



US 20200178622A1

(19) **United States**(12) **Patent Application Publication****Jascomb et al.**(10) **Pub. No.: US 2020/0178622 A1**(43) **Pub. Date:****Jun. 11, 2020**(54) **MECHANICALLY BONDED VISOR SYSTEM FOR SURGICAL HOOD**(71) Applicant: **O&M Halyard, Inc.**, Mechanicsville, VA (US)(72) Inventors: **Jerald T. Jascomb**, Roswell, GA (US);  
**Margaret A. Howell**, Atlanta, GA (US)(21) Appl. No.: **16/704,478**(22) Filed: **Dec. 5, 2019****Related U.S. Application Data**

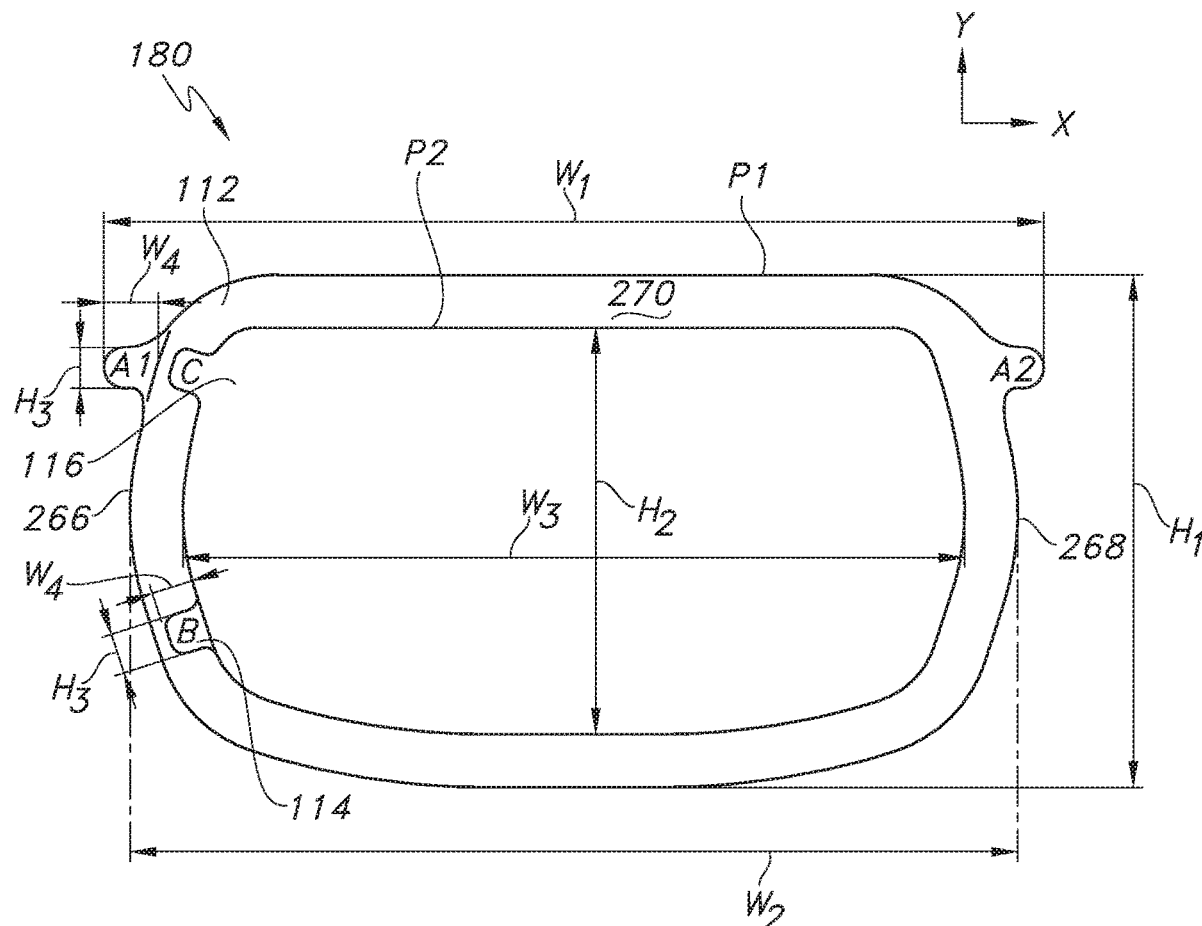
(60) Provisional application No. 62/775,988, filed on Dec. 6, 2018.

**Publication Classification**(51) **Int. Cl.**  
*A41D 13/11* (2006.01)  
*A41D 31/30* (2006.01)(52) **U.S. Cl.**CPC ..... *A41D 13/1192* (2013.01); *A41D 13/1153* (2013.01); *A41D 31/305* (2019.02); *A41D 2600/20* (2013.01); *A41D 2300/52* (2013.01); *A41D 2400/72* (2013.01); *A41D 2500/52* (2013.01); *A41D 2200/20* (2013.01)

(57)

**ABSTRACT**

A visor system for a surgical hood is provided. The system includes a base film and one or more removable films that are mechanically bonded (e.g., via ultrasonic energy and pressure, which allows ethylene oxide gas to penetrate between the films to provide for a “new” sterile surface should the surgeon elect to peel away a soiled or splattered removable film during the course of a surgical procedure so that an unobstructed view can be maintained. The mechanical bond points are intermittent rather than continuous so that the perimeter of the visor is not sealed, thus allowing for adequate ethylene oxide gas penetration and exposure to each of the films. Further, because the bond points are located about the perimeter of the removable films, viewing is not obscured, yet the layers are held securely in place until easily removed from the underlying removable film or base film.



