

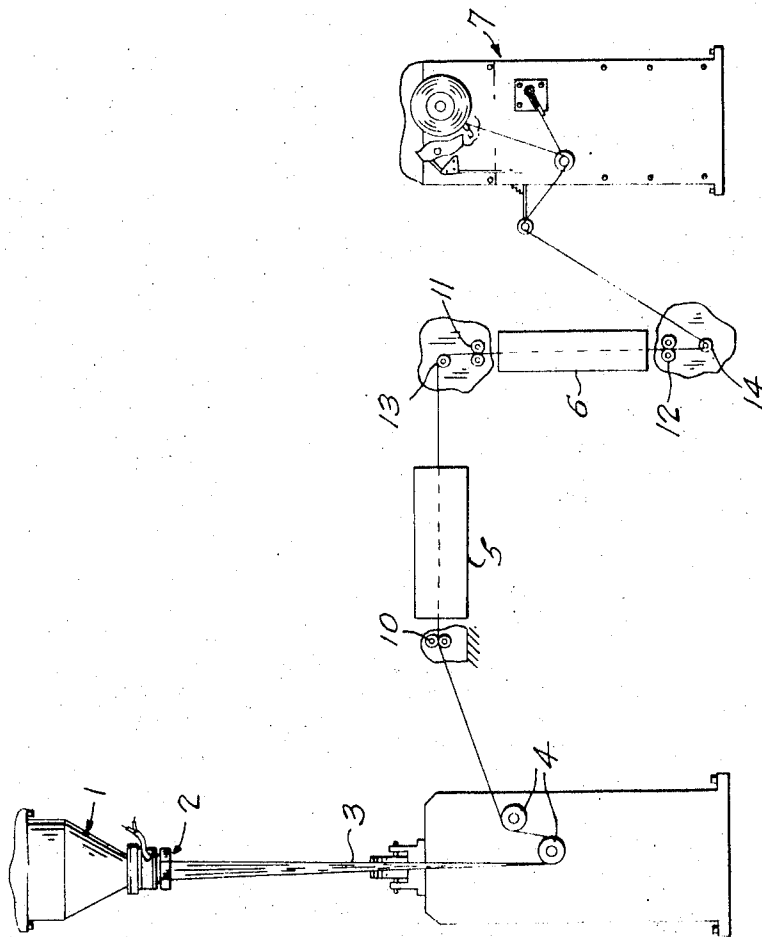
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BULKED SYNTHETIC FIBRES

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BULKED SYNTHETIC FIBRES

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9 Claims 10

ABSTRACT OF THE DISCLOSURE

A process for making low tenacity bulked yarns which have permanent elastic recovery, by (1) melt-extruding polyolefin into fibres; (2) spinning the fibres into yarns; (3) crimping without intermediate heat stretching the yarns; (4) heat treating the crimped yarns at a temperature short of a melting temperature while the yarn is left to a relaxed state.

More specifically, the invention relates to polyolefin bulked yarns or fibres which have good crimp recovery and high breaking elongation.

Undrawn fibres formed by melt extrusion of polypropylene and other polyolefins are noted for low tensile strength and a high permanent deformation from extension. These fibres, as extruded, are not normally considered to be textile grade and to make them fit for use in bulk fibre or yarn form, they are usually hot stretched. To this end, they are first heated and, while still hot from extrusion, are stretched several times their original length. Only after this stretching step have they been thought ready for bulking. At this stage they have high tensile strength and fairly complete elastic recovery from an extension of from 8–15% but break when extended further beyond 20%, for example, of their original length.

The nature of the stretching is critical and gives rise to quality control problems. Stretching, as an additional step, adds to cost. Stretching also makes the yarn non-uniform in size along its length and in colour from package to package where the melt has been pigmented or the yarn dyed. The highly oriented yarns produced by this process also have a great tendency to shrink on being heated. Further, mechanical crimp applied to an already oriented fibre is not permanent enough.

The present invention is based upon the discovery that new and useful bulked yarns suitable principally for application such as carpet tufting where high tensile strength is not necessary, may be obtained, the yarn and its method of production avoiding or reducing many of the disadvantages outlined above.

In general, polyolefin fibres such as fibres of polypropylene or polyacetal with no stretching other than draw down from the spinnerette, are crimped mechanically. After crimping, the yarn is heat set. Preferably, the fibres are not cold drawn before crimping, but the invention does not preclude cold drawing to less than 100% and desirably not more than 50%.

