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PROCESS FOR PRODUCING FIBERS

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ABSTRACT OF THE DISCLOSURE

Novel polyamide fibers of trans-1,4-cyclohexanedicarboxylic acid, terephthalic acid and 3,3'-ethylenedioxybis-(propylamine) in a molar ratio of trans-1,4-cyclohexanedicarboxylic acid:terephthalic acid:3,3'-ethylenedioxybis (propylamine) of about 70–100:30–0:100. The novel synthetic fibers are heat set by a particular technique and possess a unique set of properties. Preparation of the novel synthetic fibers may be by melt spinning the polyamide at a temperature of at least 290° C., drawing the resulting fiber to at least three times its original length at a temperature of at least about 125° C. and stabilizing the drawn fiber at a temperature of at least about 220° C. while allowing the fiber to relax by at least 3 percent of its drawn length.

The present invention is directed to a process for producing new synthetic fibers which have unexpectedly soft silk-like hand in fabrics, and to a process for their production. More particularly, the invention is concerned with the preparation of synthetic fibers from polyamides of trans-1,4-cyclohexanedicarboxylic acid and 3,3'-ethylenedioxybis(propylamine) containing 0–30 mole percent terephthalic acid.

Fibers obtained from the melt spinning of polyamides of trans-1,4-cyclohexanedicarboxylic acid and 3,3'-ethylenedioxybis(propylamine) containing 0–30 percent terephthalic acid present considerable difficulty in heat setting. For example, as will be demonstrated below, if one utilizes an elevated temperature heat-setting operation at constant length, the resulting fibers still exhibit excessive shrinkage in boiling water (e.g., greater than 15 percent), which renders the fibers unsuitable for use in the manufacture of textile apparel. If, on the other hand, one utilizes elevated temperature heat-setting with free shrinkage, the resulting fibers still do not have sufficiently low boiling-water shrink to be useful for apparel. In addition, if one uses a high enough temperature to effect substantial shrinkage during heat-setting, the fibers suffer serious loss of tenacity and elongation as a consequence of the heat-setting.

Although drawn or drafted fibers of the polyamides of the invention may be satisfactorily heat set by short time restrained boiling water treatment followed by short time unrestrained boiling water treatment, such a stabilizing process unfortunately turns out to be very difficult to adapt to continuous commercial operations because the modulus, which is low in the dry fiber and thus contributes a desirable hand to fabrics, becomes even lower when the fiber is in contact with hot water. Consequently, it becomes very difficult to control yarn tensions in hot water in order to achieve restrained and unrestrained conditions by passage of the yarn around rolls.

According to this invention a process has now been

discovered which can be readily adapted to continuous commercial operations and which provides melt spun fibers of the polyamide to which the invention is directed that can be easily heat set. Moreover, the process of the invention provides novel and unusual fibers having a unique set of properties. The novel polyamide fibers of the present invention can be characterized by a tenacity of at least about 2 grams/denier; an elongation of at least about 20 percent; an elastic modulus of about 25 grams/denier, maximum; a boiling water shrink of about 15 percent, maximum; high elastic recovery, about 100 percent at 10 percent extension and about 95 percent recovery at 15 percent extension; a modulus (when wet) of about 15 grams/denier, maximum; and an inherent viscosity (measured at 25° C. in 60/40 phenol tetrachloroethane) of at least about 0.8 (usually up to about 1.4). This set of properties cannot be found in any other fiber currently on the market or described in the prior art and polyamide fibers exhibiting these properties produce fabrics of novel and desirable properties such as a soft comfortable hand and an unexpectedly silk-like feel. The high elastic recovery of the fiber, for example, contributes to good snap-back and shape retention in fabrics. Also, the relatively high values of tenacity and elongation make the fibers readily blendable with other fibers now on the market such as polyesters and acrylics. Other uses for which the novel fibers of this invention are particularly well suited include carpets and pile fabrics or synthetic furs.

The novel polyamides of the invention may be prepared by a process which comprises melt spinning the polyamide at a temperature of at least about 290° C. (usually up to about 320° C.), drawing the resulting fiber to at least 3 times its original length (usually up to about 6 times its original length), at a temperature of at least about 125° C. (usually up to about 250° C.), and stabilizing the drawn fiber at a temperature of at least about 220° C. (usually up to about say 260° C.) while allowing the fiber to relax by at least about 3 percent (usually up to about 30 percent) of its drawn length. In a preferred embodiment the polyamides are melt spun at a temperature of from about 290° C. to 310° C. with the resulting fiber then being drawn four to five times its original length at a temperature of 200 to 250° C. The drawn fiber is then stabilized at a temperature in the range of from about 250 to 260° C. and allowed to relax by about 5 to 20 percent of its drawn length.

