TWISTED AND HEAT-SET BI-COMPONENT BCF YARN

FIELD OF THE DISCLOSURE

[0001] The present disclosure relates to the textile industry, and, more particularly, to a bulked continuous side-by-side bi-component filament (BCF) yarn, a method for making such BCF yarn, and a floor covering material made from such BCF yarn.

BACKGROUND OF THE DISCLOSURE

[0002] Continuous filament yarn comprises a group of filaments, wherein each such filament is made of a polymer material that is extruded as a long fiber. Such yarn is also referred to as continuous multi-filament yarn although for the sake of the present disclosure, the fact that there are multiple filaments in the respective yarns will be assumed, where not specifically mentioned. Continuous filament yarn may be a continuous mono-component filament yarn or a continuous bi-component filament yarn. Depending upon the requirements and usages, the continuous mono-component filament yarn or the continuous bi-component filament yarn are chosen for respective purposes. Publications such as EP0921219, EP 1059372, US 5958548, EP 3382069 and JP2013198647 all disclose examples of bi-component filaments. The continuous bi-component filament yarn may be available in various arrangements, such as a sheath-core arrangement and a side-by-side arrangement. In the sheath-core arrangement, each filament of the continuous bi-component filament yarn includes one of the two polymers forming a core while the other forms a sheath. In the side-by-side arrangement, each filament of the continuous bi-component filament yarn includes the two polymers arranged side-by-side to each other. While both types of continuous bi-component filament yarns are widely used and have specific requirements in the textile industry, the present disclosure relates to continuous side-by-side bi-component filament yarn and articles made therefrom.

[0003] The continuous side-by-side bi-component filament yarns are used for making various kinds of articles, including, but not limited to, carpets, as an alternative e.g. to carpets made using spun yarn comprised of staple fibers. Generally, such continuous side-by-side bi-component filament yarns are texturized for increasing bulkiness and for better wear resistance and resilience performance, prior to making the carpet therefrom. However, the articles, such as, the carpets, made from such continuous side-by-side bi-component filament

yarns may undergo delamination over time, a degradation process wherein the bi-component polymers begin to separate from one another, particularly, when such carpets are subject to high levels of wear and tear, affecting integrity and long-term durability of such articles.

[0004] Accordingly, there exists a need to provide such bulk continuous side-by-side bi-component filament yarns or articles made therefrom that may be able to withstand high levels of wear and tear and avoid delamination of bi-components from each other over the maximum period of time.

SUMMARY OF THE DISCLOSURE

[0005] In view of the foregoing disadvantages inherent in the prior art, the general purpose of the present disclosure is to provide a twisted and heat-set bulked continuous side-by-side bi-component filament (BCF) yarn, a method for making such twisted and heat-set BCF yarn, and a floor covering material made from such twisted and heat-set BCF yarn, to include all advantages of the prior art, and to overcome the drawbacks inherent in the prior art.

[0006] Therefore, an object of the present disclosure is to provide such bulk continuous side-by-side bi-component filament yarns that may be able to withstand high levels of wear and tear and avoid delamination of bi-components from each other over the maximum period of time.

[0007] Another object of the present disclosure is to provide a method for making such bulk continuous side-by-side bi-component filament yarns that may be able to withstand high levels of wear and tear and avoid delamination of bi-components from each other over the maximum period of time.

[0008] Yet another object of the present disclosure is to provide a floor covering material, such as, carpets that may be able to withstand high levels of wear and tear and avoid delamination of bi-components from each other over the maximum period of time.

[0009] In light of the above objects, in one aspect of the present disclosure, a twisted and heat-set Bulked Continuous side-by-side bi-component Filament (BCF) yarn is provided as defined in claim 1. ~~The BCF yarn may include a plurality of side-by-side bi-component filaments. Each side-by-side bi-component filament of the plurality of side-by-side bi-component filaments may include a first polymer component and a second polymer component. The first polymer component may form a first side of the side-by-side bi-component filaments, wherein the first polymer component comprises polybutylene terephthalate (PBT) in at least 25 and up to 75 volume percent of the filament in the BCF yarn.~~

~~Further, the second polymer component may form a second side of the side-by-side bi-component filaments, wherein the second polymer component comprises one of polyethylene terephthalate (PET) or polylactic acid (PLA) in at most 75 and down to 25 volume percent of the filament in the BCF yarn. The BCF yarn may be obtained by a single-step continuous process which is subsequently followed by steps of cabling and heat-setting at predetermined parameters to form the twisted and heat-set BCF yarn.~~ The BCF yarn as obtained may exhibit an elongation to break in a range of 40% to 65%, and carpet or floor covering formed therefrom may exhibit a Hexapod rating after 12000 cycles of more than 2.

