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(54) **Deep dyeing helically crimped conjugate yarn process.**

(57) A deep dyeing helically crimped-conjugate yarn is made by high speed melt spinning, preferably with an in-line draw. The drawing step increases the degree of crimp, and the resulting yarn dyes deeper than conventional yarns and has greater dye stability than it would have without the drawing step.

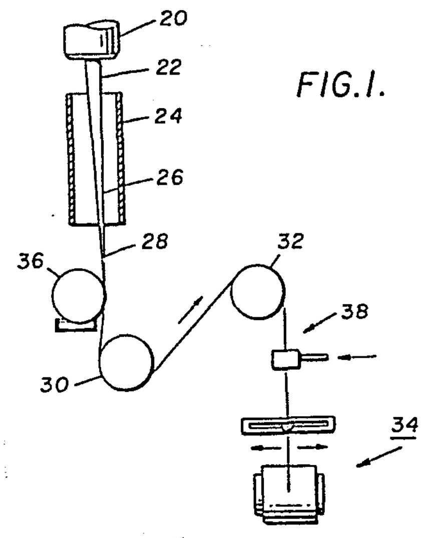

FIG. 1.

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DEEP DYEING HELICALLY CRIMPED CONJUGATE YARN PROCESS

SPECIFICATION

The invention relates to the art of producing melt-spun deep-dyeing conjugate filaments which have latent crimp, and more particularly to directly producing such filaments in a single continuous manufacturing operation.

Conjugate filaments which have latent crimp are known and have been in limited commercial use for certain applications. Such filaments or yarns containing such filaments are typically made by melt-spinning dissimilar polymers as side-by-side conjugate filaments at fairly low winding speeds of the order of 1,500 meters per minute (MPM) or less. The filaments wound on the spin package are then hot drawn (or drawn and textured) in one or more separate operations to produce filaments with helical crimp. The relatively slow speeds and multiple processing steps are time consuming and relatively expensive, and the product quality is frequently undesirable in such properties as denier uniformity and dyeability.

According to the invention, these and other problems of the prior art are avoided by the provision of a novel process for manufacturing conjugate filaments having latent crimp and improved dyeability.

According to a first principal aspect of the invention, there is provided a process for melt-spinning a deep-dyeing conjugate filament having latent helical crimp from first and second dissimilar polymers, comprising generating a first molten sub-stream of the first polymer and a second molten sub-stream of the second polymer converging to merge side-by-side as a combined stream before extrusion from the face of a spinneret, quenching the combined stream to form a conjugate filament comprising a first sub-filament of the first polymer conjugated side-by-side with a second sub-filament of the second polymer, and withdrawing the filament from the combined stream at a predetermined spinning speed above 2200 MPM, and winding the filament on a bobbin at a winding speed above 3000 MPM, the polymers, the spinning speed and the winding speed being selected such that the filament wound on the bobbin has a shrinkage greater than 10%.

According to a second aspect of the invention, the first sub-stream is nylon 66 and the second sub-stream is poly(ethylene terephthalate).

According to a third aspect of the invention, the polymers and the spinning speed are selected such that the filament has a shrinkage greater than 20% and an elongation less than 100%.

According to a fourth aspect of the invention, the filament is drawn at a given draw ratio prior to winding the filament at a higher speed than the predetermined spinning speed, the polymers, the spinning speed, and the draw ratio being selected such that the filament has a shrinkage greater than 20%.

According to a fifth aspect of the invention, the polymers, the spinning speed, and the draw ratio are selected such that the filament has a shrinkage greater than 25%.

According to a sixth aspect of the invention, the polymers, the spinning speed, and the draw ratio are selected such that the filament has an elongation less than 75%.

According to a seventh aspect of the invention, the polymers, the spinning speed, and the draw ratio are selected such that the filament has an elongation less than 50%.

Other aspects will in part appear hereinafter and will in part be apparent from the following detailed description taken in connection with the accompanying drawings, wherein:

FIGURE 1 is a schematic front elevation view of the preferred spinning process;

FIGURE 2 is a generalized graph showing qualitatively how yarn shrinkage varies with spinning speed for PET (poly(ethylene terephthalate)) and for N66 (nylon 66) yarns;

FIGURE 3 is a vertical sectional view of a preferred spinneret usable in the practice of the invention;

FIGURE 4 is a bottom plan view of the FIGURE 3 spinneret; and

FIGURE 5 is a sectional view of a conjugate filament according to the invention.

