ABSTRACT

The disclosure relates to ballistic material with structural stays, in particular, the disclosure relates to ballistic material having resilient structural stays woven directly into the ballistic material. Ballistic material having structural stays resists bunching or pulling, providing improved force distribution and better user protection in the event of multiple ballistic strikes.
BALLISTIC MATERIAL WITH STRUCTURAL STAYS

BACKGROUND OF THE INVENTION


[0002] Current soft body armor, including many bullet-proof or ballistic vests, is made up using multiple layers of woven or non-woven fabric materials. The layers in the body armor can be of the same type or an assortment of different ballistic fabrics stacked in a configuration that utilizes the best qualities of each layer during a ballistic impact event. The multiple layers of ballistic fabric are commonly fastened together by sewing a matrix of lines or quilting the layers together. The multiple layer fabric configurations provide user comfort and adequate protection during a single ballistic strike. However, the dynamics of a ballistic impact event show that as the force of the bullet is displaced across the face, or strike-side, of the soft armor, the fabric will have a tendency to bunch or pull. This may leave vital areas of the user exposed in the event of a second ballistic strike. This concern is at least partially addressed with hard body armor, the soft ballistic vest with a sub-frame as described in US patent, ENERGY ABSORBING DEVICE FOR BALLISTIC BODY ARMOR, U.S. Pat. No. 6,961,957, filed May 15, 2003, to Carlson, and with the soft body armor having attached reinforcing strips as described in US patent application, SOFT BODY ARMOR INCLUDING REINFORCING STRIPS, US2011/0185463, filed Jan. 29, 2010, to Weber. The hard body armor will normally sacrifice both mobility and comfort. The above cited patent and patent application, has structural support that is added onto the ballistic material or integrated between panels of ballistic material.

[0003] What is needed is a flexible ballistic material having structural support that will provide unrestricted user mobility, improved user comfort and will resist bunching to provide improved protection in the event of multiple ballistic strikes.

SUMMARY OF THE INVENTION

[0004] The present invention is an improved ballistic material created by blending traditional fibers like, but not limited to, Kevlar®, Dynema®, or Spectra®, performance fibers with resilient flexible strips or strips woven into the material for increased fabric stiffness and ballistic performance without sacrificing user comfort. The resilient flexible material strips or strips have structural properties that resist elongation during a ballistic strike but are also flexible and will ergonomically conform to the body of the user. Ballistic material having flexible strips or strips resists bunching or pulling during multiple ballistic strikes, allowing the body armor to maintain complete protective coverage. The typical bunching and pulling with traditional soft body armor indicates a greater proportion of the ballistic strike energy progressing through the body armor as back-face impact, which may cause significant blunt force trauma to the user. The flexible strips or strips of the present invention reduce overall material deformation, and distributes the ballistic strike energy laterally throughout the ballistic material, reducing overall back-face impact or energy transferred to the user. Soft body armor made using the ballistic material of the present invention can be constructed using a single panel of the ballistic material, can be constructed using multiple panels of the ballistic material having the bias of the flexible strips or strips running in the same direction, can be constructed using multiple panels of the ballistic material having the bias of the flexible strips or strips running in different, opposing directions, or can be constructed using the material of the present invention in conjunction with traditional ballistic material panels. The resilient flexible strips or strips woven into the ballistic material allows the use of fewer ballistic material layers, while still providing superior protection and overall weight reduction of the body armor.

[0005] One embodiment of the present invention includes strips or strips having traditional ballistic fibers running the length of the stay to maintain the material thread count across the face of the fabric.

[0006] Another embodiment of the present invention is an improved ballistic material having unidirectional flexible material strips or strips woven into the fabric. The strips or stays are positioned in the weave in one direction either, warp or weft, depending on the weaving process used. Multiple panels can be cut and positioned with the unidirectional strips or stays in an alternating x and y configuration. Multiple alternating layers may be used in soft body armor that will resist more aggressive rounds may be incorporated into protective clothing used by other high risk specialists, such as bomb disposal.