[0010] Although the invention is disclosed in the context of PBT and PET or PLA as the respective first and second polymer components, it will be understood that PET may be the first component and PBT may be the second component. The use of polyesters such as PET and PBT for the first and second components ensures that they can be intimately co-extruded together without requiring a binding or compatibil~~it~~ising agent or third component~~.~~ ~~The skilled person will also understand that other equivalent polyesters may also be used as first and second polymer components, including aliphatic polyesters and aromatic or semi-aromatic polyesters~~.

[0011] In the present context, reference to a single-step continuous process is intended to refer to a process that takes place without intermediate winding e.g. to a bobbin. Nevertheless, the single step process may be terminated by winding the BCF yarn to a roll or bobbin. It will be well understood that twisting and/or cabling will generally take place at a far lower speed than that of extrusion and spinning. In the above, the single step process may include winding of the yarn prior to performing the cabling and/or twisting. The cabled and/or twisted BCF yarn may then again be wound to a bobbin or reel prior to being heat set.

[0012] It should be also appreciated that twisting in the context of the present invention may refer to twisting alone or steps of twisting and cabling. Twisting may thus include twisting a single yarn comprising a plurality of filaments, or twisting a plurality of yarns around each other. The term ‘cabling’ means twisting at least one yarn comprising at least one filament around at least one other yarn comprising at least one filament. Cabling usually requires filaments or yarns wound on at least two bobbins to be combined together. Further, one bobbin can comprise a plurality of individual filaments or yarns bundled together. In the following, a bobbin, reel, roll, tube and the like are all referred to as bobbin.

[0013] In another aspect of the present disclosure, a method for forming a twisted and heat-set Bulked Continuous side-by-side bi-component Filament (BCF) yarn is provided <u>according to claim 9</u>. ~~The method may include: extruding the first polymer component~~

and the second polymer component e.g. at a gradual temperature having a range of 240°C to 300°C through a plurality of temperature zones, and at a pressure range of e.g. 60 bars to 130 bars to obtain a plurality of side-by-side bi-component filaments grouped together to obtain a continuous side-by-side bi-component filament yarn. Each side-by-side bi-component filament of the plurality of side-by-side bi-component filaments may include a first polymer component and a second polymer component. The first polymer component may form a first side of the side-by-side bi-component filaments, wherein the first polymer component comprises polybutylene terephthalate (PBT) in at least 25 and up to 75 volume percent of the filament in the BCF yarn. Further, the second polymer component may form a second side of the side-by-side bi-component filaments, wherein the second polymer component comprises one of polyethylene terephthalate (PET) or polylactic acid (PLA) in at most 75 and down to 25 volume percent of the filament in the BCF yarn. The method may further include: cabling the continuous side-by-side bi-component filament yarn in a range of 40 TPM (Twist Per meter) to 350 TPM, with at least one other ply to obtain the continuous side-by-side bi-component filament yarn having twists. This is also referred to as twisted BCF yarn. Subsequently, the twisted BCF yarn is heat set, preferably in a range of 100°C to 200°C to obtain a twisted and heat set BCF yarn Such twisted and heat-set BCF yarns have been shown to exhibit an elongation to break in a range of 40% to 65%, and floor coverings manufactured therefrom exhibit a Hexapod rating after 12000 cycles of more than 2.