As shown in FIGURE 1, polymers are extruded from orifices in spinneret 20 as molten conjugate streams 22. Streams 22 are quenched by transversely moving quench air in quench chamber 24 into filaments 26, the several filaments being converged into a yarn bundle 28. The yarn passes in partial wraps around unheated godets 30 and 32 before passing to winder 34. A conventional spin finish is applied at 36, and the several filaments constituting the yarn can be entangled together by tangle chamber 38.

In the spinning apparatus as thus illustrated, each filament is withdrawn from its associated molten stream at a spinning speed determined by the speed at which godet 30 is driven. According to the invention, the spinning speed must be above 2200 MPM, and is preferably above 3000 MPM.

Referring to FIGURES 3-5, the preferred spinneret orifice design is constructed to merge molten streams of two dissimilar polymers side-by-side as a combined stream before extrusion from face 40 of spinneret 20. Capillaries 42 and 44 each have diameters of 0.254 mm, and converge within the spinneret to form an included angle of 90°. As shown in FIGURE 4, the axes of capillaries 42 and 44 intersect with the plane of face 40 at points 0.15 mm apart. Capillaries 42 and 44 together constitute a combined orifice for spinning a single combined stream, with a first polymer metered through capillary 42 and a second polymer metered through capillary 44. In practice, the spinneret would include a number of combined orifices, one for each filament. Referring again to FIGURE 1, each stream 22 is a combined stream of the type described in this paragraph.

According to the invention, the first and second polymers are dissimilar. That is, the polymers produce melt spun filaments having different levels of shrinkage at high spinning speeds. The preferred first and second polymers are nylon 66 and PET, whose shrinkage variations with spinning speed are qualitatively illustrated in FIGURE 2. As there illustrated, the shrinkage of PET yarns are quite high at intermediate spinning speeds of about 3000 MPM, and falls off rapidly from levels of about 50-70% to levels of about 5% or so over a narrow range of spinning speed. The location of the narrow range varies somewhat with capillary diameter (jet stretch) for a given filament denier, but can ~~be~~ readily be located for a given capillary and filament denier by spinning at different spinning speeds. The shrinkage behavior of nylon 66 yarns is quite different in that it merely rises slowly over the speed range illustrated to about 5% or so, and does not exhibit the very high values of PET yarns.

According to the broadest aspect of the invention, the side-by-side conjugate filament is spun at a speed greater than 2200 MPM, the spinning speed being selected such that the filament has a shrinkage greater than 10%. Under these conditions, the constituent sub-filaments have substantially different shrinkages and the filament will have latent crimp.

Referring again to FIGURE 1, it is preferred that godet 32 be driven at a higher speed than godet 30 so that yarn 28 is drawn prior to winding. This drawing increases the dye-fastness of the nylon 66 component to disperse dyes and generally increases the crimp level in the yarn. Preferably the drawing is sufficient to reduce the yarn elongation to below 75%, with best results achieved when the yarn elongation is reduced to below 50%.

EXAMPLE

Using the above disclosed apparatus, 60% by volume nylon 66 polymer and 40% by volume PET polymer of normal molecular weights for apparel end uses are metered through capillaries 42 and 44 respectively at a temperature of 280°C to provide a filament denier of 4.7. The speed of both godets is 4000 MPM, and the yarn is wound at a winding tension of 0.1 grams per denier. The yarn has an elongation of 74%, good latent crimp, and dyes more deeply than prior art conjugate yarns which have been textured by the false-twist method.

The process of the preceding paragraph is repeated except that the speed of godet 32 is increased to 4500 MPM so as to apply an in-line draw to the yarn. The dye-fastness of the nylon 66 component to disperse dyes is substantially increased, and the yarn continues to dye deeper than prior art yarns which have been hot drawn or textured by the false-twist method. The latent crimp in the yarn is also increased by the step of drawing immediately after quenching and before winding. By selection of the speeds of godets 30 and 32 (and hence the draw ratio), the yarn elongation may be reduced to the preferred level of below 75%, and to the particularly preferred level of below 50%.

