tufted into a carpet among untreated yarns prior to dyeing, thus creating an aesthetic alternative.
Alternatively, the disclosed process can be modified to include dye application, optional anti-stain application and/or anti-soil application after the twisted BCF yarn is wound and prior to heat setting. For example, the twisted BCF yarn is unwound from a core or package, contacts the dye applicator, contacts the optional anti-stain applicator, and contacts the anti-soil applicator, then goes through a heat setting process to lock in the yarn twist, dye, anti-soil, and optional anti-stain.

Further disclosed is a system for applying a dye composition and one or more performance enhancing compositions to the twisted BCF yarn. The system includes: (a) a first yarn take-up device that transmits a single yarn member made from at least two individual yarn members; (b) a dye composition applicator disposed downstream of said yarn take-up device that applies said dye composition to said single yarn member; (c) an optional anti-stain blocker applicator disposed downstream of said dye composition applicator that applies anti-stain composition to said single yarn member; (d) an anti-soil applicator disposed downstream of said dye composition applicator that applies anti-soil composition to said single yarn member; and (e) a second yarn take-up device that receives a dyed single yarn member. The first yarn take-up device can be a take-up roll or reel that can twist the at least two individual yarn members into a single yarn member. Alternatively, the first yarn take-up device can receive BCF yarn that has been air twisted. The individual yarn members can be single filaments or fibers, or yarns made from a plurality of filaments or fibers. Each applicator can be any suitable device that applies wet ingredients to a dry substrate, including, but not limited to: applicator pad, nip rollers, wet-wick, dip-tank, sprayer, and mister. The wet pick-up of composition is between about 5 wt.% and about 50 wt.%, including
between about 10 wt.% and about 30 wt%, about 20 wt.% to about 30 wt%, and about 10 wt.% to about 20 wt%. The resulting twisted BCF yarn, if a stain blocker is used, is present on weight of fiber from about 500 ppm to about 4%, including from about 1000 ppm to about 3%, from about 0.5% to about 2%, and from about 0.5% to about 1%. The resulting twisted BCF yarn, if a fluorine based anti-soil component is used, can have an on weight of fiber from about 100 ppm to about 1000 ppm elemental fluorine, including from about 100 to about 500 ppm elemental fluorine, from about 200 to about 400 ppm, and from about 100 ppm to about 300 ppm elemental fluorine. The second yarn take-up device can be a winder.

[00051] Figure 1 shows the current cable twisting process. Here, creel yarn 10 and bucket yarn 15, which is fed at a spindle speed of 7000 rpm, pass through an anti-balloon device 20 and onto a take-up roll 25. From here, the twisted yarn is wound up on a winder 30. Figure 2 shows one aspect of the disclosed process. Here, creel yarn 110 and bucket yarn 115, which is fed at a spindle speed of 7000 rpm, pass through anti-balloon device 120 and onto a take-up roll 125. A dye applicator 140 is disposed downstream of take-up roll 125, which applies a dye component to the twisted yarn. From here, the twisted and dyed yarn is wound up on a winder 130. Figure 3 shows another aspect of the disclosed process containing both a dye applicator and anti-stain / anti-soil applicator. Here, creel yarn 310 and bucket yarn 315, which is fed at a spindle speed of 7000 rpm, pass through anti-balloon device 320 and onto a take-up roll 325. A dye applicator 340 is disposed downstream of take-up roll 325, which applies a dye component to the twisted yarn. An anti-soil / anti-stain applicator 350 is disposed downstream of the dye applicator 340, which applies an anti-soil / anti-stain component
to the dyed, twisted yarn. From here, the twisted and treated yarn is wound up on a winder 330.

[00052] Figure 4 shows the current heat setting process. Here, cable twisted BCF yarn 410 enters a false twisting unit 420, followed by a coiler or stuffer box 430, prebulker 440, and finally a heatset chamber 450 to produce a heatset yarn 455. Figure 5 shows another aspect of the disclosed process where cable twisted BCF yarn is dyed prior to heat setting. Here, cable twisted BCF yarn 510 enters the dye applicator 515, followed by a false twisting unit 520, a coiler or stuffer box 530, prebulker 540, and finally a heatset chamber 550 to produce a dyed, heatset yarn 555.