[0014] In another aspect of the present disclosure, a floor covering material is provided according to claim 13. The floor covering material may include a base backing and a plurality of twisted and heat-set Bulked Continuous side-by-side bi-component Filament (BCF) yarns configured on the base backing. The twisted and heat-set BCF yarns may include a plurality of side-by-side bi-component filaments. Each side-by-side bi-component filament of the plurality of side-by-side bi-component filaments may include a first polymer component and a second polymer component. The first polymer component may form a first side of the side-by-side bi-component filaments, wherein the first polymer component comprises polybutylene terephthalate (PBT) in at least25 and up to 75 volume percent of the filament in the BCF yarn. Further, the second polymer component may form a second side of the side-by-side bi-component filaments, wherein the second polymer component comprises one of polyethylene terephthalate (PET) or polylactic acid (PLA) in at most 75 and down to 25 volume percent of the filament in the BCF yarn. The BCF yarn may be obtained by a single-step continuous process, and subsequently, after the single-step continuous process, is followed by

~~steps of cabling and heat-setting at predetermined parameters~~. The floor covering as obtained may exhibit a Hexapod rating after 12000 cycles of more than 2.

[0015] This together with the other aspects of the present disclosure, along with the various features of novelty that characterize the present disclosure, is pointed out with particularity in the claims annexed hereto and forms a part of the present disclosure. For a better understanding of the present disclosure, its operating advantages, and the specified object attained by its uses, reference should be made to the accompanying drawings and descriptive matter in which there are illustrated exemplary embodiments of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The advantages and features of the present disclosure will become better understood with reference to the following detailed description taken in conjunction with the accompanying drawings, in which:

[0017] FIG. 1 illustrates a cross-sectional perspective view of a twisted and heat-set Bulked Continuous side-by-side bi-component Filament (BCF) yarn, in accordance with an exemplary embodiment of the present disclosure;

[0018] FIGS. 2A to 2L illustrate various cross-sectional views of side-by-side bi-component filaments, in accordance with exemplary embodiments of the present disclosure;

[0019] FIG. 3 illustrates a block diagram of a method for forming a Bulked Continuous side-by-side bi-component Filament (BCF) yarn, in accordance with an exemplary embodiment of the present disclosure; and

[0020] FIG. 4 illustrate an article, such as a floor covering material made from Bulked Continuous side-by-side bi-component Filament (BCF) yarns, in accordance with an exemplary embodiment of the present disclosure.

[0021] Like reference numerals refer to like parts throughout the description of several views of the drawing.

DETAILED DESCRIPTION OF THE DISCLOSURE

[0022] The exemplary embodiments described here in detail for illustrative purposes are subject to many variations in implementation. The present disclosure provides a bulked continuous side-by-side bi-component filament (BCF) yarn, a method for making such BCF yarn, and a floor covering material made from such BCF yarn. It should be emphasized,

however, that the present disclosure is not limited to floor covering materials and methods for preparing the same. It is understood that various omissions and substitutions of equivalents are contemplated as circumstances may suggest or render expedient, but these are intended to cover the application or implementation without departing from the spirit or scope of the present disclosure.

[0023] The terms “a” and “an” herein do not denote a limitation of quantity, but rather denote the presence of at least one of the referenced items.

[0024] The terms “having”, “comprising”, “including”, and variations thereof signify the presence of a component.

[0025] The present disclosure provides a twisted and heat-set Bulked Continuous side-by-side bi-component Filament (BCF) yarn. The BCF yarn ~~may~~ includes a plurality of side-by-side bi-component filaments. Each side-by-side bi-component filament of the plurality of side-by-side bi-component filaments ~~may~~ includes a first polymer component and a second polymer component. The first polymer component ~~may~~ forms a first side of the side-by-side bi-component filaments, wherein the first polymer component comprises polybutylene terephthalate (PBT) in at least 25 and up to 75 volume percent of the filament in the BCF yarn. Further, the second polymer component ~~may~~ forms a second side of the side-by-side bi-component filaments, wherein the second polymer component comprises one of polyethylene terephthalate (PET) or polylactic acid (PLA) in at most 75 and down to 25 volume percent of the filament in the BCF yarn. The BCF yarn ~~may~~ is~~be~~ obtained by a single-step continuous process which is subsequently followed by steps of cabling and heat-setting at predetermined parameters. The twisted and heat-set BCF yarn as obtained may exhibit an elongation to break in a range of 40% to 65%. Floor covering produced from the yarn may exhibit a Hexapod rating after 12000 cycles of more than 2.

[0026] A twisted and heat-set Bulked Continuous side-by-side bi-component Filament (BCF) yarn will now be explained in conjunction with FIGS. 1 to 4 as below, in accordance with various exemplary embodiments of the present disclosure. Without departing from the scope of the present disclosure, the drawings as shown herein are only for better understanding of the disclosure and may not be in anyway considered to be limiting only to the diagrams as disclosed herein. There may be various other forms that may be covered by the claims of the present disclosure.

