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(54) **Cut resistant jacket for ropes, webbing, straps, inflatables and the like.**

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(73) Proprietor: **ALLIED-SIGNAL INC. (a Delaware corporation), Columbia Road and Park Avenue P.O. Box 2245R, Morristown New Jersey 07960(US)**

(72) Inventor: **Wincklhofer, Robert Charles c/oAllied Corporation, P.O. Box 2245R, Morristown New Jersey07960(US)**

(74) Representative: **Brock, Peter William et al, URQUHART-DYKES & LORD 91 Wimpole Street, London W1M 8AH(GB)**

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Description

This invention relates to a cut resistant jacket for ropes, webbing, straps, inflatables and the like, more particularly a cut resistant article comprising a cut resistant jacket surrounding a less cut resistant member where the jacket comprises a fabric of a yarn and the yarn consists essentially of a high strength, longitudinal strand having a tensile strength of at least 1 GPa and the strand is wrapped with a fiber.

It is known to make cut resistant fabric for gloves used for safety in the meat cutting industry. For example see US-A 4 470 251, -4 384 449 and -4 004 295. It is also known to make a composite line containing two different filamentary materials in the form of a core and a jacket of different tensile strengths and elongations as in US-A4321854.

EP-A 0 027 708 describes a hose for the transport of fluids comprising a thermoplastic elastomer liner and a thermoplastic elastomer cover. Burst strength is provide by a textile reinforcement between the liner and cover. This textile reinforcement can for example be of knitted, braided, woven or non-woven construction, formed from a variety of natural or synthetic textile materials, including aromatic polyamides.

It is also known to make composite strand, cables, yarns, ropes, textiles, filament and the like in other prior U.S. patents not cited herein.

This invention is concerned with the problem of providing cut-resistance, i.e. resistance against forces acting from outside and leading to rupture of ropes, webbing, straps, inflatables, etc.

According to the invention this problem is solved by forming a cut resistant jacket from a yarn having a specific contruction in which a yarn of high tensile Strength is wrapped with a fiber.

By ultrahigh molecular weight is meant 300,000 to 7,000,000. Normal molecular weight is then below 300,000.

This invention is a cut resistant article comprising a Cut resistant jacket surrounding a less cut resistant member. The jacket comprises a fabric of yarn. The yarn consists essentially of a high strength, longitudinal strand having a tensile strength of at least 1 GPa. Wore than one strand can be used. This strand (or strands) is wrapped with a fiber. The fiber may be the same or different than the longitudinal yarn.

It is preferred that the fiber wrapped around the strand also have a tensile strength of at least 1 GPa.

The less cut resistant member can be selected from the group consisting of rope, webbing, strap, hose and inflatable structures.

The core strand fiber of the rope, webbing, strap or inflatable structures could be fiber of nylon, polyester, polypropylene, polyethylene, aramid, ultrahigh molecular weight high strength polyethylene or any other known fiber for the use.

The inflatable structure would be a less cut resistant layer having the fabric of this invention as a jacket or outer layer. The strand used for the fiber in the jacket may be selected from the group consisting of an aramid, ultrahigh molecular weight polyolefin, carbon, metal, fiber glass and combinations thereof. The fiber used to wrap the longitudinal strand (or strands) can be selected from the group consisting of an aramid fiber, ultrahigh molecular weight polyolefin fiber, carbon fiber, metal fiber, polyamide fiber, polyester fiber, normal molecular weight polyolefin fiber, fiber glass, polyacrylic fiber and combinations thereof. When the fiber wrapping is a high strength fiber having strength over 1 GPa, the preferred fiber wrapping is selected from the group consisting of aramid fiber, ultra high molecular weight polyolefin fiber, carbon fiber, metal fiber, fiber glass and combinations thereof.

The polyolefin fiber of this invention can be ultrahigh molecular weight polyethylene or polypropylene, preferably polyethylene, commercial examples are Spectra® 900 or Spectra® 1000.

The fiber wrapping can also be a blend of a lower strength fiber with the high strength fiber. Such lower strength fiber can be selected from the group consisting of polyamide, polyester, fiber glass, polyacrylic fiber and combinations thereof.

