METHODS

Title: LIGHTWEIGHT ARMOR PROTECTION SYSTEMS, TRANSPORTABLE BALLISTIC SHIELD SYSTEMS, AND METHODS OF USING SUCH SYSTEMS

Abstract: Lightweight armor protection systems, shield systems and methods for using such systems are disclosed herein. One embodiment of a lightweight armor protection system (100), for example, can include a shield assembly (102) having a plurality of panels (110) positioned adjacent to one another along lengthwise panel edges (116) and spaced apart from one another by gaps. The panels (110) can have a front side (112) and a back side (114) facing opposite from the front side (112). The shield assembly (102) can also have one or more flexible straps (120) interposed in the gaps between the panels (110) and attached to the panels (110) on alternating front and back sides (112 and 114) of adjacent panels (110). The straps (120) can couple adjacent panels (110) along the lengthwise panel edges (116) and permit the panels (110) to pivot bidirectionally relative to the adjacent panels (110). The panels (110) can pivot relative to the adjacent panels (110) to fold to a stacked panel position and to expand to a self-supporting position (101).
LIGHTWEIGHT ARMOR PROTECTION SYSTEMS, TRANSPORTABLE BALLISTIC SHIELD SYSTEMS, AND METHODS OF USING SUCH SYSTEMS

CROSS-REFERENCE TO RELATED APPLICATION(S)


TECHNICAL FIELD

[0002] The present disclosure relates generally to lightweight armor protection systems, transportable shield systems and methods for using such systems.

BACKGROUND

[0003] Law enforcement and military personnel are commonly exposed to life-threatening injuries during routine and emergency-related response and security assignments. These injuries may be inflicted by bullets, shrapnel, explosions, etc. Conventional bullet-proof and/or protective armor are used regularly by the military and law enforcement for protection during combat and/or other operative duties. For example, bullet proof vests, ballistics shields, etc. can be worn and/or carried for protection against injury. Portable and non-portable shields can be sized and deployed for the protection of an individual person for personal protection, or can be sized appropriately for the protection of additional persons and/or equipment.

[0004] Typically, protective body armor is made from a variety of bullet-resistant and gunfire-proof materials providing a range of protection selectively available during combat. The United States National Institute of Justice Level has classified several levels of protection for characterizing body armors, based on, for example, the armor's ability to defeat specific projectiles (e.g., bullets) fired from various firearms.
BRIEF DESCRIPTION OF THE DRAWINGS

[0005] Figures 1A and 1B are partially schematic, isometric and front views illustrating an embodiment of a lightweight armor protection system configured in a self-supporting position.

[0006] Figures 2A and 2B are partially schematic, front and isometric views of a disclosed embodiment, illustrating adjacent panels coupled along lengthwise panel edges with flexible straps.

[0007] Figures 2C and 2D are partially schematic, top views of an embodiment, illustrating flexible straps interposed in gaps between adjacent panels and configured to couple the adjacent panels.

[0008] Figure 3 is a partially schematic, top view of another embodiment, illustrating a ballistic panel pivoting with respect to an adjacent panel.

[0009] Figures 4A and 4B are partially schematic, top and isometric views, respectively, illustrating a lightweight armor protection system configured in accordance with a further embodiment, shown in a partially extended position.

[0010] Figure 5A is a partially schematic, isometric view of a lightweight armor protection system configured in accordance with an embodiment, configured in a stacked panel position.

[0011] Figures 5B and 5C are partially schematic, isometric views of retention devices configured in accordance with an embodiment.

[0012] Figure 6A is a partially schematic, isometric view illustrating an embodiment of a lightweight armor protection system configured in a self-supporting position.

[0013] Figures 6B-6D are partially schematic, perspective views illustrating a plurality of notches formed in the panels configured in accordance with an embodiment of the disclosure.
[0014] Figure 7 is a partially schematic, side view illustrating a lightweight armor protection system configured in accordance with an embodiment of the disclosure shown in an extended position and attached to a side of a vehicle.

[0015] Figure 8 is a flow chart illustrating a method for deploying a lightweight armor protection system in accordance with an embodiment of the disclosure.

[0016] Figures 9A-9C are partially schematic, isometric and side views of a lightweight armor protection system configured in accordance and embodiment of the disclosure.

[0017] Figure 10A is a partially schematic, isometric view illustrating a lightweight armor protection system configured in accordance with another embodiment of the disclosure shown in an extended position and attached to a vehicle.

[0018] Figure 10B is a partially schematic, isometric view illustrating the lightweight armor protection system of Figure 10A and including a vehicle bracket having two lightweight armor protection systems in retracted positions in accordance with an embodiment of the disclosure.

[0019] Figure 11A is an isometric front view illustrating an embodiment of a lightweight armor protection system configured in a self-supporting position.

[0020] Figure 11B is an isometric back/bottom view illustrating the lightweight armor protection system shown in Figure 11 configured in an inverted position.

[0021] Figures 12A and 12B are top views illustrating the lightweight armor protection system shown in Figure 1 in various deployed positions.

[0022] Figures 12C-12E are partially schematic top views of other embodiments of a lightweight armor protection system, illustrating various lengthwise panel edges of adjacent panels.

[0023] Figure 13A is a schematic view illustrating the lightweight armor protection system shown in Figure 11 in a stacked panel position.
[0024] Figures 13B-13G are schematic views illustrating the lightweight armor protection system shown in Figure 11 in various self-supporting deployed positions.

[0025] Figure 14 is an isometric back view illustrating another embodiment of a lightweight armor protection system configured in a self-supporting position.

[0026] Figure 15 is a top view of an embodiment of a lightweight armor protection system illustrating a hinge backing plate covering a gap between adjacent panels.

[0027] Figures 16A-16C are partially schematic top views illustrating another embodiment of a hinge backing plate covering a gap between adjacent panels.

[0028] Figure 17 is a schematic top view illustrating another embodiment of a lightweight armor protection system configured in a self-supporting position.

[0029] Figure 18A is a schematic side view illustrating another embodiment of a lightweight armor protection system configured in a self-supporting position.

[0030] Figure 18B is a schematic, detail view of the roller for the lightweight armor protection system shown in Figure 18A.

[0031] Figure 18C is a schematic, isometric view illustrating another embodiment of a lightweight armor protection system configured in a self-supporting position.

DETAILED DESCRIPTION

A. Overview

[0032] The present disclosure relates generally to lightweight armor protection systems, transportable shield systems and methods for using such systems. One embodiment of a lightweight armor protection system, for example, can include a shield assembly. The shield assembly can have a plurality of panels positioned adjacent to one another along lengthwise panel edges and spaced apart from one another by gaps. The panels can have a front side and a back side facing opposite from the front side. Additionally, the panels can be composed of a ballistic material. The shield assembly can also have one or more flexible straps interposed in the gaps between the panels and
attached to the panels on alternating front and back sides of adjacent panels. The straps can couple adjacent panels along the lengthwise panel edges and permit the panels to pivot bidirectionally relative to the adjacent panels. The panels can pivot relative to the adjacent panels to fold to a stacked panel position. The panels can also pivot relative to the adjacent panels to expand to a self-supporting deployed position.

[0033] The present disclosure is also directed generally to transportable ballistic shield systems. For example, in one embodiment, the transportable ballistic shield system can include a one or more rigid panels positioned adjacent to other ones of the panels along lengthwise panel edges. The panels include ballistics material for providing United States National Institute of Justice Level III projectile protection. The system can also include one or more coupling straps attached to and spanning adjacent panels to couple the panels. The straps can be interwoven alternately over and under adjacent panels such that the panels pivot bidirectionally. In one embodiment, the shield system can be stored in a compact folded configuration and be deployed in an expanded configuration to provide a ballistic shield.

[0034] Additionally, the present disclosure is directed generally to a lightweight shield system for providing self-supporting armor protection. The system can include a shield assembly and a retention device for securing the shield assembly in a stacked panel position. The shield assembly can include a plurality of generally rectangular panels each having a front side and a back side facing opposite from the front side. The panels can be aligned and rotatively coupled along vertical edges to adjacent panels such that the panels pivot with respect to adjacent panels. Together, the coupled panels can form an articulated ballistic shield. The shield assembly can also include a plurality of elongated flexible straps attached to the panels, wherein each strap can be interwoven between and alternately over and under adjacent panels to provide a bidirectional hinge between adjacent panels. The elongated straps can be attached to each panel at one of a front side or a back side. Additionally, each strap can couple adjacent panels along the vertical edges. Furthermore, the bidirectional hinge can permit the panels to (a) pivot relative to
the adjacent panels to fold to a stacked panel position for storage, and/or (b) pivot relative to the adjacent panels to an expanded, free-standing position.