More specifically, there is provided in accordance with one aspect of the invention a process for the production of bulked yarns of polyolefin fibres, the yarns being characterized by low tenacity and high and permanent elastic recovery, the process comprising the steps of melt extruding the polyolefin into fibres, spinning the fibres into yarns, crimping the yarns mechanically to obtain a controlled regular crimp without intermediate heat stretching, and heat setting the crimped yarns by subjecting the yarns in substantially relaxed state to a heat treatment at a temperature short of the melting temperature.

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According to a preferred aspect of the invention, there is provided a process for the production of bulked yarns of isotactic polypropylene characterized by a tenacity below substantially 2.5 grams per denier and high and permanent elastic recovery, the process comprising subjecting melt spun polypropylene fibres which have been drawn down from the spinning jet but have not been subsequently heat stretched to a mechanical crimp treatment and subsequently to a heat treatment at a temperature short of the melting temperature under conditions such that shrinkage of the fibres occurs.

According to another aspect of the invention, there is provided a bulked yarn composed of regularly crimped fibres of polyolefin, the freshly prepared yarn being characterized by a tenacity of less than about 2.5 grams per denier, an elastic recovery of at least 95% after an extension of 5% and an elastic recovery of at least 90% after an extension of 50%. The fibres preferably have a breaking elongation of at least 150%.

According to yet another aspect of the invention, there is a carpet, the tufting of which comprises bulked yarns composed of crimped fibres as defined above or made by the process of the invention.

The bulked yarns produced in accordance with the invention are particularly suitable for the tufting of carpets. Such carpets are made by conventional procedures or may be made with a backing in accordance with co-pending application, U.S. Ser. No. 498,389, filed Oct. 20, 1965. They are also suitable for knitting or weaving into bulky garments such as sweaters, stockings and stretch fabrics, by conventional techniques.

The mechanical crimping may be, for example, by stuffer box, gear crimper, false twister, or the like. The crimped yarns are then heat set in relaxed state. Being relaxed, the fibres can shrink during heating. If the crimping includes heating, the heat setting may be done while crimping. Then heating may, if desired, be omitted after crimping.

Where the bulked yarns are used in articles, which are heat-treated in finished or semi-finished form, this heat treatment will heat set the yarn at the same time.

The crimp or bulk is enhanced and strengthened by the heat setting. The heat setting also improves the crimp stiffness and crimp recovery of the fibres, particularly when they are subjected to high extension. This is specially so with polypropylene yarn as compared to other materials.

The yarn in continuous filament or cut staple forms in the loose state may be heat set in an oven heated to a given temperature. The yarn may shrink as much as 50%. The process may be carried out continuously by passing the yarn through a zone heated by hot air, e.g., in a jacketed tube, di-electric heating, infra-red radiation, or otherwise. The fibre temperature can come close to the melting point, although lower temperatures are generally sufficient, for example, within the range of about 80° C. to 160° C. Within this range, the time is not critical. A preferred temperature range is 125° C. to 145° C.

Isotactic polypropylene having a melting point between 160–170° C. and degree of isotacticity above 70% is a preferred material, although the degree of isotacticity is not critical.

The extruded polyolefin fibres may be cold drawn (not more than 100% and preferably less than 50%) before they are crimped, although the preferred product is obtained without post-extrusion drawing. Some limited amount of drawing takes place in many of the crimping processes.

A preferred procedure according to the invention is illustrated in FIGURE 1 of the accompanying drawing which is a semi-schematic flow sheet showing the prog-

ress of the polymer from extrusion through to take up as yarn.

With reference to FIGURE 1 of the drawings, the polyolefin is extruded from the melt extruder 1 fitted with the spinnerette 2. Any type of melt extruder suitable for melt spinning polyolefin yarns may be used, such as that shown in U.S. Patent No. 3,078,509. A preferred extruder is the subject of our copending patent application U.S. Ser. No. 347,595, filed Feb. 26, 1964.

The yarn is drawn from the melt extruder by means of godet rolls 4 plus a lubricating roll 3. The yarn is then passed through drive rolls 10 to a crimper 5 which may, for example, consist of a stuffer box, or crimping gears, or a false twister. From the crimping unit, the crimped yarn passes over guide roll 13 past drive rolls 11 and through a heat setting oven 6. The yarn is maintained in a substantially relaxed condition in the oven 6 between nip rolls 11 and 12. After passing through the oven, the yarn passes around guide roll 14 to the constant tension winder 7 which is of known construction. The temperatures and conditions maintained in the heat setting oven are exemplified in the following examples.