Another embodiment of the present invention is an improved ballistic material having flexible material strips or strips that are woven into the fabric in a crossing or cross-axis fashion. In one embodiment, the flexible material stays intersect at 90 degrees or at a right angle. In yet another embodiment, the flexible material stays intersect at an angle less than 90 degrees. A multi-axial weave configuration may increase the ballistic material performance and stability of the flexible strips or stays.

[0007] One embodiment of the present invention is an improved ballistic material having flexible material strips or strips woven into the fabric, wherein, the flexible material strips or stays are substantially flat strips having a rectilinear cross-section. In other embodiments of the present invention, the flexible material strips may have a different shape or cross-section, such as, substantially, round, oval, square or another conventional geometric shape. Flexible material strips or strips having a rectilinear or similar cross-section have the advantage of superior flexibility when deflected perpendicular to the long axis of the section and substantial rigidity when deflected against the long axis of the section. It is contemplated that in one embodiment of the present invention, the flexible material strips or stays may have an irregular shape or cross-section that will interlock with the woven ballistic fibers, providing increased energy transfer between the individual ballistic material fibers and the flexible material strips or stays.

[0008] In one embodiment of the present invention or improved ballistic material, the flexible strips or stays are made using low-density polyethylene (LDPE). In other embodiments of the present invention, the flexible strips or stays may be made using a material such as nylon, vinyl, or another impact resistant plastic material having a flex modulus and physical properties similar to LDPE. In other embodiments, it is contemplated that the flexible strips or stays are formed using a composite material, such as, but not limited to, Kevlar®, Dynema®, or Spectra®, in a flexible epoxy matrix. This embodiment may provide improved protection from a strike directly upon the flexible strip or stay.
[0009] In another embodiment of the present invention or improved ballistic material, it is contemplated that one or more of the resilient flexible material strips or stays may be attached directly to the soft body armor panel closure strips or suspension. This arrangement in a soft body armor vest would allow ballistic energy to more efficiently transfer around the user’s body and into the ballistic panels on the side opposite the ballistic strike.

[0010] These and other features and advantages of the disclosure will be set forth and will become more fully apparent in the detailed description that follows and in the appended claims. The features and advantages may be realized and obtained by the instruments and combinations particularly pointed out in the appended claims. Furthermore, the features and advantages of the disclosure may be learned by the practice of the methods or will be obvious from the description, as set forth hereinafter.

BRIEF DESCRIPTION OF DRAWINGS

[0011] The following description of the embodiments can be understood in light of the Figures, which illustrate specific aspects of the embodiments and are part of the specification. Together with the following description, the Figures demonstrate and explain the principles of the embodiments. In the Figures the physical dimensions of the embodiment may be exaggerated for clarity. The same reference numerals in different drawings represent the same element, and thus their descriptions may be omitted.

[0012] FIG. 1 illustrates a detailed perspective view of the present invention or ballistic material with structural stays, and;

[0013] FIG. 2 illustrates ballistic material with structural stays,

[0014] FIG. 3A illustrates ballistic material with unidirectional structural stays,

[0015] FIG. 3B illustrates ballistic material with multidirectional structural stays,

[0016] FIG. 4A illustrates overlapping panels of ballistic material for a vest,

[0017] FIG. 4B illustrates a cross section of ballistic material under impact, and;

[0018] FIG. 4C illustrates a perspective view of overlapping ballistic material under impact.

