

TITLE

UV Resistant Elastomeric Monofilament

BACKGROUND OF THE INVENTION

5 The present invention relates to a method for improving the resistance of elastomeric polyester monofilament, especially a co-extruded, two-component monofilament, to degradation from exposure to ultraviolet (UV) light. More particularly, the present invention relates to UV resistant elastomeric monofilament having a sheath and a core which each contain a UV protecting amount of carbon in the range of from about 1.8% up to 3.0% by wt.

10 U.S. Patent No. 4,469,739 describes an oriented woven furniture support material made in part from elastomeric monofilament and in part from natural or synthetic yarn. The elastomer is woven in a first direction and the yarn in a second direction perpendicular to the first direction followed by heat setting of the resulting woven fabric. According to one embodiment, the thermoplastic
15 elastomer filaments are co-extruded, two-component sheath/core monofilaments in which the elastomer comprising the sheath has a melting point of at least 20°C lower than the core elastomer. Heretofore, use of such a woven fabric, e.g., as a seat support material, has been restricted to applications where it would not be exposed to UV light, for example, applications in which the fabric is covered by
20 another layer of material which, in turn, prevents UV light from directly or indirectly contacting the fabric. UV light has been shown to cause a substantial reduction in physical properties of the woven fabric, especially the elastomeric monofilament component of the fabric.

SUMMARY OF THE INVENTION

25 The present invention resides in the discovery that the resistance of a two component elastomeric polyester monofilament comprising a sheath and a core to degradation from exposure directly or indirectly to UV light can be substantially improved by incorporating into the elastomeric material of the sheath and the core a UV protecting amount of carbon. According to one aspect, therefore, the
30 invention is a method for improving the UV resistance of a two component elastomeric monofilament having a core and a sheath by incorporating into said core and into said sheath a UV protecting amount of carbon.

According to another aspect, the present invention is an improved two-component elastomeric monofilament having a core consisting essentially of a
35 first polyester elastomer and a sheath consisting essentially of a second polyester elastomer, said second, i.e., sheath, elastomer having a melting point which is at least 20°C lower than the first elastomer, wherein the improvement comprises incorporating into said first elastomer and into said second elastomer a UV

protecting amount of carbon, e.g., an amount generally in the range of from about 1.8% to 3.0% by wt. carbon of predetermined particle size. In a preferred embodiment the carbon is incorporated into each elastomer composition by first preparing a concentrate comprising 75% by wt. of that elastomer and 25% by wt. carbon, and then uniformly blending the carbon/elastomer concentrate into the corresponding base elastomer in a ratio of 10% by wt. concentrate to 90% by wt. base elastomer. The resulting concentration of carbon in each of the core and the sheath elastomer components should be in the above-described range, although for best results the concentration of carbon is about 2.5% by wt.

According to yet another aspect, the present invention is an improved oriented woven support material, such as, for example, a support material for furniture, comprising crossed strands in a first direction and in a second direction perpendicular to the first direction, wherein the strands in the first direction comprise oriented thermoplastic elastomer monofilament of a sheath/core configuration selected from the group consisting of copolyetheresters, polyurethanes, and polyesteramides, and the sheath is an elastomer whose melting point is at least 20°C lower than the melting of the elastomer in the core, and the strands in the second direction comprise a non-elastomeric, natural or synthetic yarn, the improvement comprising incorporating into said sheath and into said core a UV protecting amount of carbon, e.g., an amount generally in the range of from about 1.8% up to 3.0% by weight, and preferably 2.5% by wt. carbon.

When carbon has been incorporated into both the core and the sheath as described, the resulting elastomeric monofilament has substantially improved resistance to degradation by UV light than when carbon is incorporated into the sheath alone or not at all.

DETAILED DESCRIPTION

The thermoplastic elastomer used in the sheath/core monofilament of the invention can be an orientable copolyetherester elastomer, a polyurethane elastomer, or a polyesteramide elastomer, where the melting point of the sheath component is substantially less than the melting point of the core component, i.e., at least about 20°C lower than the melting point of the elastomer in the core. The preferred thermoplastic elastomers for use according to the invention is a copolyetherester elastomer as described in one or more of U.S. Patent Nos. 3,651,014; 3,763,109, 3,766,146; and 4,136,715, the teachings of which are incorporated herein by reference. Such copolyetherester polymers consist essentially of a multiplicity of recurring intralinear long-chain and short-chain ester units connected head-to-tail through ester linkages, their chemical structures being well known to those skilled in the art.