[0027] Referring now to FIG. 1, a cross-sectional perspective view of a twisted and heat-set Bulked Continuous side-by-side bi-component Filament (BCF) yarn 100 is illustrated in accordance with an exemplary embodiment of the present disclosure. The yarn

100 ~~may~~ includes a plurality of side-by-side bi-component filaments 110. Each side-by-side bi-component filament 110, as shown in FIG. 2A, of such plurality of side-by-side bi-component filaments ~~may~~ includes a first polymer component 112 and a second polymer component 114. The first polymer component 112 ~~may~~ forms a first side 110a of the side-by-side bi-component filaments 110. Further, the second polymer component 114 ~~may~~ forms a second side 110b of the side-by-side bi-component filaments 110. In ~~one preferred embodiment of~~ the present disclosure, the first polymer component 110 ~~may~~ includes polybutylene terephthalate (PBT) in at least 25 and up to 75 volume percent of the filament 110 in the BCF yarn 100. Further, ~~in one preferred embodiment of the present disclosure,~~ the second polymer component 114 ~~may~~ includes one of polyethylene terephthalate (PET) or polylactic acid (PLA) or recycled PET in at most 75 and down to 25 volume percent of the filament 110 in the BCF yarn 100~~. However, without departing from the scope of the present disclosure, the first and second polymer components 112, 114 may be any suitable polyesters, in any desired volume percent of the filament 110 in the BCF yarn 100 depending upon the requirement~~.

[0028] The twisted and heat-set BCF yarn 100 may include various shapes of the side-by-side bi-component filament 110, such as shown in FIGS. 2A to 2L. As shown in FIGS. 2A and 2B, the side-by-side bi-component filament 110, respectively, include a side-by-side full semi-circular cross-sectional shape, a side-by-side hollow semi-circular cross-sectional shape. Further, as shown in FIGS. 2C and 2D, the side-by-side bi-component filament 110 includes a side-by-side full tri-lobal cross-sectional shape and a side-by-side hollow tri-lobal cross-sectional shape, respectively. Further, as shown in FIGS. 2E and 2F, the side-by-side bi-component filament 110 includes a side-by-side full delta cross-sectional shape and a side-by-side hollow delta cross-sectional shape, respectively. Further, as shown in FIGS. 2G and 2H, the side-by-side bi-component filament 110 includes a side-by-side full concave cross-sectional shape and a side-by-side hollow concave cross-sectional shape, respectively. Further, as shown in FIGS. 2I and 2J, the side-by-side bi-component filament 110 includes a side-by-side full octa-lobal cross-sectional shape and a side-by-side hollow octa-lobal cross-sectional shape, respectively. Further, as shown in FIGS. 2K and 2L, the side-by-side bi-component filament 110 includes a side-by-side full elliptical cross-sectional shape and a side-by-side hollow elliptical cross-sectional shape, respectively. However, without departing from the scope of the present disclosure, the side-by-side bi-component filament 110 may include various other shapes, such as, a side-by-side full multi-lobal cross-sectional shape, a side-by-side hollow multi-lobal cross-sectional shape, or any other shape as required. Further, without departing from the scopes of the present disclosure, the first and the

second side together as a whole comprise a side-by-side full circle cross sectional shape, a side-by-side hollow circular cross-sectional shape. It is furthermore not excluded that the filament 110 may include a third or fourth component, also in a side-by-side relation and the term bi-component may be understood to include at least two components intimately bonded together.

[0029] The twisted and heat-set BCF yarn 100, as described, ~~may be~~is obtained by a single-step continuous process. The skilled person will understand that such processes ~~may generally~~ include steps of extruding, spinning, quenching, spin finish application, drawing, texturizing, cooling, intermingling and winding at the predetermined parameters. These steps, sub-steps or process elements are all generally performed without intermediate winding to a bobbin. It will be understood that the yarn or filament may be buffered or taken-up temporarily but that the process is otherwise continuous. For the sake of the present discussion, the output of the single-step continuous process will be referred to as BCF yarn, for the purpose of distinguishing it from the twisted and heat set product of the subsequent process steps. The BCF yarn is at least bulked by the further described texturizing process.

