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(54) **MILITARY HELMET**

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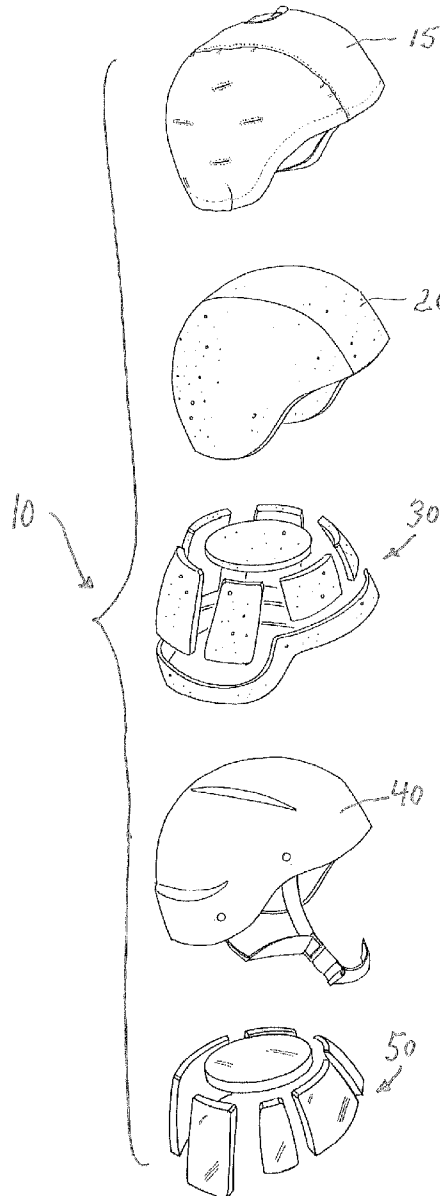
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(57) **ABSTRACT**

Embodiments of a protective helmet have a shell formed from a cushioning material, a cushioning spacer layer coupled to the shell and only partially covering an inner surface of the shell, a ballistic-resistant inner shell having an outer surface attached to the cushioning spacer layer and an inner surface, and an innermost cushioning pad layer attached to the inner surface of the ballistic-resistant inner shell. A flexible thin cover extending around an outer surface of the cushioning shell and with or without graphics may be provided.