[0035] The present disclosure relates generally to lightweight armor protection systems, transportable shield systems and methods for using such systems. One embodiment of a lightweight armor protection system, for example, can include a shield assembly. The shield assembly can have a plurality of panels positioned adjacent to one another along lengthwise panel edges. The panels can have a front side and a back side facing opposite from the front side. Additionally, the panels can be composed of a ballistic material. The shield assembly can also have a plurality of hinges pivotally coupling adjacent panels. Individual hinges include a pivot pin extending parallel to the lengthwise panel edges. Additionally, the hinges can to permit adjacent panels coupled by individual hinges to pivot relative to one another. Adjacent panels can pivot relative to one another to fold to a stacked panel position. Adjacent panels can also pivot relative to one another to expand to a self-supporting deployed position.

[0036] Another embodiment of a lightweight armor protection system according to the present disclosure can also include, for example, a shield assembly having adjacent panels overlap one another along the lengthwise panel edges. Still another embodiment of a lightweight armor protection system according to the present disclosure can also include, for example, a shield assembly having continuous hinges that extend approximately the entire length of the lengthwise panel edges. Yet still another embodiment of a lightweight armor protection system according to the present disclosure can also include, for example, a shield assembly having hinge backing plates that overlap individual lengthwise panel edges.

[0037] A further embodiment of a lightweight armor protection system according to the present disclosure can also include, for example, a shield assembly consisting of four panels including two center panels and first and second end panels flanking the center panels. The end panels can weigh less than the center panels. Still a further embodiment of a lightweight armor protection system according to the present disclosure can have the
center panels be composed of a material that provides a higher level of projectile protection than the material of which the ends panels are composed.

[0038] Several embodiments are also directed toward methods for deploying a lightweight armor protection system (LAPS). For example, one embodiment of such a method can include transporting a stored LAPS in a stacked panel position to a first desired deployment location. In one embodiment, the LAPS can include a plurality of panels positioned adjacent to one another along lengthwise panel edges and spaced apart from one another by gaps. The panels can have a first side and a second side facing opposite from the first side. Additionally, the panels can be composed of a ballistic material. The LAPS can also include one or more flexible straps interposed in the gaps between the panels and attached to the panels on alternating first and second sides of adjacent panels. The straps can be configured to couple adjacent panels along the lengthwise panel edges and configured to permit the panels to pivot bidirectionally relative to the adjacent panels. The method can further include expanding the LAPS from the stacked panel position to an extended position. Expanding the LAPS can include pivoting the panels relative to the adjacent panels such that the panels are aligned along the lengthwise panel edges. The method can further include pivoting the panels relative to adjacent panels to form a semicircular shaped, free-standing configuration.

[0039] Additionally, several embodiments are also directed toward methods for deploying a lightweight armor protection system (LAPS). For example, one embodiment of such a method can include transporting a stored LAPS in a stacked panel position to approximately a first desired deployment location. In one embodiment, the LAPS can include a plurality of panels positioned adjacent to one another along lengthwise panel edges. The panels can have a front side and a back side facing opposite from the front side. Additionally, the panels can be composed of a ballistic material. The shield assembly can also have a plurality of hinges pivotally coupling adjacent panels. Individual hinges include a pivot pin extending parallel to the lengthwise panel edges. Additionally, the hinges can to permit adjacent panels coupled by individual hinges to pivot relative to one another. Adjacent panels can pivot relative to one another to fold to the stacked panel
position and can also pivot relative to one another to expand to a self-supporting deployed position. Additionally, at least one roller can be coupled to the LAPS to at least partially support the LAPS. The method can further include expanding the LAPS from the stacked panel position to the self-supporting deployed position. Expanding the LAPS can include positioning the at least one roller on a support surface. The method can further include rolling the LAPS on the at least one roller to the first desired deployment location.

[0040] Many specific details of certain embodiments of the disclosure are set forth in the following description and in Figures 1A-9D to provide a thorough understanding of these embodiments. A person skilled in the art, however, will understand that the disclosure may be practiced without several of these details or additional details can be added to the invention. Well-known structures and functions have not been shown or described in detail to avoid unnecessarily obscuring the description of the embodiments of the disclosure. Where the context permits, singular or plural terms may also include the plural or singular term, respectively. Moreover, unless the word "or" is expressly limited to mean only a single item exclusive from the other items in reference to a list of two or more items, the use of "or" in such a list is to be interpreted as including (a) any single item in the list, (b) all of the items in the list, or (c) any combination of the items in the list. Additionally, the term "comprising" is used throughout to mean including at least the recited feature(s) such that any greater number of the same feature and/or additional types of features are not precluded.

B. Embodiments of Lightweight Armor Protection Systems and Methods for Using Such Systems

[0041] Figures 1A and 1B are partially schematic, isometric and front views illustrating a lightweight armor protection system (referred to herein as "LAPS") 100 configured in accordance with an embodiment of the disclosure shown in a self-supporting position 101. The LAPS 100 can include a shield assembly 102, wherein the shield assembly includes (a) a plurality of panels 110a-f (referred to collectively as 110) positioned adjacent to one another, and (b) a plurality of flexible straps 120a-d (referred to collectively as 120) attached widthwise across the panels 110 to couple the panels together. The shield
assembly 102, in one arrangement can be an articulated shield, wherein the plurality of panels 110 can pivot bidirectionally relative to adjacent panels 110. Operatively, the shield assembly 102 can be transitioned to and from the expanded self-supporting position 101 and a folded position suitable for transport (described in more detail below). The self-supporting position 101 of the shield assembly 102, as illustrated in Figures 1A-1B, includes panels 110 pivoted in a first direction relative to adjacent panels 110 to form a semi-circular shape 130. Generally, the panels 110 can be self-supported vertically such that a user would be able to kneel, crouch, sit, squat, etc. within the protection area 132 and be protected and/or hidden from view.

[0042] The panels 110 can be structurally rigid and be composed of a ballistics material. Ballistics materials generally are designed to resist penetration by bullets and other ballistic projectiles. For example, the panels 110 can include rigid, lightweight composite material (e.g., high-density plastic, steel, aluminum, resin composite material, titanium, etc.). In one embodiment, the ballistics material can include material for providing United States National Institute of Justice (NIJ) Level III ballistic protection. NIJ Level III is classified as armor that at least protects against 7.62 mm full metal jacketed bullets with nominal masses of 9.6 grams (147 grains) that impact the material at a velocity of $847 \pm 9.1$ meters/second (2780 $\pm$ 30 feet/second). Other standards promulgated by NIJ include Level Ml-A and Level II ballistic protection for body armor. NIJ Level Ml-A is classified as armor that at least protects against .357 SIG full metal jacketed bullets with nominal masses of 8.1 grams (125 grains) that impact the material at a velocity of $448 \pm 9.1$ meters/second (1470 $\pm$ 30 feet/second). NIJ Level II is classified as armor that at least protects against 9 mm full metal jacketed bullets with nominal masses of 8.0 grams (124 grains) that impact the material at a velocity of $398 \pm 9.1$ meters/second (1305 $\pm$ 30 feet/second). One of ordinary skill in the art will recognize a variety of suitable materials that can be used to form the panels 110. Moreover, the skilled artisan will recognize that the ballistics material used to form the panels 110 can be rated at varying levels of armor protection and/or have other protective characteristics. For example, the panels 110 can be fire and/or heat resistant for providing protection against explosions. In
other embodiments, the panels 110 can include additional materials or be composed of more than one type of material.

[0043] In one embodiment, the panels 110 can have a front side 112 and a back side 114 facing opposite from the front side 112. In some embodiments the front and back sides 112 and 114 are generally the same in appearance and/or retain approximately the same protective characteristics. In addition to ballistics resistance and material characteristics, some arrangements can include panels 110 that have a camouflage appearance, coloring and/or texture.

[0044] In some embodiments, the panels 110 can be generally rectangular having a panel length \(L_i\) and a panel width \(W_i\). In one specific embodiment, the panels 110 can have a panel length \(L_i\) of approximately 35 inches to approximately 45 inches, and have a panel width \(W_i\) of approximately 7 inches to approximately 11 inches. In some embodiments, the lengths \(L_i\) and widths \(W_i\) of the individual panels 110 can be generally the same. In other embodiments, however, the panels 110 may have varying lengths \(L_i\) and/or widths \(W_i\). The disclosure is not limited by the specific examples used herein and one of ordinary skill in the art will recognize that the panels 110 may have other dimensions, shapes and/or configurations.

[0045] As illustrated in Figures 1A-1B, the panels 110a-f can be positioned adjacent to one another along lengthwise panel edges 116. In one embodiment, the panels 110 can be positioned adjacent to other ones of the panels 110, such that the panels are moveable relative to the adjacent ones of the panels along the lengthwise panel edges 116. In this arrangement, the panels 110a-f can pivot relative to adjacent panels to form the semi-circular shape 130 having a protection area 132, wherein a center of gravity of the assembly 102 is positioned within the protection area 132 to provide for greater stability.