If the spinning speed were so high that the PET shrinkage (and hence the yarn shrinkage) were below the level required for satisfactory yarn crimp, application of the in-line draw would increase the PET shrinkage and improve the crimp level.

Yarn shrinkage is determined by the following method. The bobbin is conditioned at 21°C and 65% relative humidity for one day prior to testing. 100 meters of surface yarn are stripped off and discarded. Using a Suter denier reel or equivalent, the yarn is wound to form a skein having about 18,000 skein denier. That is, the denier reel revolutions are 9000 divided by the yarn denier. The skein yarn ends are tied together. The skein is suspended from a rod having a diameter of one centimeter and a 1000 gram weight is attached to the bottom of the skein. After 30 seconds, the skein length is measured to provide length L1. The 1000 gram weight is then replaced by a 50 gram weight, whereupon the rod with skein and 50 gram weight are placed in a vigorously boiling water bath sufficiently deep that the skein is under tension from the 50 gram weight. After 10 minutes in the boiling water bath, the rod with skein and the 50 gram weight are removed from the bath and hung up for three minutes to permit excess water to drain off. The rod with skein and suspended 50 gram weight are then placed in a 120°C oven for 15 minutes, after which the rod with skein and suspended 50 gram weight are removed from the oven and hung for 15 minutes at room temperature. The suspended 50 gram weight is then removed and replaced by a 1000 gram weight. After 30 seconds, the skein length is is measured to provide L2. The % shrinkage is defined as 100(L1 - L2) divided by L1.

What is claimed is:

1. A process for melt-spinning a deep-dyeing conjugate filament having latent helical crimp from first and second dissimilar polymers, comprising:

a. generating a first molten sub-stream of said first polymer and a second molten sub-stream of said second polymer converging to merge side-by-side as a combined stream before extrusion from the face of a spinneret;

b. quenching said combined stream to form a conjugate filament comprising a first sub-filament of said first polymer conjugated side-by-side with a second sub-filament of said second polymer; and

c. withdrawing said filament from said combined stream at a predetermined spinning speed above 2200 mpm; and

d. winding said filament on a bobbin at at a winding speed above 3000 mpm;

e. said polymer, said spinning speed, and winding speed being selected such that said filament wound on said bobbin has a shrinkage greater than 10%.

2. The process defined in claim 1, wherein said first sub-stream is nylon 66 and said second sub-stream is poly(ethylene terephthalate).

3. The process defined in claim 2, wherein said polymers and said spinning speed are selected such that said filament has a shrinkage greater than 20% and an elongation less than 100%.

4. The process defined in claim 2, wherein said filament is drawn at a given draw ratio prior to winding said filament at a higher speed than said predetermined spinning speed, said polymers, said spinning speed, and said draw ratio being selected such that said filament has a shrinkage greater than 20%.

5. The process defined in claim 4, wherein said polymers, said spinning speed, and said draw ratio are selected such that said filament has a shrinkage greater than 25%.

6. The process defined in claim 4, wherein said polymers, said spinning speed, and said draw ratio are selected such that said filament has an elongation less than 75%.

7. The process defined in claim 4, wherein said polymers, said spinning speed, and said draw ratio are selected such that said filament has an elongation less than 50%.