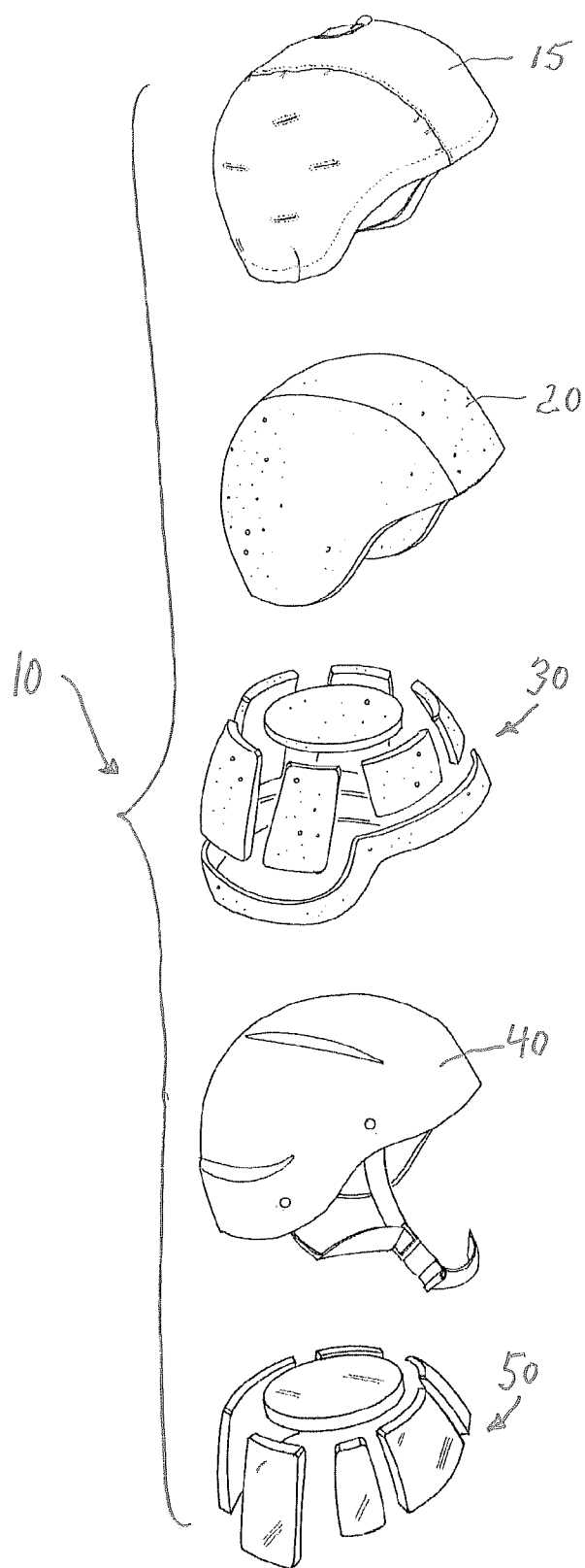


FIG. 1

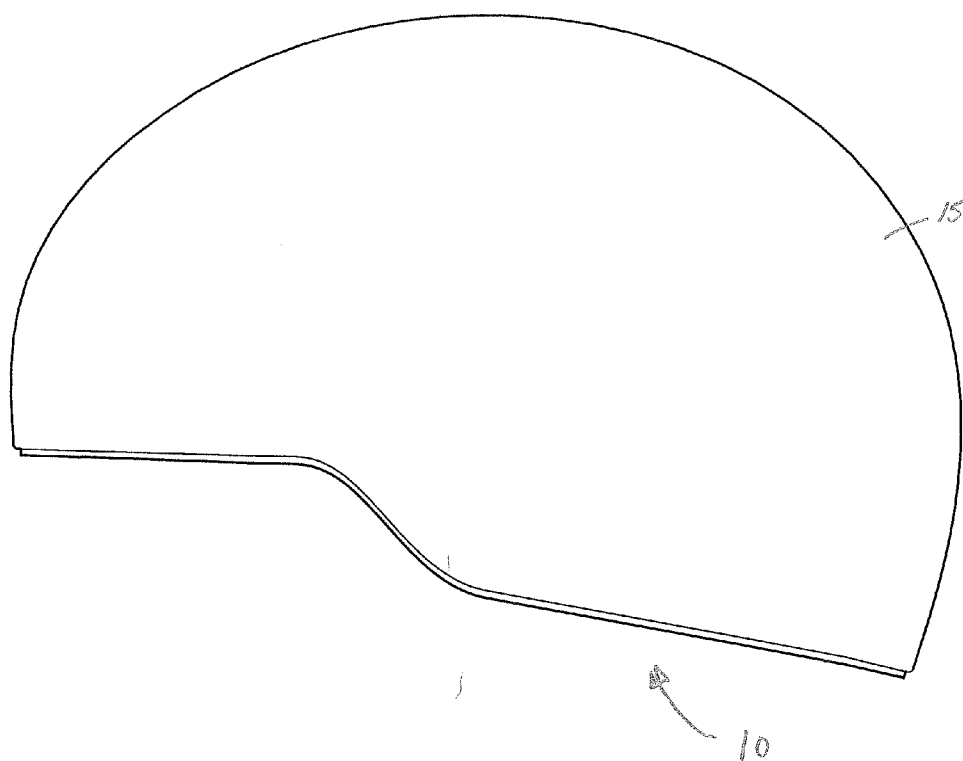
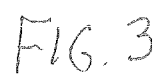