[0046] In another embodiment, the panels 110 can have tapered lengths \(L_i\). For example, and as illustrated in the embodiment shown in Figures 1A-1B, the panels 110 can have widthwise panel edges 117a and 117b that taper progressively from a first
lengthwise panel edge 116a (shown for panel 110c in Figure 1B) to a second lengthwise panel edge 116b. In some embodiments, the panels 110 may be tapered off horizontal by approximately 1 degree to approximately 25 degrees. In one embodiment, the edges 117a and 117b are both tapered. In another embodiment, the panels 110 can include tapered edges 117b and non-tapered edges 117a.

[0047] The shield assembly 102 may include a plurality of panels 110 each having different degrees of taper. The tapered widthwise panel edges 117b can provide a close contact with the ground or other support surface when the shield assembly 102 is in the semi-circular shape 130 (e.g., the self-supporting position 101), thus providing greater stability. In a specific example, the shield assembly 102 can have the 6 panels 110a-f in which the center panels 110c and 110d have an approximate 4 degree taper, the flanking panels 110b and 110e have an approximate 10 degree taper, and the terminal panels 110a and 110f have an approximate 20 degree taper. In other embodiments, the panels 110 can have other dimensions and/or configurations, and the disclosure is not limited by the specific examples used herein. Additionally, the shield assembly 102, as illustrated in Figures 1A-1B, includes six panels 110a-f; however, in other embodiments, the assembly can include a different number of panels (e.g., about 2 panels to about 8 panels, 4 panels, 5 panels, etc.).

[0048] In one embodiment, the panels 110a-f can be aligned such that a vertical height Hi of the shield assembly 102 decreases along the direction from a center point 118 (height H-i) of the assembly to an outer edge 119 (height H2) of the assembly. In one embodiment, the panels 110 can be aligned such that the transition between panels 110 along the widthwise panel edges 117a and 117b is relatively smooth, such as illustrated in Figures 1A-1B. In such an arrangement, the panel length L1 at the lengthwise panel edge 116b is less than the length Li at lengthwise panel edge 116a, but is approximately equal to the length L1 of a lengthwise panel edge 116c of the adjacent panel 110b. In other embodiments, the panels 110 can have additional shapes and/or configurations such as, for example, having rounded corners and/or having non-tapered lengths.
The shield assembly 102 also includes one or more flexible straps 120 configured to couple the panels 110 (e.g., 110a and 110b) to adjacent panels 110. Figures 2A and 2B are partially schematic, front and isometric views, respectively, illustrating adjacent panels 110a and 110b coupled along lengthwise panel edges 116 with flexible straps 120a and 120b configured in accordance with an embodiment of the disclosure. In the illustrated embodiment, the panels 110a and 110b can be spaced apart from one another by a gap 204, wherein the gap 204 is between the lengthwise panel edges 116. The flexible straps 120a and 120b can be interposed in the gap 204, as shown with respect to strap 120b in Figure 2B, between the panels 110a and 110b and can be attached to the panels 110a and 110b on alternating front and back sides 112 and 114 of the adjacent panels 110a and 110b. For example, a first strap 120a can be attached to the front side 112 of a first panel 110a. The first strap 120a can then thread through the gap 204 and be attached to the back side 114 of the second panel 110b.

As illustrated in Figure 2A, one or more fasteners 206 can be used to attach the straps 120a and 120b to the panels 110a and 110b. In one embodiment, the fasteners 206 can include rivets or bolts configured to penetrate through the panels 110 and the straps 120 for securing the flexible straps 120a and 120b in position to couple the panels 110a and 110b. In other embodiments, the straps 120a and 120b can be adhesively attached to the panels 110a and 110b.

Referring to Figures 1A-1B and 2A-2B together, the flexible straps 120, in one embodiment, can be composed of flexible ballistic material suitable to resist projectile penetration through the attached strap material or the strap material positioned in the gaps 204. For example, the strap material can be a mesh or fiber-based ballistic material. Suitable flexible ballistic materials are available from a variety of companies, including Spectra® fiber from Honeywell International, Inc., KEVLAR® brand ballistic material from DuPont, and Dyneema® brand ballistic material from DSM Dyneema of the Netherlands.

Additionally, the straps 120 can be any suitable width and length for at least spanning the gap 204 between any two adjacent panels 110. Figures 2A-2B show the flexible straps 120 having a length suitable to couple two adjoining panels 110a and 110b;
however, in other embodiments, and as illustrated in Figures 1A-1B, the flexible straps 120 may be elongated straps configured to interweave through the gaps 204 of multiple adjacent panels 110 and attach alternately to either the front side 112 or the back side 114 of each independent panel. In some embodiments, a plurality of elongated straps 120 may be used to couple the panels 110 to each other. In one arrangement, the plurality of straps 120 can be configured to alternate directions such that each panel 110 is attached to a strap 120 on both the front side 112 and the back side 114 of the panel. The combination of two flexible straps 120 interwoven in opposite directions (e.g., straps 120a and 120b, etc.) can provide a bidirectional hinge along the lengthwise panel edges 116 that allow the panels 110 to pivot about the axis A (Figure 2A) with respect to the adjacent panels 110. Furthermore, any number of straps 120 may be used to couple the panels 110 of the shield assembly 102 (e.g., greater than two straps), and the straps 120 may be positioned at any or multiple attachment sites along the length L1 of the panels 110.

[0053] Figures 2C and 2D are partially schematic, top views illustrating flexible straps 120a and 120b interposed in the gap 204 between adjacent panels 110a and 110b and configured to couple the adjacent panels in accordance with an embodiment of the disclosure. In one embodiment, the flexible straps 120 are resistant to stretching such that the straps 120 can prevent separation of the panels 110 during use of the LAPS 100. In another embodiment, the straps 120 can have elastomeric characteristics configured to maintain resistance against panel separation. Accordingly, the gaps 204 between the panels 110 can be minimized and the shield assembly 102 can provide protection, e.g., for a user under gun fire. For example, in one configuration, a gap width W2 can be approximately equal to a strap width (not shown). As illustrated in Figure 2C, the lengthwise panel edges 116 of the panels 110 can be generally squared. In another embodiment, illustrated in Figure 2D, the lengthwise panel edges 116 of the panels can be rounded. In this arrangement, the panels 110a and 110b may pivot relative to each other while minimizing the gap 204 between the panels and while minimizing wear on the strap 120 during panel rotation.
As noted above, the flexible straps 120 can also be configured to flex or bend such that the straps provide a bidirectional hinge between the panels 110 and permit the panels to pivot relative to adjacent panels 110. Figure 3 is a partially schematic, top view illustrating a panel 110a pivoting with respect to an adjacent panel 110b in accordance with an embodiment of the disclosure. As shown in the illustrated embodiment, the flexible straps 120a and 120b can flex or bend to allow the panel 110a to pivot with respect to adjacent panel 110b and to permit the panel 110a to stack against the panel 110b. Accordingly, the flexible straps 120 allow the shield assembly 102 to transition between an extended position (described below) and a stacked panel position by permitting the panels 110 to pivot bidirectionally.

The shield assembly 102 shown in Figures 1A and 1B can be quickly and readily collapsed for efficient storage when not in use and/or for transport by a user. The panels 110a-f can be configured to pivot in alternating opposite directions such that the panels can fold to a compact stacked position. For example, Figures 4A and 4B are partially schematic, top and isometric views, respectively, illustrating a lightweight armor protection system 100 configured in accordance with a further embodiment of the disclosure shown in a partially extended position 401. As illustrated in Figures 4A and 4B, the panels 110 can be pivoted with respect to adjacent panels 110 until each panel lies flat against its neighboring (i.e., adjacent) panel. The panels 110 can pivot in alternating and/or opposite directions, as shown by arrows 402, such that the shield assembly 102 can be folded in accordion fashion. As shown in Figure 4B, the partially extended position 401 in which the panels 110 are pivoted in alternating directions can be a free-standing position.

Figure 5A is a partially schematic, isometric view of a lightweight armor protection system 100 configured in accordance with an embodiment of the disclosure shown in a stacked panel position 501. The stacked panel position 501 can be readily stored, transported and/or carried by a user. As illustrated in Figure 5A, the panels 110 can lay flat against adjacent panels 110 such that the shield assembly 102 in the stacked panel position 501 has a storage length L₂ approximately equal to the panel length Lᵢ, a
storage width \( W_2 \) approximately equal to the panel width \( W_i \), and a storage thickness \( T_1 \) approximately equal to the sum of the individual thicknesses of the plurality of panels \( 110 \). The LAPS 100 can also include a retention device 502 for maintaining the shield assembly 102 in the stacked panel position 501. Additionally, the LAPS 100 can include a carrying handle 504 attached to one of the retention device 502 and/or the panels 110. In one embodiment, the retention device 502 can be retention straps sized to wrap widthwise around the panels 110 when in the stacked position 501. The retention straps 502 can be secured with buckles 506 (as shown in Figure 5B), corresponding hook and loop strips, elastic loops 508 (as shown in Figure 5C), etc. In other embodiments, the retention device 502 can include bags, webbing, etc., which may be used to secure the shield assembly 102 in the stacked panel position 501.