Example 1

Using the apparatus of FIGURE 1, a continuous multifilament yarn of 1500 denier and of 75 filaments composed of polypropylene was extruded from an extruder having a spinnerette with 75 holes each of 0.013 inch diameter. The resin used was "Profax 6501" isotactic polypropylene resin (Hercules Powder Company). The extruder was operated at 275° C. with an output of two pounds per hour. The draw speed of the yarn at the godet rolls 4 was 150 feet per minute. A small amount of processing lubricant (glycerol monostearate) was applied to the yarn at the lubricating roll 3 shown in FIGURE 1.

The yarn was carried to the crimper 5 of FIGURE 1 which in this instance was an intermeshing set of gears maintained at 110° C. and arranged to impose 9 crimps per inch on the yarn. The yarn so crimped was continuously passed downwardly through a vertical hot air oven (6 of FIGURE 1) so that the only tension on the yarn was due to its own weight. The oven was maintained at a temperature of 145° C. and was of seven foot length. The heat set yarn was then taken up on the constant tension winder 7, in this case a "Leesona" winder. Between the winder and the oven, the yarn passed through room temperature and was permitted to cool down to at least 50° C.

The yarn as produced had the following properties:

Yarn denier	1550
Tenacity	grams per denier-- 1.2
Breaking elongation	percent-- 250
Crimp	crimps per inch-- 9

After 15 consecutive cycles of extension and recovery in the crimp region (8% elongation) the yarn had the following properties:

	Percent
Work recovery	87
Elastic recovery	85

Example 2

The yarn produced by Example 1 was twisted with 0.7 turn per inch of Z twist and then three ends of this yarn were plied together with 1.5 turns per inch of Z twist. A carpet was tufted by using a Singer Cobble cut-pile tufting machine. The carpet had a warm and soft hand, like a woollen carpet, no piling tendency and excellent crush and wear properties.

If desired, the heat treatment may be carried out as a discontinuous step as exemplified in the following examples.

Example 3

A 900 denier continuous multifilament yarn was extruded using "Profax 6701" polypropylene resin (Hercules Powder Company) mixed with commercial pigment and conventional stabilizers. A spinnerette having 150 holes of 0.012 inch diameter was used. A small amount of a processing lubricant (glycerol monostearate) was applied to the yarn by means of a lubricating roll as shown in FIGURE 1, the yarn being drawn by means of godet rolls as shown at 4 in FIGURE 1. Samples of this yarn tested without further processing, were found to have a tenacity of 1.8 grams per denier and a breaking elongation of 500%. The modulus of elasticity for the fibres was about 23 grams per denier at 1% elongation. The modulus remained nearly constant after 5% elongation.

The extruded yarn described above was bulked using a "Sotexa FT 12" false twisting machine (Societe Mecanique et Textile de l'Ardeche). The false twister gave less than 10% stretch between the input and output ends. The bulked yarn was twisted with three turns per inch of S twist and then four ends of this yarn were plied together with 1.5 turns per inch Z twist. The plied yarn was put on skeins and left in an oven completely relaxed at 145° C. for one hour. The fibres resulting had the following properties:

Yarn denier	1000
Tenacity	grams per denier-- 1.5
Breaking elongation	percent-- 200
Crimp	crimps per inch-- 11

After 15 consecutive cycles of extension and recovery in the crimp region (8% elongation) the yarn had the following properties:

	Percent
Work recovery	92
Elastic recovery	90

Example 4

The heat set yarn produced in Example 3 was used to knit sweater samples. The samples were washed in boiling water for 15 minutes. When dried, the samples showed no appreciable change in dimensions.

Example 5

A continuous multifilament yarn of polypropylene, of 1500 denier and 75 filaments, was extruded using "Profax 6501" polypropylene resin (Hercules Powder Company) mixed with commercial pigment and stabilizers. The spinnerette used had 75 holes each of 0.013 inch diameter, and the draw-down ratio of extrusion was about 25.

Samples of fibres tested without further processing were found to have a tenacity of 1.47 grams per denier and breaking elongation of 650%. The modulus of elasticity for these fibres was found to be 20 grams per denier at 1% elongation.

The yarn was drawn down over godet rolls as shown at 4 in FIGURE 1 and a small amount of lubricant was applied by lubricating roll as shown at 3 in FIGURE 1. The lubricant used was glycerol monostearate.