FIG. 2



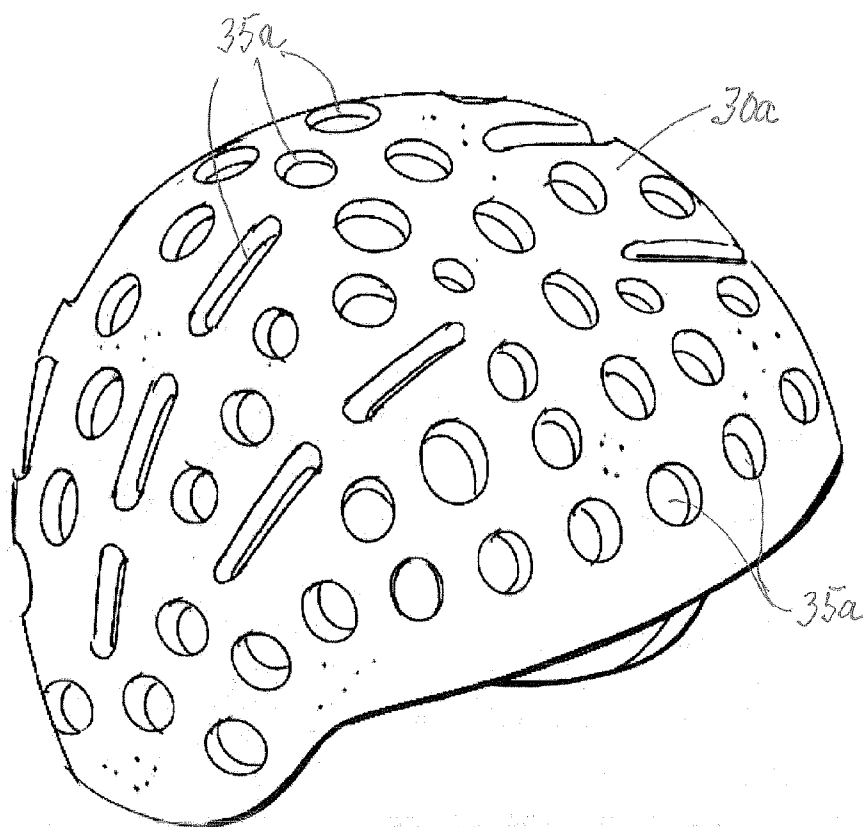
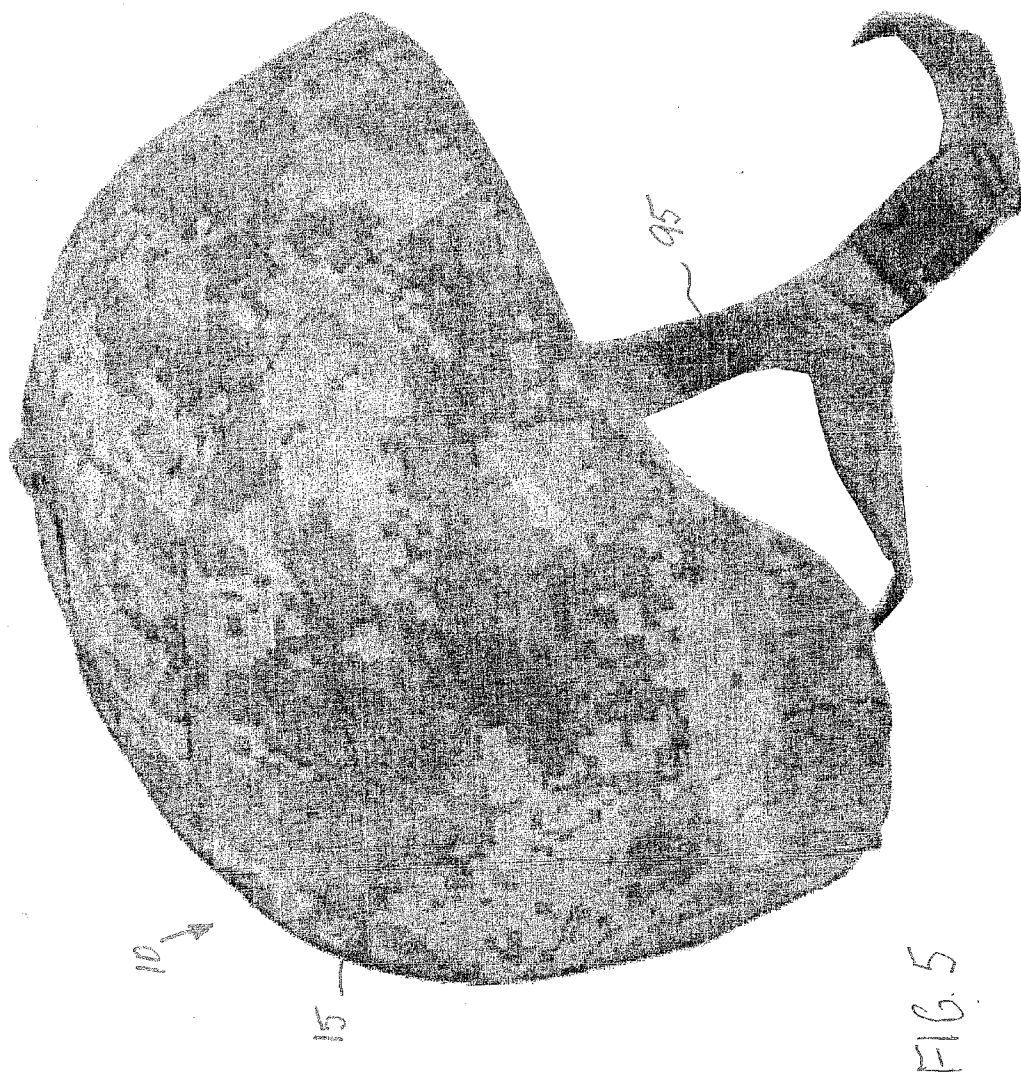


FIG. 4



MILITARY HELMET

BACKGROUND

[0001] 1. Field

[0002] The present disclosure relates to military helmets. More particularly, the present disclosure relates to military helmets having enhanced protective performance characteristics.