[0057] The shield assembly 102 may also include additional and/or different features. For example, Figure 6A is a partially schematic, isometric view illustrating a lightweight armor protection system 100 including a shield assembly 102 configured in accordance with another embodiment of the disclosure and shown in a self-supporting position 601. The shield assembly 102 illustrated in Figure 6 includes, for example, a plurality of center panels 610a-d, a first end support panel 612a and a second end support panel 612b, wherein the first and second end support panels 612a and 612b are coupled to the center panels 610a and 610d, respectively, with flexible straps (not shown). Accordingly, the first and second end support panels 612a and 612b can pivot with respect to adjacent center panels 610a and 610b, respectively, to support the center panels 610a-d in a generally vertical orientation.

[0058] The shield assembly 102 can provide a barrier between a protection area 603 and one or more points of threat. In one embodiment, the user may want to have a line of sight from the protection area 603 to the one or more points of threat. Furthermore, the user may want to use a firearm or other weapon while remaining protected behind the shield assembly 102. Accordingly, the shield assembly 102 may include one or more notches 604 for providing a line of sight from behind the shield assembly toward an area in front of the assembly. The notches may 604 also provide a firearm rest for rifles and other
firearms (not shown). In one embodiment, the notches 604 may be disposed in an upper portion of the shield assembly 102. As shown in Figure 6A, for example, notches 604 can be formed at or near the lengthwise panel edges 116 of the center panels 610. The notches 604 can be generated by material cut out of one or more adjacent panels 610. Figures 6B-6D are partially schematic, perspective views illustrating a plurality of notches that can be formed in the panels 610 and configured in accordance with an embodiment of the disclosure.

[0059] Referring back to Figure 6A, the center panels 610a-d can also include one or more carry handles 614, wherein the carry handles 614 can be used by a shield user to reposition the shield assembly 102 while the assembly is in the self-supporting position 601. The carrying handles 614 can include straps, bars, and/or other handheld attachments fastened to a surface of at least one of the center panels 610. In one embodiment, the carry handles 614 can lay flush against the center panels 610 such that the shield assembly 102 can be transitioned to a stacked panel position 501 (as shown in Figure 5A) for transport and/or storage.

[0060] The shield assembly 102 may also include one or more extension fasteners 616 positioned along one or more shield edges 618 and configured to engage a corresponding extension fastener on a second shield assembly (not shown) for extending a width and/or circumference of an area of shield protection 602. For example, one or more users can connect two or more shield assemblies 102 to extend the shield protection area 603 to protect a greater number of people and/or supplies from a ballistic threat.

[0061] As illustrated in Figure 6A, the shield assembly 102 may also include one or more hanging fasteners 620 configured to support the shield assembly when attached to and hanging from a vehicle, building and/or other structure. For example, the LAPS 100 can be used to protect an unarmored or lightly armored vehicle. Figure 7 is a partially schematic, side view illustrating the lightweight armor protection system 100 of Figures 1A and 1B configured in accordance with an embodiment of the disclosure shown having the shield assembly 102 in an extended position 702 and attached to a side of a vehicle 704. In this embodiment, the LAPS 100 can provide protection to driver, passengers and/or
cargo inside the vehicle 704. In other embodiments, the shield assembly 102 can be attached to a different portion of the vehicle (e.g., roof, window, etc.).

[0062] In addition to using an extended shield assembly 102 on the side of an unarmored vehicle (as shown in Figure 7), the shield assembly 102 can also be at least partially unfolded from the stacked panel position and hung in a vertical or horizontal position across doors, windows, cargo containers, fuel tanks, etc. Furthermore, the shield assemblies 102 can be deployed and positioned inside the cabin or on the decks of boats and other water vessels. The shield assemblies 102 can also be erected and positioned inside security check point enclosures, guard shacks, temporary storage tents, as well as in front of critical equipment, sensitive items, wounded individuals, or other work environments.

[0063] One feature of the present system 100 is that a user can deploy the shield assembly 102 from a stacked panel position to a self-supporting position to create a protective shield easily and efficiently. In one specific example, the shield assembly 102 can be deployed from a stacked panel position (i.e., for stowage) to a self-supporting position in approximately 10 seconds to approximately 30 seconds by a user (i.e., about 10 seconds to about 15 seconds). In other embodiments, the shield assembly 102 can be adapted to an automatic deployment module by installing a gas generator powered actuator (not shown) to the panels 110 or straps 120. In one embodiment, the gas generator can be initiated by a fire signal from a vehicle radar system configured to acquire and track small arms fire. In another embodiment, the shield assembly 102 can be configured to automatically deploy using a spring-based release mechanism that can be remotely activated.

[0064] Recent war-time conflicts have identified a vulnerability of soldiers to ballistic attacks. The exposure can increase when soldiers must dismount from armored or unarmored vehicles, or for soldiers positioned in the rear of unarmored trucks. Soldiers can also be exposed to ballistic threats at outposts, check points or during a direct assault. Similar exposure can be experienced by law enforcement personnel and SWAT teams during their job-related duties. Navy and the Coast Guard personnel can have potentially
the same vulnerability in water vessels when patrolling and intercepting enemy boats and ships. Existing personnel shields require active support and holding by the user, which can significantly inhibit the use of weapons other equipment (e.g., radios, etc.).

[0065] Protection from the threat of small arms such as 7.62 mm ammunition and shrapnel from near-by exploded ordnance is needed by a variety of military and law enforcement officers. Current armor systems having protection at ballistic NIJ Level III and above are typically heavy armor plates, permanently installed as panels in or on vehicles. Individual shields with this level of protection are typically heavy, cumbersome and require a user to hold and support the shield, which can significantly inhibit the user's offensive capability (e.g., perform other tasks requiring two hands, aim and fire a firearm, etc.).

[0066] In contrast, use of the system 100 disclosed herein can provide soldiers and other law enforcement personal with a man-portable, self supporting shield assembly 102 that can be quickly and easily stowed, rapidly deployed, and re-positioned as needed. Because the shield assembly 102 is self-supporting in a deployed configuration, the user has full capability to operate their weapons and other equipment. The use of the lightweight, rigid composite materials disclosed herein can provide ballistic shields having approximately half the weight of conventional shields of the same size and protection level. For example, in some embodiments, the shield assembly 102 disclosed herein can weight approximately 50 pounds to approximately 70 pounds. In other embodiments, the shield assembly 102 can weigh approximately 55 pounds to approximately 60 pounds.

[0067] One advantage of the present system 100 is that the lightweight armor protection system (LAPS), which includes several flat panels of composite armor connected by straps that serve both as interconnections, handles and packaging, has no loose components, frames, fasteners, containers or other ancillary hardware required to manufacture or deploy the protective armor. Additionally the panels are configured to fold into a compact size for stowage. In another embodiment, one or more panels 110 of the shield assembly 102 can be removed and/or replaced if they become damaged, thereby enhancing the longevity and protection level of the assembly.
Another advantage of the present system 100 is that, when deployed, the panels are free standing and provide a ballistics shield that can be easily and quickly re-configured to the nature and direction of the threat. Furthermore, the shield assembly 102 can be combined with additional assemblies to provide a larger area of protection. The shield assemblies can be used for dismounted vehicle occupants, truck beds, watch positions, checkpoints, watercraft, and during assault maneuvers. Furthermore, the shield assemblies 102 can be attached to the exterior of a vehicle to provide temporary protection when transiting into or through a hostile area.

Figure 8 is a flow chart illustrating a method 800 for deploying a lightweight armor protection system (LAPS) in accordance with an embodiment of the disclosure. The method 800 can be performed, for example, using the system 100 described above or other suitable armor and/or ballistics shield systems. The method 800 can include transporting a stored LAPS in a stacked panel position to a first desired deployment location (block 810). In one embodiment, the LAPS can include a plurality of panels positioned adjacent to one another along lengthwise panel edges and spaced apart from one another by gaps. The panels can have a first side and a second side facing opposite from the first side. Additionally, the panels can be composed of a ballistic material. The LAPS can also include one or more flexible straps interposed in the gaps between the panels and attached to the panels on alternating first and second sides of adjacent panels. The straps can be configured to couple adjacent panels along the lengthwise panel edges and configured to permit the panels to pivot bidirectionally relative to the adjacent panels. The method 800 can further include expanding the LAPS from the stacked panel position to an extended position (block 820). Expanding the LAPS can include pivoting the panels relative to the adjacent panels such that the panels are aligned along the lengthwise panel edges. The method 800 can further include pivoting the panels relative to adjacent panels to form a semicircular shaped, free-standing configuration (block 830).
C. Additional Embodiments of Lightweight Armor Protection Systems and Methods for Using Such Systems

[0070] Figures 9A-9C and 10A-10B illustrate lightweight armor protection systems configured in accordance with additional embodiments of the disclosure. These systems can include several features generally similar to the system 100 described above with respect to Figures 1A-7. The systems described below can also have many of the same advantages as the system 100 described above with respect to Figures 1A-7.