[00053] The disclosed process is counterintuitive and surprisingly results in yarn that contains acceptable dyed and performance enhancement properties when manufactured into a carpet or fabric. One would expect that rearranging the process as described above would fowl up down-stream carpet manufacturing processes and lead to poor quality carpet. Thus, the results reported below are surprising and unexpected.

EXAMPLES

[00054] The following are examples of carpets made from BCF fibers that have been treated according to various aspects of the process disclosed above, and similar fibers with no treatment. Selection of alternative dyeing and performance enhancing components, fibers and textiles having different surface chemistries will necessitate minor adjustments to the variables herein described.
**Test Methods**

**Acid Dye Stain Test.**

[00055] Acid dye stain resistance is evaluated using a procedure modified from the American Association of Textile Chemists and Colorists (AATCC) Method 175-2003, "Stain Resistance: Pile Floor Coverings." 9 wt % of aqueous staining solution is prepared, according to the manufacturer's directions, by mixing cherry-flavored KOOL-AID® powder (Kraft/General Foods, White Plains, N.Y., a powdered drink mix containing, *inter alia*, FD&C Red No. 40). A carpet sample (4x6-inch) is placed on a flat non-absorbent surface. A hollow plastic 2-inch (5.1cm) diameter cup is placed tightly over the carpet sample. Twenty ml of the KOOL-AID® staining solution is poured into the cup and the solution is allowed to absorb completely into the carpet sample. The cup is removed and the stained carpet sample is allowed to sit undisturbed for 24 hours. Following incubation, the stained sample is rinsed thoroughly under cold tap water, excess water is removed by centrifugation, and the sample is dried in air. The carpet sample was visually inspected and rated for staining according to the FD&C Red No. 40 Stain Scale described in AATCC Method 175-2003. Stain resistance is measured using a 1-10 scale. An undetectable test staining is accorded a value of 10.

**Example 1 (Comparative)**

[00056] Two 920 denier, 8 dpf, colorless nylon 6,6 BCF yarns were processed on a Volkman twisting machine as described in figure 1 to form a 5.75 tpi (twist per inch) 2-ply cable twisted yarn. The twisting speed was about 7000 rpm (turns per minute) and winding speed was about 50 meter per minute. The cable twisted yarn had no color. The cable twisted yarn was heatset on Superba, and converted into cut pile carpet on a
1/8 ga tufting machine to 22/32 inch pile height, 35 oz/sq yard carpet and dyed on a continuous dye line to get medium pie crust color. This example was made using the state of art carpet making process with continuous dyer to add color to carpet.

**Example 2 (Inventive)**

[00057] Two 920 denier, 8 dpf, colorless nylon 6,6 BCF yarns were processed on a Volkman twisting machine as described in figure 2 to form a 5.75 tpi (twist per inch) 2-ply cable twisted yarn. A wicking dye applicator was inserted between take up roll and winder. A ½ inch wide, 1 inch thick cotton wick (Wet Wick by Perperell MA) was used to apply a mixture of acid dyes (Blue 4R @ 5.0 g/l & Orange 3G @ 2.0 g/l in deionized water, pH 9.47) onto the cable twisted yarn. The twisting speed was about 7000 rpm (turns per minute) and winding speed was about 50 meter per minute. The cable twisted yarn was heatset on Superba at 265°F, and tufted into cut pile carpet on a 1/8 ga tufting machine to 22/32 inch pile height, 35 oz/sq yard carpet. The tufted carpet had medium shade green color (L 51.26, a -9.71, b +1.45 by Minolta).

**Example 3 (Inventive)**

[00058] Two 920 denier, 8 dpf, colorless nylon 6,6 BCF yarns were processed on a Volkman twisting machine as described in figure 2 to form a 5.75 tpi (twist per inch) 2-ply cable twisted yarn. A wicking dye applicator was inserted between take up roll and winder. A ½ inch wide, 1 inch thick cotton wick (Wet Wick by Perperell MA) was used to apply a mixture of acid dyes (Orange 3G @ 5.712 g/l, Red 2B @ 2.52 g/l, Blue 4R @ 2.268 g/l in deionized water, pH 6) onto the cable twisted yarn. The twisting speed was about 7000 rpm (turns per minute) and winding speed was about 50 meter per minute. The cable twisted yarn was heatset on Superba at 265°F, and tufted into cut pile carpet.
on a 1/8 ga tufting machine to 22/32 inch pile height, 35 oz/sq yard carpet. The tufted carpet had light shade brown color (L 39.17, a 10.48, b 18.14 by Minolta). There were numerous dark, medium and light spots randomly distributed over the carpet that created an interesting salt and pepper toner mixture effect.