[0003] 2. State of the Art

[0004] Head trauma resulting in traumatic brain injury (TBI) has become a common occurrence in the military. A common cause of TBI is damage caused by explosive devices such as improvised explosive devices (IEDs).

[0005] TBI injuries fall into several categories that may have different symptoms. Mild TBI (MTBI), commonly referred to as a concussion, is a brief loss of consciousness or disorientation ranging up to thirty minutes. Although brain damage may not be visible on an MRI or CAT scan, common symptoms of MTBI include headache, confusion, lightheadedness, dizziness, blurred vision, ringing in the ears, fatigue or lethargy, behavioral or mood changes, and trouble with memory, concentration or attention. Severe traumatic brain injury is associated with loss of consciousness for over thirty minutes or amnesia. Symptoms of severe TBI include all those of MTBI as well as headaches that increase in severity or do not abate, repeated vomiting or nausea, convulsions or seizures, dilation of the eye pupils, slurred speech, weakness or numbness in the extremities, loss of coordination, and increased confusion or agitation. TBI injuries can cause lasting physical and cognitive damage.

[0006] Presently, the U.S. army utilizes the Advanced Combat Helmet (ACH) that incorporates ballistic fiber such as KEVLAR (a trademark of DuPont of Wilmington, Del.), TWARON (a trademark of Teijin Twaron, B.V. of the Netherlands), or ultra-high-molecular-weight polyethylene (UHMWPE). The ACH has a suspension system including a rear suspension system to which a ballistic "nape pad" is attached. The nape pad is intended to reduce soldier deaths from shrapnel wounds to the neck and lower head.

[0007] Despite the introduction of the ACH, TBI injuries continue to be a major cause of concern.

SUMMARY

[0008] This summary is provided to introduce a selection of concepts that are further described below in the detailed description. This summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used as an aid in limiting the scope of the claimed subject matter.

[0009] A military helmet includes a multilayered system including a cushioning outer shell, a hard ballistic resistant inner shell, a cushioning spacer layer between the cushioning outer shell and the hard inner shell, with the cushioning spacer layer arranged relative to the hard inner shell to redirect energy transmitted from the cushioning outer shell along a circuitous path to air and to the hard inner shell, and plurality of innermost cushioning pads coupled to the inside of the hard inner shell.

[0010] In one aspect, the cushioning outer shell serves the purpose of absorbing or deflecting an acoustic shock wave that can impact the military helmet in advance of the impact of a projectile (e.g., bullet).

[0011] In one embodiment, the cushioning outer shell is covered by a flexible thin cover. The flexible thin cover may be a fabric, film, foil, or other cover such as a ballistic nylon (a high denier nylon thread with a dense basket weave) that is used as a cover for the ACH. The flexible thin cover may provide a surface for printing graphics (e.g., camouflage). The flexible thin cover may also protect the cushioning outer shell from damage.

[0012] In one embodiment, the hard ballistic resistant inner shell is formed from a ballistic fiber composite material such as KEVLAR.

[0013] In one embodiment, the cushioning spacer layer includes a plurality of elements glued or otherwise attached to the cushioning outer shell and to the hard inner shell. In another embodiment, the cushioning spacer layer comprises a single member defining a plurality of spaces. The cushioning spacer layer elements or member may include a plurality of layers of different densities.

[0014] In one embodiment one or more of cushioning layers or elements is formed from a foam material such as an elastomeric, cellular foam material. In another embodiment, one or more of the cushioning layers is made of thermoplastic polyurethane (TPU).

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. 1 is a perspective exploded view of a first embodiment of a military helmet.

[0016] FIG. 2 is a side view of the first embodiment.

[0017] FIG. 3 is a cross-sectional view of the first embodiment.

[0018] FIG. 4 is a perspective view of an alternative cushioning spacer layer.

[0019] FIG. 5 is a perspective view of a military helmet including straps and accessories.

DETAILED DESCRIPTION

[0020] One embodiment of a military helmet 10 is seen in FIGS. 1-3. Helmet 10 includes a multilayered system including an optional outermost cover 15, a cushioning outer shell 20 having a convex outer surface 22 and a concave inner surface 24, a hard ballistic-resistant inner shell 40 with a convex outer surface 42 and a concave inner surface 44, a cushioning spacer layer 30 located between and separating the cushioning outer shell 20 and the hard inner shell 40, and one or more innermost cushioning pads 50 coupled to the inside surface 44 of the hard inner shell 40. The innermost cushioning pads 50 may be covered by another fabric layer 60. As will be discussed in more detail hereinafter, the cushioning spacer layer 30 separates the cushioning outer shell 20 from the ballistic-resistant inner shell 40 and redirects energy transmitted from the cushioning outer shell along a circuitous path to air gaps and to the ballistic-resistant inner shell, thereby causing dissipation of shock (pressure) wave energy. Pressure wave energy that does reach the ballistic-resistant inner shell 40 is further dissipated by the innermost cushioning pads 50 before reaching the head of the helmet user (not shown).