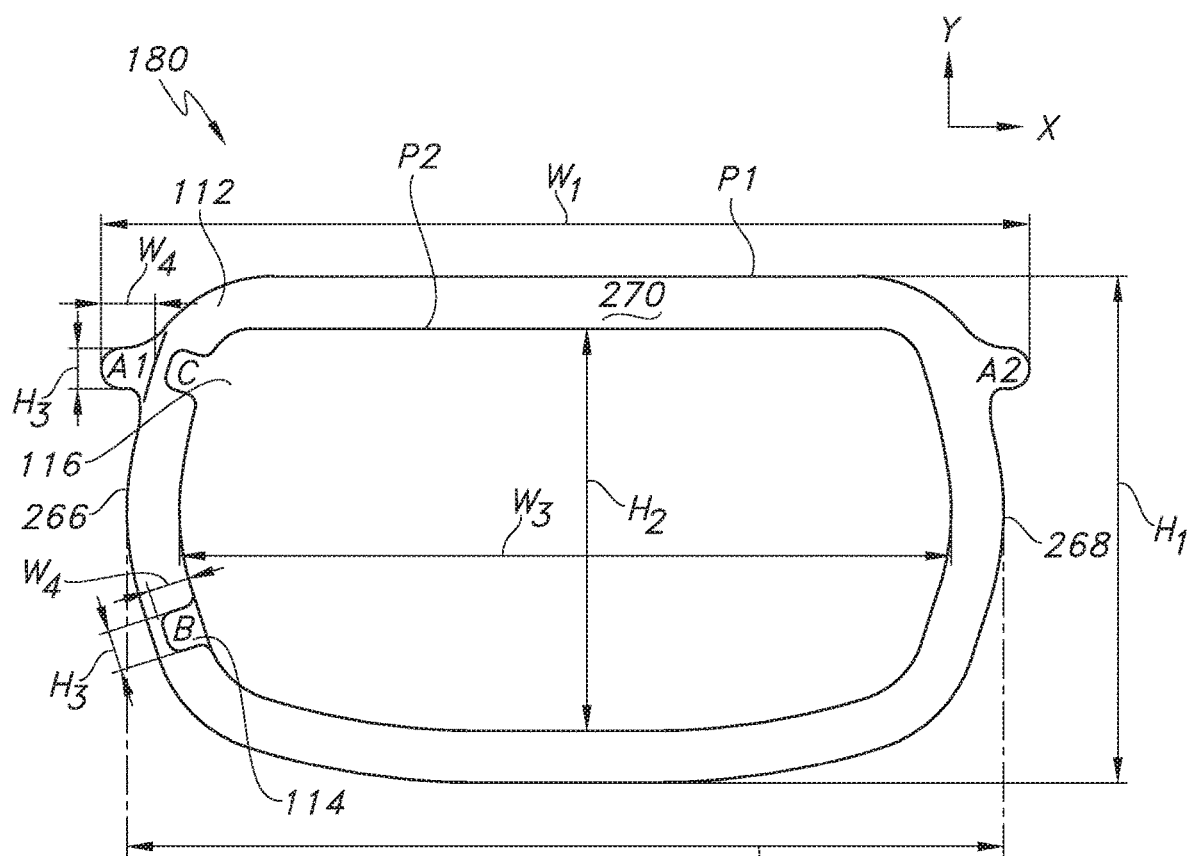


FIG. 1

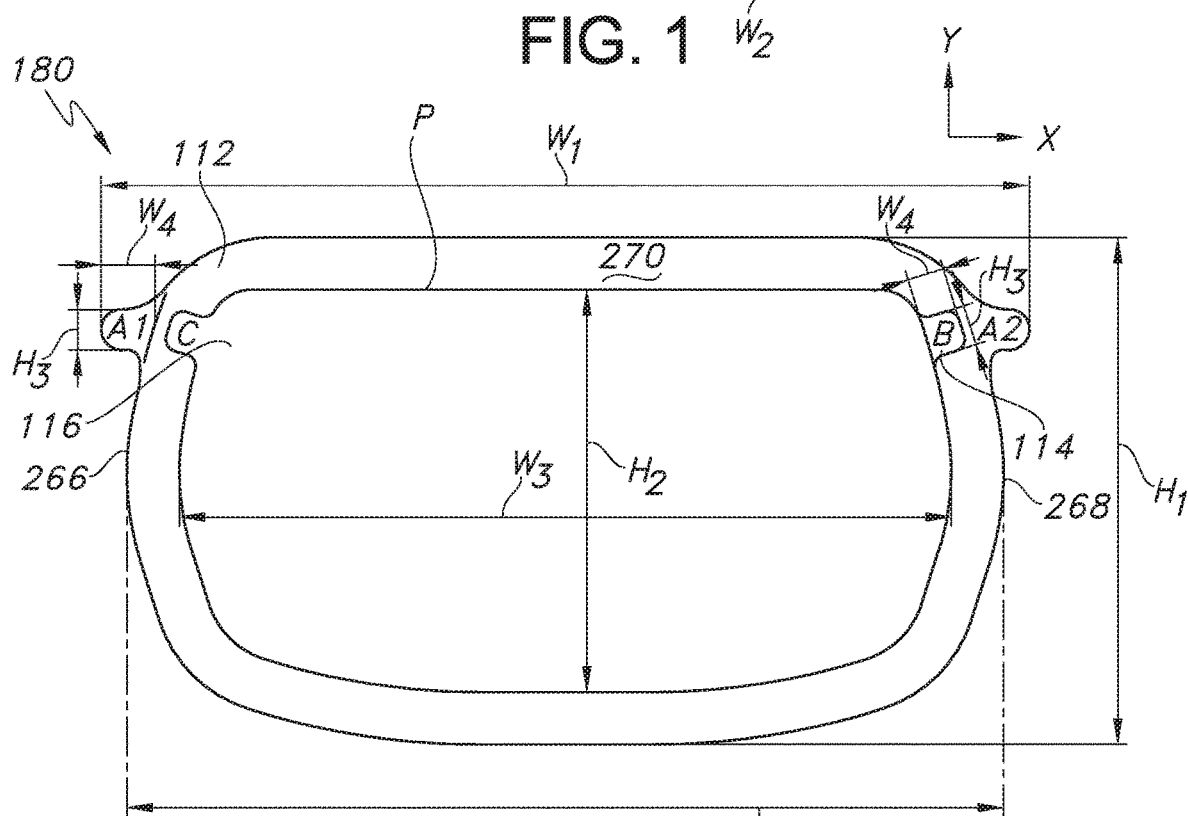


FIG. 2

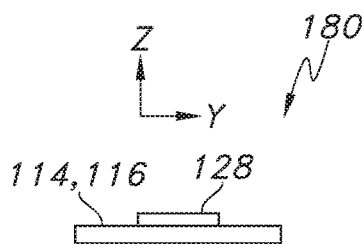


FIG. 3A

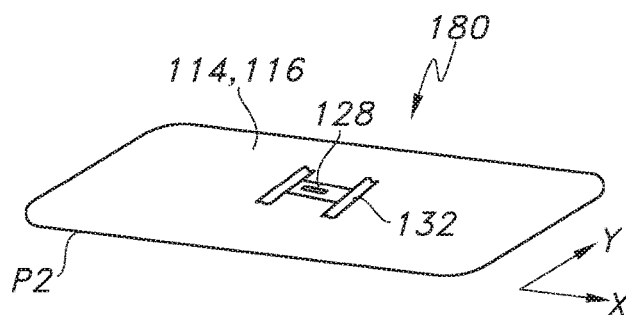


FIG. 3B

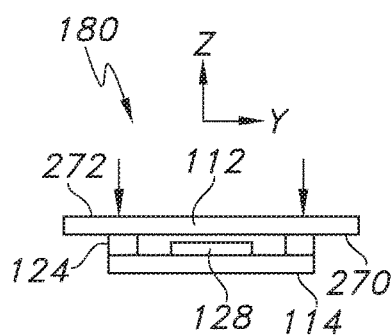


FIG. 4A

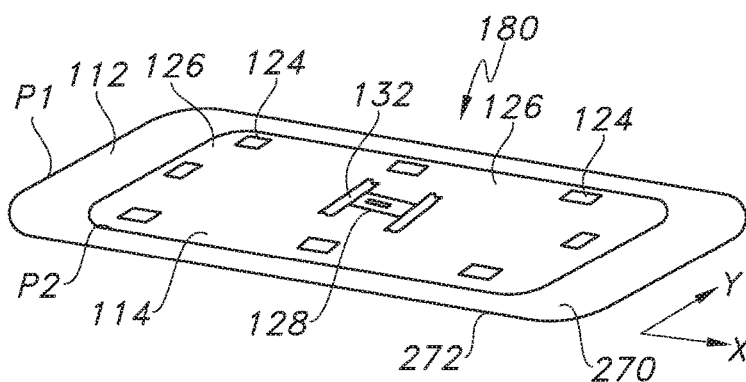


FIG. 4B

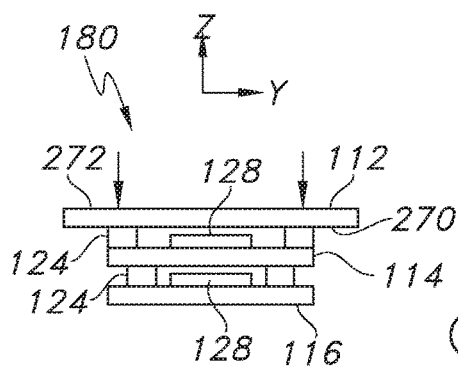


FIG. 5A

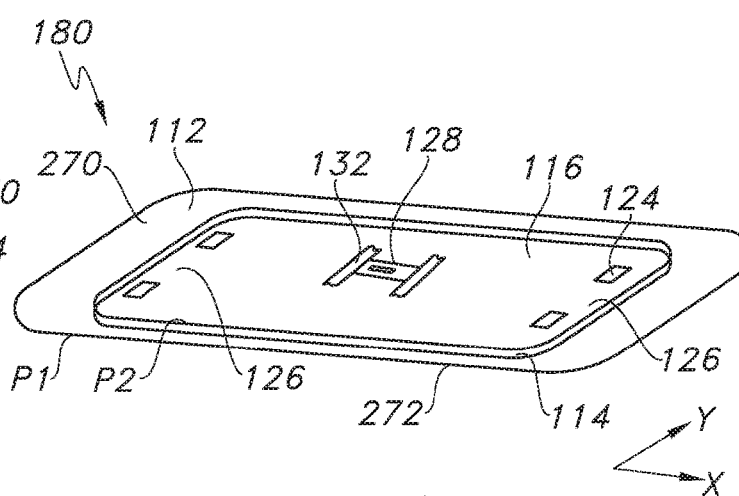


FIG. 5B

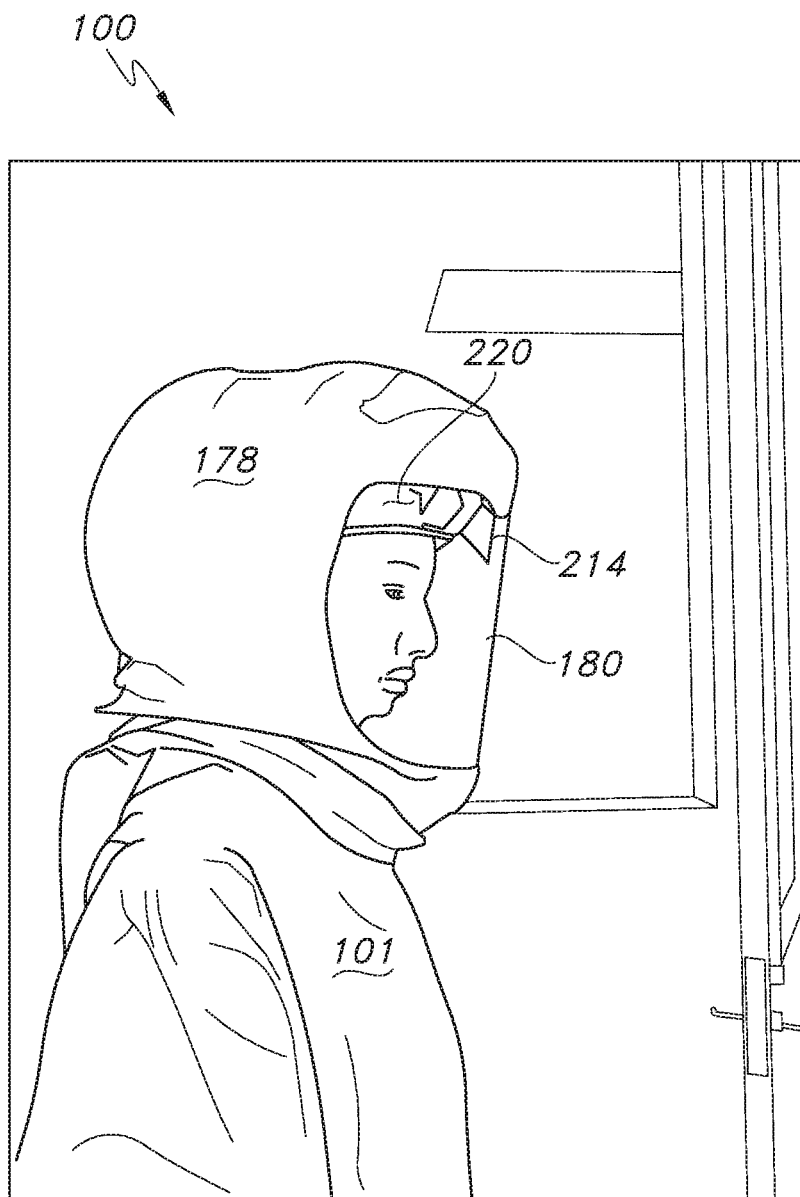


FIG. 6

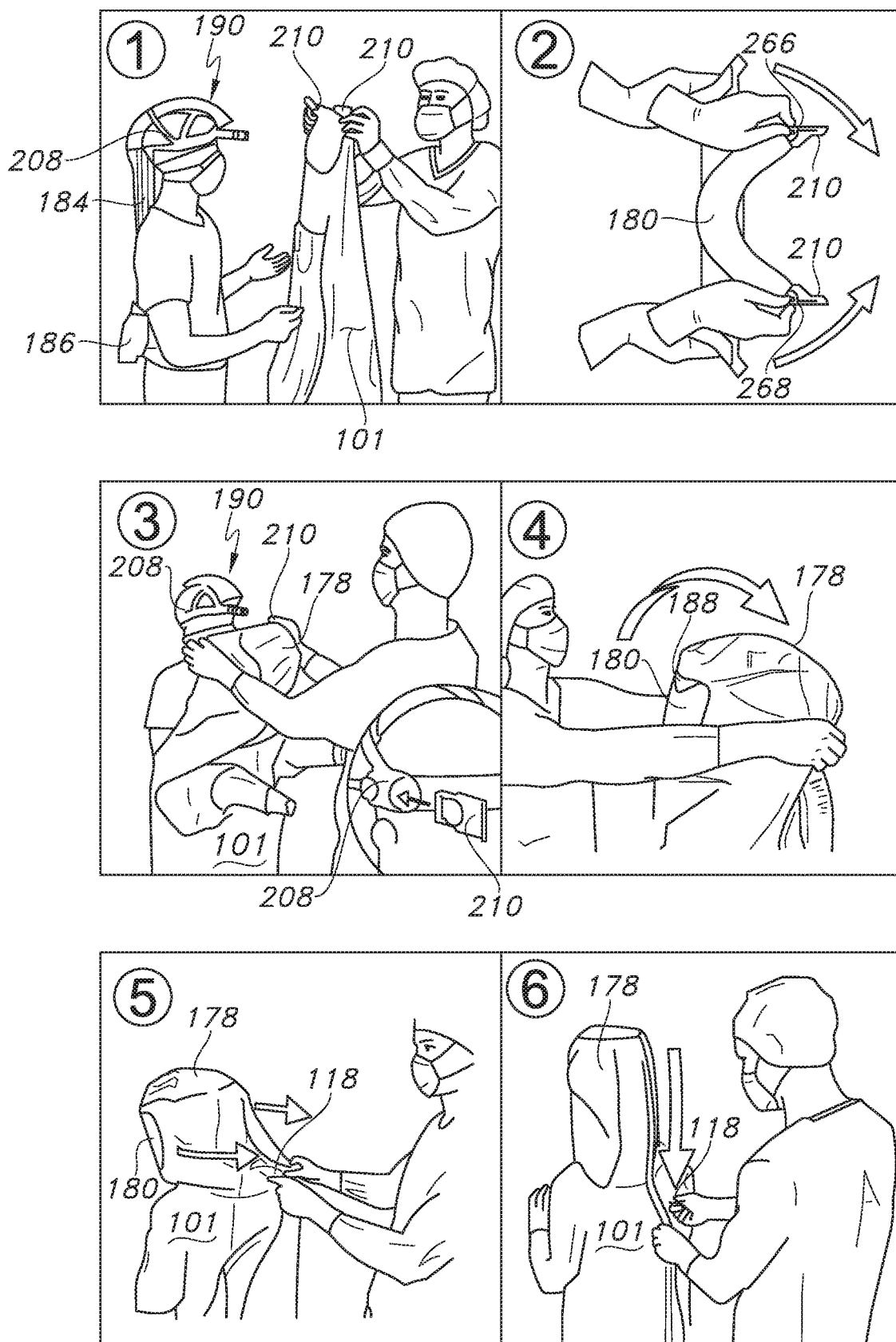


FIG. 7

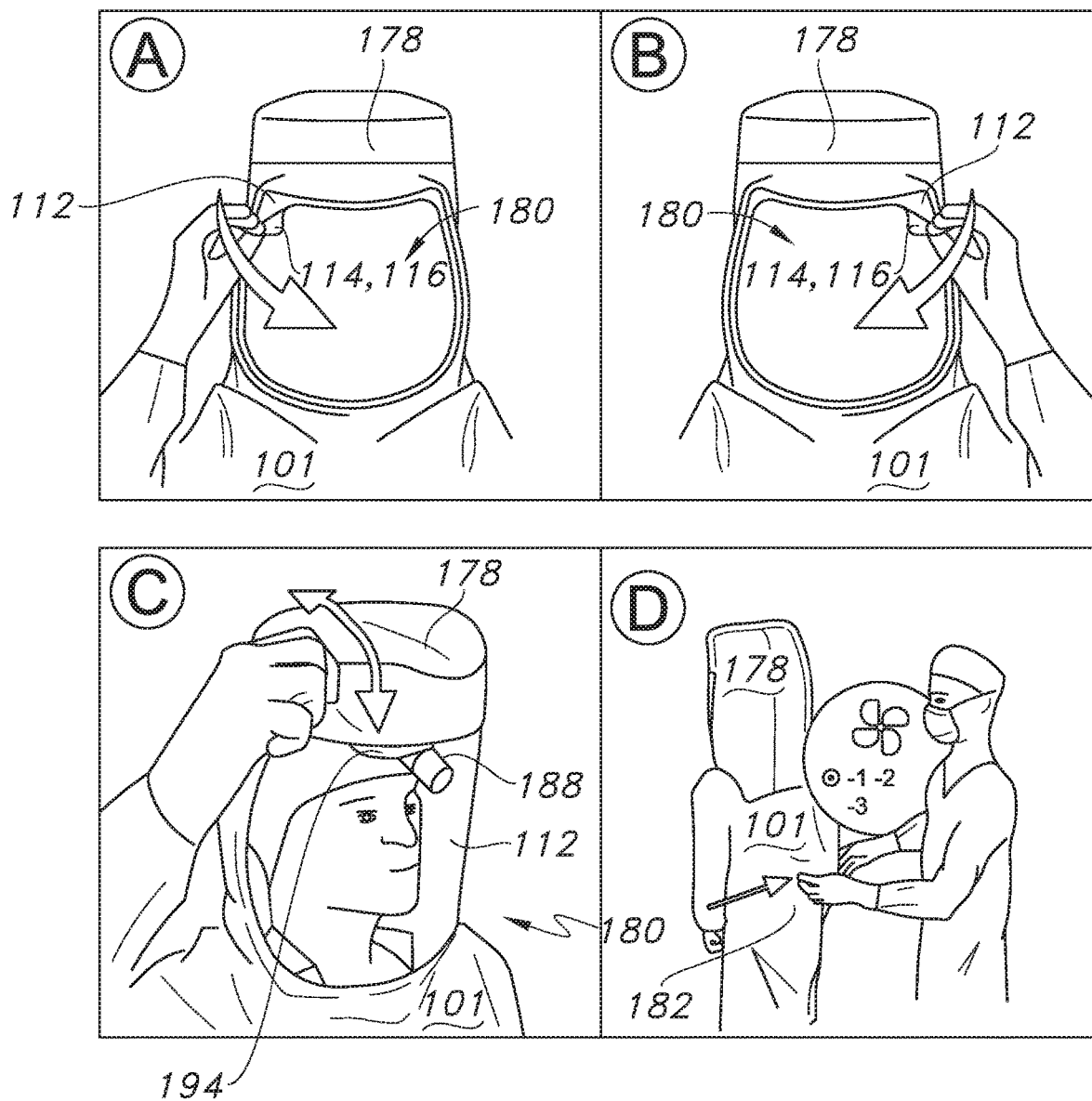


FIG. 8

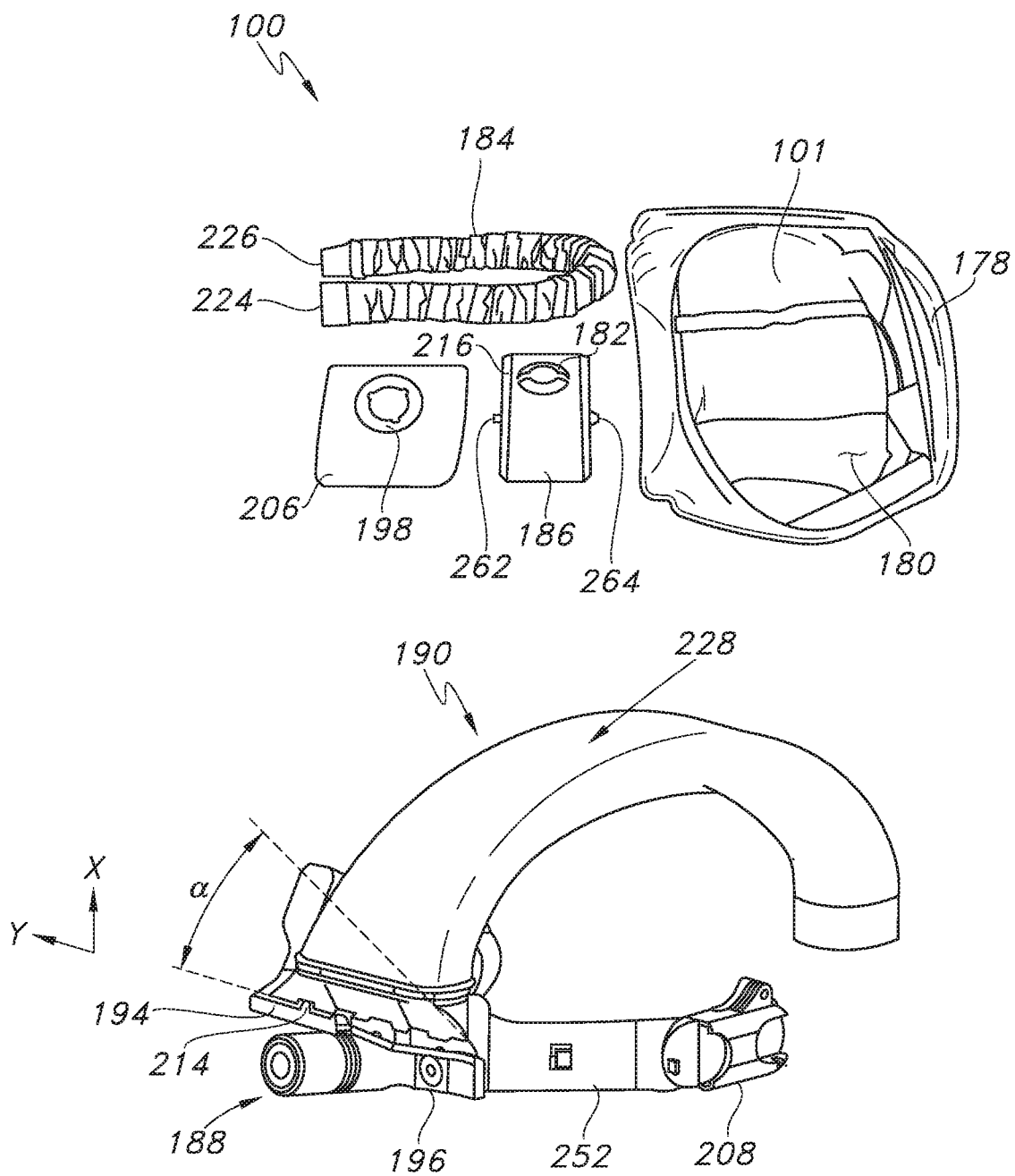


FIG. 9

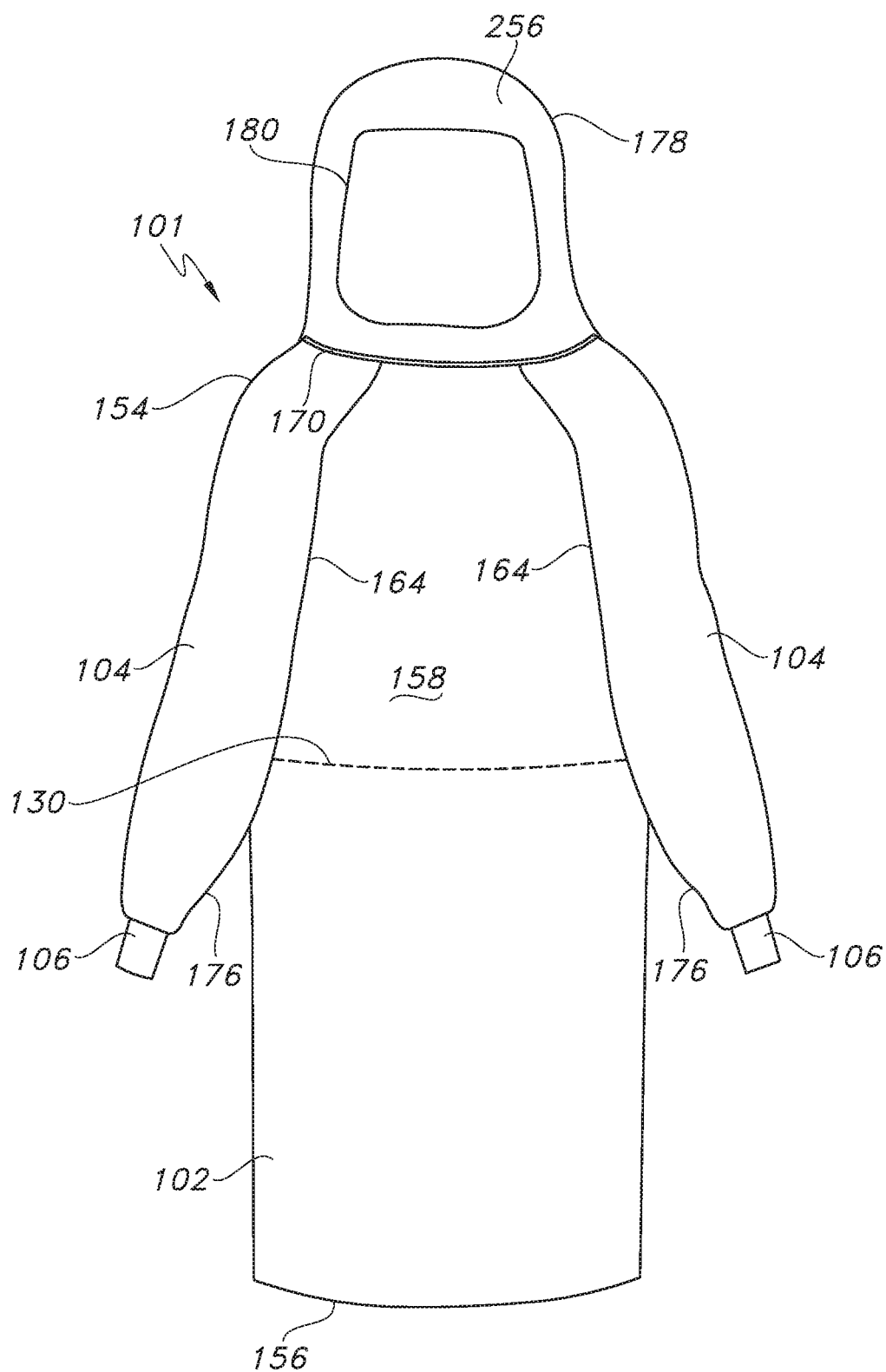


FIG. 10



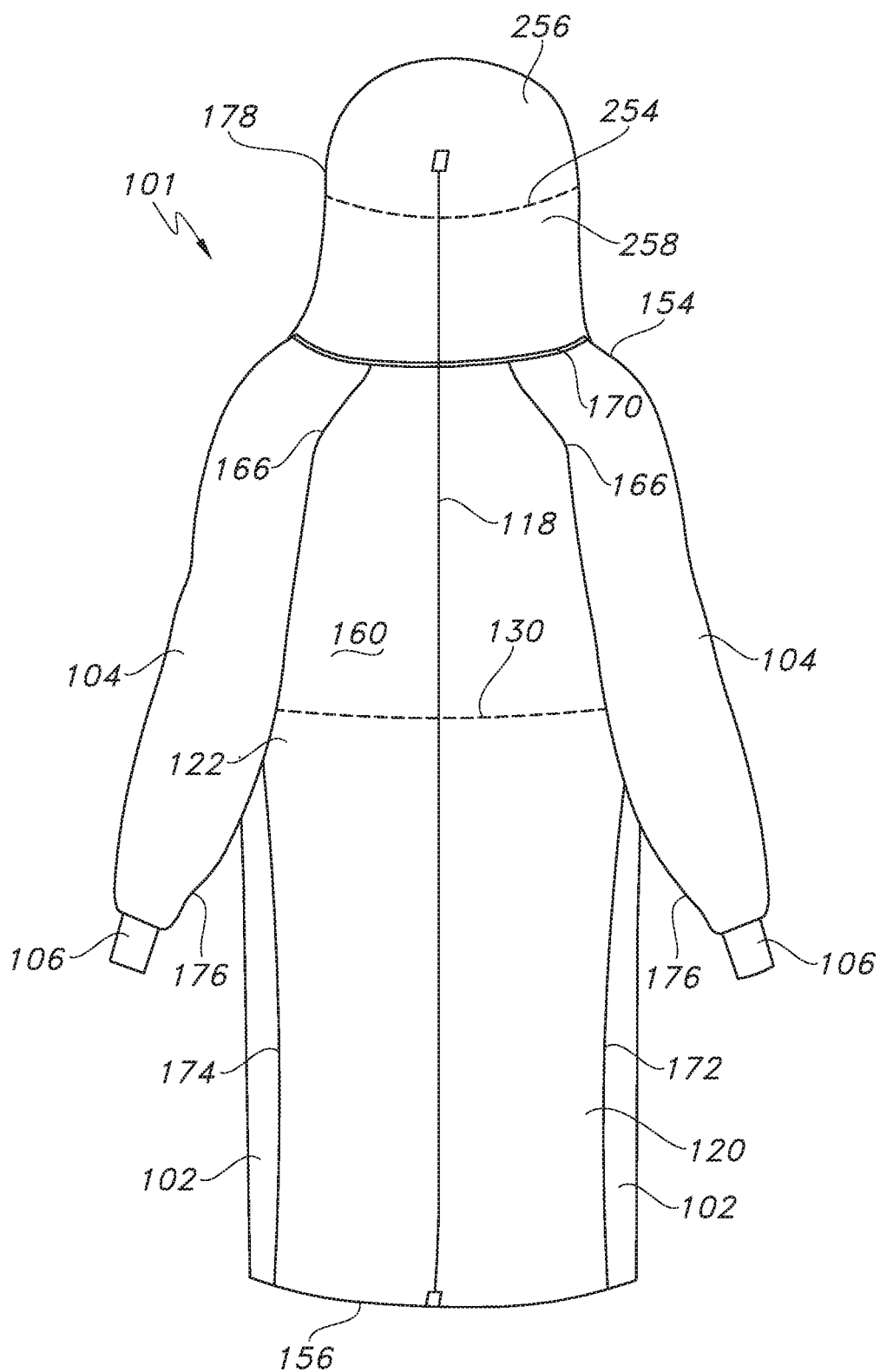


FIG. 11

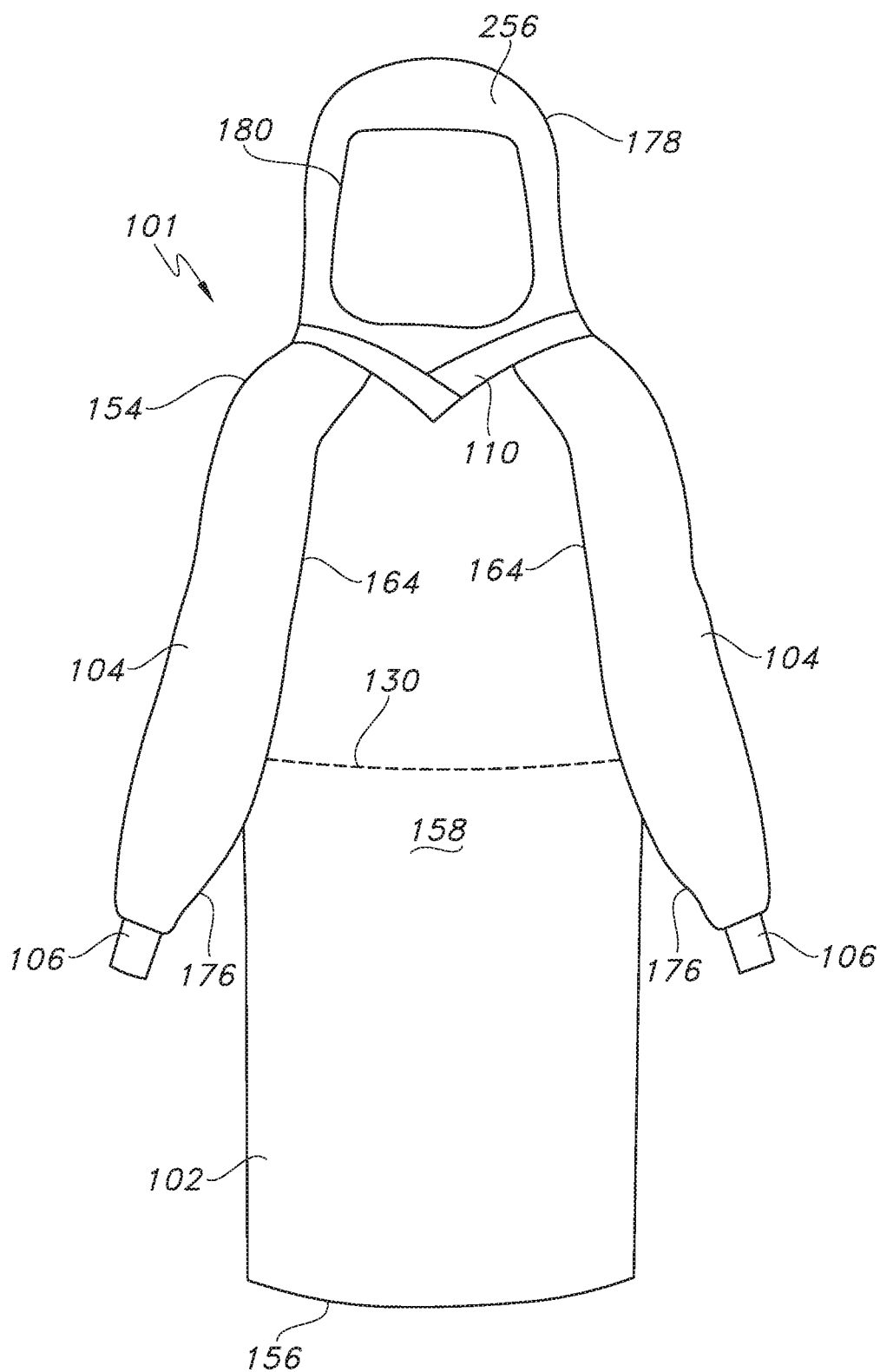


FIG. 12

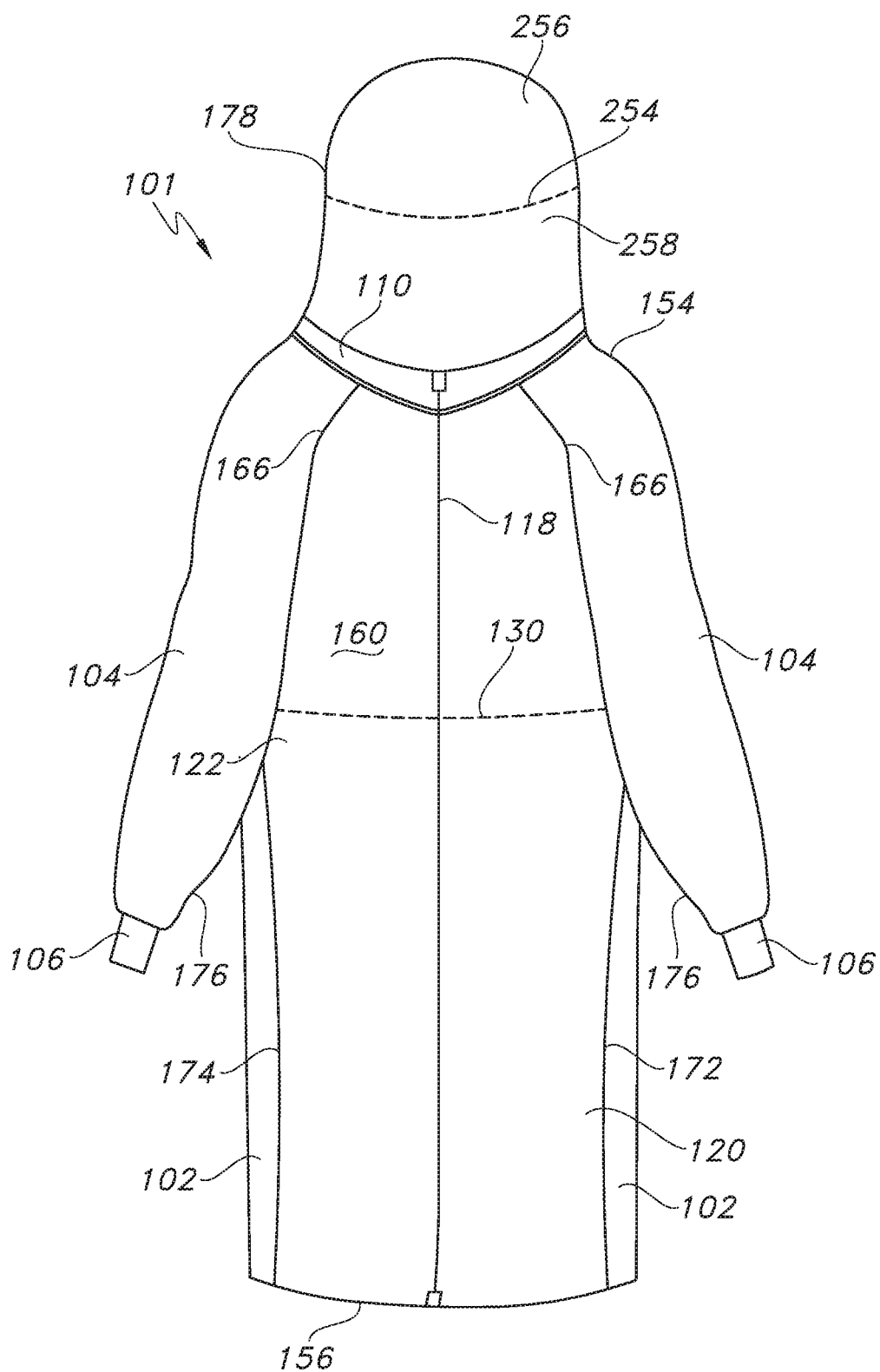


FIG. 13

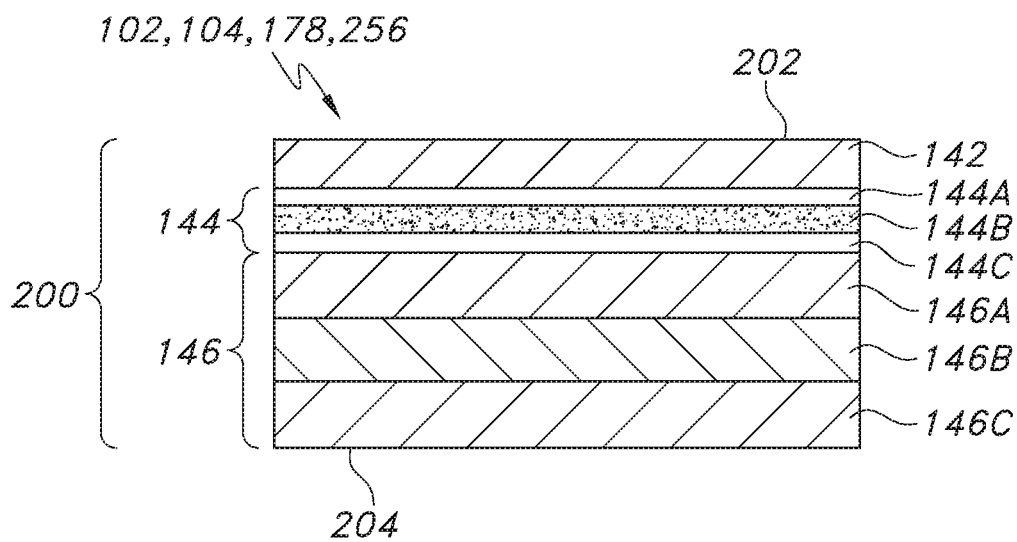


FIG. 14

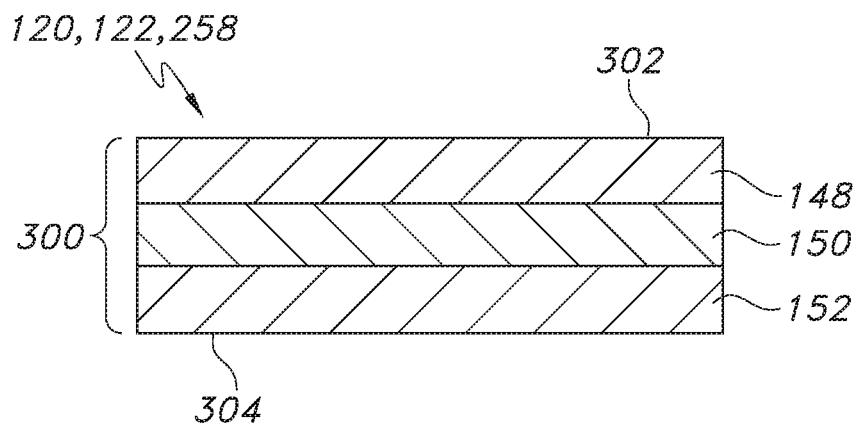


FIG. 15

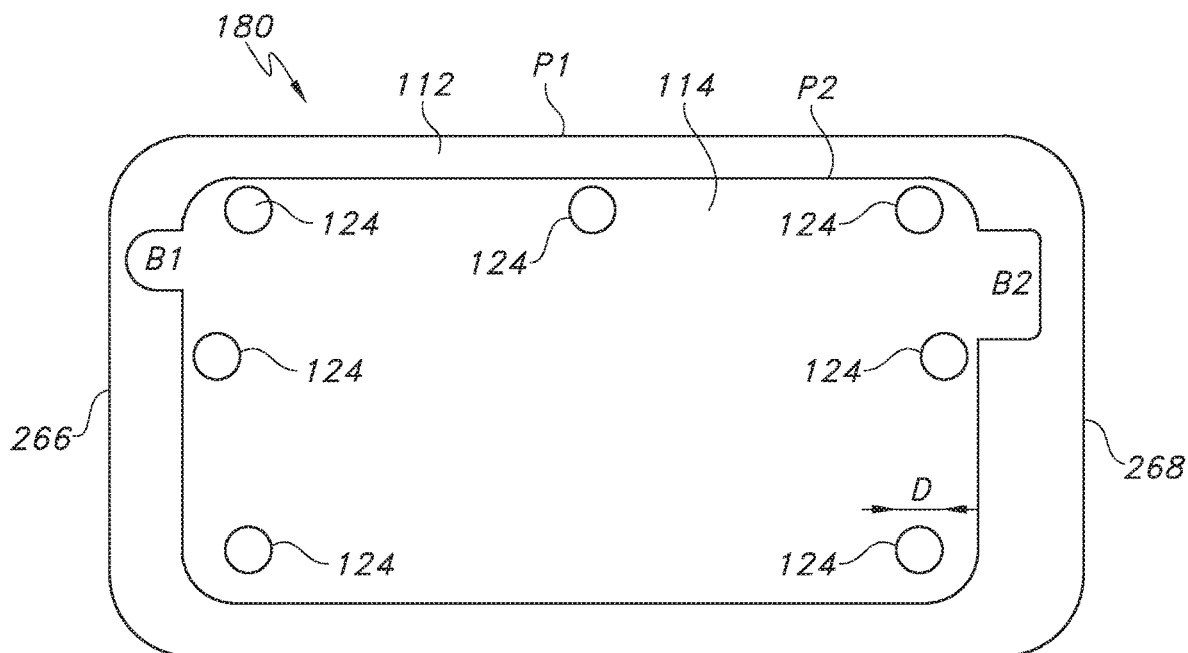


FIG. 16

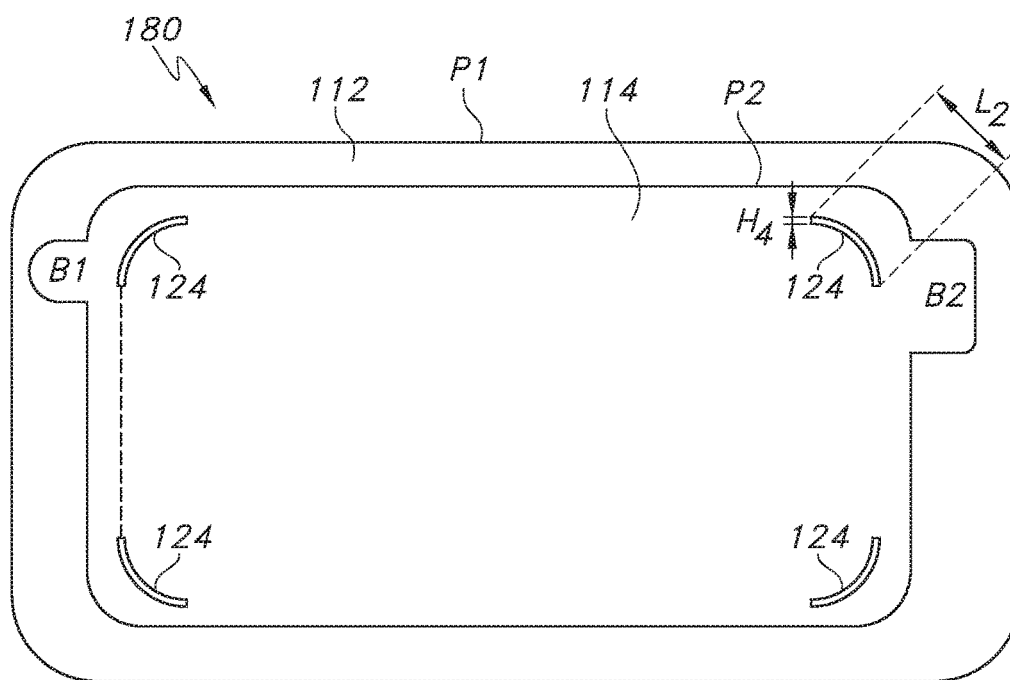


FIG. 17

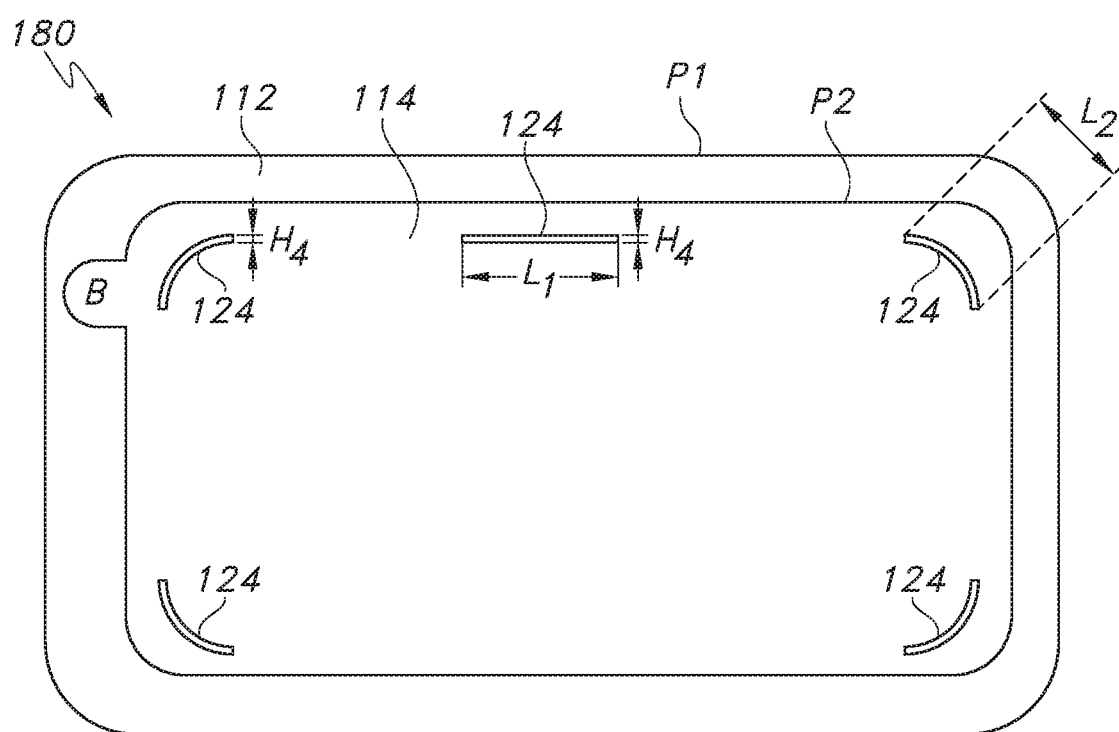


FIG. 18

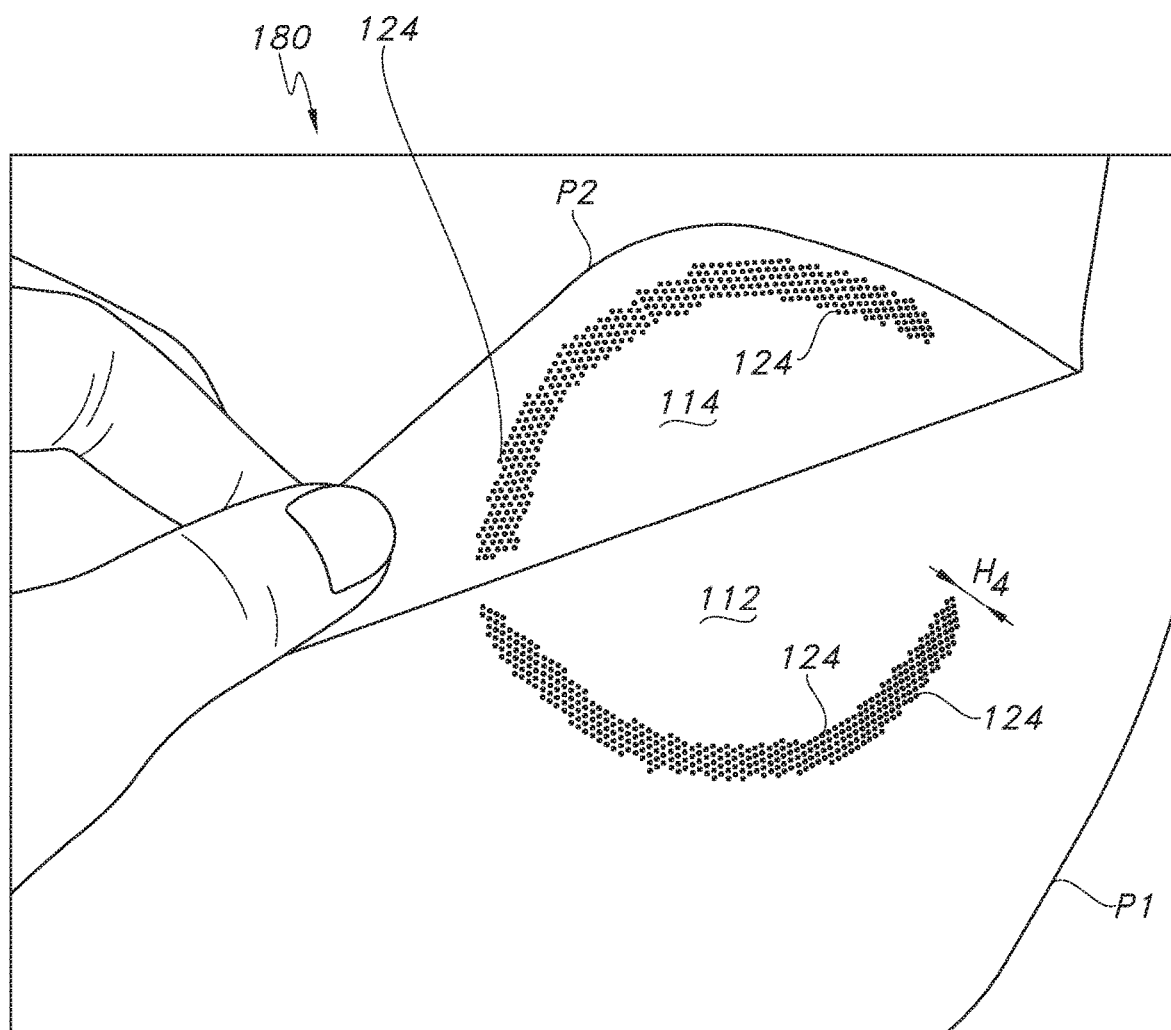


FIG. 19

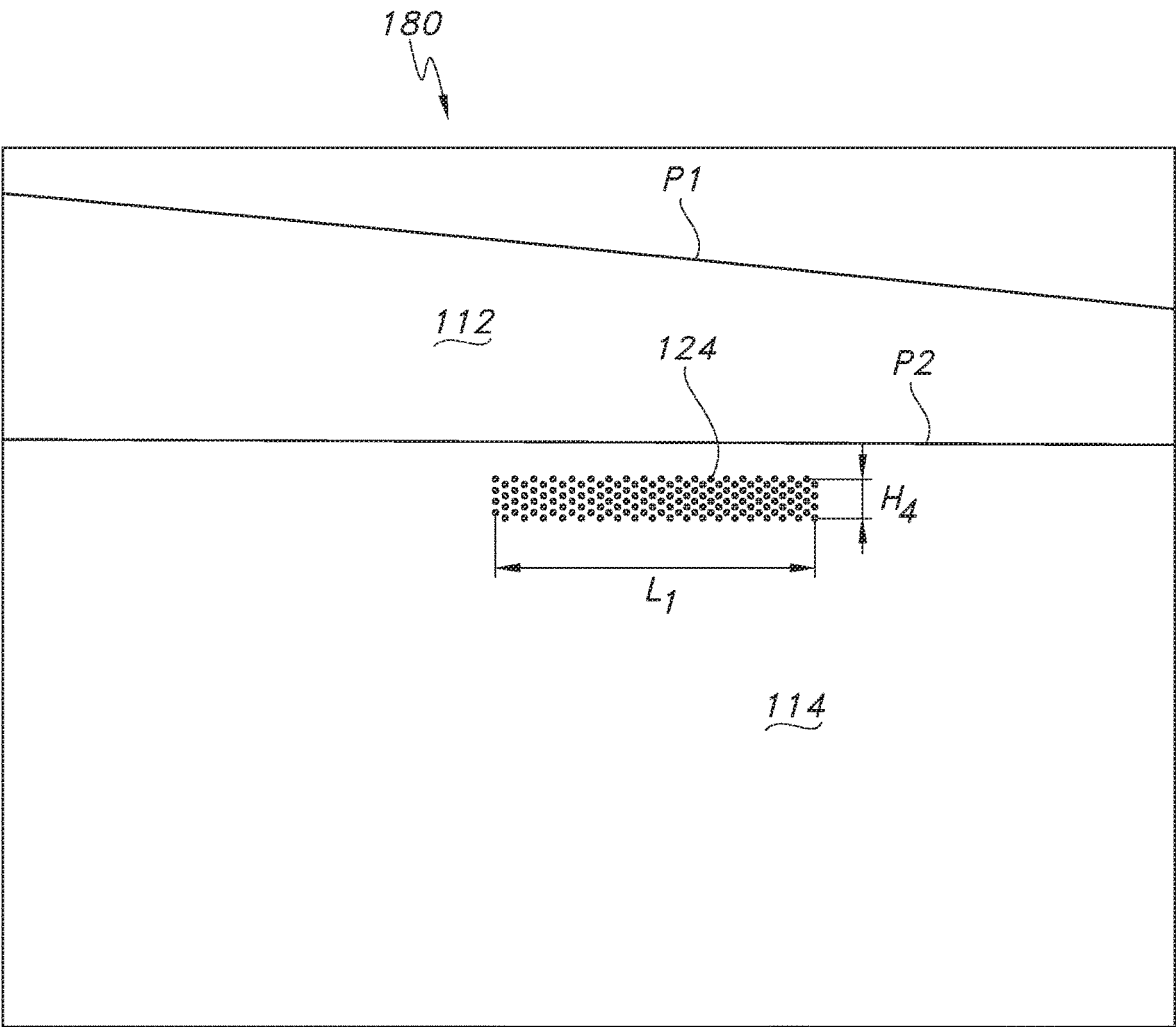


FIG. 20



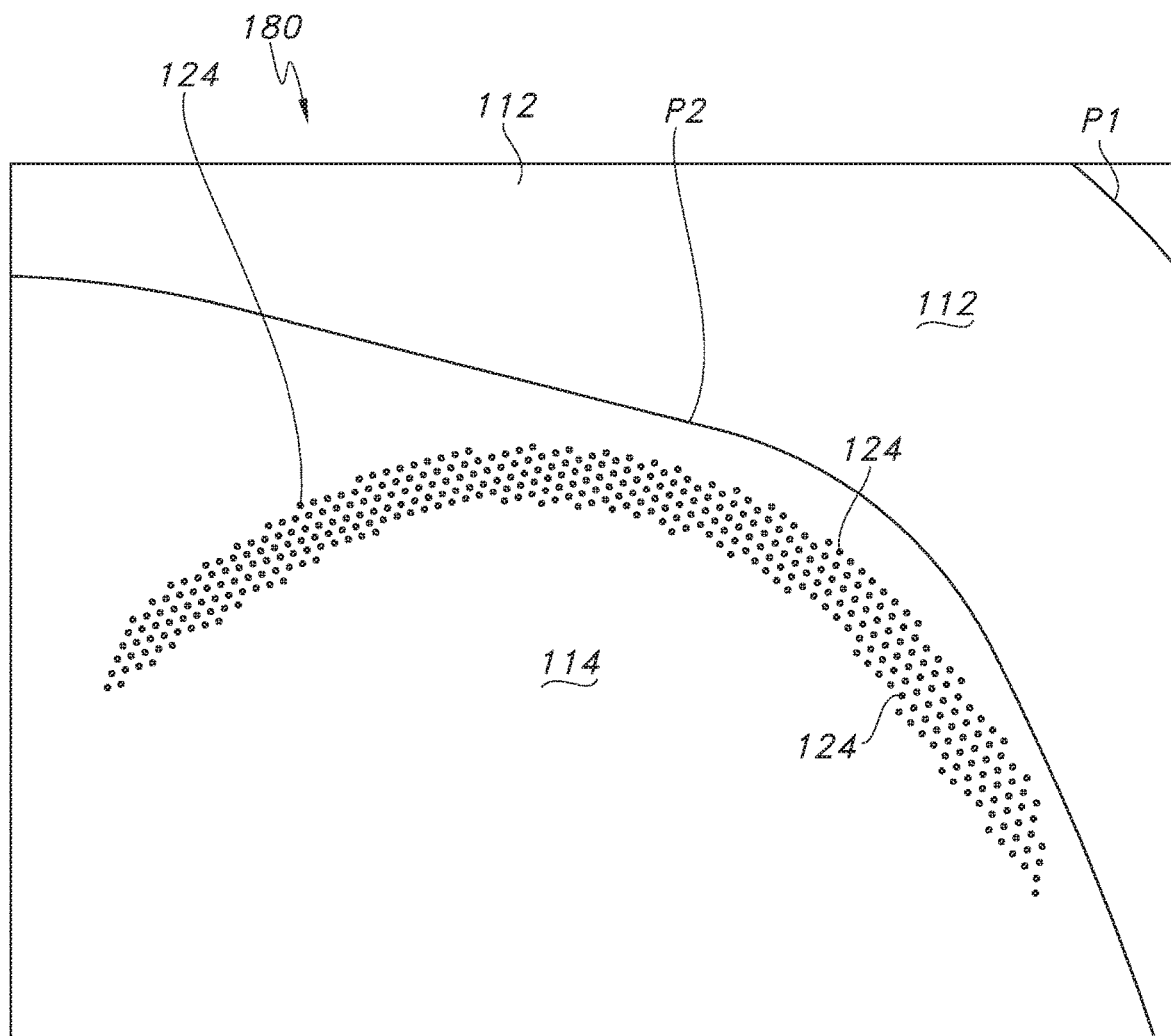


FIG. 21

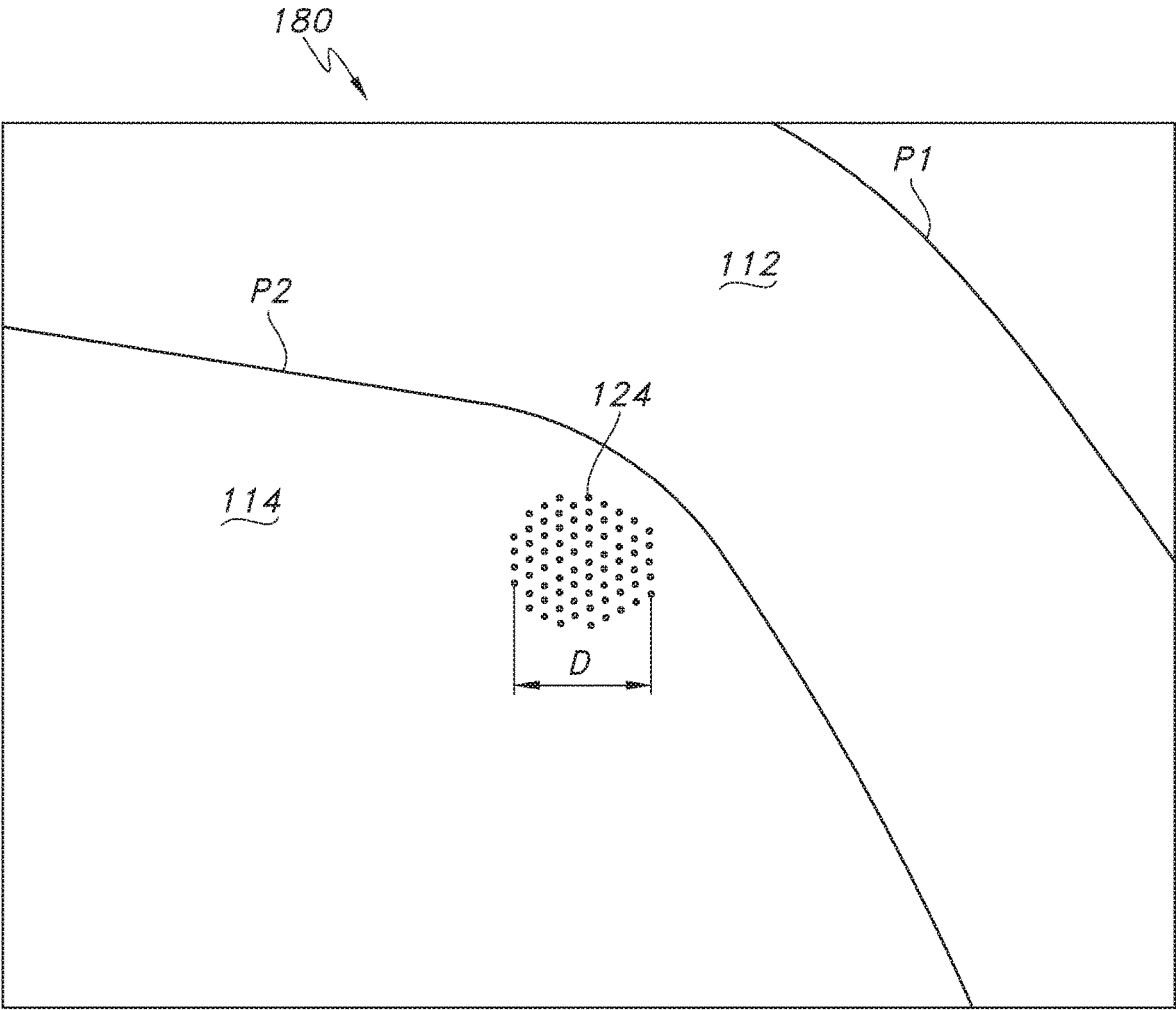


FIG. 22

## MECHANICALLY BONDED VISOR SYSTEM FOR SURGICAL HOOD

### RELATED APPLICATION

[0001] The present application claims priority to U.S. Provisional Patent Application No. 62/775,988, filed on Dec. 6, 2018, the entire contents of which are incorporated herein by reference.

### FIELD OF THE INVENTION

[0002] The present invention relates to the visor component of surgical hoods that can be used in conjunction with surgical gowns, helmets, and ventilation systems worn by medical care providers in the operating room or people in any other environment where exposure to hazardous materials and liquids is a risk.

### BACKGROUND OF THE INVENTION

[0003] Surgeons and other healthcare providers often wear a combination of a nonwoven-based surgical suit or gown, a hood with a visor, and an air cooling or ventilation system during operating procedures, particularly orthopedic total joint replacement surgeries such as arthroplasties and revisions of the knee, hip, and shoulder, in order to ensure sterile conditions in the operating room, protect the