Example 4 (Inventive)

[00059] Two 920 denier, 8 dpf, colorless nylon 6,6 BCF yarns were processed on a Volkman twisting machine as described in figure 2 to form a 5.75 tpi (twist per inch) 2-ply cable twisted yarn. A wicking dye applicator was inserted between take up roll and winder. A ½ inch wide, 1 inch thick cotton wick (Wet Wick by Perperell MA) was used to apply a mixture of acid dyes (Orange 3G @ 11.424 g/l, Red 2B @ 5.040 g/l, Blue 4R @ 4.536 g/l in deionized water, pH 6.0) onto the cable twisted yarn. The twisting speed was about 7000 rpm (turns per minute) and winding speed was about 50 meter per minute. The cable twisted yarn was heatset on Superba at 265°F, and tufted into cut pile carpet on a 1/8 ga tufting machine to 22/32 inch pile height, 35 oz/sq yard carpet. The tufted carpet had dark brown color (L 23.63, a 12.61, b 15.15). This carpet also had dark and light spots similar to example 3 except the contrast was very subtle, almost invisible.

Example 5 (Inventive)

[00060] Two 901 denier, 3 dpf, colorless nylon 6,6 BCF yarns were processed on Volkman twisting machine as described in figure 1 to form a 4.5 tpi (twist per inch) 2-ply cable twisted yarn. The twisting speed was about 7000 rpm (turns per minute) and winding speed was about 60 meter per minute. The cable twisted yarn had no color.
The cable twisted yarn was heatset on Superba equipped with two wicking dye applicators inserted in tandem between the creel and the false twisting unit. Each dye applicator had one inch wide, 4 inch thick cotton wick (Wet Wick by Perperell MA) that wicked a mixture of acid dyes (Orange 3G @ 14.85 g/l, Red 2B @ 6.55 g/l, Blue 4R @ 5.90 g/l, 15 g/l wetting agent in deionized water) onto the cable twisted yarn at 350 ypm. After color application, the cable twisted yarn was processed through a coiler, a prebulker with steam and heatset in a pressurized chamber with saturated steam at 129.4°C. The dwell time in the pressurized chamber was about 36 seconds. The yarn was cooled with air and wound on tube. The colored yarn was subsequently converted into 5/8 inch pile height, 12 stitches per inch cut pile carpet on a 1/10 gauge tufting machine. The finished carpet had a medium brown color (L 37.9, a 10.7, b 16.9).

**Example 6 (Inventive)**

[00061] Two 901 denier, 3 dpf, colorless nylon 6,6 BCF yarns were processed on Volkman twisting machine as described in figure 1 to form a 4.5 tpi (twist per inch) 2-ply cable twisted yarn. The twisting speed was about 7000 rpm (turns per minute) and winding speed was about 60 meter per minute. The cable twisted yarn had no color.

The cable twisted yarn was heatset on Superba equipped with two wicking dye applicators inserted in tandem between the creel and the false twisting unit. Each dye applicator had one inch wide, 4 inch thick cotton wick (Wet Wick by Perperell MA) that wicked a mixture of green acid dyes (orange 3 G 4 g/l, Blue 4 R 10 g/l, 15 g/l wetting agent in deionized water) onto the cable twisted yarn at 350 ypm. After color application, the cable twisted yarn was processed through a coiler, a prebulker with steam and heatset in a pressurized chamber with saturated steam at 129.4°C. The
dwell time in the pressurized chamber was about 36 seconds. The yarn was cooled with air and wound on tube. The colored yarn was subsequently converted into 5/8 inch pile height, 12 stitches per inch cut pile carpet on a 1/10 gauge tufting machine. The finished carpet had a light green color (L 61.5, a -8.9, b 2.7)

Example 7 (Inventive)

[00062] Two 901 denier, 3 dpf, colorless nylon 6,6 BCF yarns were processed on Volkman twisting machine as described in figure 1 to form a 4.5 tpi (twist per inch) 2-ply cable twisted yarn. The twisting speed was about 7000 rpm (turns per minute) and winding speed was about 60 meter per minute. The cable twisted yarn had no color.