[0030] Subsequently, after the single-step continuous process, steps of cabling and heat-setting at predetermined parameters are followed. The BCF yarns according to the invention are preferably one, two, three, or four ply where two, three, or four ply yarns are twisted or cabled. The term ‘single-step process’ means that all such steps are performed on a single machine having various machine sections, and may also be referred to as single machine process. Referring now to FIG. 3, to describe a method 200 of making the BCF yarn 100 via the single-step continuous process 300, and subsequently followed by steps of cabling or twisting 210 and heat-setting 220.

[0031] The method 200 as shown in FIG. 3 will be described in conjunction with FIGS. 1 and 2A. As shown, the method 200 includes the single-step continuous process 300, which starts at 310 by extruding the first polymer component 112 via a first extruder E1 and the second polymer component 114 via a second extruder E2. The first polymer component 112 and the second polymer component 114 are extruded under predetermined conditions, such as gradual temperature and pressure to obtain a plurality of side-by-side bi-component filaments 110. These may be grouped together to obtain a continuous side-by-side bi-component filament yarn. The skilled person will be aware that the point at which the individual filaments become a yarn may be indeterminate although the filaments designated to form each final yarn will already be defined. In one embodiment of the present disclosure, the

first polymer component 112 and the second polymer component 114 may be extruded by conventional means at a gradual temperature having a range of 240℃ to 305℃ through a plurality of temperature zones (t1…tn), and at the pressure range of 60 bars to 130 bars. Further, at 320 spinning of the continuous side-by-side bi-component filament is performed. Further, at 330, the continuous side-by-side bi-component filament is gradually quenched, at the predetermined parameters, via, an air flow. In one embodiment the predetermined parameters of the quenching air flow may include: a quenching air flow temperature in a range of 10℃ to 25℃, quenching air flow rate in a range of 0.1mps to 0.8mps, and quenching air flow pressure in a range of 1 mbars to 4 mbars. After quenching, spin finish application is performed at 340 on the continuous side-by-side bi-component filament yarn. The spin finish application may also be otherwise conventional. Furthermore, at 350, after the spin finish application, the spin finish application yarn is sequentially drawn under predetermined conditions, such as drawing speed and drawing temperature. In one embodiment of the present disclosure, the drawing speed may be in a range of 760mpm to 3500mpm and even up to 4000mpm or 5000mpm, and the drawing temperature range may be in a range of 75℃ to 200℃. Thereafter, at 360, the drawn yarn is texturized at a texturizing temperature range of 130℃ to 200℃ and a texturizing vacuum pressure range of -50 mbars to -150 mbars. Various conventional texturizing processes may be employed. Moreover, at 370, the continuous side-by-side bi-continuous filament yarn is cooled at a cooling drum speed having a range of 10 mpm to 60 mpm and a cooling drum vacuum having a range of -20mbars to -80mbars. The cooled continuous side-by-side bi-continuous filament may further be optionally intermingled at 380 and wound at 390. At this point, subsequent to the texturizing process, the yarn may be referred to as BCF yarn.

[0032] In one embodiment of the present disclosure, at least one of the first and second polymer components 112, 114 is provided with a dye, either before or after being extruded. The first and/or second polymer components 112, 114 may be solution-dyed, either using pigments or solvent dyes or a combination thereof. Further, in one embodiment of the present disclosure, the at least one of the first and second polymer components is hank-dyed, space-dyed or yarn-dyed. One way to dye the at least one of the first and second polymer components 112, 114 is to dip them in a vat of dye after they are extruded.

[0033] Subsequently to the single-step process, the BCF yarn is cabled and/or twisted at step 210. This is understood to be a separate step i.e. it does not take place in line and at the same speed as the single-step process and is performed from one or more bobbins of the BCF yarn. In this context it is further understood that individual filaments may be

twisted or plied together or that groups of filaments or bundles of yarns may be cabled by a combination of individual twists and collective rotations. Reference to twisting is thus intended to encompass all alternatives of such twisting, plying and cabling operations.