In a preferred embodiment of the invention, the sheath of the monofilament is Hytrel® 4056 polyetherester block copolymer, and the core of the monofilament is Hytrel® 7246 polyetherester block copolymer (available commercially from E. I. du Pont de Nemours and Company, Wilmington, Delaware). The monofilament is prepared by co-extruding the core and sheath from molten thermoplastic through a die by conventional methods known in the art, such as described in U.S. Patent No. 5,313,909. The monofilament ordinarily consists of about 75% core and about 25% sheath, although exact percentages of elastomer comprising the core and the sheath can vary over a wide range.

The carbon used in the invention can be any commercially available carbon black, such as, for example, Vulcan® 9A32 or Elftex 12, having a "fine" to "medium" particle size (available commercially from Cabot Corporation). By "fine" is meant that the particle size of the carbon black is generally in the range of about 19 nm, whereas "medium" particle size means that carbon particles can range in size from "fine" up to about 37-41 nm. Finer particle size carbon tends to offer a higher level of protection from UV degradation, but finer particles can become more difficult to disperse in a polymer and also tend to absorb moisture more quickly than medium or coarse carbon particles. Irrespective of particle size, it is preferred that the carbon black be of a grade which has as low a moisture absorption rate as possible.

For best results, it is important that the carbon black be uniformly distributed within the sheath and core polymer components. It has been found that such a uniform distribution can be achieved by first preparing a carbon/elastomer "concentrate" comprising 25% by wt. carbon and 75% by wt. of the respective base elastomer. The carbon component is intensely mixed and dispersed into the corresponding molten base elastomer in a machine designed for this purpose, such as, for example, a Farrell Continuous Mixer or a Banbury Mixer, and then the concentrate is cut into pellet form using either a melt cutter or a strand cutter. In a preferred embodiment of the invention the carbon-containing concentrate is pre-dried to a low moisture level in the range of from 0.005% to 0.02% by weight before it is blended into the corresponding base elastomer, although drying can also be accomplished after blending. Low moisture content has been found to enhance processability of the base polymer containing the carbon. The pre-dried carbon-containing concentrate in pellet form and the respective base polymer for the core and the sheath, also in pellet form, are then pre-mixed to insure generally uniform distribution of the carbon-containing concentrate throughout the base polymer pellet mixture. Each base polymer pellet mixture is then extruded in either a single or twin screw extruder where melting

and further mixing of the components can occur in the molten state as the melt is metered into a die system where sheath and core components are formed in heated dies designed for this purpose. The molten strands exit the die, are cooled, and then post-oriented in the machine direction to impart strength to the
5 monofilament. The oriented monofilament is then wound onto spools.

Testing

Monofilament samples produced as described above, i.e., the sheath of the monofilament being Hytrel® 4056 polyetherester block copolymer, and the core
10 of the monofilament being Hytrel® 7246 polyetherester block copolymer, were then placed in a Xenon light source standard Weatherometer® (i.e., an "indoor test cycle") and exposed to ultraviolet light to levels of 200 and 400 KJ/m². The cycle was conducted in accordance with SAE J1885. Control samples of each production run were retained and protected from exposure to any UV light. In the
15 table that follows, these control samples are referred to as "0" KJ/m² exposure samples.

After exposure to UV light, all of the samples, of which there were (3) specimens of each run, were tensile tested in an Instron Tensile Testing Machine. The samples were 10" (25.4 cm) gage length, crosshead speed was set at
20 10 in/min (25.4 cm/min), and all samples were preconditioned for 24 hours at 23°C, 40% RH. Table 1, which follows, shows the tensile properties recorded for each sample.

Under visual examination of the samples before testing, it was observed that all of the samples which had been exposed to UV light had developed cracks
25 and were crazed at the surface except those samples which contained 2.5% carbon in the core and in the sheath. These had a very shiny, smooth surface, the same in appearance as the control samples. The samples which contain 2.5% by weight carbon according to the invention exhibit very little difference in breakload, tensile strength, and particularly elongation at break when compared to the
30 unexposed (0 KJ/m²) samples.