The article of this invention can also have more than one jacket surrounding the less cut resistant member.

In another embodiment, the article of this invention has a material present in the interstices of the fabric of the jacket to bond the yarn of the fabric to adjacent yarn of the fabric thereby increasing penetration resistance of the jacket. The material used in the interstices can be any elastomer, preferably a thermoplastic rubber and more preferably a material selected from the group consisting of polyurethane, polyethylene and polyvinyl chloride.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Yarns for Jacket Fabric

A yarn to be used to make the protective jacket fabric is made by wrapping one longitudinal strand of stainless steel wire having a diameter of 0.11 mm and one parallel strand of an ultrahigh molecular weight polyethylene fiber having a tensile strength of 3 GPa modulus of 171 GPa, elongation of 2.7 percent, denier of 650 and 120 filaments per strand or end. This yarn is commercially available as Spectra® 1000 fib-

er from Allied Corporation. The wrapping fiber is a polyester of 500 denier, 70 filaments per end, having a tensile strength of 1.00 GPa, modulus of 13.2 GPa, elongation of 14 percent. For yarn A two layered wraps of the above polyester fiber are used to wrap the parallel strands of wire and high strength polyethylene.

For yarn B one layer of the ultrahigh molecular weight polyethylene fiber described above is used as the innermost layer wrapped around the strands, the outer layer being the polyester fiber.

Alternatively, an aramid such as Kevlar could be used to replace the ultrahigh molecular weight polyethylene, either as the strand or as the fiber for wrapping.

Comparative Yarn C - a polyester of 3600 denier, 1 GPa tensile strength, 13.2 GPa modulus and 14 percent elongation, without wrapping.

This wrapped yarn (A or B) or comparative yarn C can then be braided, knitted, woven or otherwise made into fabric used as the jacket of this invention.

This jacket can then be used to surround ropes, webbing, straps, inflatable structure, and the like. The jacket can be made from one or more ends of yarn per carrier in the braider apparatus. Either full or partial coverage of the core of braided or parallel strands can be achieved. The yarn for the fabric used for the jacket in this invention can also be wrapped in a conventional manner such as simply wrapping the strand of high strength fiber or by core spinning or by Tazalanizing or any other method to put a wrap of yarn around the strands or strands.

Example 1 - Tests on Ropes

Three different stranded ropes, jacketed with a cut protective fabric, were tested for cut resistance. Three conventional stranded ½-inch (0.6 cm) ropes were made and a special braided yarn fabric was used to surround the rope core as a jacket. The jacket can be formed either separately and placed on the core of rope or formed around the core during one of the manufacturing steps.

Comparative Sample 1 was a Kevlar stranded rope jacketed with fabric braided from comparative yarn C. Comparative Sample 2 was an ultrahigh molecular weight high strength polyethylene (Spectra® 900) fiber stranded rope jacketed with fabric braided from comparative yarn C. Example of this invention Sample 3 was the above-described ultrahigh molecular weight polyethylene (Spectra®) fiber strand rope, surrounded with a jacket braided from Yarn A Spectra 900 fiber has a denier of 1200, 118 filaments per strand typically, tensile strength of 2.6 GPa, modulus of 120 GPa and elongation of 3.5 percent.

The three jacketed ropes were tested by a guillotine test. In the guillotine test, the rope was held in a fixture so its movement was restricted. Clamps prevented it from moving along its axis and the rope was inside two pieces of pipe to prevent it from deflecting during cutting. The two pieces of pipe were separated very slightly where the blade made the cut. The maximum force needed to completely sever the rope was measured.

In the second test, the cut-damage test, the rope was laid on a wooden surface without further restraint. A blade was then forced into the rope at 250 pounds (113.6 kg) of force. The damaged ropes were tested for retained strength. In both tests a new Stanley blade no. 1992 was used for each sample tested. The results of the test are given below.