[0034] In the twisting or cabling step at 210, the BCF yarn is imparted with permanent and distinctive texture in the form of twists. In addition, cabling or twisting improves tip definition and integrity. The tip is that end of the yarn which is extending vertically from the carpet backing and visually and physically apparent to the consumer. Twists are generally expressed as twists per meter or TPM. Such cabling and/or twisting of the continuous side-by-side bi-component filament yarn may be done in a range of 40 TPM to 350 TPM; preferably 100 TPM-300 TPM; more preferably 200 TPM-250 TPM, for example about 230 TPM, to obtain the continuous side-by-side bi-component filament yarn having such twists. Cabling or twisting parameters with respect the combination of types of the first and second polymer components 112, 114 are shown in Table 1.

Polymer	PET-50% & PBT-50%	PET-33% & PBT-67%	PET-67% & PBT-33%
TPM	230	230	230
Twist Direction	"S"	"S"	"S"
Spindle Rpm	5000	5000	5000

Table 1

[0035] As defined above in Table 1: ‘Twist direction’ “S” refers to a yarn spun in clockwise direction and is normally used to create left-handed twill. Further, ‘spindle rpm’ refers to the speed of the spindle where the twisting takes place. Subsequent to cabling and/or twisting, the yarn may again be wound to a bobbin or the like for subsequent processing in the next step of the process.

[0036] As described above, cabling or twisting imparts twists to the yarn, however, increases the tendency of undesirable torqueing in the yarn. Therefore, after twisting and cabling, at step 220, the twisted BCF yarn is heat set. Heat treating of the fibers, filaments or yarn of the present invention is carried out by a fluid, such as air, steam, or any other compressible liquid or vapor capable of transferring heat to the twisted yarn as it continuously travels through a heat setting device. It should be noted that the heat set is performed while the filaments or yarn are in relaxed state. The temperature of such fluid must be such that the yarn does not melt. This step of heat setting utilizes such fluid stream capable of transferring

heat to the twisted BCF yarn as it continuously travels through the heat setting device, at a temperature of 85°C to 200°C; preferably 100°C to 190°C; more preferably 130°C to 180°C, for example about 130°C or 140°C. This process is affected by the length of time during which the twisted BCF yarn is exposed to the heating medium (time/temperature effect). Generally, useful exposure times are from 30 seconds to 3 minutes; preferably from 45 seconds to 1½ minutes; for example, about 1 minute.

[0037] Preferably, the twisted BCF yarn is heated to a temperature sufficiently above the glass transition temperature of the respective materials for heat setting to occur. Without being bound by theory. It is believed that heat setting above the glass transition temperature relieves the stress in the filaments resulting from the drawing and twisting. Bonds created as linkages and entanglements between the molecular chains that have been frozen-in during processing can be overcome by the supply of heat, giving rise to greater freedom for the bonds to revert to states of lower energy. Subsequent cooling, will result in a state of lower stress and the yarn will be heat-set in its new configuration and will not draw back or untwist once released.

[0038] Table 2 illustrates cabling or heat setting parameters used on the Power-Heat-Set type machine (operating with superheated steam at atmospheric pressure) with respect to the combination of types of the first and second polymer components 112, 114.

Polymer	PET-50% & PBT-50%	PET-33% & PBT-67%	PET-67% & PBT-33%
Twist Direction	"S"	"S"	"S"
Over feed speed	285	285	285
Delivery speed	250	250	250
Dwell time	60 Sec	60 Sec	60 Sec
Stuffing pressure 1	32%	32%	32%
GKK temp 1&2	170˚C	170˚C	170˚C
Dew point set 1&2	90°C	90°C	90°C
Cooling fan on/off	ON	ON	ON
Accumulator basic speed	215	215	215
Accumulator jump speed	225	225	225
no. of ends per tunnel	10	10	10

Table 2

[0039] As defined above in the table:

[0040] “Twist direction” as “S” represents a yarn is twisted in clockwise and is normally used to create left-handed twill. However, without departing from the scope of the present disclosure, the twist direction may also be “Z”, which represents that a yarn is twisted in counter-clockwise and is normally used to create right-handed twill.

[0041] “Over feed Speed” represents the speed in m/min at which the over-feed rollers in the heat set machine run. This is normally 10-30% more than the delivery speed, to keep the yarn slack before entering the actual heat set process, ensuring that heat setting takes place in the relaxed condition of the yarn.

[0042] “Delivery Speed” represents the feed speed in m/min of the yarn at the heat set machine.

[0043] “Dwell time” represents the total time yarn stays inside the actual heat setting process.