wearer, and create a comfortable environment for the wearer. During the course of such surgeries, aerosolized or droplets of biological fluid can spray onto the visor, obstructing the view of the surgeon or other healthcare provider. Thus, in order to provide surgeons and other healthcare providers with improved visibility, the visor can include one or more removable transparent films, where the surgeon or other healthcare provider can remove or peel away the transparent film should it become covered with biological fluids, tissue, etc., thus exposing a clean, unobstructed surface of an additional removable transparent film or the transparent base film of the visor positioned below the transparent film that was removed. The transparent films must be sterile, and because the transparent films are in close contact with each other, sterilization of the transparent films is often problematic.

[0004] Currently, ethylene oxide (EO) gas is used to sterilize all nonwoven-based surgical suits or gowns and hoods. However, a problem exists when using EO gas to sterilize visors with multiple transparent films, as the transparent films are typically in direct contact with each other, which prevents the EO gas from penetrating through the outermost, exposed transparent film to sterilize the underlying additional transparent films present.

[0005] As such, a need exists for a visor design that allows for EO gas to be used to sterilize a visor having a transparent base film and one or more transparent removable films attached thereto in conjunction with the hood and/or surgical suit or gown with which it will be worn.

### SUMMARY OF THE INVENTION

[0006] In accordance with one particular embodiment of the present invention, a visor system for a personal protection system is provided. The visor system includes a base film and a first removable film mechanically bonded to an outer-facing surface of the base film via a first plurality of mechanical bond points, where gaps are present between adjacent mechanical bond points.

[0007] In another embodiment, the first removable film can include a tab, and the tab can facilitate removal of the first removable film from the base film.

[0008] In still another embodiment, the base film and the first removable film can be transparent.

[0009] In yet another embodiment, the base film can include a polyester or a polycarbonate.