DETAILED DESCRIPTION OF THE INVENTION

[0019] For the purposes of promoting an understanding of the principles in accordance with the disclosure, reference will be made to the embodiments illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the disclosure is thereby intended. Any alterations and further modifications of the inventive features illustrated herein, and any additional applications of the principles of the disclosure as illustrated herein, which would normally occur to one skilled in the relevant art and having possession of this disclosure, are to be considered within the scope of the disclosure. As used in this specification and the appended claims, the singular forms “a,” “an,” and “the” include plural referents unless the context clearly dictates otherwise. In describing and claiming the present disclosure, the following terminology will be used in accordance with definitions set out below. As used herein, the terms “comprising,” “including,” “containing,” “characterized by,” and the grammatical equivalents thereof are inclusive or open-ended terms that do not exclude additional, unrecited elements or method processes.

[0020] The disclosure relates to ballistic material with structural stays, in particular, the disclosure relates to ballistic material having resilient structural stays woven directly into the ballistic material. Ballistic material having structural stays resists bunching or pulling, providing improved force distribution and better user protection in the event of multiple ballistic strikes.

[0021] Ballistic material is material woven from long high tensile strength fibers to form an interlocking fabric weave. Fibers may include, but are not limited to, aramid or copolymer, marketed as Kevlar®, Dyneema® and Spectra®.

[0022] Structural strips or stays are long flexible resilient material strips, having a rectangular cross section, or a rectangular cross-section. The rectangular cross-sections may have another similar cross section. The structural strips or stays will bend, or they are flexible, when pressure is applied to the flat surface or across the short axis; however, the structural strips or stays resist bending, or are stiff, when pressure is applied to the edge or across the long axis. The structural strips or stays can be made from any suitable material that will conform to the user’s body while still having sufficient tensile strength or resistance to elongation.

[0023] Soft body armor is considered compliant body armor usually composed of a carrier garment with multiple ballistic fabric panels placed inside integrated pockets or compartments.

[0024] Hard body armor may be composed of a carrier garment with steel, ceramic, composite or high density plastic panels attached.

[0025] Strike-face is the front side or outside of the body armor or ballistic package.

[0026] Back-face is the inside or side of the body armor or ballistic package nearest the user.

[0027] Illustrated in FIGS. 1 and 2, is one embodiment of the present invention or ballistic material with structural stays 100. The ballistic material 110 composed of a plurality of lateral fibers 111 and longitudinal fibers 112 woven into an interlocking fabric. The fabric having a plurality of structural stays 150 woven directly into the material 110. A plurality of longitudinal fiber 125 cover directly over the structural stays 150 in order to maintain tred count and provide optimal ballistic protection.

[0028] FIG. 3A illustrates one embodiment of the present invention or ballistic material with structural stays 100, having unidirectional structural stays 150 woven into the ballistic material 110.

[0029] FIG. 3B illustrates one embodiment of the present invention or ballistic material with structural stays 100, having multidirectional structural stays 150 woven into the ballistic material 110. The crossing structural stays 151 and 152 may intersect at 90 degrees, or a right angle, or may intersect at an angle less than 90 degrees. The crossing structural stays 151 and 152 may simply overlap or may be woven in an interlocking, over-one, under-one, fashion (not shown).

[0030] Ballistic material having multidirectional structural stays may have performance advantages over ballistic material having unidirectional structural stays or multiple layers of ballistic material having unidirectional structural stays arranged with the structural stays intersecting.

[0031] Illustrated in FIG. 4A is overlapping vest panels 200 of ballistic material with structural stays 100. The structural stays 150 of the first panel 201 are woven into the material 110.
with a horizontal bias. The structural stays 150 of the second panel 202 woven into the material 110 with a vertical bias. Combining both panels 201 and 202 creates an intersecting matrix of structural stays 150 and will improve ballistic performance.

[0032] FIGS. 4B and 4C each illustrate the performance of the present invention or ballistic material with structural stays 100 during a ballistic strike. When the ballistic material is impacted by a bullet on the front side or strike-face 210, the material 110 will deflect toward the user or back-face 220. The force of bullet F will be substantially absorbed by transferring the energy through the material 110 fibers and into the structural stays 150. The structural stays 150 will dissipate (shown as F) the bullet energy F across the strike-face 210, through the vest panels 200 (FIG. 4A) and into the vest suspension (not shown). The overlapping structural stays 150 of FIG. 4C show the bullet energy F displaced f through the structural stays 150. The distribution of the displaced energy f is shown conceptually, the actual percentage of energy f displaced by each structural stay 150 will vary depending on the proximity of the bullet strike to the structural stay 150.