Table 1
Tensile Test Results (Monofilament)

Monofilament Composition (% Carbon Black)	UV Exposure (KJ/m ²)	Breakload Newtons	Tensile Strength (MPa)	Elongation (%)	Toughness kPa
Core 0 Sheath 0	0	27.6	294.4	87.3	151.7
	200	7.6	85.5	24.8	13.1
	400	5.8	64.1	22.9	9.7
Core 0 Sheath 0.4	0	26.7	269.6	101.4	157.2
	200	8.9	90.3	27.4	15.2
	400	4.4	44.8	13.9	4.8
Core 0.4 Sheath 0.4	0	25.4	250.3	122.7	180.6
	200	10.2	101.4	35.5	22.1
	400	9.3	95.1	31.2	17.9
Core 0.75 Sheath 0.4	0	23.6	237.9	115.0	164.8
	200	10.7	105.5	37.9	24.1
	400	10.2	102.7	35.5	22.8
Core 1.5 Sheath 0.4	0	23.1	231.7	119.9	170.3
	200	11.1	111.7	44.4	32.4
	400	11.5	113.8	47.2	36.5
Core 2.5 Sheath 0.4	0	23.1	231.0	122.8	173.1
	200	11.6	116.5	54.0	44.8
	400	11.6	113.1	56.6	44.8
Core 0.75 Sheath 0.75	0	24.5	240.6	118.1	173.1
	200	11.1	109.6	36.6	24.8
	400	10.7	106.2	34.4	22.1
Core 1.5 Sheath 1.5	0	25.4	242.7	128.8	186.8
	200	15.6	149.6	81.5	82.0
	400	12.0	113.1	47.9	35.9
Core 2.5 Sheath 2.5	0	22.7	225.5	122.4	169.6
	200	22.2	207.5	133.4	168.2
	400	19.1	178.6	117.1	132.4

Toughness is by definition, the area under the stress-strain curve.

Woven Fabric Test Results

The oriented woven support material of the invention is a woven fabric having a configuration which comprises crossed strands in a first direction and in a second direction perpendicular to the first direction, wherein the strands in the

5 first direction comprise oriented thermoplastic elastomer monofilament of a sheath/core configuration selected from the group consisting of copolyetheresters, polyurethanes, and polyesteramides, and the sheath is an elastomer whose melting point is at least 20°C lower than the melting point of the elastomer in the core, and the strands in the second direction can be the same as the strands in the first

10 direction or, as in the examples which follow, they comprise a non-elastomeric, natural or synthetic yarn. Such yarns can include, but are not limited to, cotton, polyester, nylon, rayon, acrylic, modacrylic and olefin yarn. The fabric support material can be prepared as described in U.S. Patent No. 4,469,739, the teachings of which are incorporated herein by reference, and is available commercially as

15 Dymetrol® brand woven, heat sealed spring fabric (E. I. du Pont de Nemours and Company, Wilmington, Delaware). Samples of Dymetrol® fabric were also exposed to ultraviolet light in a Weatherometer® in accordance with SAE J1885 and physically tested in an Instron Tensile Testing Machine. The fabric was a

20 14-pick coextruded core/sheath elastomeric monofilament weave, polyester warp sateen weave and all samples were pulled in the monofilament direction.

In each case, both the predominantly polyester side as well as the predominantly monofilament side of the sateen-woven fabric was placed in the test so that each side faced the light source. These sides are referred to as the "white" side and "black" side, respectively, in the test results reported below in

25 Table 2.

Table 2
Woven Fabric Test Results

Monofilament Composition (% Carbon)	Side of Fabric Sample Facing Light Source	Exposure Level (KJ/m ²)	Breakload Newtons	Elongation at Break (%)	Toughness kPa
Sheath 0.4	-	0	232.6	82.7	707.4
Core 0	Black	451.2	32.0	3.0	2.8
	White	451.2	52.0	10.5	22.8
Sheath 2.5	-	0	202.4	102.0	832.2
Core 2.5	Black	451.2	187.7	88.8	695.0
	White	451.2	194.4	96.8	766.0

Fabric Sample Width: 2.54 cm (exactly 14 strands monofilament)

UV Exposure Test in accordance with SAE J1885.

5 Instron: gauge length 10.16 cm; crosshead speed 25.4 cm/min

Test Conditions: 23°C, 50% RH

Test: 3 Samples per exposed test, results being averaged.

Monofilament composition: Core Hytrel® 7246; Sheath Hytrel® 4056;

monofilament consisting of 75% core and 25% sheath by volume .