[0010] In an additional embodiment, the first removable film can include a polyester or a polycarbonate.

[0011] In one more embodiment, the first plurality of mechanical bond points can be ultrasonic bond points.

[0012] In another embodiment, the gaps can permit penetration of ethylene oxide gas between the base film and the first removable film.

[0013] In still another embodiment, the base film can define a perimeter and the first removable film can define a perimeter, where the perimeter of the first removable film can be contained completely within the perimeter of the base film. Further, the first plurality of mechanical bond points can be located about the perimeter of the first removable film.

[0014] In yet another embodiment, the visor system can further include a second removable film, where the second removable film can be mechanically bonded to the first removable film via a second plurality of mechanical bond points, where gaps can be present between adjacent mechanical bond points.

[0015] In an additional embodiment, the second removable film can include a tab, where the tab can facilitate removal of the second removable film from the first removable film.

[0016] In one more embodiment, the second removable film can be transparent.

[0017] In another embodiment, the second removable film can include a polyester or a polycarbonate.

[0018] In still another embodiment, the second plurality of mechanical bond points can be ultrasonic bond points.

[0019] In yet another embodiment, the gaps can permit penetration of ethylene oxide gas between the first removable film and the second removable film.

[0020] In an additional embodiment, the base film can define a perimeter and the second removable film can define a perimeter, where the perimeter of the second removable film can be contained completely within the perimeter of the base film. Further, the second plurality of mechanical bond points can be located about the perimeter of the second removable film.

[0021] In one more embodiment, the visor system can be ethylene oxide gas sterilized.

[0022] In accordance with another particular embodiment of the present invention, a surgical hood comprising the visor system as described above is provided, where the surgical hood and the visor system are ethylene oxide gas sterilized.