The cable twisted yarn was heatset on Superba equipped with two wicking applicators inserted in tandem between the creel and the false twisting unit. The first wicking applicator was use to apply brown color dyes (Orange 3G @ 14.85 g/l, Red 2B @ 6.55 g/l, Blue 4R @ 5.90 g/l, 15 g/l wetting agent in deionized water, pH 6) and the second applicator was used to apply stain block chemistry (SR-500, 250 g/l, pH 6) onto the cable twisted yarn. The processing speed was about 350 ypm. After color and stain chemical application, the cable twisted yarn was processed through a coller, a prebulker with steam and heatset in a pressurized chamber with saturated steam at 129.4°C. The dwell time in the pressurized chamber was about 36 seconds. The yarn was cooled with air and wound on tube. The colored yarn was subsequently converted into 5/8 inch pile height, 12 stitches per inch cut pile carpet on a 1/10 gauge tufting machine. The finished carpet had a medium brown color and excellent stain resistance (rating 10 on 24 hour Kool-aid test).
Example 8 (Inventive)

[00063] Two 901 denier, 3dpf, colorless nylon 6,6 BCF yarns were processed on a Volkman twisting machine as described in figure 1 to form a 4.5 tpi (twist per inch) 2-ply cable twisted yarn. The twisting speed was about 7000 rpm (turns per minute) and winding speed was about 60 meter per minute. The cable twisted yarn had no color.

The cable twisted yarn was heatset on Superba equipped with two wicking applicators inserted in tandem between the creel and the false twisting unit. The first wicking applicator was used to apply green color acid dyes (orange 3 G 4 g/l, Blue 4 R 10 g/l, 15 g/l wetting agent in deionized water) and the second applicator was used to apply brown color acid dyes (Orange 3G @ 14.85 g/l, Red 2B @ 6.55 g/l, Blue 4R @ 5.90 g/l, 15 g/l wetting agent in deionized water, pH 6) onto the cable twisted yarn. The processing speed was about 350 ypm. After color and stain/soil chemical application, the cable twisted yarn was processed through a coller, a prebulker with steam and heatset in a pressurized chamber with saturated steam at 129.4°C. The dwell time in the pressurized chamber was about 36 seconds. The yarn was cooled with air and wound on tube. The colored yarn was subsequently converted into 5/8 inch pile height, 12 stitches per inch cut pile carpet on a 1/10 gauge tufting machine. The finished carpet had an interesting salt and pepper brown and green color (L 47.5, a -3.5, b 9.4).

Example 9 (Inventive)

[00064] Two 1400 denier, 10 dpf, colorless polyester BCF yarns were processed on a Volkman twisting machine as described in figure 2 to form a 5.25 tpi (twist per inch) 2-ply cable twisted yarn. A wicking dye applicator was inserted between take up roll and winder. A ½ inch wide, 1.25 inch thick cotton wick (Wet Wick by Perperell MA)
was used to apply a mixture of disperse dyes (Dianix yellow E-3GE 21.5 g/l, Red E-FB 15.3 g/l, blue ER-AM 5.6 g/l all by Dystar in deionized water, pH 5.0) onto the cable twisted yarn. The twisting speed was about 7000 rpm (turns per minute) and winding speed was about 60 meter per minute. The cable twisted yarn was heatset on Suessen at 185° C at 375 ypm, ~60 second dwell time, and tufted into cut pile carpet on a 5/32 ga tufting machine to 22/32 inch pile height, 45 oz/sq yard carpet. The tufted carpet had medium brown color (L 47.43, a 15.58, b 15.98).
CLAIMS

What is claimed is:

1. A process for treating twisted BCF yarn with a dye composition comprising:
   a. providing twisted BCF yarn;
   b. winding said BCF yarn on a take-up reel; and
   c. contacting said BCF yarn with said dye composition while said BCF yarn
      is in motion and prior to said BCF yarn contacting and winding up on said take-up reel.

2. The process of claim 1, further comprising heat setting said BCF yarn after
   contacting said BCF yarn with said dye composition.

3. The process of claim 1, wherein said dye composition comprises one or more
   acid dye components.

4. The process of claim 1, wherein said dye composition comprises one or more
   disperse dye components.

5. The process of claim 1, wherein said dye composition comprises at least one
   performance enhancing composition.

6. A process for treating twisted BCF yarn with a dye composition and at least
   one performance enhancing composition comprising:
   a. providing twisted BCF yarn;
   b. winding said BCF yarn on a take-up reel;
   c. contacting said BCF yarn with said dye composition; and
   d. contacting said BCF yarn with a first performance enhancing composition
      prior to said BCF yarn contacting and winding up on said take-up reel, wherein said
BCF yarn is in motion while contacted with said dye composition and said first performance enhancing composition.