[0033] In view of the foregoing, those having ordinary skill in the relevant art will appreciate the advantages provided by the features of the present disclosure.

[0034] It is to be understood that the above mentioned arrangements are only illustrative of the application of the principles of the present disclosure. Numerous modifications or alternative arrangements may be devised by those skilled in the art without departing from the spirit and scope of the present disclosure and the appended claims are intended to cover such modifications and arrangements. Thus, while the present disclosure has been shown in the drawings and described above with particularity and detail, it will be apparent to those of ordinary skill in the art that numerous modifications, including, but not limited to, variations in size, materials, shape, form, function and manner of operation, assembly and use may be made without departing from the principles and concepts set forth herein.

1. A ballistic material comprising:
   a plurality of ballistic filaments woven into a fabric, and,
   a plurality of structural stays interwoven with the ballistic filaments.

2. The ballistic material of claim 1 wherein the structural stays are constructed as an elongate flat strip having a rectangular cross-section.

3. The ballistic material of claim 1 wherein the cross-section of the structural stays are one of, round, oval and square.

4. The ballistic material of claim 1 wherein the structural stays are comprised of one of, low density polyethylene, aramid, vinyl and impact resistant plastic.

5. The ballistic material of claim 1 wherein the structural stays are comprised of a ballistic composite material such as Kevlar, Dyneema and Spectra in a flexible epoxy matrix.

6. The ballistic material of claim 1 wherein the plurality of structural stays is equidistantly spaced.

7. The ballistic material of claim 1 wherein the plurality of structural stays is irregularly spaced.

8. The ballistic material of claim 1 wherein the plurality of structural stays form a unidirectional pattern.

9. The ballistic material of claim 1 wherein the plurality of structural stays form a crossing pattern.

10. The ballistic material of claim 9 wherein at least one of the plurality of structural stays intersect with at least another of the plurality of structural stays at 90 degrees.

11. The ballistic material of claim 9 wherein at least one of the plurality of structural stays intersect with at least another of the plurality of structural stays at an angle less than 90 degrees.

12. The ballistic material of claim 1 wherein the plurality of structural stays have an irregular surface profile.

13. The ballistic material of claim 12 wherein at least one the plurality of ballistic filaments mechanically interlock with at least one of the plurality of structural stays.

14. The ballistic material of claim 1 wherein the structural stays are woven into the warp of the fabric.

15. The ballistic material of claim 1 wherein the structural stays are woven into the weft of the fabric.

16. A ballistic material panel comprising:
   a plurality of ballistic material layers having,
   a plurality of ballistic filaments woven into a fabric,
   a plurality of structural stays interwoven with the ballistic filaments, and,
   the plurality of structural stays forming a unidirectional pattern.

17. The ballistic material panel of claim 16 wherein the plurality of material layers having the structural stays aligned in the same direction.

18. The ballistic material panel of claim 16 wherein a least one of plurality of material layers having the structural stays aligned in a non-uniform direction.

19. A ballistic protection device comprising:
   a carrier garment having,
   a ballistic panel envelope,
   a carrier suspension,
   a ballistic material panel inside of the panel envelope having,
   a plurality of ballistic material layers comprising,
   a plurality of ballistic material filaments woven into a fabric, and,
   a plurality of structural stays interwoven with the ballistic filaments.

20. The ballistic protection device of claim 19 wherein the ballistic material panel includes at least one layer of ballistic material without structural stays.

21. The ballistic protection device of claim 19 wherein the carrier suspension mechanically connects to at least one of the plurality of structural stays.