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# SYNTHETIC FIBER SEWING THREAD

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## ABSTRACT OF THE DISCLOSURE

Sewing thread made from a polyethylene terephthalate staple fiber having a denier/filament less than 1.5 and a length 1.5 inches. The thread is characterized by; a modulus generally equal to that of cotton threads; low elongation and elastic recovery; stable to hot air and hot water; resistance to durable press finishing chemicals; and a high strength to size ratio. These sewing threads possess excellent sewability characteristics and possess advantages of both cotton and synthetic based threads without the disadvantages of either.

This invention relates to sewing thread made from synthetic fibers, and more particularly to spun staple threads made from synthetic fibers.

The prior art is replete with examples of sewing thread made of natural fibers, blends of natural fibers and synthetic fibers, and 100% synthetic fibers. The prior art sewing threads generally were designed to merely mechanically join one piece of fabric to another.

The sewing threads used in the "cut and sew" industry were primarily cotton for many years. However, in recent years, the acceptance of the new "ease of care" concepts has directed attention to the shortcomings of the sewing threads commonly used in the fabrication of garments and the like. The problem of the proper sewing thread in overall garment performance has become larger as new fabrics are developed. Particularly, the durable press fabrics have presented problems in fabrication and subsequent durability as to seam geometry and strength. The resins used to obtain the durable press characteristic in fabrics attacked cotton sewing threads and caused significant loss in strength. For this reason alone a great need exists for a sewing thread which will not be degraded by these chemicals and yet will retain desirable characteristics.

Cotton sewing threads have long been regarded as the standard of the "cut and sew" industry. Most sewing machines now in use are primarily designed to obtain optimum sewing performance with cotton threads. The use of most known synthetic threads on the present day sewing machines requires machine modifications and even basic alterations of the machines in order to use the synthetic threads. These modifications become necessary to obtain improved sewability (efficient sewing of a garmet with quality seams) with the newer synthetic based threads which have different physical and behavior characteristics as compared with cotton threads.

The acceptance of synthetic based threads has been forced on the "cut and sew" industry to obtain desired qualities but this acceptance is an obvious compromise between the qualities of cotton threads and the needed qualities of the newer synthetic based threads. Some of the thread properties that are needed for sewing garments with today's finishes are high strength to size ratio, low elongation and low elastic recovery, good stability to hot water and hot air, good whiteness retention to heat treatments, good resistance to chemicals, and good sewability.

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It is common in the manufacture of synthetic based sewing threads to subject the threads to treatments after they are spun in an attempt to impart thereto characteristics which will help enhance the stability characteristics of the thread. This treatment may consist of heating the spun thread while subjecting it to a slight draft. Of course such operations are expensive and must be run under a high degree of control. Variations in the processing results in the synthetic based threads not having the good stability characteristics which are necessary in order to obtain good quality seams.

The sewing threads made in accordance with my invention are characterized by uniform and excellent stability characteristics and therefore do not require expensive aftertreatment to render them useful as high quality sewing threads.

Cotton threads have low elongation and low elastic recovery, relatively low strength, poor whiteness retention to heat, and poor resistance to finishing chemicals (i.e. dihydroxydimethyl ethylene urea) used in durable press and other finishes.

The synthetic based threads now available have good strength, poor sewability, poor whiteness retention to heat treatments, high elongation and elastic recovery unless subjected to expensive processing after spinning, poor stability to hot air and hot water treatments unless stabilized, and in some instances good resistance to chemicals.

It is therefore an object of this invention to provide a sewing thread spun from a high modulus fiber of a linear condensation polymer. Another object is to provide a spun polyester sewing thread which has a modulus generally equal to cotton threads. Still another object of this invention is to produce a polyester sewing thread which when spun has low elongation and low elastic recovery. A further object of this invention is to produce a sewing thread which is stable to hot air and to hot water. A still further object is to produce a sewing thread which is characterized by sewability and resistance to chemicals normally used in durable press finishing processes.

As a preferred embodiment of my invention, I spin the yarn used to make the sewing thread from a polyethylene terephthalate staple fiber having a denier/filament less than 1.5, and a length of 1.5 inches. This preferred fiber is characterized by an I.V. $>0.55$; ultimate tenacity $>5.2$ g./d. (grams per denier); tenacity at 10 percent elongation $>4$ g./d.; ultimate elongation $<25$ percent; elastic modulus $>45$ g./d.; and total modulus

$$(\text{modulus} \times \text{d./f.}) > 45$$

grams/filament.

The sewing thread of my invention will be made from fibers having the above identified characteristics, will normally have about 20 turns per inch of S twist singles and about 20 turns per inch Z twist ply and will be two or more ply. The thread will also be treated with a lubricant which will result in low steel to fiber friction. Hereinafter, for ease of description, I will refer to the sewing thread of this invention as novel H.T. thread.

