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(54) **Protective garment with a ballistic resistant torso portion and stab and cut resistant sleeves**

(57) The invention relates to a protective garment for protecting personnel, comprising a torso portion and left and right arm sleeves extending from the torso portion, **characterized in that** the torso portion is made of a fabric material and a liner comprising a stack of 4 to 40 ballistic resistant fabric layers, and each sleeve is made of a sin-

gle stab resistant fabric layer or a stack of 2 stab resistant fabric layers and/or a single cut resistant fabric layer and/or a stack of 2 cut resistant fabric layers, or a single combined cut-stab resistant fabric layer or a stack of 2 combined cut-stab resistant fabric layers.

EP 2 199 727 A1

Description

[0001] The invention pertains to protective garment having a torso portion and sleeves, for protecting humans against ballistic, stab and cut injuries.

[0002] Until recently, effective body protection was an uncomfortable compromise between ballistic protection and restricted freedom of movement. Thanks to the development of new generations of microfilament fibers, that compromise is much improved. Nevertheless bullet resistant body protection mainly regards torso protection using sleeveless garment, i.e. bullet-resistant vests. The materials used for body protection are still too stiff to allow free movement of arms, thereby seriously hampering actions of the person wearing such garment, for which reason commercially available garments are invariably made without sleeves, or at the best have very short sleeves for protection of the shoulders. Body armor is used throughout the world today by the police as well as by military personnel against bullets, explosive fragments and direct fire. However, garment that is acceptable for military personnel may be less suitable for police. For instance, military personnel primarily should be protected against explosives and bullets, whereas police and security officers frequently are faced with knife and stab incidents. Therefore, there is a serious need for lightweight protective garment that can protect the body against bullets and the arms against stabbing and cutting, and that is flexible and provides a good ventilation to guarantee wear comfort and thermoregulation, so that particularly police officers can freely move while wearing the garment. Such garment is unknown until today.

[0003] In WO 2006/096981 a military and emergency service personnel garment has been described having a torso portion formed of flexible material and sleeves including one or more pockets for retaining a protective armor element to the sleeve. Each armor element comprises a flexible or rigid ballistic resistant material for protecting the limbs of a wearer against bullets and fragmentation from explosives. However, such garment does not protect the wearer from stab and cut injuries, and furthermore due to its weight, still seriously hampers the free movement of the arms.

[0004] In WO 2005/099499 a protective sleeve for protecting a person's arm has been disclosed comprising various parts including a forearm section, an upper arm section, and a flexible connection between the forearm section and upper arm section. An elbow section is connected between the forearm and upper arm sections and covers the flexible connection. The sections of the protective sleeve each comprise a plurality of layers of cut resistant material enclosed within an outer covering. This garment protects the wearer from stabbing and cutting, but the production of such garment is complicated and expensive, and the wear comfort is low.

[0005] None of these references really solves the problem of acceptable protection and at the same time sufficient flexibility and thermoregulation which guarantees freedom of movement of the wearer.

[0006] It is an object of the present invention to provide ballistic, cut and stab resistant garment rendering protection against bullets, explosive materials, knives and other sharp devices. The garment has sleeves, which effectively provides protection to the wearer with giving minimum restriction to his flexibility.

[0007] The present invention provides a solution to these problems by a protective garment for protecting personnel, comprising a torso portion and left and right arm sleeves extending from the torso portion, **characterized in that** the torso portion is made of a fabric material and a liner comprising a stack of 4 to 40 ballistic resistant fabric layers, and each sleeve is made of a single stab resistant fabric layer or a stack of 2 stab resistant fabric layers, and/or a single cut resistant fabric layer and/or a stack of 2 cut resistant fabric layers, or a single combined cut-stab resistant fabric layer or a stack of 2 combined cut-stab resistant fabric layers.

[0008] The primary task of the protective material is absorbing ballistic energy in the shortest possible time and preventing sharp objects cutting and stabbing through the fabric. This is achieved with the present invention by using fabrics having high energy absorption, high tenacity, and high modulus of elasticity, which permits rapid dispersion of the deformation waves. These high modulus fabrics can be made of known materials such as aramid (such as Twaron®, Kevlar®, Artec®) and HD polyethylene (such as Dyneema® and Spectra®), or combinations thereof. The torso portion may contain 4 to 40 layers, but 15 to 36 layers are preferred. The ballistic fabrics as such are made according to known methods in the form of a weave, knitted fabric, unidirectional layer, or non-woven felt.