[0071] Figure 9A, for example, is a partially schematic, isometric view and Figures 9A-9B are partially schematic, side views of a lightweight armor protection system 900 in accordance with another embodiment of the disclosure. The system 900 can be generally similar to the system 100 described above with respect to Figure 1A-7. The system 900 differs from the system 100, however, in that the system 900 includes a shield assembly 902 having a different configuration than the shield assembly 102. More specifically, the system 900 includes a support frame 904 for retaining the shield assembly in an elevated, but stowed position until the shield is needed and/or deployed. For example, the support frame 904 may be installed above windows, doors, in front of critical equipment or operations, etc.

[0072] Referring to Figures 9A-9C together, and in one embodiment, the support frame 904 can include a support chamber 906 that can extend lengthwise along a desired distance in a first direction and be supported by the frame 904 and/or a structure (not shown) in an elevated position and a position generally horizontal the ground. The system 900 also includes the shield assembly 902 carried by the support chamber 906 and extending along the first direction. The shield assembly 902 can have any desired length \( L_3 \). In one embodiment the length \( L_3 \) of the shield assembly 902 can be generally similar to a length \( L_4 \) of the support chamber 906.

[0073] The shield assembly 902 can include (a) a plurality of panels 910 positioned adjacent to one another, and (b) a plurality of flexible straps (not shown) attached widthwise across the panels 910 to couple the panels together. As described with respect to the shield assembly 102 illustrated in Figures 1A-7, the panels 910 can be aligned along
lengthwise panel edges 912 (shown in Figure 9C) and each panel 110 can be coupled to adjacent panels 110 by the flexible straps. In the embodiment illustrated in Figures 9A-9C, the plurality of panels 910 can pivot bidirectionally relative to adjacent panels 910 to fold (i.e., in an accordion manner) into a retracted (i.e., stack panel) position. In one embodiment, a chamber door 908 can be configured to be latched in a closed chamber position to retain the shield assembly 902 in the retracted position.

[0074] As shown in Figure 9C, release of the shield assembly 902 for use as protection or barrier, can be achieved through manual or other operative action that swivels the chamber door 908 to an open position. The shield assembly 902 can be deployed, using gravity for example, as the connected panels 910 pivot relative to adjacent panels to an extended position that can function as a "curtain" of protection. Additionally, the shield assembly 902 can be transitioned to and from the folded retracted position and the extended position. In one embodiment, the chamber door 908 and/or the panels 910 can be released and extended manually. A pulley system 914 (shown in Figure 9B), winch and/or other device may be used, for example, to raise and lower the panels 910 to and from the support chamber 906. In other embodiments, a remote sensor or actuator may be used to release the panels 910 and extend the shield apparatus 902.

[0075] Figures 10A-10B illustrate a lightweight armor protection system 1000 configured in accordance with another embodiment of the disclosure. This system 1000 can include several features generally similar to the system 100 described above with respect to Figures 1A - 8 and system 900 with respect to Figures 9A-9C. The system 1000 described below can also have many of the same advantages as the systems 100 and 900. The system 1000 differs from the systems 100 and 900, however, in that the system 1000 includes a shield assembly 1002 having a different configuration than the shield assembly 102. More specifically, the system 1000 includes a vehicle roof bracket 1004 configured to be attached to unarmored or lightly armored vehicles 1006, trucks, trailers, etc. The vehicle roof bracket is configured to carry one or more shield assemblies 1002.
[0076] Figure 10A is a partially schematic, isometric view of the system 1000 illustrating the vehicle roof bracket 1004 positioned on a roof of a vehicle 1006 and having the shield assembly 1002 in a deployed configuration. Figure 10B is a partially schematic, isometric view of the system of Figure 10A illustrating the vehicle roof bracket 1004 removed from the vehicle 1006 and having two shield assemblies 1002 in retracted positions in accordance with an embodiment of the disclosure.

[0077] Referring to both Figures 10A and 10B, the vehicle roof bracket 1004 can include, in one embodiment, a first support chamber 1008a and a second support chamber 1008b, the first and second support chambers 1008a and 1008b extending lengthwise along a first direction generally parallel to a length L5 of the vehicle 1006. The roof bracket 1004 can also include one or more cross arms 1010 (shown independently as 1010a and 1010b) extending between the first and second support chambers 1008a and 1008b in a second direction generally normal to the first direction. The cross arms 1010 extend a length L6 which can be equal to or greater than a width W3 of the vehicle 1006. Accordingly, the first and second support chambers 1008a and 1008b can be carried by the cross arms 1010 and extend beyond the width W3 of the vehicle 1006.

[0078] The roof bracket 1004 can also include a plurality of fasteners 1012 configured to couple the roof bracket 1004 to the vehicle 1006. In one embodiment, the fasteners can be positioned to connect to a conventional roof rack 1014 (shown in Figure 10A) or other roof component. The fasteners 1012 can include bolts, screws, etc. In another embodiment, straps (not shown) may be used to connect the roof bracket to the roof of the vehicle.

[0079] The system 1000 also includes one or more shield assemblies 1002 carried by the first and/or second support chambers 1008a and 1008b. The shield assemblies 1002 can extend along the first direction generally parallel to the length L5 of the vehicle 1006. The shield assemblies can have any desired length L7. In one embodiment the length L7 of the shield assemblies 1002 can be generally similar to a support chamber length L5. Generally, the lengths L7 and L8 do not exceed the length L5 of the vehicle 1006.
As shown in Figure 10A, individual shield assemblies 1002 can include (a) a plurality of panels 1016 positioned adjacent to one another, and (b) a plurality of flexible straps 1020 attached widthwise across the panels 1016 to couple the panels together. In one embodiment, the panels 1016 can be generally rectangular and have a first side and a second side facing opposite the first side. The panels 1016 can be aligned along lengthwise panel edges 1018 and each panel can be coupled to adjacent panels by the flexible straps 1020. In the embodiment illustrated in Figure 10B, the plurality of panels 1016 can pivot bidirectionally relative to adjacent panels 1016 to fold into a retracted position.

A shield assembly deployment mechanism, such as described above with respect to Figures 9B and 9C, can be incorporated into the system 1000. When the shield assemblies 1002 are not in use, the shield assemblies can be held in the retracted position via a chamber door (i.e., chamber door 908) or other pulley system. When ballistics protection is needed, deployment can be achieved, in one embodiment, through manual or remote operation of the chamber doors (e.g., via a spring-based release mechanism, pulley/winching system, etc.), or in another embodiment, through actuation of a pulley system from inside the vehicle, for example. Operatively, the shield assemblies 1002 can be transitioned to and from the folded retracted position and the extended position (shown in Figure 10A).

As shown in Figure 10A, first and second support chambers 1008a and 1008b are positioned along sides of the vehicle 1006; however, one of ordinary skill in the art will recognize that additional support chambers may be carried by the vehicle roof bracket 1004. For example, a third support chamber (not shown) may be positioned to cover a rear window or cargo compartment of the vehicle 1006. Additionally, the vehicle roof bracket 1004 can be sized to accommodate specific vehicles or vessels. Accordingly, these sized vehicle roof brackets 1004 with support chambers 1008 and shield assemblies 1002 can be packaged as sold as a kit that can be attached and/or removed from a vehicle as necessary. An additional feature of the system 1000 is that shield assemblies 1002 that become damaged or otherwise compromised in protection can be replaced.
Figures 11A and 11B are isometric front and back/bottom views, respectively, illustrating a lightweight armor protection system (referred to herein as "LAPS") 100 configured in accordance with an embodiment of the disclosure shown in a self-supporting position. The LAPS 100 can include a shield assembly 102, wherein the shield assembly includes (a) a plurality of panels 110 (individual panels 110a-d are shown in Figures 11 and 12) positioned adjacent to one another, and (b) a plurality of hinges 120 (individual hinges 120a-i are shown in Figures 11 and 12) attached widthwise across the panels 110 to couple the panels together. The shield assembly 102, in one arrangement can be an articulated shield, wherein the plurality of panels 110 can pivot relative to adjacent panels 110. Operatively, the shield assembly 102 can be transitioned to and from the expanded self-supporting position and a folded position suitable for transport (described in more detail below). The self-supporting position of the shield assembly 102, as illustrated in Figures 11A and 11B, includes panels 110 pivoted in a first direction relative to adjacent panels 110 to form a chevron shape. Generally, the panels 110 can be self-supported vertically such that a user would be able to kneel, crouch, sit, squat, etc. within the protection area 130 and be protected and/or hidden from view.