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15 These results show that with the addition of 2.5% carbon in the sheath and core components of monofilament which comprises the fabric, the strength and integrity of the fabric is retained to a UV exposure level of at least 451.2 KJ/m² in a Weatherometer®. For example, considering the "black" samples where the predominantly monofilament side of the sateen-weave fabric sample was directly exposed to the Xenon light source in the Weatherometer®, it can be seen that the toughness, which is the area under the stress-strain curve and represents a combination therefore of breakload and elongation, is improved 25,100%.

Exterior Automotive Weatherometer® Test Results

UV tests were also conducted in a Weatherometer® where the monofilament was subjected to the standard exterior automotive cycle where the samples are intermittently wetted in accordance with test procedure SAE J1960.

5 Tensile results are shown below in Table 3.

Table 3

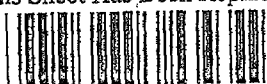
Monofilament Composition (% Carbon)	UV Exposure (KJ/m ²)	Breakload Newtons	Elongation (%)	Toughness kPa
Sheath 0.4	0	26.2	103	140.6
Core 0	451.2	10.2	34	21.4
Sheath 2.5	0	24.5	123	162.0
Core 2.5	451.2	20.9	122	142.0



What is claimed is:

1. A method for improving the UV resistance of a two component elastomeric monofilament having a core and a sheath, said core consisting essentially of a first polyester elastomer and said sheath consisting essentially of a second polyester elastomer having a melting point which is at least 20°C lower than the first elastomer, said core and sheath elastomers being selected from the group consisting of copolyetheresters, polyurethanes, and polyesteramides, which comprises incorporating into said core and into said sheath a UV protecting amount of carbon.
2. The method of claim 1 in which the carbon is incorporated into each of said core and said sheath elastomer components by first forming a carbon/elastomer concentrate of each component comprising 75% by wt. of each of said elastomer and 25% by wt. carbon, drying the concentrate to a low moisture level in the range of from 0.005% to 0.02% by weight moisture, and then uniformly blending the resulting said carbon/elastomer concentrate into the corresponding base elastomer in a ratio of 10% by wt. concentrate to 90% by wt. base elastomer whereby the resulting concentration of carbon in each of the said core and said sheath elastomer components is in the range of from about 1.8% up to about 3.0% by wt. carbon.
3. The method of claim 1 in which the carbon /elastomer concentrate is first uniformly blended into each of the corresponding base polymers, and then the resulting base polymer/concentrate blends are dried until the moisture level of the concentrate is in the range of from 0.005% to 0.02% by weight.
4. An improved two-component elastomeric monofilament having a core consisting essentially of a first polyester elastomer and a sheath consisting essentially of a second polyester elastomer, said second elastomer having a melting point which is at least 20°C lower than the first elastomer, said core and said sheath elastomers being selected from the group consisting of copolyetheresters, polyurethanes, and polyesteramides, wherein the improvement comprises incorporating into said first elastomer and into said second elastomer a UV protecting amount of carbon.
5. The monofilament of claim 3 in which the carbon comprises particles having a size in the range of from about 19 nm to about 45 nm.

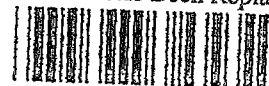
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6. An improved oriented woven support material which is a fabric having a configuration which comprises crossed strands in a first direction and in a second direction perpendicular to the first direction, wherein the strands in the first
- 5 direction comprise oriented thermoplastic elastomer monofilament of a sheath/core configuration selected from the group consisting of copolyetheresters, polyurethanes, and polyesteramides, said sheath being an elastomer having a melting point which is at least 20°C lower than the melting point of the elastomer comprising said core, and the strands in the second direction comprise a non-
- 10 elastomeric, natural or synthetic yarn, the improvement comprising incorporating into said first elastomer and into said second elastomer a UV protecting amount of carbon.
7. The fabric of claim 5 wherein the strands in the second direction comprise
- 15 oriented thermoplastic elastomer monofilament of a sheath/core configuration selected from the group consisting of copolyetheresters, polyurethanes, and polyesteramides, said sheath being an elastomer having a melting point which is at least 20°C lower than the melting point of the elastomer comprising said core and the UV protecting amount of carbon is uniformly distributed within the sheath and
- 20 within the core at a concentration in the range of about 1.8% to 3.0% by weight.

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