The polyamides to which the invention is directed can be obtained by condensing trans-1,4-cyclohexanedicarboxylic acid and terephthalic acid with 3,3'-ethylenedioxybis(propylamine) in molar ratios of from 100/0/100 trans-1,4-cyclohexanedicarboxylic acid/terephthalic acid/3,3'-ethylenedioxybis(propylamine) to 70/30/100 trans-1,4-cyclohexanedicarboxylic acid/terephthalic acid/3,3'-ethylenedioxybis(propylamine). The preferred polyamides of the invention are those containing 0–20 mole percent terephthalic acid. Condensation methods and techniques utilized for the preparation of the polyamides of the invention are well known to those skilled in the art, having been previously described in the literature. See, for example, U.S. Pat. 2,939,862 to Caldwell and Gilkey, herein incorporated by reference.

The process described above for the preparation of the novel polyamides of the invention can be readily adapted to a continuous operation, for example, by passing multi-

ple ends of drawn yarn around a set of godet rolls driven at a preselected linear speed X, then into a high temperature stabilizing oven and then, after emerging from the oven, around another set of godet rolls driven at a speed somewhat less than X. The speed of the rolls at the output of the stabilizing oven is determined by the amount of relaxation desired, and can be calculated from the formula:

$$\text{Output Speed} = (1.0 - P)X$$

where X=speed of input godet rolls in meters/minute or feet/minute, and P=percentage relaxation desired÷100.

In this way the drafted or drawn yarn can be allowed to relax a predetermined amount during its passage through the elevated temperature oven. Thus, if the yarn speed on emerging from the drafter, for example, is 25 meters/minute, this is also the speed of the godet rolls at the input to the stabilizing oven. If, by way of illustration, it is desired to permit 10 percent relaxation of the yarn during stabilizing treatment, then the speed of the godet rolls at the output of the stabilizing oven is calculated from the above formula as follows:

$$\text{Output Speed} = \left(1.0 - \frac{10}{100}\right) 25 \text{ meters/minute}$$

$$= 22.5 \text{ meters/minute}$$

The importance of the elevated-temperature relaxation step cannot be emphasized enough because yarns produced without it still retain high boiling-water shrink, that is, greater than 15 percent usually 25 percent or more, thus making them unsuitable for apparel use because of the high uncontrolled shrinkage that fabrics made from them would undergo in subsequent contact with hot water, as in scouring, dyeing, laundering, etc.

Both continuous filament and staple fiber having the aforementioned properties can be produced by the practice of the present invention. Such fibers can be readily handled on textile processing equipment for conversion into fabrics. Staple fiber, for example, can be readily carded and drafted into spun yarn and then woven or knitted, or tufted into carpets. Likewise, continuous filament yarn can be readily woven or knitted using standard textile equipment and techniques.

The following examples are included to further illustrate the invention. In all the examples given below the copolyamide or homopolyamide, hereinafter referred to as polymer, is prepared by the following prepolymer-solid-phase process: A solution of the salt in water, (i.e. mole ratios of 100–70 trans-1,4-cyclohexanedicarboxylic acid and 0–30 terephthalic acid combined with 100 moles of ethylenedioxybis(propylamine)) is fed to a multistage, continuous type reactor. Water of solution and water of reaction are removed at a pressure of 150–200 p.s.i. and a temperature of 240–250° C. The resulting prepolymer is then granulated and built up in the solid phase at a temperature of 220–230° C. Inherent viscosities, hereinafter designated as I.V., are determined on polymer and fiber by a procedure well known to workers in the field of polymers, in 60/40 phenol/tetrachloroethane solution at a temperature of 25° C.

EXAMPLES 1–6

The homopolyamide of trans-1,4-cyclohexanedicarboxylic acid and 3,3'-ethylenedioxybis(propylamine) having an I.V. of 1.4 is melt spun with a ¾-inch screw extruder and a spinneret having 5 holes of 0.3-mm. diameter each, at a temperature of 300° C. The melt-spun yarn has an I.V. of 1.1. This yarn is drafted 4.6 times its original length by means of differentially driven godet rolls, in air at 130° C. Drafted yarn samples are then subjected to various heat-setting treatments and the properties of the heat-set yarns are then measured by techniques well known to workers in the field of fibers. The results obtained from these measurements are given in Table I.