In some embodiments, the panels 110 can be generally rectangular having a panel length Li and a panel width Wi. In one specific embodiment, the panels 110 can have a panel length Li of approximately 35 inches to approximately 45 inches, and have a panel width Wi of approximately 10 inches to approximately 18 inches, and can have a panel width Wi of approximately 15 inches. In some embodiments, the lengths Li and widths Wi of the individual panels 110 can be generally the same. In other embodiments, however, the panels 110 may have varying lengths Li and/or widths Wi. The disclosure is not limited by the specific examples used herein and one of ordinary skill in the art will recognize that the panels 110 may have other dimensions, shapes and/or configurations.

As illustrated in Figures 11A and 11B, the panels 110a-d can be positioned adjacent to one another along lengthwise panel edges 116. In one embodiment, the panels 110 can be positioned adjacent to other ones of the panels 110, such that the panels are moveable relative to the adjacent ones of the panels along the lengthwise panel
edges 116. In this arrangement, the panels 110a-d can pivot relative to adjacent panels to form the generally arcuate or chevron shape having a protection area 130, wherein a center of gravity of the assembly 102 is positioned within the protection area 130 to provide for greater stability.

[0086] In another embodiment, the panels 110 can have tapered lengths L]. For example, and as illustrated in the embodiment shown in Figures 11A and 11B, the panels 110 can have widthwise panel edges 117a and 117b that taper progressively from a first lengthwise panel edge 116a (shown for panel 110b in Figure 11B) to a second lengthwise panel edge 116b. In some embodiments, the panels 110 may be tapered off horizontal by approximately 1 degree to approximately 25 degrees. In one embodiment, the edges 117a and 117b are both tapered. In another embodiment, the panels 110 can include tapered edges 117b and non-tapered edges 117a.

[0087] The shield assembly 102 may include a plurality of panels 110 each having different degrees of taper. The tapered widthwise panel edges 117b can provide a close contact with the ground or other support surface when the shield assembly 102 is in the generally arcuate or chevron shape (e.g., the self-supporting position), thus providing greater stability. In a specific example, the shield assembly 102 can have the four panels 110a-d in which the center panels 110b and 110c have an approximate 4 degree taper, and the flanking panels 110a and 110d. In other embodiments, the panels 110 can have other dimensions and/or configurations, and the disclosure is not limited by the specific examples used herein. Additionally, the shield assembly 102, as illustrated in Figures 11A and 11B, includes four panels 110a-d; however, in other embodiments, the assembly can include a different number of panels (e.g., about 2 panels to about 8 panels, 3 panels, 6 panels, etc.).

[0088] In one embodiment, the panels 110a-d can be aligned such that a vertical height Hi of the shield assembly 102 decreases along the direction from a center point 118 (height Hi) of the assembly to an outer edge 119 (height H2) of the assembly 102. In one embodiment, the panels 110 can be aligned such that the transition between panels 110 along the widthwise panel edges 117a and 117b is relatively smooth, such as illustrated in
Figures 11A and 11B. In such an arrangement, the panel length \( L_1 \) at the lengthwise panel edge 116b is less than the length \( L_1 \) at lengthwise panel edge 116a, but is approximately equal to the length \( L_o \) of a lengthwise panel edge 116c of the adjacent panel 110a. In other embodiments, the panels 110 can have additional shapes and/or configurations such as, for example, having rounded corners and/or having non-tapered lengths.

[0089] The shield assembly 102 also includes one or more hinges 120 configured to couple the panels 110 (e.g., 110a and 110b) to adjacent panels 110. Figures 12A and 12B are top views of the LAPS 100 in various deployed positions illustrating adjacent panels 110a and 110b coupled along lengthwise panel edges 116 with hinges 120a-120c (only hinge 120a is visible in Figures 12A and 12B) configured in accordance with an embodiment of the disclosure. In the illustrated embodiment, the panels 110a and 110b can overlap one another at the lengthwise panel edges 116. The hinges 120 can extend across the lengthwise panel edges 116, as shown in Figure 12B, or partially between the panels 110a and 110b and can be attached to the panels 110a and 110b on the same front or back sides 112 and 114 of the adjacent panels 110a and 110b.

[0090] Referring to Figures 11A, 11B, 12A and 12B together, one or more fasteners 206 can be used to attach the hinges 120 to the panels 110. In one embodiment, the fasteners 206 can include rivets or bolts configured to penetrate through the panels 110 and the straps 120 for securing the hinges 120 in position to pivotally couple adjacent panels 110. In other embodiments, the hinges 120 can be adhesively attached to the panels 110.

[0091] The hinges 120, in one embodiment, can be butt hinges, a butterfly hinges, flush hinges, and/or continuous hinges (a.k.a. "piano hinges") and be composed of rigid metal plates pivotally coupled by a pivot pin. The material of the hinges 120 should resist projectile penetration. For example, the hinge material can be a very strong stainless steel.

[0092] Additionally, the hinges 120 can be any suitable width and length for at least spanning between any two adjacent panels 110. Figures 12A and 12B show the hinges
120 having a length suitable to couple two adjoining panels 110a and 110b, and as illustrated in Figures 11A and 11B, a plurality of hinges 120 can be spaced along the lengthwise panel edges 116 to couple adjacent panels 110 to each other. In one arrangement, three hinges 120 can be approximately uniformly distributed along the lengthwise panel edges 116. Any number of hinges 120 may be used to couple the panels 110 of the shield assembly 102, and the hinges 120 may be positioned at any or multiple attachment sites along the length Li of the panels 110.

[0093] Figures 12C-12E are partially schematic top views of other embodiments of the LAPS 100, illustrating various lengthwise panel edges 116 between adjacent panels 110 and configured so that the adjacent panels 110 overlap in accordance with an embodiment of the disclosure. As shown in Figures 12C and 12D, the lengthwise panel edges 116 include lap joints between the adjacent panels 110. Any portion of the panel width Wi can be selected for each panel 110 to overlap the adjacent panel 110. The width of the overlapping portions can be selected such that the path of a projectile cannot directly impinge on the hinge 120 in the extended position of the panels 110 as shown in Figure 12D. The thickness of the overlapping portions can be approximately half that of the panels 110. Different types of overlapping joints may be used. For example, Figure 12E shows a scarf joint in lieu of the lap joint shown in Figures 12C and 12D. The disclosure is not limited by the specific examples used herein and one of ordinary skill in the art will recognize that the overlap of the panels 110 may have other dimensions, shapes and/or configurations. As noted above, the hinges 120 allow the panels 110 to move between stacked and extended positions; however, the overlap between the panels 110 can limit the range of movement of the hinges.

[0094] The shield assembly 102 shown in Figures 11A and 11B can be quickly and readily collapsed for efficient storage when not in use and/or for transport by a user. The panels 110a-d can be configured to pivot in alternating opposite directions such that the panels can fold to a compact stacked position. For example, Figure 13A is a schematic top view illustrating the panels 110 in the stacked panel position of the shield assembly 102 in accordance with an embodiment of the disclosure. As illustrated in Figures 14A and
14B, the panels 110 can be pivoted with respect to adjacent panels 110 until each panel lies approximately flat against its neighboring (i.e., adjacent) panel. The panels 110 can pivot in alternating and/or opposite directions such that the shield assembly 102 can be folded in accordion fashion. Accordingly, as shown in the illustrated embodiment, the hinges 120 allow the adjacent panels 110 to pivot with respect to one another and thereby permit the panels 110 to stack in the stacked panel position shown in Figure 13A.

[0095] Figures 13B-13G are schematic views illustrating the LAPS 100 in various self-supporting deployed positions. Specifically, the hinges 120 also allow the shield assembly 102 to transition between the stacked panel position and at least six basic extended positions. Figure 13B shows a fully extended position with the panels 110 deployed in a generally planar configuration. Figure 13C shows an L-shaped extended position with the panel 110a deployed at an approximately 90 degree angle to the other panels 110b-110d. Figure 13D shows a U-shaped extended position with the end panels 110a and 110d deployed at an approximately 90 degree angles to the central panels 110b and 110c. Figure 13E shows an double-thickness chevron-shaped extended position with the end panels 110a and 110d stacked on the center panels 110b and 110c, respectively, and the central panel 110b deployed at an approximately 90 degree angle to the other central panel 110c. Figure 13F shows a single-thickness chevron-shaped extended position with the panels 110a and 110b deployed in a generally planar configuration, the panels 110c and 110d deployed in a generally planar configuration, and the central panels 110b and 110c deployed at an approximately 90 degree angle relative to one another. Figure 13G shows another L-shaped extended position including a double thickness portion with the end panel 110a stacked on the center panel 110b. Different angular relationships, e.g., other than 90 degrees, may also be used. The disclosure is not limited by the specific examples used herein and one of ordinary skill in the art will recognize that the extended positions of the shield assembly 102 may have other angles, shapes and/or configurations.