[0009] The cut and stab resistant sleeves are preferably made of layers of HD polyethylene (such as Dyneema® and Spectra®), but other known cut and stab resistant materials can also be used. It is usually preferred to combine HD polyethylene with one or more other fibers such as nylon, polyester, cotton, glass, to improve the ability to stretch. The fabric layers can be woven, knitted or be non-woven such as a felt. These materials are commercially available, for instance at Fuchshuber, Germany, Jules-Tournier, France, VdS/Textile de Lignes, Belgium/France, and Aluart, Spain.

[0010] The sleeves contain 1 to 2 stab resistant fabric layers, or 1 to 2 cut resistant fabric layers, or preferably both stab and cut resistant layers, or alternatively they contain 1 to 2 combined cut-stab resistant fabric layers. It is preferred not to use more than a total of two layers to maintain optimal flexibility of the sleeve portions. When a combined stab-cut resistant fabric is used a single layer already renders satisfactory protection. The stab resistant layer can be made of a relatively hard fabric, whereas the cut resistant layer can be made of a relatively soft fabric, which may be compared with felt-like material. The terms "relatively soft" and "relatively hard" relate to the flexibility of the fabric layers in relation to each other. It was found that the combination of relatively soft and relatively hard fabrics practically completely prevents

stab and cut injuries.

[0011] This effect is strikingly better than when only stab resistant or only cut resistant layers are used. It is however more preferred to use only soft (i.e. highly flexible) materials, which are also available for the stab resistant layers. Most preferably the newer materials are used wherein the stab and cut resistant properties are combined. If only one of these layers is used, i.e. a single cut resistant and a single stab resistant layer, or preferably a single layer of the combined cut-stab resistant fabric layer, the highest possible flexibility is obtained. These fabrics can be obtained as knitted or woven fabric, or as a non-woven felt-like material.

[0012] In a preferred embodiment the torso portion, the sleeve portion, or both portions are provided with an inner layer at the inner side of the garment (at the side of the liner or fabric layers that is farthest removed from the fabric material).

[0013] Such inner layer improves the wear comfort substantially. The inner layer not necessarily is bullet or knife resistant itself, but can also be made of any other suitable material such as polyester, silk, cotton, linen and the like.

[0014] The garment can be made in the form of a coat, overcoat, jacket, sweater, jersey, and the like. The fabric material at the outside of the garment can be made of any synthetic or natural material. It can be advantageously, although not required, be made from fabric material having ballistic, cut or stab resistant properties. Specially when worn as coat, overcoat, or jacket the garment does not closely fit to the body, as bullet resistant vests typically do, thereby leaving some air layer between the body of the wearer and the garment. The air layer can be as thick as a few centimeters. The air layer so created enhances the comfort of wearing and improves the thermoregulation. Further such air layer diminishes the trauma effect when hit by for instance a bullet.

[0015] In a further embodiment the garment is provided with an inlay. Such inlay is provided at the inside of the torso portion and contains the liner with ballistic layers. It is preferred that the inlay can easily be separated from the rest of the garment. This enables using the same inlay for different garments, for instance summer and winter garments, or using different inlays for the same garment, and also enables using the garment as a stab-cut protecting garment only (by removing the inlay containing the liner) or as a full protection garment by attaching the inlay to the fabric material of the garment. It also enables to replace the ballistic material if damaged or when it has lost some of its ballistic properties. The inlay can be secured to the rest of the garment, if so desired, by common fixing means such as snap fasteners, zippers, Velcro, and the like.

[0016] The inlay can be made of any suitable material and is made in the form to fit in the rest of the garment. Fleece materials, cotton, linen, silk, polyester, Goretex®, and the like, or even stab, cut or ballistic resistant materials are particularly suitable as inlay material.

[0017] If it is desirable to provide cut and/or stab resistance to the ballistic torso portion the torso portion between the fabric material and the ballistic resistant fabric layers, can be provided with one or more stab resistant, cut resistant, or combined cut-stab resistant layers.

[0018] If the garment is provided with pockets these may be reinforced by making them using extra fabric layers.

[0019] The following examples are only for illustrating the invention and are not intended to restrict the invention.