[0044] “Stuffing pressure 1” represents the level of additional crimp (known as frieze) given in the yarn during the heat setting process.

[0045] “GKK temp 1&2” represents the actual temperature yarn is exposed for heat setting.

[0046] “Dew point set 1&2” represents the moisture level inside the actual heat setting tunnel.

[0047] “Accumulator basic speed” represents the normal speed in m/min of the yarn outlet from the heat setting tunnel.

[0048] “Accumulator jump speed” represents the higher optional speed of the yarn outlet from the heat setting tunnel.

[0049] “No of ends per tunnel” represents total number of yarns which are heat set together in each heat setting tunnel.

[0050] Heat setting for the twisted BCF yarns stabilizes the twist and causes the BCF yarn 100 to lock in the twists and gain volume in the BCF yarn 100. This volume growth may be described as "bulk development". Heat setting also retains the twist during use and there is not such a loss of resilience and of overall appearance due to matting. The unique yarn and carpet made therefrom based on the side-by-side bi-component filaments disclosed herein, results in an ability to thermally lock in the twist structure and enables to gain volume in the BCF yarn 100. In the present invention, the twisted and heat-set BCF yarn is produced having the number of the side-by-side bi-component filaments in the range of 25 filaments to 1000 filaments. Further, the twisted and heat-set BCF yarn 100 exhibits a denier per filament

(DPF) ratio in the range of 0.5 DPF to 50 DPF, and a linear density in a range of 600 denier to 6000 denier. The denier value is obtained for the BCF yarn after the one-step process and before the heat set. The skilled person understands that this value may change upon heat setting the BCF yarn 100.

[0051] According to an important aspect of the invention, the yarn may also be subjected to a frieze process prior to heat setting. In one configuration, this involves introducing the twisted BCF yarn into a stuffing box subsequent to it being removed from the bobbin and prior to introduction into the heat setting machine. This bunching up of the yarn creates crinkles in the yarn, which is then set in place during the heat set process. Heat setting is thus a necessary step to produce such frieze yarn.

[0052] Moreover, in the present invention, the twisted and heat-set BCF yarn 100 that is produced using the above process has an elongation to break in a range of 40% to 65%. In the present specification, elongation to break is determined according to ASTM D 2256 (2015) using a gauge length of 500 mm, a test speed of 500 mm/min, a pretension of 0.5 cN/tex and break identified by a 90% drop in peak force.

[0053] More importantly, carpet produced with twisted and heat-set BCF yarn 100 comprising the compositions of the first and second polymers 112, 114 arranged in side-by-side arrangements of the invention were tested for performance in a Hexapod Tumble Test typically used in the art to evaluate commercial carpet performance and found to have a Hexapod rating after 12000 cycles of more than 2.

[0054] Such Hexapod rating of more than 2 after 12000 cycles is obtained due to the unique combination of the first polymer component 112 forming the first side 110a in at least 25 and up to 75 volume percent, and the second polymer component 114 forming the second side 110a in at most 75 and down to 25 volume percent of the filament in the BCF yarn, along with the heat setting of such yarn.

[0055] Table 3, presented below, illustrates various combinations of the first and second polymer components 112, 114 and resulting properties including “elongation to break” and “Hexapod rating” as obtained in the BCF heat set yarns 100 and carpets made from such yarns, in comparison to other conventionally available yarns. The parameters of the carpets are chosen to be as close as possible to each other in order to provide a fair comparison between different yarns. For all cases, the filaments are circular cross-section. The table clearly shows that the items made from twisted and heat-set BCF yarns exhibit

higher Hexapod rating compared to the items that were made from mono-component heat-set yarns or bi-component BCF yarns that were not heat set.