TABLE I.—PROPERTIES OF YARNS

Ex. No.	Heat-setting	Tenacity, grams/denier	Percent elongation	Elastic modulus, grams/denier	Percent boiling water shrink
1	None	2.9	40	15	24
2	5 minutes at 140° C.[1]	2.9	31	17	21
3	5 minutes at 140° C.[2]	2.0	35	14	20
4	5 minutes at 175° C.[1]	2.8	19	21	17
5	5 minutes at 175° C.[2]	0.6	5	12	12
6	1 minute[3]	2.7	50	13	0

[1] Yarn heat-set at constant length (restrained).
[2] Yarn heat-set with free shrink (unrestrained).
[3] Boiling water at constant length followed by 1 minute boiling water with free shrinkage.

EXAMPLES 7–10

A polymer as in Example 1 but of 1.3 I.V. is melt-spun using a 1½-inch screw extruder feeding a gear pump which delivered the melt to a spinneret having 50 holes of 0.3-mm. diameter each. Temperature of the extruder, gear pump, and spinneret is 300° C. The melt-spun yarn has an I.V. of 1.0. The yarn is now drafted 4.5 times its original length in air at 130° C., samples are heat-set under various conditions, and properties of the resulting yarns are measured. Results of these tests are given in Table II.

TABLE II.—PROPERTIES OF YARNS

Ex. No.	Heat-setting	Tenacity, grams/denier	Percent elongation	Elastic modulus, grams/denier	Percent boiling water shrink
7	None	2.6	38	19	33
8	5 minutes at 140° C.[1]	2.6	24	18	28
9	5 minutes at 175° C.[1]	1.9	44	19	18
10	1 minute [2]	2.5	50	15	0

[1] Yarn heat-set at constant length (restrained).
[2] In boiling water at constant length followed by 1 minute in boiling water with free shrinkage.

EXAMPLES 11–14

A polymer as in Example 1 but of 1.5 I.V. is melt-spun using a screw extruder feeding a gear pump which delivered the melt to a 100-hole spinneret of 0.25-mm. hole diameter. The extruder, grear pump and spinneret are held at 300° C. The yarn I.V. is 1.1. Yarn is drafted, with differentially-driven sets of godet rolls, through an air oven of 2-feet length. After emerging from the drafter, the yarn is passed through a second hot-air oven of 12-feet length; by adjusting the speeds of the input and output sets of godet rolls for this oven, the drafted yarn can be allowed to relax by a predetermined amount. Air temperature in the drafting oven is 240° C.; that in the stabilizing oven is 260° C.; yarn speed at the input rolls of the drafter is 5.0 meters/minute and the output speed is 25.0 meters/minute so that a draft ratio of 5.0 times its original length is given to the yarn. Speed of the input rolls to the relaxing oven is accordingly also 25.0 meters/minute. Relaxing conditions used and properties of the resulting yarns are shown in Table III on the following page.

TABLE III.—PROPERTIES OF YARNS

Example Number	Amount of percent of relaxation in 260° C. stabilizing oven	Tenacity, grams/denier	Percent elongation	Elastic modulus, grams/denier	Percent boiling water shrink
11	0	4.5	30	18	20
12	10	4.4	38	16	8
13	15	4.0	41	16	7
14	20	3.6	43	14	4

EXAMPLE 15

Filament yarn is produced under the conditions given in Example 14 in Table III above. After drafting, sufficient packages are plied together to give a tow of approximately 25,000 total denier; this tow is passed through a crimper to give approximately 10 crimps/inch, then through a tow dryer at 120° C., after which it is

then cut into 2-inch staple length on rotating staple-cutting wheels. Properties of this staple are measured while in both a dry and wet state, the latter after immersing in distilled water at room temperature for 1 hour. Properties obtained from these tests are listed in Table IV.

TABLE IV.—PROPERTIES OF 4.5 DENIER/FILAMENT, 2-INCH HOMOPOLYAMIDE STAPLE

	Dry [1] (average of 30 measurements)	Wet (average of 30 measurements)
Denier	4.5	4.5
Tenacity, grams/denier	3.3	1.8
Elongation, percent	52.0	38.0
Elastic modulus, grams/denier	16.0	7.0
Boiling water shrink, percent	3.0	
Elastic recovery, percent:		
From 10 percent extension	100.0	100.0
From 15 percent extension	95.0	95.0

[1] Conditioned to standard testing conditions of 70° F. and 65 percent relative humidity.