7. The process of claim 6, wherein said first performance enhancing composition comprises an anti-soil component.

8. The process of claim 6, wherein said first performance enhancing composition comprises an anti-stain component.

9. The process of claim 6, wherein said first performance enhancing composition comprises both an anti-stain component and an anti-soil component.

10. The process of claim 6 further comprising contacting said BCF yarn with a second performance enhancing composition after contacting with said first performance enhancing composition and prior to said BCF yarn contacting and winding up on said take-up reel.

11. The process of claim 10, wherein said first performance enhancing composition comprises an anti-stain component and said second performance enhancing composition comprises an anti-soil component.

12. The process of one of claims 6-9 further comprising heat setting said BCF yarn after contacting said BCF yarn with said first performance enhancing composition.

13. The process of claim 10 or 11 further comprising heat setting said BCF yarn after contacting said BCF yarn with said second performance enhancing composition.

14. The process of one of claims 8, 9, and 11, wherein said anti-stain component is one or more selected from the group consisting of: syntans, sulfonated novolacs, sulfonated aromatic aldehyde condensation products (SACs) and/or reaction products of formaldehyde, phenolics, substituted phenolics, thiophenolics, sulfones, substituted
sulfones, polymers or copolymers of olefins, branched olefins, cyclic olefins, sulfonated olefins, acrylates, methacrylates, maleic anhydride, and organosulfonic acids.

15. The process of one of claims 7, 9, and 11, wherein said anti-soil component is selected from the group consisting of fluorochemicals, silicones, silsesquioxanes, silane-modified particulates, organosilane-modified particulates, alkylated particulates, anionic non-fluorinated surfactants, and anionic hydrotrope non-fluorinated surfactants.

16. The process of claim 15, wherein said fluorochemical is selected from the group consisting of: fluorochemical allophanates, fluorochemical polyacrylates, fluorochemical urethanes, fluorochemical carbodiimides, fluorochemical guanidines, and fluorochemicals incorporating C2 to C8 chemistries.

17. The process of claim 15, wherein said fluorochemical has one or more monomeric repeat units bearing less than or equal to six perfluorinated carbons.

18. The process of claim 15, wherein said fluorochemical is a fluorochemical urethane.

19. The process of one of claims 8, 9, or 11, wherein said anti-stain component is present at an on weight of fiber from about 500 ppm to about 4%.

20. The process of one of claims 1-11, wherein said dye composition has a pH from about 4 to about 9.0.

21. The process of claim 6, wherein said first performance enhancing composition comprises a component selected from the group consisting of: odor control agents, anti-microbial agents, anti-fungal agents, fragrance agents, bleach resist agents, softeners, and UV stabilizers.
22. The process of claim 6, wherein said first performance enhancing composition comprises a component selected from the group consisting of: dye auxiliaries, sequestrants, pH control agents, and surfactants.

23. The process of one of claims 7, 9, or 11, wherein said anti-soil component is present at an on weight of fiber from about 100 ppm elemental fluorine to about 1000 ppm elemental fluorine.

24. The process of claim 2, wherein said heat setting is performed at a temperature from about 125°C to about 200°C.

25. The process of claim 1 or 6, wherein said BCF yarn comprises polyamide fiber.

26. The process of claim 25, wherein said polyamide fiber is selected from the group consisting of: nylon 6,6, nylon 6, nylon 4,6, nylon 6,10, nylon 10,10, nylon 12, its copolymers, and blends thereof.

27. The process of claim 1 or 6, wherein said BCF yarn comprises polyester fiber.

28. The process of claim 27, wherein said polyester fiber is selected from the group consisting of poly(ethylene terephthalate), poly(propylene terephthalate), poly(butylene terephthalate), copolymers, and blends thereof.

29. The process of claim 1 or 6, wherein said BCF yarn comprises a polyamide component and a polyester component.

30. The process of any of the preceding claims, wherein said contacting is performed by a device selected from the group consisting of: applicator pad, wet-wick, dip-tank, sprayer, and mister.
31. An untufted, twisted BCF yarn comprising a dye component, wherein said dye component is present on said untufted, twisted BCF yarn.