[0096] Figure 14 is an isometric back view illustrating another embodiment of the LAPS 100 configured in a self-supporting position. As shown in Figure 14, the hinges 120 include continuous hinges that pivotal couple adjacent panels. In particular, an individual
hinge 120 extends along each lengthwise panel edge 116. These hinges, which are also referred to as piano hinges, can extend approximately the entire length of the lengthwise panel edges 116.

[0097] Figure 15 is a top view of an embodiment of the LAPS 100 including hinge backing plates 122. The hinge backing plates 122 are coupled on the opposite side of the panels from the hinges 120 and can reinforce the coupling between the hinges 120 and the panels 110. When bolts or rivets are used as the fasteners 206 to attach the hinges 120 to the panels 110, the same fasteners 206 can also be used to couple the hinge backing plates 122 with the panels 110 and hinges 120. Additionally, side edges of the hinge backing plates 122 can project laterally across the lengthwise panel edge 116 and cover gaps between the panels 110 when the shield assembly 102 is in the generally arcuate shape 130 (e.g., the self-supporting position).

[0098] The hinge backing plates 122 can be composed of rigid metal plates. The material of the hinge backing plates 122 should resist projectile penetration. For example, the hinge backing plate material can be a very strong stainless steel. Also, the hinge backing plates 122 can extend approximately the entire length of the lengthwise panel edges 116 as shown in Figure 15. Other embodiments according to the present disclosure can include hinge backing plates 122 that extend in relation to the length and/or positioning of the hinges 120.

[0099] Figures 16A-16C are partially schematic top views illustrating another embodiment of the hinge backing plates 122 for covering gaps between adjacent panels 110. In an extended position of the shield assembly 102 shown in Figure 16A, a hinge backing plate 122a extends on the back side 114 of the shield assembly 102 and a hinge backing plate 122b extends on the front side 112 of the shield assembly 102. Both hinge backing plates 122a and 122b cover the lengthwise panel edges 116 between respective panels 110. Figures 16B and 16C show detail views of the hinge backing plates 122a and 122b, respectively, when the shield assembly 102 is in the stacked panel position. The cross-sectional shape and size of the hinge backing plates 122 can be selected in accordance with the particular configuration of the shield assembly 102 in the fully
extended position. The disclosure is not limited by the specific examples used herein and one of ordinary skill in the art will recognize that the hinge backing plates 122 may have other sizes, shapes and/or configurations.

[0100] Figure 17 is a schematic top view of another embodiment of the LAPS 100 in a self-supporting position. The arrow shown in Figure 17 indicates a ballistic direction with respect to the shield assembly. For the given ballistic direction, the angle of incidence for a projectile strike on the central panels 110b and 110c is greater than on the end panels 110a and 110d. Accordingly, the capability of the end panels 110a and 110d to resist penetration by a projectile does not need to be as great as that of the central panels 110b and 110c. Therefore, the shield assembly 102 shown in Figure 17 includes central panels 110b and 110c that are composed of a ballistics material that can provide NIJ Level III projectile protection and the end panels 110a and 110bc are composed of a ballistics material that can provide NIJ Level II-A or Level II projectile protection. The material that provides NIJ Level III-A or Level II projectile protection can be lighter weight than the material that provides Level III projectile protection. Accordingly, a weight savings is achieved by the shield assembly 102 as shown in Figure 17. Further weight savings can be achieved by reducing the size of the end panels 110a and 110d relative to the central panels 110b and 110c. For example, in some embodiments, the weight of the shield assembly 102 disclosed herein can be reduced by five to 10 pounds or more.

[0101] Figure 18A is a schematic side view of another embodiment of the LAPS 100 illustrating a roller 130 to facilitate positioning the shield assembly 102. To make the LAPS 100 more mobile, one or more rollers 130 can be added to the widthwise panel edge 117b without interfering with the ability to fold the shield assembly to the stacked panel position. Referring additionally to Figure 18B, the roller 130 can include a ball roller, a pivotally mounted wheel, or another device that is self aligning to a direction of movement of the shield assembly. In operation, the shield assembly 102 can be tilted to shift at least a portion of the weight of the LAPS 100 to the roller 130 and then the LAPS 100 can be rolled to another position in a manner similar to handling wheel barrow. According to other embodiments, additional rollers 130 can add additional stability and make the LAPS 100...
more easily moved. For example, as shown in Figure 18C, three rollers 130 can be added to the widthwise panel edge 117b of the shield assembly 102.

[0102] From the foregoing, it will be appreciated that specific embodiments of the disclosure have been described herein for purposes of illustration, but that various modifications can be made without deviating from the spirit and scope of the disclosure. For example, although many of the embodiments are described herein with respect to lightweight armor protection systems, or other types of transportable shield systems (e.g., hand-held shields, hanging shields, firearm and/or other military training shields, fire and/or heat shields, etc.) may be within the scope of the disclosure. Moreover, specific elements of any of the foregoing embodiments can be combined or substituted for elements in other embodiments. Furthermore, while advantages associated with certain embodiments of the disclosure have been described in the context of these embodiments, other embodiments may also exhibit such advantages, and not all embodiments need necessarily exhibit such advantages to fall within the scope of the invention. Accordingly, embodiments of the disclosure are not limited except as by the appended claims.
CLAIMS

I/We claim:

[c1] 1. A lightweight armor protection system, the system comprising:

a shield assembly that includes -

a plurality of panels positioned adjacent to one another along lengthwise panel edges and spaced apart from one another by gaps, the panels having a front side and a back side facing opposite from the front side, wherein the panels are composed of a ballistic material; and

one or more flexible straps interposed in the gaps between the panels and attached to the panels on alternating front and back sides of adjacent panels, the straps couple adjacent panels along the lengthwise panel edges and permit the panels to pivot bidirectionally relative to the adjacent panels, wherein the panels pivot relative to the adjacent panels to fold to a stacked panel position and pivot relative to the adjacent panels to expand to a self-supporting deployed position.

[c2] 2. The system of claim 1 wherein the flexible straps are composed of a ballistic material.

[c3] 3. The system of claim 1 wherein the flexible straps are attached to the panels at least one of rivets, bolts, and adhesive.
4. The system of claim 1 wherein the one or more flexible straps include elongated straps interposed in the gaps between the panels and attached to each one of the plurality of panels on alternating front and back sides of adjacent panels.

5. The system of claim 1 wherein the one or more flexible straps includes-
   a first flexible strap attached to at least the front side of a first panel and the back side of an adjacent second panel; and
   a second flexible strap attached to at least the back side of the first panel and the front side of the adjacent second panel, wherein the first and second flexible straps provide a bidirectional hinge between the first panel and the adjacent second panel.

6. The system of claim 1 wherein the ballistics material includes rigid, lightweight composite material for providing United States National Institute of Justice Level III projectile protection.

7. The system of claim 1 wherein the panels pivot relative to adjacent panels in alternating directions to form the stacked panel position.

8. The system of claim 1, further comprising a retention device for maintaining the shield assembly in the stacked panel position.

9. The system of claim 1 wherein the flexible straps are configured to couple adjacent panels such that the gap between the lengthwise panel edges is approximately equal to a strap width.

10. The system of claim 1 wherein the lengthwise panel edges are rounded.
11. The system of claim 1 wherein the shield assembly further includes one or more fasteners for coupling the shield assembly to a second shield assembly.

12. The system of claim 1 wherein the shield assembly further includes one or more fasteners for attaching the shield assembly to one of a vehicle and a building.

13. The system of claim 1 wherein the shield assembly provides a barrier between a protection area and a point of threat, and wherein one or more panels include a notch for providing a line of sight from the protection area to the point of threat.

14. The system of claim 1 wherein the plurality of panels include: one or more center panels; and a first end panel and a second end panel, the first and second end panels flanking the center panels, wherein the first and second end panels are configured to support the center panels in a generally vertical orientation.

15. The system of claim 1 wherein the self-supporting deployed position includes panels pivoted relative to adjacent panels to form a semi-circular shape.

16. The system of claim 1 wherein:

- the panels have tapered lengths with widthwise panel edges configured to contact a support surface when the shield assembly is positioned in a semi-circular shape;
- a center of gravity of the self-supporting deployed position is positioned within a protection area formed by the semi-circular shape; and
- the panels are aligned such that a vertical height of the shield assembly decreases along the direction from a center point of the assembly to an outer edge of the assembly.
17. The system of claim 1 wherein the shield assembly weighs approximately 50 pounds to approximately 70 pounds.