EXAMPLE 16

Ten pounds of staple fiber are produced as in Example 15. This staple is made into a lap and carded on a conventionel flat top card with metallic wire doffer and cylinder. Two drawing passes are made on a draw frame at 500 feet/minute and a 20/1 cotton-count yarn is spun from two ends of 2.00 hank roving on an SZ–5 spinning frame. Properties of this 20/1 cotton-count spun yarn are measured and are listed in Table V below.

TABLE V.—PROPERTIES OF 20/1 COTTON-COUNT HOMOPOLYAMIDE SPUN YARN

	Dry	Wet
Tenacity, grams/denier	2.0	1.1
Elongation, percent	32	34
Elastic modulus, grams/denier	9	5
Elastic recovery:		
From 5 percent extension, percent	100	100
From 10 percent extension, percent	99	99
From 15 percent extension, percent	95	96
Boiling water shrink, percent	4.0	4.0
Shrink in 175° C. air, percent	0	0

Packages of this spun yarn are then used to knit a circular tube on a laboratory circular knitting machine. This knit tube is found to have a surprisingly soft and pleasant hand.

EXAMPLES 17–19

The copolyamide of 0.85 mole trans-1,4-cyclohexanedicarboxylic acid/0.15 mole terephthalic acid/1.0 mole 3,3'-ethylenedioxybis(propylamine) of 1.3 I.V. is melt-spun on an extruder, gear pump, spinneret unit held at 300° C., using a 50-hole/0.3-mm. hole diameter spinneret. Samples of this yarn are drafted exactly as in Examples 11–14 above, except that after drafting the yarn is permitted to relax 10 percent during the stabilizing treatment, and the stabilizing-oven treatment is varied, as shown in Table VI below. Yarn I.V. is 1.0.

TABLE VI.—PROPERTIES OF YARNS OF COPOLYAMIDE OF 0.85 MOLE TRANS-1,4-CYCLOHEXANEDICARBOXYLIC ACID/0.15 MOLE TEREPHTHALIC ACID/1.0 MOLE 3,3'-ETHYLENEDIOXYBIS(PROPYLAMINE)

Example Number	Temperature of stabilizing oven for 10 percent relaxation	Tenacity, grams/denier	Percent elongation	Elastic modulus, grams/denier	Percent boiling water shrink
17	Control [1]	3.3	30	15	30
18	260	3.0	20	13	6
19	250	3.2	20	14	10

[1] Not given any elevated-temperature stabilizing treatment.

EXAMPLES 20–44

Packages of continuous filament yarn of approximately 70 total denier (40 filaments) are made as follows. The polymer of Example 7 is melt-spun using an extruder, gear pump, spinneret unit heated at 295° C., with a 40/0.3-mm. spinneret being employed. Separate melt-spun packages are then drafted and heat-relaxed, by the technique described in Examples 12–14 above except that draft input speed is 8 meters/minute. A relaxation of 8 percent is permitted during the heat-stabilization step, and other conditions are varied as shown in Table VII. Yarn I.V. is 1.1.

TABLE VII.—CONTINUOUS FILAMENT (70/40) HOMOPOLYAMIDE YARN

Example Number	Draft: Ratio	Draft: Air temp., ° C.	Air temp. for 8 percent relaxation used	Tenacity, grams/denier	Percent elongation	Elastic modulus, grams/denier	Percent boiling water shrink
20	4.0	150	180	2.2	54	15	26
21	4.0	150	220	2.2	60	15	23
22	4.0	150	260	2.2	64	12	8
23	4.5	150	180	2.5	48	16	31
24	4.5	150	220	2.8	46	17	25
25	4.5	150	260	2.5	51	13	4
26	4.0	200	200	2.3	56	18	27
27	4.0	200	220	2.3	61	16	25
28	4.0	200	260	2.3	64	13	6
29	4.5	200	200	2.6	30	19	26
30	4.5	200	220	3.3	43	18	26
31	4.5	200	260	2.5	35	14	4
32	5.0	200	200	3.3	20	21	30
33	5.0	200	220	3.4	24	20	29
34	5.0	200	260	3.2	23	19	11
35	4.0	220	220	2.1	40	22	25
36	4.0	220	260	2.2	37	16	11
37	4.5	220	220	2.5	26	17	24
38	4.5	220	260	2.6	32	16	10
39	4.0	240	220	2.2	47	17	18
40	4.0	240	260	2.0	38	15	10
41	4.5	240	220	2.6	26	19	17
42	4.5	240	260	2.4	41	15	7
43	5.0	240	220	2.5	41	19	17
44	5.0	240	260	3.4	20	20	11