[0023] In accordance one more embodiment of the present invention, surgical gown comprising an integrated surgical hood and the visor system as described above is provided, where the surgical gown, the integrated surgical hood, and the visor system are ethylene oxide gas sterilized.

[0024] A personal protection system including a surgical gown and a separate surgical hood comprising the visor system as described above is also contemplated by the present invention, where the personal protection system is ethylene gas sterilized in a single package.

[0025] These and other features, aspects and advantages of the present invention will become better understood with reference to the following description and appended claims. The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

#### BRIEF DESCRIPTION OF THE FIGURES

[0026] A full and enabling disclosure of the present invention to one skilled in the art, including the best mode thereof, is set forth more particularly in the remainder of the specification, including reference to the accompanying figures, in which:

[0027] FIG. 1 illustrates a front view of a visor system according to one embodiment of the present invention;

[0028] FIG. 2 illustrates a front view of another visor system according to one embodiment of the present invention;

[0029] FIG. 3A illustrates a cross-sectional view of one of the removable films of the visor system of the present invention;

[0030] FIG. 3B illustrates a perspective view of the removable film of FIG. 3A;

[0031] FIG. 4A illustrates a cross-sectional view of the visor system of the present invention where one removable film is mechanically bonded to a base film;

[0032] FIG. 4B illustrates a perspective view of the visor system of FIG. 4A;

[0033] FIG. 5A illustrates a cross-sectional view of the visor system of the present invention where a first removable film is mechanically bonded to a base film and a second removable film is mechanically bonded to the first removable film;

[0034] FIG. 5B illustrates a perspective view of the visor system of FIG. 5A;

[0035] FIG. 6 illustrates a side view of a user wearing a personal protection and ventilation system, including a disposable surgical gown, a hood with which the visor system of the present invention is integrated, and a helmet;