Guillotine Test Results Pounds of Force to Cut			
Test	Comparative Sample 1	Comparative Sample 2	Sample 3
	(kg)	(kg)	(kg)
1	132 (60)	227 (103)	684 (311)
2	139 (61.8)	335 (152)	638 (290)
3	144 (65.5)	286 (130)	616 (280)
Avg.	138 (62.7)	282 (128)	646 (294)

Cut Damage Test Results, Percent Strength Retained		
73	85	97

Observation of the cut damage test ("abused") ropes showed that the Sample 1 rope was cleanly cut part way through. The Sample 2 rope jacket was also partly cut through but the filaments were not as cleanly cut. Sample 3 rope showed only a depression where the blade was pressed. There was no evidence of even the jacket having been cut. Because of this only Sample 3 rope was tested at 500 pounds force in the cut damage test. It retained 92 percent strength and sustained no jacket cutting.

Example 2 - Abrasion Resistance

Comparative Sample 2 and Sample 3 (this invention) were tested for abrasion resistance of the jacket by the test described below. Sample 3 was a ½-inch (0.6 cm) stranded rope jacketed with a braided fabric of yarn A.

In the test each sample rope was bent in a 90 degree angle over a 10-inch (25.3 cm) diameter abrasive wheel. The ropes were loaded with 180 pounds (81.8 kg) and reciprocated through a 3-inch (7.6 cm) stroke as the abrasive wheel rotated at 3 rpm. The test ended when the jacket wore through. The number of strokes (cycles) for each was 8 for Comparative Sample 2 and 80 for Sample 3.

Example 3 - Braided Rope

Four ½-inch (0.6 cm) braided ropes were tested with various jackets. Comparative Sample 4 rope was braided from the high strength, ultrahigh molecular weight polyethylene yarn described above and the jacket was braided from a polyester yarn of 1000 denier, 192 filaments per end, 1.05 GPa tensile strength, 15.9 GPa modulus, and 15 percent elongation.

Sample 5 rope was braided from Kevlar yarn of 1875 denier, 2.53 GPa tensile strength, 60.4 GPa modulus and 3.5 percent elongation. The jacket was as in Sample 3.

Sample 6 rope was also braided, from the high strength ultrahigh molecular weight polyethylene yarn described above, under low tension to give a "soft" rope. The jacket used was as in Sample 3.

Sample 7 rope was identical to Sample 6 except more tension was applied during braiding of the rope to create a "hard" rope.

A fixed load was applied to the rope as in Example 1. When the ropes were taut under the knife, there was little difference in cut resistance between ropes. In the cut damage test, the results are below.

Cut Damage Tolerance

Percent Strength Retained

Sample			
4	5	6	7
43	54	100	82

Best Mode

The following is the best mode of this invention.

It is believed the most cut resistant structure, rope, webbing or strap, would use either of the above described ultrahigh molecular weight polyethylene fibers as core, either braided or as strands, covered by a jacket made, preferably braided, from a yarn having the inner strands of 0.11 mm stainless laid parallel to a strand of the ultrahigh molecular weight polyethylene fiber of highest tensile strength (Spectra 1000), the strands being wrapped with an inner wrap of the lower tensile strength polyethylene fiber (Spectra 900) and outer wrap of polyester fiber described in yarn B, above.

Claims

1. A cut resistant article comprising a cut resistant jacket comprising a fabric of yarn surrounding a less cut resistant member characterised in that the yarn of said jacket consists essentially of at least one high strength longitudinal strand having a tensile strength of at least 1 GPa, and said strand being wrapped with a fiber.

2. An article according to Claim 1 characterised in that the fiber wrapped around said strand also has a tensile strength of at least 1 GPa.

3. An article according to Claim 1 characterised in that the less cut resistant member is rope, webbing, strap, hose or an inflatable structure.

4. An article according to any one of Claims 1 to 3 characterised in that the strand is aramid, ultrahigh molecular weight polyolefin, carbon, metal, fiber glass or a combination thereof.

5. An article according to any one of Claims 1 to 4 characterised in that the wrapping is aramid fiber, ultrahigh molecular weight polyolefin fiber, carbon fiber, metal fiber, polyamide fiber, polyester fiber, fiber glass, polyacrylic fiber, normal molecular weight polyolefin fiber or a combination thereof.

6. An article according to Claim 2 characterised in that the fiber wrapping is aramid fiber, ultrahigh molecular weight polyolefin fiber, carbon fiber, metal fiber or a combination thereof.