The extruded yarn above was bulked by means of a false twist machine as described in Example 3, which after adjustment was found to give about 20% stretch to the yarn during false twisting. The bulked yarn was put on skeins and left in an oven completely relaxed at 145° C. for one hour. The fibres so produced have the following properties:

Yarn denier	1500
Tenacity	grams per denier-- 1.2
Elongation	percent-- 250
Crimp	crimps per inch-- 9

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After 15 consecutive cycles of extension and recovery in the crimp region (8% elongation) the yarn was found to have the following properties:

	Percent
Work recovery -----	87
Elastic recovery -----	85

Example 6

The yarn produced according to Example 5 was twisted with 0.7 turn per inch of S twist and then three ends of this yarn were plied together with 1.0 turns per inch of Z twist. A carpet was tufted according to normal commercial practice using this yarn for the pile. The carpet had a warm and soft hand, like a woollen carpet, and showed excellent crush and wear properties.

The stretch recovery properties of the freshly prepared bulked fibres of Examples 1 and 5 are given in Table I below:

TABLE I.—STRETCH RECOVERY PROPERTIES OF BULKED FIBRES

Elongation, percent	Elastic recovery, percent	Work recovery, percent
5 (crimp region) -----	99	95
10 -----	97	92
25 -----	96	75
50 -----	94	70
100 -----	88	60

The comparable properties of the bulked yarns of Example 3 were somewhat better. The above properties refer to one loading and unloading cycle only.

The carpets of Examples 2 and 6 were found to have crush properties as set forth in Table II below:

TABLE II.—CRUSH PROPERTIES OF CARPETS

	No. of treads applied	Pile crush, percent
Hot drawn polypropylene -----	5,000	24
	10,000	27
	15,000	35
Bulked synthetic fibres of Examples 2 and 6 -----	5,000	12
	10,000	18
	15,000	20

The carpet pile weight was 2 pounds per square yard.

In all the examples the elastic recovery at 5% elongation of the freshly prepared yarns was over 95% and the elastic recovery at an elongation of 50% was at least 90%. The resin used had a relative specific viscosity above 3 and a lower melt index value below 2. The yarn tension at extrusion was within the range of about 0.04 gram to about 0.08 gram per denier.

We claim:

1. A process for the production of bulked yarns of polyolefin fibres, the yarns being characterized by low tenacity and high and permanent elastic recovery, the process comprising the steps of melt extruding the polyolefin into fibres, spinning the fibres into yarns, crimping the yarns mechanically to obtain a controlled, regular crimp without intermediate heat stretching, and heat setting the

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crimped yarns by subjecting the yarns in substantially relaxed state to a heat treatment at a temperature short of the melting temperature.

2. A process as claimed in claim 1 wherein the fibres are of isotactic polypropylene.

3. A process as claimed in claim 1 for the production of bulked yarns of isotactic polypropylene, characterized by a tenacity below substantially 2.5 grams per denier and high and permanent elastic recovery, the process comprising subjecting melt spun polypropylene fibres which have been drawn down from the spinning jet but have not been subsequently heat stretched to a mechanical crimp treatment and subsequently to a heat treatment at a temperature short of the melting temperature under conditions such that shrinkage of the fibres occurs.

4. A process as claimed in claim 3 wherein the polypropylene is spun with a draw down of at least 20 times.

5. A process as claimed in claim 3 wherein the polypropylene is spun with a draw down tension within the range of about 0.04 to 0.08 gram per denier.

6. A process as claimed in claim 3 wherein the heat setting temperature is maintained with the range from about 125° C. to 145° C.

7. A process as claimed in claim 3 wherein the yarn is spun, crimped, and passed through a heat setting oven in continuous successive steps.

8. A process as claimed in claim 3 of melt extruding and spinning isotactic polypropylene into spun fibres under a draw down tension within the range of about 0.04 to about 0.08 gram per denier, subjecting the spun yarns to a mechanical crimping treatment to obtain a regular controlled crimp, thereafter subjecting the crimped yarns to a heat setting under a heat treatment at a temperature within the range of about 125° C. to 145° C., without any intermediate heat stretching step, to produce a bulked yarn characterized by a tenacity of less than about 2.5 grams per denier, an elastic recovery greater than 95% after an extension of 5% and an elastic recovery greater than 90% after an extension of 50%.

9. A process as claimed in claim 8 wherein the yarn is spun, crimped, and passed through a heat setting oven in continuous successive steps.

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