18. The system of claim 1 wherein the shield assembly has a first side, a second side facing opposite of the first side, a bottom edge, and a top edge orientated opposite of the bottom edge, and wherein the shield assembly is symmetrical such that (a) the first side or the second side can face a protection area when in the self-supporting deployed position, and (b) the bottom edge or the top edge can support the shield on a surface when in the self-supporting deployed position.

19. A transportable ballistic shield system, comprising:
   one or more rigid panels positioned adjacent to other ones of the panels, wherein the panels are moveable relative to the adjacent ones of the panels along lengthwise panel edges, and wherein the panels include ballistics material for providing United States National Institute of Justice Level III projectile protection; and
   one or more coupling straps attached to and spanning adjacent panels to couple the adjacent panels, wherein the straps are interwoven through gaps between multiple adjacent panels and attach alternately to either a first side or a second side facing opposite from the first side of each independent panel such that the panels pivot bidirectionally with respect to adjacent panels, and wherein the shield system can be stored in a compact folded configuration and be deployed in an expanded configuration to provide a ballistic shield.

20. The system of claim 19 wherein lengths of the individual panels are tapered and the panels are aligned and coupled such that a height of the ballistic shield decreases from a high point at a shield center to a low point at an outside edge of the shield.
21. The system of claim 19 wherein the expanded position includes panels pivoted relative to adjacent panels to form a self-supporting semi-circular shaped shield.

22. The system of claim 19 wherein the shield system is deployed automatically by a gas generator powered actuator.

23. The system of claim 19, further comprising:
   a support frame for carrying the rigid panels and positioning the rigid panels in an elevated position;
   a spring-based release mechanism on the support frame that is triggered to release the rigid panels from the compact folded configuration to the expanded configuration.

24. A lightweight shield system for providing self-supporting armor protection, the system comprising:
   a shield assembly that includes -
   a plurality of generally rectangular panels each having a front side and a back side facing opposite from the front side, the panels aligned and rotatively coupled along vertical edges to adjacent panels such that the panels pivot with respect to adjacent panels, wherein the coupled panels form an articulated ballistic shield;
   a plurality of elongated flexible straps attached to the panels, wherein:
   each strap is interwoven between and alternately over and under adjacent panels to provide a bidirectional hinge between adjacent panels;
   the straps are attached to each panel at one of a front side or a back side;
   each strap couples adjacent panels along the vertical edges; and
the bidirectional hinge permits the panels to (a) pivot relative to the adjacent panels to fold to a stacked panel position for storage, and (b) pivot relative to the adjacent panels to an expanded, free-standing position; and a retention device for securing the shield assembly in the stacked panel position.

[c25] 25. The system of claim 24 wherein the plurality of elongated flexible straps includes -

- a first elongated flexible strap attached to at least the front side of a first panel and the back side of an adjacent second panel; and
- a second elongated flexible strap attached to at least the back side of the first panel and the front side of the adjacent second panel, wherein the first and second elongated flexible straps provide a bidirectional hinge between the first panel and the adjacent second panel.

[c26] 26. The system of claim 24 wherein the panels include ballistics material for providing United States National Institute of Justice Level III projectile protection, and wherein the elongated flexible straps include a fiber-based ballistic material.

[c27] 27. A method for deploying a lightweight armor protection system (LAPS), the method comprising:

- transporting a stored LAPS in a stacked panel position to a first desired deployment location, the LAPS having -

- a plurality of panels positioned adjacent to one another along lengthwise panel edges and spaced apart from one another by gaps, the panels having a first side and a second side facing opposite from the first side, wherein the panels are composed of a ballistics material; and
one or more flexible straps interposed in the gaps between the panels and attached to the panels on alternating first and second sides of adjacent panels, the straps configured to couple adjacent panels along the lengthwise panel edges and configured to permit the panels to pivot bidirectionally relative to the adjacent panels;
expanding the LAPS from the stacked panel position to an extended position, wherein expanding the LAPS includes pivoting the panels relative to the adjacent panels such that the panels are aligned along the lengthwise panel edges; and
pivoting the panels relative to adjacent panels to form a semi-circular shaped, free-standing configuration.

[c28] 28. The method of claim 27, further comprising repositioning the LAPS to a second desired deployment location from the first desired deployment location, wherein repositioning the LAPS includes -
re-expanding the LAPS from the semi-circular shaped, free-standing configuration to the extended position;
alternately pivoting adjacent panels in opposing directions such that the plurality of panels are accordion-folded to form the stacked panel position;
transporting the LAPS in the stacked panel position to the second desired deployment location;
expanding the LAPS from the stacked panel position to the extended position; and
pivoting the panels relative to adjacent panels to form the semi-circular shaped, free-standing configuration.

[c29] 29. A lightweight armor protection system, the system comprising:
a shield assembly that includes -
a plurality of panels positioned adjacent to one another along lengthwise panel edges, the panels having a front side and a back side facing opposite from the front side, wherein the panels are composed of a ballistic material; and

a plurality of hinges pivotally coupling adjacent panels, individual hinges include a pivot pin extending parallel to the lengthwise panel edges and are configured to permit adjacent panels coupled by individual hinges to pivot relative to one another, wherein adjacent panels pivot relative to one another to fold to a stacked panel position and pivot relative to one another to expand to a self-supporting deployed position.

[c30] 30. The system of claim 29 wherein the lengthwise panel edges of adjacent panels comprise lap joints.

[c31] 31. The system of claim 29 wherein the lengthwise panel edges of adjacent panels comprise scarf joints.

[c32] 32. The system of claim 29 wherein adjacent panels overlap one another along the lengthwise panel edges.

[c33] 33. The system of claim 29 wherein the shield assembly further includes at least one of rivets, bolts, and adhesive coupling the hinges to the panels.

[c34] 34. The system of claim 29 wherein the hinges comprise at least one of a butt hinge, a butterfly hinge, and a flush hinge.

[c35] 35. The system of claim 34 wherein at least two hinges pivotal couple individual pairs of adjacent panels.
36. The system of claim 29 wherein the hinges comprise continuous hinges pivotally coupling adjacent panels.

37. The system of claim 36 wherein the continuous hinges extend approximately an entire length of the lengthwise panel edges.

38. The system of claim 29 wherein the shield assembly further includes hinge backing plates coupled to the panels on the opposite side from the hinges.

39. The system of claim 38 wherein individual hinge backing plates overlap individual lengthwise panel edges.

40. The system of claim 38 wherein the shield assembly further includes at least one of rivets and bolts coupling the hinges, panels, and hinge backing plates.

41. The system of claim 29 wherein the plurality of panels consists of four panels including two center panels and first and second end panels flanking the center panels.

42. The system of claim 41 wherein the two center panels are composed of a material for providing United States National Institute of Justice Level III projectile protection and the first and second end panels are composed of a material for providing United States National Institute of Justice Level III-A/II projectile protection.

43. The system of claim 41 wherein each of the first and second end panels weigh less than an individual center panel.
44. The system of claim 41 wherein the four panels are configured to be folded with respect to one another in one stacked panel position and six self-supporting deployed positions.

45. The system of claim 29, further comprising at least one roller coupled to the shield assembly and configured to at least partially support the shield assembly.

46. The system of claim 45, further comprising at least three rollers coupled to the shield assembly and configured to support the shield assembly.

47. A method for deploying a lightweight armor protection system (LAPS), the method comprising:

- transporting a stored LAPS in a stacked panel position approximately to a first desired deployment location, the LAPS having -
- a plurality of panels positioned adjacent to one another along lengthwise panel edges, the panels having a front side and a back side facing opposite from the front side, wherein the panels are composed of a ballistic material;
- a plurality of hinges pivotally coupling adjacent panels, individual hinges include a pivot pin extending parallel to the lengthwise panel edges and are configured to permit adjacent panels coupled by individual hinges to pivot relative to one another, wherein adjacent panels pivot relative to one another to fold to a stacked panel position and pivot relative to one another to expand to a self-supporting deployed position; and
- at least one roller coupled to the LAPS and configured to at least partially support the LAPS;

expanding the LAPS from the stacked panel position to the self-supporting deployed position, wherein expanding the LAPS includes positioning the at least one roller on a support surface; and
rolling the LAPS on the at least one roller to the first desired deployment location.

[48] The method of claim 47, further comprising repositioning the LAPS to a second desired deployment location, wherein repositioning the LAPS includes rolling the LAPS on the at least one roller from the first desired deployment location to a second desired deployment location.
800

810 Transporting a stored LAPS in a stacked panel position to a first desired deployment location

820 Expanding the LAPS from the stacked panel position to an extended position

830 Pivoting the panels relative to adjacent panels to form a semicircular shaped, free-standing configuration

FIG. 8