[0036] FIG. 7 illustrates a procedure for donning the disposable surgical gown and hood with which the visor system of the present invention is integrated;

[0037] FIG. 8 illustrates various adjustment procedures that can be carried out while using a personal protection and ventilation system that includes the visor system of the present invention.

[0038] FIG. 9 illustrates a personal protection and ventilation system with which the visor system of the present invention can be used;

[0039] FIG. 10 illustrates a front view of one embodiment of a disposable surgical gown with which the visor system of the present invention can be used;

[0040] FIG. 11 illustrates a rear view of one embodiment of the disposable surgical of FIG. 10;

[0041] FIG. 12 illustrates a front view of another embodiment of a disposable surgical gown with which the visor system of the present invention can be used;

[0042] FIG. 13 illustrates a rear view of the disposable surgical gown of FIG. 12;

[0043] FIG. 14 illustrates a cross-sectional view of one embodiment of a first material used in forming the front

panel, sleeves, and hood of a disposable surgical gown with which the visor system of the present invention can be used; and

[0044] FIG. 15 illustrates a cross-sectional view of one embodiment of a second material used in forming the first rear panel and the second rear panel of a disposable surgical gown with which the visor system of the present invention can be used.

[0045] FIG. 16 illustrates a front view of a visor system according to one embodiment of the present invention.

[0046] FIG. 17 illustrates a front view of a visor system according to another embodiment of the present invention.

[0047] FIG. 18 illustrates a front view of a visor system according to still another embodiment of the present invention.

[0048] FIG. 19 illustrates a perspective view of a visor system according to one embodiment of the present invention, where one layer of removable film is being removed from a base film.

[0049] FIG. 20 illustrates a zoomed in view of a visor system according to one embodiment of the present invention showing one of the ultrasonic welding sections in detail.

[0050] FIG. 21 illustrates a zoomed in view of a visor system according to another embodiment of the present invention showing one of the ultrasonic welding sections in detail.