[0020] A fleece inlay for a coat contains two portions. The first portion is the shoulder part up to the top of the breast. It consists of punched fabric. This allows automatic release of heat from down to up.

[0021] The second portion is attached to the punched part and stretches to the hips. This portion contains double-sided Velcro, whereby the inside is the soft side of Velcro. The inlay can be attached to the torso portion of the garment by Velcro.

[0022] A third portion is elastic cut and stab resistant sleeves. These sleeves are attached to the fabric material of the torso portion. The sleeves can be provided with zippers or Velcro to allow detachment from the torso portion.

[0023] This coat does not need an inner layer since the soft side of the Velcro acts as inner layer.

[0024] Ballistic front and back panels can be inserted in the double-sided Velcro parts of the inlay.

[0025] The Velcro parts of the fleece inlay can be used to attach pockets, gun cases, and the like.

[0026] Velcro can further be mounted on the shoulders to allow attachment to the outer coat (the fabric material). The outer coat (fabric material) can easily be attached and detached from the inlay.

[0027] Ballistic materials for the ballistic liner can be selected from 4 to 40 layers (the specific numbers of layers that were used in test materials are given between brackets) of one or more of known ballistic materials such as:

Dyneema® AXN NL2	- class 2	(22 layers)
Dyneema® Dyneemflex EP	- class 3a	(36 layers)
Dyneema® iX3.8	- class 3a	(34 layers)
Twaron® S6 Protection	- class 3a	(32 layers)
Artec® R1 Protect	- class 3a	(30 layers)

[0028] Stab and cut resistant materials include ALS®, (polyethylene/nylon/glass) Aluart, Spain having cut level 4 and 5.

[0029] Other suitable cut or stab resistant materials are 4500 Armalith®, TL 009 G, TL 019 G and TL 019 H, all

obtainable from DSM Dyneema, the Netherlands, and Kevlar® (ex DuPont, USA) and Twaron® (ex Teijin Aramid, the Netherlands).

Claims

1. A protective garment for protecting personnel, comprising a torso portion and left and right arm sleeves extending from the torso portion, **characterized in that** the torso portion is made of a fabric material and a liner comprising a stack of 4 to 40 ballistic resistant fabric layers, and each sleeve is made of a single stab resistant fabric layer or a stack of 2 stab resistant fabric layers, and/or a single cut resistant fabric layer and/or a stack of 2 cut resistant fabric layers, or a single combined cut-stab resistant fabric layer or a stack of 2 combined cut-stab resistant fabric layers.
2. The protective garment of claim 1 comprising a single stab resistant fabric layer and/or a single cut resistant fabric layer, or a single combined cut-stab resistant fabric layer.
3. The protective garment of claim 1 or 2 wherein the fabric material is a ballistic resistant fabric material, a stab resistant fabric material, a cut resistant fabric material, or a combined cut-stab resistant fabric material.
4. The protective garment of any one of claims 1 to 3 wherein the torso portion and/or the sleeve portion contains an inner layer at the side of the liner or fabric layers that are farthest removed from the fabric material.
5. The protective garment of any one of claims 1 to 4 wherein the sleeves are constructed as the fabric material overlaying the stab layer or layers, which overlay the cut resistant layer or layers, or wherein the fabric material overlays the combined cut-stab resistant layer or layers.
6. The protective garment of any one of claims 1 to 5 wherein the liner comprises a stack of 15-36 ballistic resistant fabric layers.
7. The protective garment of any one of claims 1 to 6 wherein the torso portion between the fabric material and the ballistic resistant fabric layers, also contains a stab resistant and/or a cut resistant, or a combined cut-stab resistant layer.
8. The protective garment of any one of claims 1 to 7 wherein the garment is a coat, overcoat, jacket, sweater or jersey.
9. The protective garment of any one of claims 1 to 8 wherein the garment is provided with an inlay comprising the liner.
10. The protective garment of claim 9 wherein the inlay is detachably connected to the fabric material.



EUROPEAN SEARCH REPORT

Application Number
EP 08 17 2168

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	US 6 029 270 A (OST LYNN VAN [US] ET AL) 29 February 2000 (2000-02-29) * column 7, line 62 - column 10, line 21 * * figures *	1-10	
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			F41H A41D
Place of search		Date of completion of the search	Examiner
The Hague		16 June 2009	Gex-Collet, A
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 08 17 2168

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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16-06-2009

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