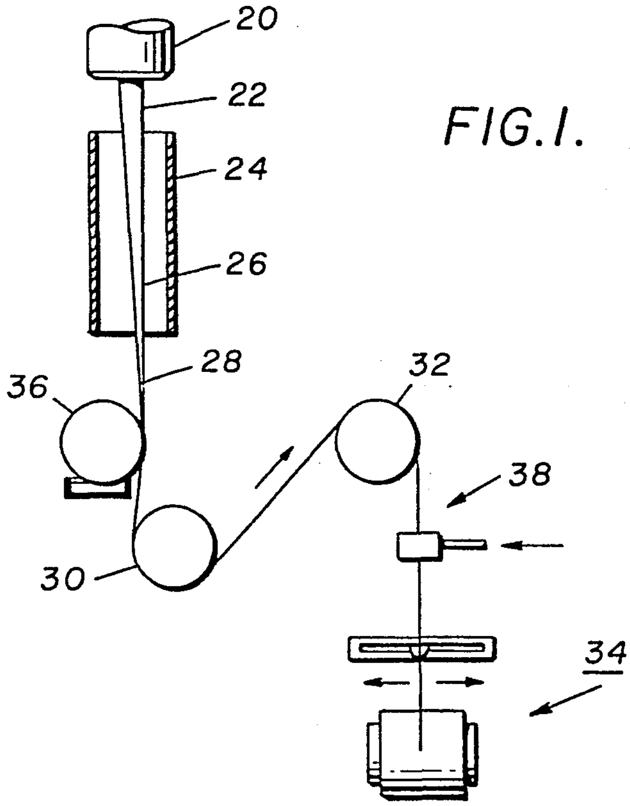
20
22
24
26
28
36
32
38
30
34

FIG.1.

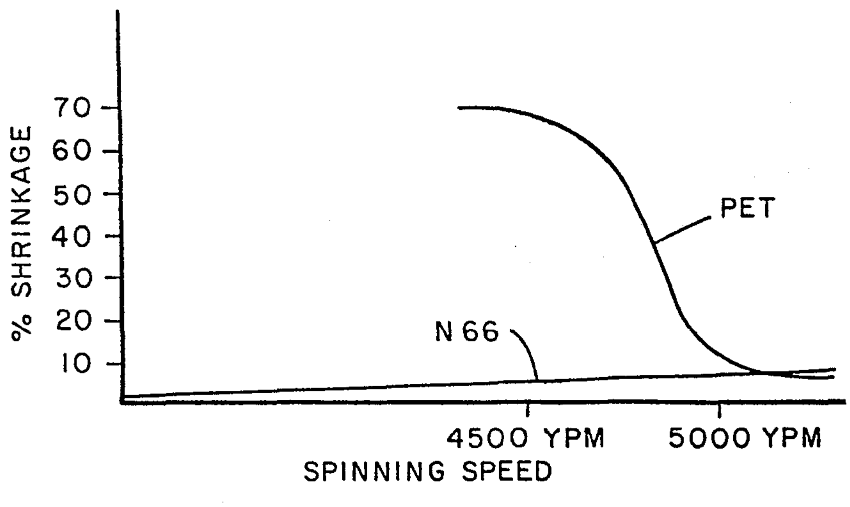
70
60
50
40
30
20
10
% SHRINKAGE
PET
N 66
4500 YPM
5000 YPM
SPINNING SPEED

FIG. 2.

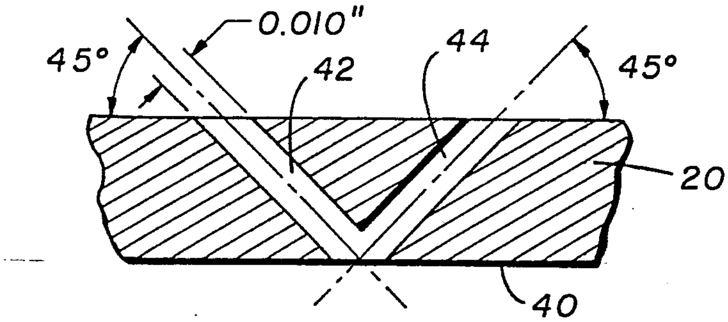

FIG. 3.

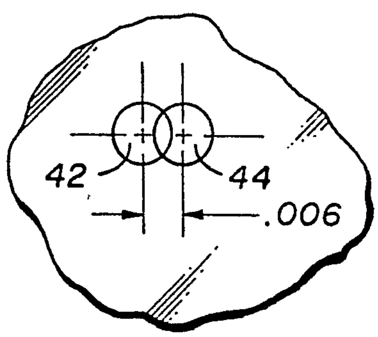

FIG. 4.

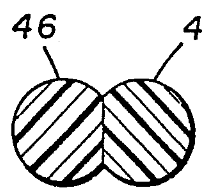

FIG. 5.