It can be seen from the above table that temperatures up to 220° C. in the heat-relaxing step are no sufficient to reduce the boiling-water shrink in the resulting yarn to less than 15 percent whereas, at a heat-relaxing temperature of 260° C., yarn is produced which has boiling-water shrink of 4–11 percent (Examples 22, 25, 28, 31, 34, 36, 38, 40, 42, and 44 above), a satisfactory level for textile yarns. An indication of the range of drafting conditions useful in the invention is also shown by the data in the above table, in that draft ratios of 4.0 to 5.0 times the yarn's original length, at air temperatures from 150 to 240° C., produced yarn of good tensile properties.

EXAMPLE 45

Packages of 70/40 continuous filament yarn are produced as in Example 42 except that the input draft speed is 8 meters/minute, draft ratio is 4.6 times the yarn's original length, and 6 percent relaxation is allowed during heat stabilization. Twenty ends of yarn are drafted and heat-stabilzed at a time and wound into separate packges with about two Z-twists/inch. Packages of 40/27 continuous filament yarn are produced from the polymer of Example 7 by the following procedure. An extruder, gear pump, spinneret unit heated at 290° C. is used for melt-spinning, with a 27/0.3-mm. spinneret being em-

ployed. The yarn is drafted 20 ends at a time, using 8 meters/minute input draft speed, 4.2 times its original length draft ratio at 240° C. draft-oven air temperature, with 5 percent relaxation at 260° C. air temperature in the relaxing oven. Properties of the continuous filament yarns are given in Table VIII.

TABLE VIII.—PROPERTIES OF CONTINUOUS FILAMENT HOMOPOLYAMIDE YARN

	70/40 yarn (average of 36 packages)	40/27 yarn (average of 78 packages)
Tenacity, grams/denier	3.2	2.8
Elongation, percent	36.0	35.0
Elastic modulus, grams/denier	17.0	14.0
Boiling water shrink, percent	7.0	5.0
I V	1.1	0.9

The continuous filament yarns are twisted to 7 turns/inch and woven into two plain-weave fabrics 50-in. wide, using 108 ends/inch of 40-denier for the warp. One fabric is woven with 92 picks/inch of 40-denier yarn for the filling, and the other with 84 picks/inch of 70-denier yarn for the filling. After a scouring and desizing treatment, both fabrics are found unexpectedly to have a very soft silky hand. Samples of these fabrics when dyed with 2 percent of Cibalan brilliant dyes at 180° F., using standard dyeing techniques, exhibited pleasing bright shades.

EXAMPLE 46

The polymer of Example 7 is melt-spun into yarn of 1.1 I.V. using an extruder, gear pump, spinneret unit heated at 300° C., with a 100/0.3-mm. spinneret being employed. 1.5 denier-filament 1½-inch staple fiber is produced as in Example 15 except that drafting and relaxing conditions used are those of Example 40 in Table VII. Thirty pounds of this staple is then converted into 30/1 cotton-count spun yarn, using processing procedures well known to those skilled in the textile art and similar to that described in Example 16 previously. This spun yarn is then knit on a 20-cut jersey knitting machine into a fabric which, after scouring and drying, is sewn into T-shirts. These T-shirts are found to have a soft hand, and when worn gave a very comfortable, pleasant feel to the wearer. In contrast, T-shirts similarly made from commercial 1½-denier polyester staple fiber are found to impart a clammy, uncomfortable sensation to the wearer.

EXAMPLE 47

The copolyamide of Example 17 is melt spun into yarn of I.V. 1.1, using an extruder, gear pump, spinneret unit heated at 300° C., with a 50/0.3-mm. spinneret being employed. The melt-spun yarn is then given the same drafting and heat-stabilizing treatment as that of Example 18. Small skeins of this yarn are then subjected to the following treatment: (A) scouring for 30 minutes at 90° C. in an aqueous solution of 1 percent Igepon T plus 1 percent tetrasodiumpyrophosphite, dyeing 1 hour at the boil with a commercial premetallized yellow dye, rinsing, scouring again, and then drying in a 250° F. oven. Samples of yarn after the above treatment are then subjected to the following treatments: (1) Hoffman pressing; (2) Stoddard-solvent dry cleaning, under a procedure specified by the AATCC (American Association of Textile Chemists and Colorists); (3) perchloroethylene dry cleaning, under a procedure specified by the AATCC. Skeins are examined after each of the three numbered treatments above and are found to exhibit substantially no evidence of loss in the bright yellow color (obtained after the first treatment A) or of fiber degradation.