[0021] When a projectile is shot at the helmet, before the projectile reaches the helmet, an energy wave hits the helmet. This energy wave can be a significant percentage of the total energy (energy or shock wave energy plus projectile energy) that impacts the helmet. In fact, in some circumstances, it is possible that only a shock wave is received, in which case, the

shock wave is 100% of the total energy impacting the helmet. The military helmet **10** is designed to lessen the total energy impact on its user in two separate manners. First, the energy wave can take various paths. For example, it should be appreciated that the cushioning outer shell **20** will absorb and/or distribute some or all of the energy. The energy may be absorbed by deflection of the foam cushioning. If some of the energy passes through the cushioning outer shell **20** it can either pass into the cushioning spacers **30** or into the air between the cushioning spacers. Again, if the energy passes into the cushioning spacers, the energy may be absorbed by deflection of the cushioning spacers. Alternatively or in addition, the energy may be absorbed in the air between the cushioning spacers. Energy passing through the cushioning spacer level will reach the hard inner shell where it can be one or more of reflected, distributed, absorbed or transmitted. Energy passing through the hard inner ballistic-resistant will be passed to the innermost cushioning pads **50** or the air gaps between the pads where the energy again may be absorbed by deflection of the cushioning pads **50** or by the air gaps therein. With all of these possible paths, it will be appreciated that the energy imparted by the energy shock wave will be significantly dissipated before reaching the head of the user. In addition, by forcing the energy wave through a tortuous path due to the use of cushioning and multiple layers with air gaps, the resistance to the energy shock waves by the helmet is increased. In this manner, the incidence of brain concussions of wearers of the military helmet **10** can be reduced.

[0022] The military helmet **10** is also adapted to lessen the impact of the projectile itself. In particular, while the cushioning outer shell **20** and the cushioning spacer layer **30** will not appreciably stop the projectile, the hard inner shell **40** formed from a ballistic-resistant material will act to stop the projectile in the manner of the previously described with reference to the Advanced Combat Helmet.

[0023] Some of the energy paths through the helmet can be seen by reference to FIG. 3 which shows three different cross-sectional paths through the military helmet. A first cross section at location A through the military helmet shows a fabric cover **15**, the cushioning shell **20**, a cushioning spacer pad **30**, a ballistic-resistant inner shell **40**, an inner cushioning pad **50**, and an inner fabric cover **60** for the inner cushioning pad **50**. Location B shows the cover **15**, cushioning shell **20**, space **35** (e.g., air between the cushioning spacer pads **30**), the ballistic-resistant inner shell **40**, an inner cushioning pad **50**, and an inner fabric cover **60** for the inner cushioning pad **50**. Location C includes the cover **15**, the cushioning shell **20**, the cushioning spacer pad **30**, the ballistic-resistant inner shell **40**, and space **55** (e.g., air gap between the inner cushioning pads **50**).

[0024] It should be appreciated that the described cross-sections give certain energy paths through the military helmet **10**, but that many other exist, and it is not necessary that all of these paths exist simultaneously in a military helmet. In fact, it will be appreciated that energy waves will generally take a path of least resistance through a substance that may not correspond exactly to any of the cross-sections. Because harder substances will generally transmit energy waves more readily than air, the air gaps will cause the energy to travel and spread radially through the cushioning shell **20** and the hard inner shell **40**. However, travel through a longer distance in the cushioning shell **20** and the ballistic-resistant inner shell **40** causes further attenuation of the energy.