[0051] FIG. 22 illustrates a zoomed in view of a visor system according to yet another embodiment of the present invention showing one of the ultrasonic welding sections in detail.

[0052] Repeat use of reference characters in the present specification and drawings is intended to represent the same or analogous features or elements of the present invention.

#### Definitions

[0053] As used herein, the term “spunbond” refers to fabric made from small diameter fibers which are formed by extruding molten thermoplastic material as filaments from a plurality of fine, usually circular capillaries of a spinneret with the diameter of the extruded filaments then being rapidly reduced as by, for example, in U.S. Pat. No. 4,340,563 to Appel et al., and U.S. Pat. No. 3,692,618 to Dorschner et al., U.S. Pat. No. 3,802,817 to Matsuki et al., U.S. Pat. Nos. 3,338,992 and 3,341,394 to Kinney, U.S. Pat. No. 3,502,763 to Hartman, and U.S. Pat. No. 3,542,615 to Dobo et al. Spunbond fibers are generally not tacky when they are deposited onto a collecting surface. Spunbond fibers are generally continuous and have average diameters (from a sample of at least 10) larger than 7 microns, more particularly, between about 10 and 20 microns.

[0054] As used herein, the term “meltblown” refers to fabric formed by extruding a molten thermoplastic material through a plurality of fine, usually circular, die capillaries as molten threads or filaments into converging high velocity, usually hot, gas (e.g. air) streams which attenuate the filaments of molten thermoplastic material to reduce their diameter, which may be to microfiber diameter. The meltblown fibers are then carried by the high velocity gas stream and are deposited on a collecting surface to form a web of randomly dispersed meltblown fibers. Such a process is disclosed, for example, in U.S. Pat. No. 3,849,241 to Butin et al. Meltblown fibers are microfibers which may be continuous or discontinuous, are generally smaller than 10

microns in average diameter, and are generally tacky when deposited onto a collecting surface.

**[0055]** As used herein, the term “SMS laminate” refers to fabric laminates of spunbond and meltblown fabrics, e.g., spunbond/meltblown/spunbond laminates as disclosed in U.S. Pat. No. 4,041,203 to Brock et al., U.S. Pat. No. 5,169,706 to Collier, et al, U.S. Pat. No. 5,145,727 to Potts et al., U.S. Pat. No. 5,178,931 to Perkins et al. and U.S. Pat. No. 5,188,885 to Timmons et al. Such a laminate may be made by sequentially depositing onto a moving forming belt first a spunbond fabric layer, then a meltblown fabric layer and last another spunbond layer and then bonding the laminate in a manner described below. Alternatively, the fabric layers may be made individually, collected in rolls, and combined in a separate bonding step. Such fabrics usually have a basis weight of from about 0.1 osy to 12 osy (about 3.4 gsm to about 406 gsm), or more particularly from about 0.75 to about 3 osy (about 25.4 gsm to about 101.7 gsm).

#### DETAILED DESCRIPTION OF REPRESENTATIVE EMBODIMENTS

**[0056]** Reference now will be made in detail to various embodiments of the invention, one or more examples of which are set forth below. Each example is provided by way of explanation of the invention, not limitation of the invention. In fact, it will be apparent to those skilled in the art that various modifications and variations may be made in the present invention without departing from the scope or spirit of the invention. For instance, features illustrated or described as part of one embodiment, may be used on another embodiment to yield a still further embodiment. Thus, it is intended that the present invention covers such modifications and variations as come within the scope of the appended claims and their equivalents.

**[0057]** Generally speaking, the present invention is directed to a visor system for a surgical hood that can be a component of a personal protection system, which can include a ventilation system in some embodiments. The visor system includes a transparent base film and one or more removable transparent films attached to an outer-facing surface of the transparent base film. The one or more removable transparent films can be attached to the transparent base film and/or each other by mechanical bonding. In one particular embodiment, the type of mechanical bonding can be ultrasonic bonding. Specifically, a first removable transparent film can be attached to the base transparent film by mechanical bonding, and a second removable transparent film can be attached to the first removable transparent film by mechanical bonding.

**[0058]** Further, to ensure that each of the transparent films and the base film are able to be adequately sterilized by ethylene oxide (EO) gas, the transparent films are attached to each other via mechanical bond points (e.g., bond points formed via ultrasonic bonding) intermittently spaced around the perimeter of the removable transparent films. As such, a plurality of gaps can separate adjacent mechanical bond points to permit EO gas to penetrate each of the films to sterilize all surfaces of the films. Such an arrangement allows each underlying film of the visor system that is exposed after peeling away an outermost film and discarding the outermost film to be adequately sterilized by EO gas. Further, it is to be understood that because the transparent films of the present invention can be formed from polycar-

bonate or polyester, which are materials through which EO gas cannot penetrate, the plurality of gaps between the mechanical bond points required by the present invention are important to ensuring adequate sterilization by EO gas. In contrast, the use of an adhesive around the entire perimeter of the removable transparent films to attach the removable transparent films to the base film and/or each other would not allow for EO gas penetration.

**[0059]** In other words, utilizing the mechanical bonding approach contemplated by the visor system of the present invention allows sterilizing EO gas to penetrate between the transparent films, which is in stark contrast to current film attachment methods that utilize adhesives. Because ethylene oxide gas cannot penetrate films bonded together via adhesives and cannot penetrate polyester and polycarbonate transparent films, unlike the visor system of the present invention, currently available visor systems often require the use of radiation sterilization (e.g., gamma radiation) as an interim step to sterilize the visor system separately before the visor system can be incorporated into a surgical hood, which is then sterilized by, for instance, EO gas, resulting in a very inefficient and time-consuming sterilization process.

**[0060]** On the other hand, the intermittently spaced mechanical bond points contemplated by the present invention allow sufficient ethylene oxide gas exposure to kill biological indicator (BI) microbes to yield an underlying sterile surface. The resulting multi-layer visor system of the present invention can thus be formed and then bonded or otherwise attached to a surgical hood or a surgical gown with attached hood, and the entire protective surgical garment can then be sterilized in one step via exposure to ethylene oxide gas, rather than having to sterilize the individual components in multiple steps as required for currently available multi-layer visor systems. This is because the gaps between the intermittent bond points allow the EO gas to penetrate the multiple films of the visor system during sterilization. This results in a surgical hood and/or gown where all of the transparent films (e.g., the base film and one or more removable films) are sterile in the event that one or more of the outermost transparent films are peeled away from the visor system and discarded as they become soiled.

**[0061]** In addition, it is to be understood that the visor system of the present invention contemplates placement of the intermittently spaced mechanical bond points around the perimeter of the removable transparent films of the visor system so as to be unobtrusive to the surgeon or other healthcare provider. Moreover, the various transparent films are attached to each other with a bond strength sufficient to secure the transparent films to each other when in use, while also allowing for the surgeon or other healthcare provider to easily peel away and remove an outermost soiled transparent film without dislodging the other layers and the underlying helmet to which the surgical hood and visor system is secured.

**[0062]** As mentioned above, to create the mechanical bond points that are intermittently spaced about the perimeter of the visor system of the present invention, mechanical bonding in the form of ultrasonic bonding can be used. Ultrasonic bonding utilizes ultrasonic energy, pressure, weld time, and hold time parameters to melt polymeric films (e.g., polyester or polycarbonate transparent films). For instance, the mechanical bond points can be formed using an ultrasonic plunge welder such as a Branson ultrasonic plunge welder utilizing a power supply having a wattage of at least 2200

Watts, such as from about 2200 Watts to about 4000 Watts, such as from about 2600 Watts to about 3400 Watts. The weld time can range from about 0.04 seconds to about 0.12 seconds, such as from about 0.05 seconds to about 0.10 seconds, such as from about 0.06 seconds to about 0.08 seconds. Further, the hold time after welding can range from about 0.1 second to about 1 second, such as from about 0.2 seconds to about 0.8 seconds, such as from about 0.4 seconds to about 0.6 seconds. In addition, the pressure applied during welding can range from about 10 pounds per square inch (psi) to about 40 psi, such as from about 15 psi to about 35 psi, such as from about 20 psi to about 30 psi.

[0063] Regardless of the specific welding parameters utilized, the resulting mechanical (e.g., ultrasonically welded) bond points are intermittently spaced apart from each other about the perimeter of the removable transparent films in the visor system of the present invention so there is no continuous seal around the perimeter of the removable transparent films. Thus, the specific bond pattern contemplated by the present invention allows for EO gas penetration at the gaps located between each of the mechanical bond points and allows the gas to contact each of the films' surfaces to ensure adequate sterilization. Further, by locating the mechanical bond points on the outer perimeter of the transparent films of the visor system, viewing is not obscured, yet the transparent films are held securely in place until the transparent films need to be peeled away from visor system. The various features of the visor system 180 of the present invention are discussed in more detail with references to FIGS. 1-8.

[0064] Turning first to FIG. 1, a front view of one visor system 180 contemplated by the present invention is shown. The visor system 180 includes a base film 112 having a perimeter P1 and also having an outer-facing surface 270 that is exposed to the environment when incorporated into a surgical hood and an inner-facing surface 272 (see FIGS. 4A-5B) that is the surface closest to a wearer's face when incorporated into a surgical hood. The base film 112 can include tabs A1 and A2 extending from a first side 266 and a second side 268 of the visor system 180. Tabs A1 and A2 can be used to secure the visor system 180 to a surgical hood, such as surgical hood 178 shown in FIGS. 6-8. The visor system 180 also includes at least one removable film 114 having a perimeter P2 that can be contained completely within the perimeter P1 of the base film layer 112. In some embodiments, the visor system 180 can include one or more additional removable films, such as removable film 116. The removable films 114 and 116 can each include tabs (e.g., tabs B and C) that enable the wearer to peel-away the outermost removable film 114 or 116 when it becomes soiled or when the wearer's visibility is otherwise diminished due to the presence of blood, tissue, or other matter coming into contact with the film 114 or 116. As shown in FIG. 1, in some embodiments, the tabs B and C can both be present on the first side 266 of the visor system 180. Meanwhile, referring to FIG. 2, in other embodiments, the tabs B and C can be on opposing sides of the visor system 180. For instance, tab B, which is associated with the removable film 114, can be present on the first side 266 of the visor system 180, while tab C, which is associated with the removable film 116, can be present on the second side 268 of the visor system 180.

[0065] The base film 112 can have a height H1 in the y-direction ranging from about 15 centimeters (cm) to about

35 cm, such as from about 17.5 cm to about 30 cm, such as from about 20 cm to about 25 cm.

[0066] Meanwhile, the removable films 114 and 116 can have a height H2 in the y-direction ranging from about 10 cm to about 30 cm, such as from about 12.5 cm to about 25 cm, such as from about 15 cm to about 20 cm.

[0067] Further, the each of the tabs A1, A2, B, and C can have a height H3 in the y-direction ranging from about 0.5 cm to about 3 cm, such as from about 0.75 cm to about 2.5 cm, such as from about 1 cm to about 2 cm.

[0068] In addition, the base film 112 can have an overall width W1 in the x-direction including the width of the tabs A1 and A2 ranging from about 35 cm to about 50 cm, such as from about 37.5 cm to about 47.5 cm, such as from about 40 cm to about 45 cm, and a width W2 in the x-direction excluding the width of the tabs A1 and A2 ranging from about 32.5 cm to about 47.5 cm, such as from about 35 cm to about 45 cm, such as from about 37.5 cm to about 42.5 cm.

[0069] Moreover, the removable films 114 and 116 can have a width W3 in the x-direction excluding the width of the tabs B and C ranging from about 25 cm to about 42.5 cm, such as from about 27.5 cm to about 40 cm, such as from about 30 cm to about 37.5 cm.

[0070] Additionally, the tabs A1, A2, B, and C can have a width W4 ranging from about 0.5 cm to about 3 cm, such as from about 0.75 cm to about 2.75 cm, such as from about 1 cm to about 2 cm.

[0071] Further, regardless of the dimensions of each of the films 112, 114, and 116, or the number of removable films present in the visor system 180, the films can each be transparent and can each be formed from polycarbonate or polyester. In one particular embodiment, the films 112, 114, and 116 can be polyester. Further, the base film 112 can have a thickness in the z-direction ranging from about 150 micrometers to about 350 micrometers, such as from about 175 micrometers to about 325 micrometers, such as from about 200 micrometers to about 300 micrometers, while the removable films 114 and 116 can each have a thickness in the z-direction ranging from about 10 micrometers to about 125 micrometers, such as from about 25 micrometers to about 100 micrometers, such as from about 50 micrometers to about 75 micrometers.

[0072] Turning now to FIGS. 3A to 5B, the attachment of the base film 112 to the one or more removable films 114 and 116 via mechanical bonding (e.g., ultrasonic bonding) is shown in detail. FIG. 3A illustrates a cross-sectional view of one of the removable films 114 or 116 of the visor system 180 of the present invention, while FIG. 3B illustrates a perspective view of the removable film 114 or 116 of FIG. 3A. FIG. 4A illustrates a cross-sectional view of the visor system 180 of the present invention where one removable film 114 or 116 is mechanically bonded to the base film 112, while FIG. 4B illustrates a perspective view of the visor system 180 of FIG. 4A. FIG. 5A illustrates a cross-sectional view of the visor system 180 of the present invention where a first removable film 114 is mechanically bonded to the base film 112 and a second removable film 116 is mechanically bonded to the first removable film 114, while FIG. 5B illustrates a perspective view of the visor system of FIG. 5A.