Fibers which are suitable for producing the novel H.T. sewing thread may be made by drafting polyethylene terephthalate fibers to the desired size and then subjecting the fibers to a heatsetting operation while holding under constant tension and then cooling the heated fiber.

Two methods of treating these fibers to produce the novel H.T. thread are set forth in Examples I and II below. A more detailed understanding of my invention will be had from a consideration of the following examples which are set forth to illustrate certain preferred embodiments.

## EXAMPLE I

Polyethylene terephthalate fiber is spun from a spinnerette containing 600 orifices, 0.4 mm. in diameter at a spinning speed of 1050 m./m. and a melt temperature of 300° C. The undrawn fiber is 4.2 d./f. and the spinning rate is 39 lbs./hour. This yarn is drafted by a conventional two-stage drafting method at a total draft of 3.5:1. The yarn is heatset for 6 seconds at constant length on hot (200° C.) rolls, and then is crimped, it is then heatset in tensionless state for 5 minutes at 140° C. and thereafter cut into staple length. Fibers produced under the above conditions will process satisfactorily on the cotton system and will have the characteristics necessary to produce a spun sewing thread having a strength to size ratio of at least 3.5 grams/denier at 10 percent elongation; elastic recovery of less than 80 percent at 10 percent elongation; boiling water shrinkage of 1 percent or less, heat stability of less than 5 percent shrinkage at 171° C. for 18 minutes; modulus of about 40 grams/denier; and a breaking elongation of less than 15 percent.

## EXAMPLE II

Polyethylene terephthalate continuous filaments are spun from a spinnerette containing 670 circular orifices, 0.45 mm. in diameter at a spinning speed of 1100 meter/minute and a melt temperature of 300° C. The undrawn denier is 4.8 d./f. and the spinning rate is 52 lbs./hour. These filaments, collected as tow, are drafted by a conventional two-stage drafting method at a total draft of 4:1. The filaments are heatset for about 33 seconds at constant length in a heatset oven at 220° C. The tow is then crimped, dried and cut into staple fiber length. Fibers produced under the above conditions will process satisfactorily on the cotton system and will have the characteristics necessary for the production of sewing threads having the characteristics set forth in Example I.

The fibers made under the conditions set forth in Examples I and II are generally made into spun sewing threads, but threads from the filament yarn may also be made in accordance with my invention.

The novel and desirable characteristics of the sewing thread of my invention can be better appreciated and understood from a consideration of the data set forth in the following tables.

Table 1.—Strength of novel H.T. threads

| Thread type: | Strength in g./d. |
|---|---|
| Mercerized cotton | 2.8 |
| Polyester corespun | 3.3 |
| Spun regular polyester | 3.8 |
| Spun novel thread | 4.4 |

The table above summarizes strength characteristics of several generic types of threads indicating the improvements offered by my spun novel H.T. threads.

Table 2.—Finer thread sizes available from spun novel polyester threads (1¼ d./f. x 1½")

| Thread size (cotton cts.): | Strength in pounds |
|---|---|
| 50/2 (210 denier) | 2.04 |
| 60/2 (178 denier) | 1.54 |
| 80/2 (133 denier) | 1.08 |
| 90/2 (118 denier) | .91 |
| 100/2 (106 denier) | .80 |
| 110/2 (89 denier) | .62 |
| 50/2 (mercerized cotton) | 1.30 |
| 50/2 (polyester corespun) | 1.53 |
| 50/2 (regular spun polyester) | 1.72 |

The cotton, corespun, and spun polyester threads tested are the smallest readily commercially available.

The high strength to size ratio of the novel H.T. thread offers several advantages. Seams with fewer stitches per inch or nearly invisible seams with adequate seam strength are available. Heretofore, a high stitch count or an obvious seam was required in garment fabrication. The latter conditions would tend to increase probability of seam puckering.

Spun staple fiber novel H.T. sewing threads are characterized by their unique improvement in modulus properties, particularly when compared to other synthetic threads. The following table will illustrate.

Table 3.—Improvement in thread modulus (force required to elongate) without further treatment

| Thread type: | Modulus (g./d.) |
|---|---|
| Polyester corespun | 13.9 |
| Regular spun polyester | 20.6 |
| Spun novel H.T. polyester | 40.7 |

The improvement in modulus will promote sewing efficiency and minimize seam puckering.

Note: Modulus as used here is defined as the slope of the thread stress-strain line in grams per denier to the first yield point which relates the thread's elongation and strength properties.

The reduction in the elongation without a decrease in strength is another unique feature of spun novel H.T. threads. The following table illustrates.

Table 4.—Elongation to break

| Thread type: | Percent elongation |
|---|---|
| Polyester corespun | 25 |
| Regular spun polyester | 25 |
| Novel H.T. spun polyester | 14 |

The significance of low elongation is that thread tension adjustments do not require continuous attention to prevent tight stitches from forming and skip stitches.