[0025] In one embodiment, the flexible thin cover **15** may be a fabric, film, foil, or other cover such as a ballistic nylon (a high denier nylon thread with a dense basket weave) that is used as a cover for the ACH. The flexible thin cover may provide a surface for printing graphics, e.g., camouflage (see FIG. 5). The flexible thin cover may also protect the cushioning outer shell from damage. If desired, the flexible thin cover may extend around the periphery of the helmet (as suggested in FIG. 3) to protect the periphery of the cushioning shell **20** and the cushioning spacer layer **30** and optionally the hard inner shell **40** and even the innermost cushioning pads **50**. Alternatively, if desired, a flexible band may be used to extend around the periphery and cover the peripheral edge of cushioning shell **20**, the spacer layer **30** and optionally the hard shell **40**. In one embodiment, the flexible thin cover is made from ballistic nylon, a high denier nylon thread with a dense basket weave such as Cordura (a trademark of Invista, Wichita, Kans.). In another embodiment, the flexible thin cover is made from a Neoprene (a trademark of DuPont, Delaware) rubber (polychloroprene) fabric. In another embodiment, the flexible thin cover is made from a polyester fabric. In another embodiment, the flexible thin cover is made from non-woven fabric. In another embodiment, the flexible thin cover is made from a printable film. In another embodiment, the flexible thin cover is made from a para-aramid synthetic fiber such as KEVLAR (a trademark of DuPont of Wilmington, Del). In another embodiment the flexible thin cover comprises TWARON (a trademark of Teijin Twaron, B.V. of the Netherlands). In another embodiment, the flexible thin cover is made from a ultra-high-molecular-weight polyethylene. By way of example only, the thin cover may be between 0.1 mm and 10 mm thick, although it may be thinner or thicker. By way of another example, the flexible thin cover may be between 0.3 mm and 3.25 mm thick. By way of another example, the flexible thin cover may be between 1.0 mm and 1.5 mm thick. The thin cover **15** may be attached at one or more places to the cushioning shell **20**, so that the cover may be removed from the shell **20** without damaging the shell. By way of example only, attachment may be made by use of Velcro (a trademark of Velcro USA Inc., Manchester, N.H.). Alternatively, the thin cover may be glued, tacked or sewn to the shell **20**. In one embodiment, the thin cover **15** covers the entire cushioning shell **20**.

[0026] In one embodiment the cushioning shell **20** is comprised of foam. The foam may be an elastomeric, cellular foam or any other desirable foam. In another embodiment, the cushioning shell is comprised of thermoplastic polyurethane (TPU). In another embodiment, the cushioning shell is comprised of open-cell polyurethane. In another embodiment, the cushioning shell is comprised of closed cell polyolefin foam. In another embodiment, the cushioning shell is comprised of polyethylene foam which may be a high density polyethylene foam. In one embodiment, the outer surface **22** of the cushioning shell **20** is generally (hemi-)spherical in shape. By way of example and not by way of limitation, the cushioning shell may be between 3 mm and 13 mm thick, although it may be thinner or thicker. By way of example, and not by way of limitation, the cushioning shell may have a density of between 3.4 lbs/ft³ (approximately 0.016 g/cm³) and 25 lbs/ft³ (approximately 0.4 g/cm³), although it may be more dense or less dense.

[0027] In one embodiment the cushioning spacer layer **30** comprises a plurality of pads **31**. The pads **31** may be circular in shape or may be formed in other shapes. Multiple shapes

may be used together. In one embodiment, the spacer layer may include a strip of material **33** (seen in FIG. **1**) around the peripheral edge of the military helmet between the shell **20** and the hard inner shell **40** that can prevent foreign material from entering between the shell **20** and the hard inner shell **40**. In another embodiment (seen in FIG. **4**) the cushioning spacer layer is a single pad **30a** defining multiple cut-outs **35a** (i.e., the equivalent of multiple connected pads). In one embodiment the spacer layer **30** is comprised of foam. The foam may be an elastomeric, cellular foam or any other desirable foam. In another embodiment, the cushioning spacer layer is comprised of thermoplastic polyurethane (TPU). In another embodiment, the cushioning spacer layer is comprised of open-cell polyurethane. In another embodiment, the cushioning spacer layer is comprised of closed cell polyolefin foam. In another embodiment, the cushioning spacer layer is comprised of polyethylene foam which may be a high density polyethylene foam. In another embodiment, the cushioning spacer layer **30** has multiple layers formed from different materials. By way of example and not by way of limitation, the cushioning spacer layer may be between 3 mm and 26 mm thick, although it may be thinner or thicker. As another example, the cushioning spacer layer may be between 6 and 13 mm thick. By way of example, and not by way of limitation, the cushioning spacer layer may have a density of between 3.4 lbs/ft³ (approximately 0.016 g/cm³) and 25 lbs/ft³ (approximately 0.4 g/cm³), although it may be more dense or less dense.

[0028] According to one embodiment, the spacer layer **30** covers approximately fifty percent of the inner surface area of the shell **20**. In another embodiment, the spacer layer **30** covers between twenty percent and eighty percent of the inner surface area of the shell. The spacer layer **30** should cover sufficient area between the shell **20** and the hard inner shell **40** so that upon most expected impacts to the helmet **10**, the shell **20** does not directly come into contact with the hard inner shell **40**. Regardless of the material and arrangement of the cushioning spacer layer **30**, in one embodiment the cushioning material is affixed to the shell **20** and to the hard inner structure. Affixation can be done with glue, Velcro or any other affixation means.