EXAMPLE 48

Yarn is produced under conditions identical to those of Example 44. Packages of this yarn are used to knit a circular tube on a laboratory knitting machine. A sample of this knit tube is dyed with 3 percent Eastman Fast Blue GLF, using standard disperse dye procedure at the boil with no carrier. The dyed sample is then subjected to 25 cycles of dry cleaning in perchloroethylene, at the end of which it showed no evidence of color loss or fiber degradation.

EXAMPLE 49

Staple fiber of 15 denier/filament and 6-inch length is produced by a procedure similar to that described in Example 15, except that in melt spinning the homopolyamide a 100-hole spinneret of 0.45-mm. hole diameter is used. This staple fiber is carded and spun into 2½ c.c. yarn with 4 Z-twists per inch in the singles and 3 S-twists per inch in the ply, using procedures well known to workers in the textile field. This spun yarn is then tufted into a 32 ounce/square yard level loop carpet, again using techniques which are familiar to those skilled in the textile art. This carpet is found to have a surprisingly soft, luxuriant feel with excellent resilience or recovery from crushing.

From the foregoing it can be seen that by practicing this invention one can produce a line of totally new synthetic fibers from a series of homopolyamides and copolyamides. That is, by following the plurality of process steps set forth hereinbefore, novel and unusual fibers are produced having the following unique set of properties:

Inherent viscosity (measured in 60/40 phenol/tetrachloroethane)—at least about 0.8
Tenacity, grams/denier—at least about 2
Elongation, percent—at least about 20
Elastic modulus, grams/denier—about 25 maximum
Boiling water shrink, percent—about 15 maximum
Elastic recovery:
  From 10 percent extension, percent—about 100
  From 15 percent extension, percent—at least about 95
Modulus (when wet), grams/denier—about 15 maximum
Moisture absorption, percent—at least 3

As mentioned hereinbefore, this set of unique properties cannot be found in any other fiber heretofore known in the art. Thus fibers of this invention having this set of properties are readily formed into fabrics and the like that have novel and highly desirable properties such as, for example, a very soft, comfortable hand with an unexpectedly silk-like feel. Furthermore, the high elastic recovery of the novel fibers contributes to good snapback and shape retention in fabrics while the relatively high values of tenacity and elongation make these fibers readily blendable with other fibers now on the market. The novel fibers can also be readily converted into carpets and pile fabrics which have a soft, luxurious feel with excellent resilience.

The invention has been described in detail with particular reference to preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention as described hereinabove and as defined in the appended claims.

We claim:

1. A process for the preparation of novel synthetic fibers of polyamides of trans-1,4-cyclohexanedicarboxylic acid, terephthalic acid and 3,3'-ethylenedioxybis(propylamine) in a molar ratio of trans-1,4-cyclohexanedicarboxylic acid : terephthalic acid : 3,3'-ethylenedioxybis (propylamine) of about 70 to 100:30 to 0:100, the fiber having an inherent viscosity (measured in 60/40 phenol-tetrachloroethane) of at least 0.8, a tenacity in grams/denier of about 2 or more, an elongation of about 20 percent or more, an elastic modulus in grams/denier of about 25 or less, boiling water shrink of about 15% or less, an elastic recovery of 100% from 10% extension, elastic recovery of about 95% or more from 15% extension and a modulus when wet of about 15 grams/denier or less, the process comprising melt spinning said polyamide at a temperature of at least 290° C., drawing the

resulting fiber to at least 3 times its original length at a temperature of about 125° C. or more and stabilizing the drawn fiber at a temperature of about 220° C. or more while allowing the fiber to relax by about 3 percent or more of its drawn length.

2. The process of claim 1 wherein the polyamide contains less than 20 percent terephthalic acid.

3. The process of claim 1 wherein the molar ratio of trans-1,4-cyclohexanedicarboxylic acid:terephthalic acid: 3,3'-ethylenedioxybis(propylamine) is 85:15:100.

4. The process of claim 1 wherein the polyamide contains 0 percent terephthalic acid.

5. The process of claim 4 which comprises melt spinning said polyamide at a temperature of between about 290 and 310° C., drawing the resulting fiber to between about 4 to 5 times its original length at a temperature of between about 200 and 250° C. and stabilizing the drawn fiber at a temperature of between about 240 and 260° C.

while allowing the fiber to relax between about 5 and 20 percent of its drawn length.

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