Seams formed with threads with high elastic recovery tend to pucker when the thread is under stress and strain during the formation of the stitch. When these stresses and strains are released, the threads return to their original configuration, causing fabric plies to jam together. To minimize this, a low elastic recovery or low memory for a thread is necessary. The uniqueness of spun novel H.T. threads is illustrated.

Table 5.—Lower and improved elastic recovery offered by spun novel H.T.

| Thread type: | Percent elastic recovery at 5% elongation |
|---|---|
| Polyester corespun | 95 |
| Spun regular polyester | 95 |
| Spun novel H.T. | 74 |

Five percent elongation was selected and the values are relative from two to ten percent elongation.

Poor thread stability to either hot water or hot air treatment leads directly to seam puckering which must be eliminated to produce a quality garment for the ultimate consumer. Novel H.T. spun threads have improved and satisfactory stability to both hot air and hot water without further treatments by the thread manufacturer. The improvement is illustrated.

Table 6.—Improved stability to hot air and hot water treatments

| Thread type | Percent shrinkage, hot air | | Percent shrinkage, hot water | |
|---|---|---|---|---|
| | 190° C. 10 min. | 171° C. 18 min. | 212° F. 2 min. | 140° F. 2 min. |
| Mercerized cotton | | −1.7 | −1.6 | −2.0 |
| Polyester corespun | −10.4 | −7.5 | −1.8 | −1.6 |
| Spun regular polyester | −12.5 | −11.0 | −5.0 | −0.5 |
| Spun novel H.T. | −3.8 | −2.6 | −1.0 | −0.4 |

The following table sets forth a comparison of physical properties of the novel thread of this invention and two prior art threads that are now in wide use in the industry.

THREAD PHYSICAL PROPERTIES COMPARISONS

| Thread type | Relative strength | Relative size to obtain strength | Resistance to elongation | Resistance to elastic recovery | Shrinkage | | | Chemical resistance | Percent elastic recovery at 5% elongation | Sewability |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Hot water | | Hot air, 350° F. 18 min. | | | |
| | | | | | 140° F. 2 min. | 212° F. 2 min. | | | | |
| Mercerized cotton | P | Large | E | E | G | G | E | P | E | E |
| Polyester corespun | F | Small | P | P | G | G | G | G | P | G |
| Regular spun polyester | G | do | P | P | E | P | P | E | P | G |
| Spun novel H.T. | E | Very small | G | G | E | E | E | E | G | E |

P—Poor, F—Fair, G—Good, E—Excellent, A—Acceptable, C—Expensive.

Another advantage of the novel H.T. sewing thread is that it can be made from polyester containing an optical brightener. This makes it possible to form a thread that retains its whiteness or brightness markedly better than cotton.

The superior combination of characteristics of the sewing thread of this invention will give to the garment industry a sewing thread having the desirable characteristics of cotton sewing thread without having the obvious disadvantages of cotton sewing thread. The sewing threads made in accordance with this invention also will have the desirable characteristics of synthetic based sewing threads without the disadvantages of presently available synthetic based sewing threads.

This 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.

I claim:

**1.** Sewing thread comprising a twisted multifilament fibrous strand characterized by:

(a) strength to size ratio of at least 3.5 grams/denier at 10% elongation;

(b) elastic recovery of 80% or less at 10% elongation; and

(c) boiling water shrinkage of 1% or less.

**2.** Sewing thread of claim **1**, being further characterized by hot air heat stability of 5% or less shrinkage at 171° C. for 18 minutes.

**3.** Sewing thread of claim **1** being further characterized by breaking elongation of less than 15%.

**4.** Sewing thread of claim **1** being further characterized by a modulus of about 40 grams/denier.

**5.** Sewing thread comprising spun staple polyester fibers, said thread being characterized by:

(a) strength to size ratio of at least 3.5 grams/denier at about 10% elongation;

(b) elastic recovery of 80% or less at about 10% elongation;

(c) boiling water shrinkage of 1% or less;

(d) hot air heat stability of 5% or less shrinkage at 171° C. for 18 minutes;

(e) modulus of about 40 grams/denier; and

(f) a breaking elongation of less than 15%.

**6.** Fibrous strand comprising fibers of polyethylene terephthalate which have been drafted to a denier per filament of less than 1.5 and heatset while maintained at a constant length, said fibers being spun into a sewing thread having about 20 turns per inch S twist in singles, said singles being twisted at least two ply and having about 20 turns per inch Z twist, said sewing thread being characterized, without further treatment after spinning, by:

(a) a strength to size ratio of at least 3.5 grams/denier at 10% elongation; and

(b) elastic recovery of 80% or less at 10% elongation.

**7.** Fibrous strand of claim **6** having a boiling water shrinkage of 1% or less.

**8.** Fibrous strand of claim **6** having a breaking elongation of less than 15% and a modulus of about 40 grams/denier.

**9.** Fibrous strand of claim **6** having a hot air heat stability of 5% or less shrinkage at 171° C. for 18 minutes.

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