[0029] In one embodiment, the hard ballistic-resistant inner shell **40** is comprised of a ballistic-resistant fibrous material. In one embodiment the inner shell material comprises a para-aramid synthetic fiber such as KEVLAR (a trademark of DuPont of Wilmington, Del.). In another embodiment the inner shell material comprises TWARON (a trademark of Teijin Twaron, B.V. of the Netherlands). In another embodiment, the inner shell material comprises ultra-high-molecular-weight polyethylene. As previously mentioned, in one embodiment the hard ballistic-resistant shell **40** is affixed to the spacer layer **30**. Affixation can be done with glue, Velcro or any other affixation means. By way of example and not by way of limitation, the hard ballistic-resistant shell is between 2 mm and 20 mm thick, although it may be thinner or thicker. As another example, the hard inner ballistic-resistant shell **40** is between 7 mm and 12 mm thick.

[0030] In one embodiment, the one or more innermost cushioning pad(s) **50** is comprised of foam. The foam may be an elastomeric, cellular foam or any other desirable foam. In another embodiment, the cushioning pad(s) **50** is comprised of thermoplastic polyurethane (TPU). In another embodiment, the cushioning pad(s) is comprised of open-cell polyurethane. In another embodiment, the cushioning pad(s) is

comprised of closed cell polyolefin foam. In another embodiment, the cushioning pad(s) is comprised of polyethylene foam which may be a high density polyethylene foam. In one embodiment the innermost cushioning pad **50** is a single pad defining multiple cut-outs (i.e., the equivalent of multiple connected pads). In another embodiment, a plurality of innermost cushioning pads **50** are provided. Regardless, the single pad with the cut-outs or the multiple pads are arranged in a desired configuration and are affixed to the hard inner structure **40**. Affixation can be done with glue, Velcro or any other affixation means. By way of example and not by way of limitation, the innermost cushioning layer may be between 3 mm and 26 mm thick, although it may be thinner or thicker. By way of example, and not by way of limitation, the innermost cushioning pads may have a density of between 3.4 lbs/ft³ (approximately 0.016 g/cm³) and 25 lbs/ft³ (approximately 0.4 g/cm³), although they may be more dense or less dense.

[0031] In one embodiment, the innermost cushioning pad(s) **50** is covered by a fabric layer **60** (seen in FIG. **3**). In one embodiment, fabric layer **60** is absorbent. In one embodiment fabric layer **60** is removable from the foam pad(s) **50**. In one embodiment, the flexible thin cover is made from ballistic nylon, a high denier nylon thread with a dense basket wave such as Cordura (a trademark of Invista, Wichita, Kans.). In another embodiment, the flexible thin cover is made from a Neoprene (a trademark of DuPont, Delaware) rubber (polychloroprene) fabric. In another embodiment, the flexible thin cover is made from a polyester fabric. In another embodiment, the flexible thin cover is made from non-woven fabric. By way of example only, the thin cover may be between 0.3 mm and 3.25 mm thick, although it may be thinner or thicker. By way of another example, the flexible thin cover may be between 1.0 mm and 1.5 mm thick.

[0032] In one embodiment, and as suggested by FIG. **5**, the military helmet **10** is adapted to be compatible with night vision devices (NVDs), communication packages, Nuclear, Biological and Chemical (NBC) defense equipment and body armor. In one embodiment, the military helmet **10** provides an unobstructed field of view and increased ambient hearing capabilities. In one embodiment, the military helmet **10** is provided with a chin strap retention system **95** (FIG. **5**). In one embodiment, the military helmet **10** is provided with an armor nape pad (not shown). In one embodiment, the armor nape pad (not shown) is provided with a cushioning outer layer, a hard ballistic-resistant inner layer, a cushioning spacer layer located between and separating the cushioning outer layer and the hard ballistic-resistant inner layer, and a cushioning pad coupled to the inside surface of the hard ballistic-resistant inner layer. The outer surface of the cushioning outer layer of the nape pad and/or the inner surface of the cushioning pad coupled to the inside surface of the hard ballistic-resistant inner layer of the nape pad may be provided with a fabric layer.

[0033] In one embodiment small holes are drilled in one or both of the cushioning shell and in the anti-ballistic hard shell for ventilation purposes and/or for attaching straps or other structures. The attachment holes may be covered by ballistic screws, nuts or bolts. Regardless, it will be appreciated that the size and number of holes in the anti-ballistic hard shell is kept to a minimum to limit the potential of penetration of projectiles through the holes. For purposes of the claims, a shell structure having holes for these purposes should still be considered a "continuous shell".