7. An article according to Claim 6 characterised in that the fiber wrapping also contains a lower strength fiber selected from polyamide, polyester, fiber glass, polyacrylic fiber and combinations thereof.

8. An article according to any one of Claims 1 to 7 characterised in that more than one jacket surrounds said less cut resistant member.

9. An article according to any one of Claims 1 to 8 characterised in that it also comprises a material present ind the interstices of the fabric to bond the yarn of fabric to adjacent yarn of the fabric, thereby increasing penetration resistance of the jacket.

10. An article according to Claim 9 characterised in that said material is an elastomer.

11. An article according to to Claim 9 characterised in that the said material is polyurethane, polyethylene or polyvinyl chloride.

12. A yarn for the manufacture of cut resistant fabric comprising a high strength longitudinal strand having a tensile strength of at least 1 GPa, and being aramid, ultrahigh molecular weight polyolefin, carbon, fiber glass or a combination thereof, wrapped with a fiber of aramid, ultrahigh molecular weight polyolefin, carbon, fiber glass or a combination thereof.

13. A fabric formed from a yarn according to Claim 12.

14. A cut-resistant jacket formed from a fabric according to Claim 13.

Patentansprüche

1. Schnittfester Gegenstand bestehend aus einer schnittfesten Ummantelung aus einem Garngewebe, das ein weniger schnittfestes Element umgibt, dadurch gekennzeichnet, daß das Garn der Ummantelung im wesentlichen aus wenigstens einem hochfesten Längsstrang besteht, der eine Zugfestigkeit von wenigstens 1 GPa hat, und daß der Strang mit einem Fasermaterial umhüllt ist.

2. Schnittfester Gegenstand nach Anspruch 1, dadurch gekennzeichnet, daß das den Strang umhüllende Fasermaterial ebenfalls eine Zugfestigkeit von wenigstens 1 GPa hat.

3. Schnittfester Gegenstand nach Anspruch 1, dadurch gekennzeichnet, daß das weniger schnittfeste Material ein Seil, ein Gurt, ein Riemen, ein Schlauch oder ein aufblasbares Gebilde ist.

4. Schnittfester Gegenstand nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, daß der Strang aus Aramid, Polyolefin mit ultrahohem Molekulargewicht, Kohlenstoff, Metall, Glasfaser oder einer Kombination davon besteht.

5. Schnittfester Gegenstand nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß die Umhüllung Aramidfasermaterial, Polyolefinfasermaterial mit ultrahohem Molekulargewicht, Kohlenstoffasermaterial, Metallfasermaterial, Polyamidfasermaterial, Polyesterfaser- material. Glasfasermaterial, Polyacrylfasermaterial, Polyolefinfasermaterial mit normalem Molekulargewicht oder eine Kombination davon ist.

6. Schnittfester Gegenstand nach Anspruch 2, dadurch gekennzeichnet, daß die Faserumhüllung Aramidfasermaterial, Polyolefinfasermaterial mit ultrahohem Molekulargewicht, Kohlenstofffasermaterial, Metallfasermaterial oder eine Kombination davon ist.

7. Schnittfester Gegenstand nach Anspruch 6, dadurch gekennzeichnet, daß die Faserumhüllung auch ein weniger festes Fasermaterial enthält, das aus Polyamid, Polyester, Glasfasermaterial, Polyacrylfasermaterial oder Kombinationen davon ausgewählt ist.

8.. Schnittfester Gegenstand nach einem der Ansprüche 1 bis 7, dadurch gekennzeichnet, daß mehr als eine Ummantelung das weniger schnittfeste Element umgibt.

9. Schnittfester Gegenstand nach einem der Ansprüche 1 bis 8, dadurch gekennzeichnet, daß er auch ein Material aufweist, das in den Zwischenräumen des Gewebes vorhanden ist, um das Gewebegarn mit benachbartem Gewebegarn zu verbinden, so daß der Eindringwiderstand der Ummantelung erhöht wird.

10. Schnittfester Gegenstand nach einem der Ansprüche 1 bis 9, dadurch gekennzeichnet, daß das Material ein Elastomer ist.