32. The untufted, twisted BCF yarn of claim 31 further comprising an anti-soil component, wherein said anti-soil component is present on said untufted, twisted BCF yarn.

33. The untufted, twisted BCF yarn of claim 31 or 32 further comprising an anti-stain component, wherein said anti-stain component is present on said untufted, twisted BCF yarn.

34. The untufted, twisted BCF yarn of claim 33, wherein said anti-stain component is selected from the group consisting of: syntans, sulfonated novolacs, sulfonated aromatic aldehyde condensation products (SACs) and/or reaction products of formaldehyde, phenol, polymethacrylic acid, maleic anhydride, and sulfonic acid.

35. The untufted, twisted BCF yarn of claim 32, wherein said anti-soil component selected from the group consisting of fluorochemicals, silicones, silsesquioxanes, silalted particulates, alkylated particulates, anionic non-fluoronated surfactants, and anionic hydrotrope non-fluoronated surfactants.

36. The untufted, twisted BCF yarn of claim 35, wherein said fluorochemical is selected from the group consisting of: fluorochemical allophanates, fluorochemical polyacrylates, fluorochemical urethanates, fluorochemical carbodiimides, fluorochemical guanidines, and fluorochemicals incorporating C2 to C8 chemistries.

37. The untufted, twisted BCF yarn of claim 35, wherein said anti-soil component is present at an on weight of fiber from about 100 ppm elemental fluorine to about 1000 ppm elemental fluorine.
38. The untufted, twisted BCF yarn of claim 31, wherein said BCF yarn comprises polyamide fiber.

39. The untufted, twisted BCF yarn of claim 38, wherein said polyamide fiber is selected from the group consisting of: nylon 6,6, nylon 6, nylon 4,6, nylon 6,10, nylon 10,10, nylon 12, its copolymers, and blends thereof.

40. The untufted, twisted BCF yarn of claim 31, wherein said BCF yarn comprises a polyamide component and a polyester component.

41. The untufted, twisted BCF yarn of claim 31, wherein said BCF yarn comprises polyester fiber.

42. The untufted, twisted BCF yarn of claim 41, wherein said polyester fiber is selected from the group consisting of: poly(ethylene terephthalate), poly(propylene terephthalate), poly(butylene terephthalate), copolymers, and blends thereof.

43. A carpet comprising twisted BCF yarn, wherein said twisted BCF yarn comprises the twisted BCF yarn from one of claims 31-42 that has been tufted.

44. The carpet of claim 43 having an AATCC 175-2003 Test rating of at least 7.

45. A process for manufacturing carpet comprising:
   a. providing an untufted, twisted BCF yarn comprising a dye component and at least one optional performance enhancing composition present on a surface of said untufted, twisted BCF yarn;
   b. tufting said BCF yarn; and
   c. weaving said tufted BCF yarn into said carpet, wherein said process foregoes the need to further dye or treat said carpet with dyes and performance enhancing compositions.
46. The process of claim 45, wherein said untufted, twisted BCF yarn comprises polyamide fiber.

47. The process of claim 46, wherein said polyamide fiber is selected from the group consisting of: nylon 6,6, nylon 6, nylon 4,6, nylon 6,10, nylon 10,10, nylon 12, its copolymers, and blends thereof.

48. The process of claim 45, wherein said untufted, twisted BCF yarn comprises polyester fiber.

49. The process of claim 48, wherein said polyester fiber is selected from the group consisting of: poly(ethylene terephthalate), poly(propylene terephthalate), poly(butylene terephthalate), copolymers, and blends thereof.

50. A system for applying a dye composition to twisted BCF fiber comprising:
   a. a first yarn take-up device that transmits a single yarn member made from at least two individual yarn members;
   b. a dye composition applicator disposed downstream of said yarn take-up device that applies said dye composition to said single yarn member; and
   c. a second yarn take-up device that receives a dyed single yarn member.

51. A system for applying a dye composition and at least one performance enhancing composition to twisted BCF fiber comprising:
   a. a first yarn take-up device that transmits a single yarn member made from at least two individual yarn members;
   b. a dye composition applicator disposed downstream of said yarn take-up device that applies said dye composition to said single yarn member;
c. a performance enhancing composition applicator disposed downstream of said dye composition applicator, and

d. a second yarn take-up device disposed downstream of said performance enhancing composition applicator that receives a dyed single yarn member.