[0034] The military helmet 10 has a concave outer surface and a convex inner surface. As seen in FIG. 3, the shape of the military helmet is adapted to cover the back, top, and sides of a soldier's head without blocking vision or hearing. As such, the bottom rim of the helmet angles upward from the back of the helmet toward the front of the helmet at a first angle α , and then angles a steeper angle β at about the ear area, and then extends substantially horizontally γ at the forehead area.

[0035] The military helmets described are particularly suited for military use although they may be used for other purposes such as, by way of example only and not by way of limitation, a protective police helmet or an explosive ordnance disposal (EOD) helmet.

[0036] There have been described and illustrated herein several embodiments of a military helmet. While particular embodiments have been described, it is not intended that the claims be limited thereto, as it is intended that the claims be as broad in scope as the art will allow and that the specification be read likewise. Thus, while particular materials for cushioning layers have been disclosed, it will be appreciated that other materials may be used as well. Similarly, while particular types of materials have been disclosed for the hard shell layer, it will be understood that other materials can be used. Also, while particular types of materials for the cover layers have been described, other materials can be use. It will therefore be appreciated by those skilled in the art that yet other modifications could be made without deviating from the spirit and scope of the claims.

What is claimed is:

1. A protective helmet comprising:

a continuous cushioning material shell having an inner surface;

a cushioning spacer layer coupled to said cushioning shell, said cushioning spacer layer only partially covering said inner surface of said cushioning shell;

a continuous hard anti-ballistic inner shell having an outer surface and an inner surface, said outer surface attached to said cushioning spacer layer;

an innermost cushioning pad layer attached to said inner surface of said hard inner structure.

2. A protective helmet according to claim 1, wherein:

said hard anti-ballistic inner shell is formed from at least one of para-aramid synthetic fiber and ultra-high-molecular-weight polyethylene.

3. A helmet according to claim 1, further comprising:

a flexible thin cover extending around an outer surface of said cushioning shell.

4. A protective helmet according to claim 1, wherein:

said cushioning shell is formed from one of foam, thermoplastic polyurethane, and open-cell polyurethane.

5. A protective helmet according to claim 1, wherein:

said cushioning spacer layer is formed from at least one of foam, thermoplastic polyurethane, and open-cell polyurethane.

6. A protective helmet according to claim 1, wherein:

said innermost cushioning pad layer is formed from at least one of foam, thermoplastic polyurethane, and open-cell polyurethane.

7. A protective helmet according to claim 2, wherein:

said hard anti-ballistic inner shell is formed from a para-aramid synthetic fiber.

8. A protective helmet according to claim 5, wherein:

said cushioning spacer layer comprises at least one spacer defining spaces.

9. A protective helmet according to claim 8, wherein:

said at least one spacer comprises a plurality of spacers.

10. A protective helmet according to claim 6, wherein:

said innermost cushioning pad layer comprises at least one pad defining spaces.

11. A protective helmet according to claim 10, wherein:

said innermost cushioning pad layer comprises a plurality of pads defining space therebetween.

12. A protective helmet according to claim 3, wherein:

said flexible thin cover comprises one of a fabric, film and foil.

13. A protective helmet according to claim 12, wherein:

said flexible thin cover comprises one of ballistic nylon, polychloroprene, polyester fabric, para-aramid synthetic fiber, and ultra-high-molecular-weight polyethylene.

14. A protective helmet according to claim 3, wherein:

said flexible thin cover is adapted to be removable from said cushioning shell without damaging said cushioning shell.

15. A protective helmet, comprising:

a continuous cushioning shell formed from at least one of foam and thermoplastic polyurethane, said continuous cushioning shell having a convex outer surface and a concave inner surface;

a cushioning spacer layer coupled to and only partially covering said concave inner surface of said cushioning shell, said cushioning spacer layer including at least one pad defining first spaces and formed from at least one of foam and thermoplastic polyurethane;

a continuous ballistic-resistant inner shell having a convex outer surface and a concave inner surface, said convex outer surface of said ballistic-resistant inner shell attached to said cushioning spacer layer and formed from at least one of a para-aramid synthetic fiber and ultra-high-molecular-weight polyethylene;

an innermost cushioning pad layer attached to said concave inner surface of said ballistic-resistant inner shell and formed from at least one of foam, thermoplastic polyurethane, and open-cell polyurethane.

16. A protective helmet according to claim 15, further comprising:

a flexible thin cover extending around said outer convex surface of said cushioning shell.

17. A protective helmet according to claim 16, wherein:

said flexible thin cover is adapted to camouflage said helmet.

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