11. Schnittfester Gegenstand nach einem der Ansprüche 1 bis 9, dadurch gekennzeichnet, daß das Material Polyurethan, Polyäthylen oder Polyvinylchlorid ist.

12. Garn zur Herstellung von schnittfestem Gewebe, das einen hochfesten Längstrang mit einer Zugfestigkeit von wenigstens einem GPa aufweist und aus Aramid, Polyolefin mit einem ultrahohen Molekulargewicht, Kohlenstoff, Glasfasermaterial oder einer Kombination davon besteht und mit einem Aramidfasermaterial, Polyolefin mit einem ultrahohen Molekulargewicht, Kohlenstoff, Glasfasermaterial oder einer Kombination davon umhüllt ist.

13. Gewebe hergestellt aus einem Garn nach Anspruch 12.

14. Schnittfeste Ummantelung, hergestellt aus einem Gewebe nach Anspruch 13.

Revendications

1. Article résistant à la coupure comprenant une enveloppe résistant à la coupure comportant une étoffe de filé entourant un élément résistant moins à la coupure, caractérisé en ce que le filé de l'enveloppe est essentiellement constitué d'au moins un toron longitudinal à haute résistance mécanique ayant une résistance à la traction d'au moins 1 GPa, et le toron étant enroulé avec une fibre.

2. Article selon la revendication 1, caractérisé en ce que la fibre enroulée autour du toron présente aussi une résistance à la traction d'au moins 1 GPa.

3. Article selon la revendication 1, caractérisé en ce que l'élément résistant moins à la coupure est une corde, une sangle, une courroie, un tuyau souple, et une structure gonflable.

4. Article selon l'une quelconque des revendications 1 à 3, caractérisé en ce que le toron est en aramide, polyoléfine à masse moléculaire ultra-haute, en carbone, en métal, en fibre de verre ou une combinaison de ceux-ci.

5. Article selon l'une quelconque des revendications 1 à 4, caractérisé en ce que l'enroulement est une fibre d'aramide, une fibre de polyoléfine de masse moléculaire ultra-haute, une fibre de carbone, une fibre de métal, une fibre de polyamide, une fibre de polyester, une fibre de verre, une fibre polyacrylque, une fibre de polyoléfine de masse moléculaire normale ou une combinaison de celles-ci.

6. Article selon la revendication 2, caractérisé en ce que l'enroulement en fibre est une fibre d'aramide, une fibre de polyoléfine de masse moléculaire ultra-haute, une fibre de carbone, une fibre de métal ou une combinaison de celles-ci.

7. Article selon la revendication 6, caractérisé en ce que l'enroulement en fibre contient également une fibre de résistance mécanique plus faible choisie parmi les fibres de polyamide, de polyester, de verre, de polyacrylique ou une combinaison de celles-ci.

8. Article selon l'une quelconque des revendications 1 à 7, caractérisé en ce que plusieurs enveloppes entourent l'élément résistant moins à la coupure.

9. Article selon l'une quelconque des revendications 1 à 8, caractérisé en ce qu'il comprend aussi un matériau présent dans les interstices de l'étoffe afin de lier le filé de l'étoffe à un filé adjacent de l'étoffe, d'où l'augmentation de la résistance à la pénétration offerte par l'enveloppe.

10. Article selon la revendication 9, caractérisé en ce que le matériau est un élastomère.

11. Article selon la revendication 9, caractérisé en ce que le matériau est le polyuréthane, le polyéthylène ou le chlorure de polyvinyle.

12. Filé pour la fabrication d'une étoffe résistant à la coupure, comprenant un toron longitudinal de haute résistance mécanique ayant une résistance à la traction d'au moins 1 GPa, et étant constitué d'aramide, de polyoléfine de masse moléculaire ultra-haute, de carbone, de fibre de verre ou d'une combinaison de ceux-ci, enroulé avec une fibre d'aramide, de polyoléfine de masse moléculaire ultra-haute, de carbone, de fibre de verre ou une combinaison de celles-ci.

13. Etoffe, formée d'un filé selon la revendication 12.

14. Enveloppe résistant à la coupure formée d'une étoffe selon la revendication 13.