Bi-Component Filament		Percentage of polymenrs		Heat setting parameter (degree C)	Denier/Filament	Final Product	% Elongation to break	Hexapod rating (tumbler wt 3.81 Kg)								
Polymer A	Polymer B	A %	B %					Guage	Stitch rate / 10 cm	Pile height (mm)	cut/loop	Carpet backing	Backing GSM	Carpet yarn GSM	Final carpet GSM	Hexapod Rating @ 12000 cycles
PBT	PET	50	50	140	1200/120	2 ply 230 tpm heat set	54,56	1/8th	48	12	CUT	Hotmelt	1300	1120	2420	2,5
PBT	Recycled PET	50	50	140	1200/120	2 ply 230 tpm heat set	55,2	1/8th	48	12	CUT	Hotmelt	1300	1120	2420	3
PBT	PLA	50	50	130	1200/120	2 ply 230 tpm heat set	58,4	1/8th	48	12	CUT	Hotmelt	1300	1120	2420	2
Mono component filament																
100% PET				140	1200/120	2 ply 230 tpm heat set	39,58	1/8th	48	12	CUT	Hotmelt	1300	1126	2426	1
100% PBT				140	1200/120	2 ply 230 tpm heat set	40,2	1/8th	48	12	CUT	Hotmelt	1300	1135	2435	1,5
PBT	PET	50	50	Without heat setting	1200/120	1 ply BCF	33,55	1/8th	48 x 2	12	CUT	Hotmelt	1300	1060	2360	1,5
PBT	Recycled PET	50	50	Without heat setting	1200/120	1 ply BCF	35,5	1/8th	48 x 2	12	CUT	Hotmelt	1300	1060	2360	1,5
PBT	PET	50	50	Without heat setting	1200/120	2 ply 230 tpm cold drawn and relaxed at 80 C, 10 s		1/8th	48	12	CUT	Hotmelt	1300	1100	2400	1,5
Mono component filament																
100% PET				Without heat setting	1200/120	1 ply BCF	28,54	1/8th	48 x 2	12	CUT	Hotmelt	1300	1050	2350	1
100% PBT				Without heat setting	1200/120	1 ply BCF	29,3	1/8th	48 x 2	12	CUT	Hotmelt	1300	1050	2350	1

Table 3

[0056] The Hexapod rating as referenced throughout the present specification is obtained using the D 5252 – 98a (2003) standard for the operation of the Hexapod tumble drum tester of 3.8 Kg weight. The test was performed using a standard, upright type vacuum cleaner as supplied with the Hexapod drum tester. As can be seen from the results, the Hexapod rating for carpets made with the bi-component filament yarns of the invention is considerably higher than that for either 100 % PET or 100% PBT. Furthermore, the Hexapod rating for carpets made with the bi-component filament yarns without heat set is also far lower than that of the invention. Also, in the case of cold drawing the cabled yarn and subsequent relaxation in warm water at 80 C, no improvement is apparent in the Hexapod rating.

[0057] Referring now to FIG. 4, a floor covering material 400 is shown in accordance with an exemplary embodiment of the present disclosure. The floor covering material 400 may include a base backing 410, and a plurality of twisted and heat-set Bulked Continuous side-by-side bi-component Filament (BCF) yarns 100 configured on the base backing 410, as described above and excluded from the description herein for the sake of brevity of the disclosure and to avoid repetition of the subject matter. The floor covering material 400 may include, but is not limited to, carpets, rugs, mats and so forth. In one embodiment of the present disclosure, the twisted and heat-set BCF yarns 100 are tufted on the base backing 410 to form the floor covering material 400. In one embodiment of the present disclosure, the twisted and heat-set BCF yarns 100 are knitted on the base backing 410 to form the floor covering material 400. In one embodiment of the present disclosure, the twisted and heat-set BCF yarns 100 are woven on the base backing 410 to form the floor covering material 400. In one embodiment of the present disclosure, the twisted and heat-set BCF yarns 100 are knotted on the base backing 410 to form the floor covering material 400.

[0058] As presented, the present disclosure is advantageous in providing such bulk continuous side-by-side bi-component filament yarns or carpets that may be able to withstand high level of wear and tear and avoid delamination of bi-components from each other over the maximum period of time.

[0059] The foregoing descriptions of specific embodiments of the present disclosure have been presented for purposes of illustration and description. They are not intended to be exhaustive or to limit the present disclosure to the precise forms disclosed, and obviously many modifications and variations are possible in light of the above teaching. The embodiments were chosen and described in order to best explain the principles of the present disclosure and its practical application, and to thereby enable others skilled in the art to best

utilize the present disclosure and various embodiments with various modifications as are suited to the particular use contemplated. It is understood that various omissions and substitutions of equivalents are contemplated as circumstances may suggest or render expedient, but such omissions and substitutions are intended to cover the application or implementation without departing from the ~~spirit or~~ scope of the present disclosure.