[0073] As shown in FIGS. 3A and 3B, the removable films 114 and 116 can each include a biological indicator 128 attached, for example, to a centrally located surface of the removable film 114 or 116, such as via one or more strips of

tape **132** or any other suitable attachment means. The biological indicator **128** can be used to ensure that the removable films **114** and **116** are adequately sterilized via EO gas in a single, simultaneous, efficient, sterilization step when sterilized separately or as part of a single package that includes a surgical gown **101** and/or surgical hood **178** of a personal protection and ventilation system **100**.

[0074] Next, as shown in FIGS. 4A and 4B, once the biological indicator **128** is attached to the removable film **114** or **116**, the removable film **114** or **116** can be mechanically bonded to an outer-facing surface **270** of a base film **112**, while the inner-facing surface **272** of the base film **112** is the surface closest to a wearer's face when incorporated into a surgical hood **178** as described in more detail below. For the purposes of FIGS. 4A and 4B, reference is made to removable film **114**. As shown, a plurality of mechanical bond points **124** can be disposed about a perimeter **P2** of the removable film **114** between the removable film **114** and the outer-facing surface **270** of the base film **112** to join the two films together, while at the same time, a gap **126** is present between adjacent mechanical bond points **124** to ensure that all of the surfaces of the base film **112** and removable film **114** can be adequately sterilized. The mechanical bond points **124** can be formed via any suitable means, such as ultrasonic welding.

[0075] Further, as shown in FIGS. 5A and 5B, once the removable film **114** is mechanically bonded to the base film **112** as described above with reference to FIGS. 4A and 4B, an additional removable film **116** can be mechanically bonded to the removable film **114**. Again, similar to the mechanical bonding between the base film **112** and the removable film **114**, a plurality of mechanical bond points **124** can be disposed about a perimeter **P2** of the removable films **114** and **116** between the removable film **116** and the removable film **114** to join the two films together, while at the same time, a gap **126** is present between adjacent mechanical bond points **124** to ensure that all of the surfaces of removable film **114** and the removable film **116** can be adequately sterilized. The mechanical bond points **124** can be formed via any suitable means, such as ultrasonic welding.

[0076] Turning now to FIGS. 16-22, specific examples of the arrangement of the plurality of mechanical bond points **124** are described in more detail, although it is to be understood that the configuration of the various patterns and spacing of the mechanical bond points **124** can vary based on application and the type of sterilization cycle utilized to sterilize the visor system **180**. It is also to be understood that the plurality of mechanical bond points **124** distributed or disposed about a perimeter **P2** of the removable films **114** and/or **116** can be made using, for example, a male knurled patterned horn interfacing with a flat surface. The male knurled patterned horn can come in a variety of shapes and dimensions to form a plurality of mechanical bond points **124** having a variety of shapes (e.g., circular, arcuate, rectangular, square, triangular, elliptical, hexagonal, etc.). Further, by controlling the depth of the bond formed by the patterned horn, more than one peelable or removable film can be adhered to another layer simultaneously. For instance, a first removable film **114** can be adhered to a base film **112**, and a second removable film **116** can be adhered to the first removable film **114**. Further, each the plurality of mechanical bond points **124** formed between the second removable film **116** and the first removable film **114** can be

adjacent to or concentrically positioned around the plurality of mechanical bond points **124** formed between the base film **112** and the first removable film **114** in the same knurled pattern. In addition, it is to be understood that although anvils are not required to form the patterns of the mechanical bond points **124** since the horn may be patterned with the male knurl pattern, a multi-plunge process could also be used where multiple anvils are mounted to a single receiving plate that receives multiple horns executing multiple plunges at one time.

[0077] The various parameters that can be controlled during bonding to form the desired mechanical bond points via ultrasonic bonding are shown below in Table 1:

TABLE 1

Ultrasonic Bonding Parameters	
Parameter	Range
Frequency	20 kHz
Power Supply	4000 Watts
Weld Time	0.010 seconds-0.300 seconds
Collapse	0.001"-0.0075" (0.00254 cm-0.01905 cm)
Energy	0.5 Joules-1.5 Joules
Hold Time	0.01 seconds-0.5 seconds
Trigger Pressure	1 pound-10 pounds (0.45 kg-4.5 kg)
Gauge Pressure	10 psi-50 psi (0.69 MPa-0.35 MPa)
Down Speed	1 inch/sec-1.75 inch/second (2.54 cm/sec-4.45 cm/sec)
Amplitude	25%-85%
Peak Power	10%

[0078] Now, various examples of patterns of mechanical bond points **124** will be discussed in more detail. Specifically, FIG. 16 illustrates a front view of a visor system **180** according to one embodiment of the present invention. In FIG. 16, the plurality of mechanical bond points **124** are arranged about the perimeter **P2** of the removable film **114** in the form of circles having a diameter **D**. The diameter **D** can be any suitable diameter but, in some embodiments, can range from about 0.5 centimeters to about 2 centimeters, such as from about 0.75 centimeters to about 1.75 centimeters, such as from about 1 centimeter to about 1.5 centimeters. Moreover, if an additional removable film **116** (not shown) is included in the visor system **180**, it can be attached to the first removable film **114** via a plurality of bond points **124** that can be in the form of a circle or any other suitable geometry can be positioned adjacent or concentrically around the outer edge of the plurality of bond points **124** joining the first removable film **114** to the base film **112**. The first removable film **114** also includes tabs **B1** and **B2** to facilitate peeling of the first removable film **114** from the base film **112**.

[0079] Further, FIG. 17 illustrates a front view of a visor system **180** according to another embodiment of the present invention. As shown, plurality of mechanical bond points **124** are in the form of an arcuate shape at the corners of the first removable film **114**, where the arcuate shape follows the radius of curvature of the removable film layer **114**, which includes tabs **B1** and **B2**. The arcuate shape can have an arc length **L2** ranging from about 10 centimeters to about 15 centimeters, such as from about 11 centimeters to about 14 centimeters, such as from about 12 centimeters to about 13 centimeters, while the radius of curvature **R** can range from about 3.5 centimeters to about 5.5 centimeters, such as from about 3.75 centimeters to about 5.25 centimeters, such as from about 4 centimeters to about 5 centimeters. In addition,

each of the arcuate mechanical bond points **124** can terminate in a straight line perpendicular to the edge of the removable film layer **114**. Further, the mechanical bond points **124** can have a height **H4** ranging from about 0.4 centimeter to about 0.9 centimeters, such as from about 0.5 centimeters to about 0.8 centimeters, such as from about 0.6 centimeters to about 0.7 centimeters. Without intending to be limited by any particular theory, the present inventors have found that such features and dimensions allow for a more continuous peel of the first removable film **114** from the base film **112** when in use. Additionally, a series of dashes or reference lines can be permanently or temporarily disposed on the first removable film **114**, the base film **112**, or both to ensure that the arcuate-shaped mechanical bond points **124** positioned at the corners of the first removable film **114** are aligned with each other.

[0080] Meanwhile, FIG. **18** illustrates a front view of a visor system **180** according to still another embodiment of the present invention where one of the plurality of mechanical bond points **124** at an upper edge of the removable film layer **114** can be in the shape of a rectangle that can have a height **H4** ranging from about 0.4 centimeter to about 0.9 centimeters, such as from about 0.5 centimeters to about 0.8 centimeters, such as from about 0.6 centimeters to about 0.7 centimeters and a length ranging from about 2 centimeters to about 8 centimeters, such as from about 3 centimeters to about 7 centimeters, such as from about 4 centimeters to about 6 centimeters, where the features and dimensions allow for a more continuous peel of the first removable film **114** from the base film **112** when in use.

[0081] In addition, FIGS. **19-22** illustrate various zoomed in views of additional visor systems **180** of the present. For instance, FIG. **19** shows the peeling of a removable film **114** from a base film **112**, where a mechanical bond point **124** is shown as being positioned on both the removable film **114** and the base film **112**. Further, FIG. **20** illustrates a zoomed in view of the rectangular shaped mechanical bond point **124** of the visor system **180** of FIG. **18**. Moreover, FIG. **21** illustrates a zoomed in view of one of the arcuate-shaped mechanical bond points **124** of the visor system **180** of FIGS. **17-18**. Lastly, FIG. **22** illustrates a zoomed in view of a visor system **180** according to yet another embodiment of the present invention showing one of the circular-shaped mechanical bond points **124** of FIG. **16** in more detail.

[0082] FIGS. **6-8** demonstrate the use of the visor system **180** of the present invention that includes the base film **112** and one or more removable films **114** and **116** described above in conjunction with a personal protection and ventilation system **100**. FIG. **6** illustrates a side view of a user wearing a personal protection and ventilation system **100** that includes the visor system **180** of the present invention once completely donned. The user or wearer's head is completely contained within a hood **178**, while the visor system **180** of the present invention provides visibility in the form of a clear shield, and a light source **188** on a helmet **190** provides illumination during a surgical procedure. Further, the hood **178** is connected to the helmet **190** via connecting tabs **210** (see FIG. **7**) present on the first side **266** and the second side **268** of the visor system **180**, where the connecting tabs **210** mate or lock with the receiving tabs **208** on either side of the helmet **190**.

[0083] Referring now to FIGS. **7-8**, FIG. **7** illustrates a procedure for donning the disposable surgical gown **101** and hood **178** with which the visor system **180** of the present

invention is integrated, while FIG. **8** illustrates various adjustment procedures that can be carried out while using a personal protection and ventilation system **100** that includes the visor system **180** of the present invention. First, in FIG. **7**, a procedure by which a wearer can don the disposable surgical gown **101** with hood **178** and visor system **180** after donning the helmet **190**, an air tube **184**, and a fan component or module **186** of the personal ventilation and protection system **100** as described in more detail below with respect to FIG. **9** is shown. First, with an assistant, the wearer can insert his arms into the sleeves of the disposable surgical gown **101**. Then, in step **2**, the assistant can bend the connecting tabs **210** on the visor system **180** towards each other in the direction of the arrows as shown, and, next, in step **3**, the assistant can move the hood **178** in the direction of the wearer to line up the connecting tabs **210** on the visor system **180** on the hood **178** with the receiving tabs **210** on the helmet **190**. Further, as the visor system **180** is connected to the helmet **190**, in step **4**, the assistant can position the hood **178** over the helmet **190** and the air tube **184**. Then, in step **5**, the assistant can ensure that the hood **178** and gown **101** are properly donned and positioned about the body of the wearer, and lastly, in step **6**, the assistant can secure the gown **101** via fastening means **118** (e.g., a zipper) by pulling the zipper downward as shown.

[0084] Further, in FIG. **8**, various adjustment procedures that can be carried out while using the personal protection and ventilation system **100** including the visor system **180** of the present invention are shown. In frames A and B, the removal of an outermost transparent or clear film **114** or **116** disposed on the visor system **180** of the hood **178** is shown, leaving base film **112** exposed. Removal of the film **114** or **116** may be desired when blood, tissue, etc. are present on the outermost film (e.g., removable film **114** or **116**) and affect the wearer's visibility during a surgical procedure. In frame C, adjustment of the positioning of the light source **188** is shown by the wearer grasping the lever **194**, where the hood **178** is present between the wearer's fingers and the lever **194** contained within the hood **178**. Lastly, in frame D, adjustment of the speed of the fan **182** by an assistant is shown, where the fan **182** can be adjust to three different speeds (e.g., low, medium, and high) by turning a fan speed adjustment knob **264** either by unfastening (e.g., unzipping) the gown **101** via fastening means **118** (see FIG. **7**, step **6**), or tactically through the gown **101** without unfastening the gown **101**.

[0085] The various components of a personal protection and ventilation system **100** with which the visor system **180** of the present invention can be used are discussed in more detail with references to FIGS. **9-15**.

[0086] FIG. **9** illustrates the various components of a personal protection and ventilation system **100** that can include the visor system **180** of the present invention. The system **100** can include a disposable surgical gown **101** that can include a separate or integral hood **178** and visor system **180**; and a helmet **190** that can include a front portion **252** with receiving tabs **208** for connecting with the hood **178** via connecting tabs **210** present on the visor system **180** (see FIG. **7**), an air conduit **228** with an air outlet **214**, and a light source **188** with a support **196**. As shown in FIG. **9**, the air outlet **214** can be positioned at an angle  $\alpha$  that ranges from about  $40^\circ$  to about  $85^\circ$ , such as from about  $45^\circ$  to about  $87.5^\circ$ , such as from about  $50^\circ$  to about  $80^\circ$  with respect to a y-axis or horizontal direction towards an x-axis or vertical



direction. It is believed that angles falling within the aforementioned ranges allow for a direction of air flow that reduces fogging in the visor system 180, limits drying of the wearer's eyes, and also provides sufficient cooling to the light source 188.

[0087] Referring still to FIG. 9, the system 100 can also include an air tube 184 as well as a fan component or module 186 that includes a fan 182 and can also include a built-in power source 216 such as a battery, a power switch 262, and a fan speed adjustment knob 264. However, it is also to be understood that the power source 216 can be a separate component from the fan component or module 186 that is attached separately to the belt 206. Further, the air tube 184 can be attached to the fan component or module 186 via fitting 224, while the air tube 184 can be attached to the helmet 190 via fitting 226 at an opposite end of the air tube 184. The fan component or module 186 can be attached to a belt 206 to secure the fan component or module 186 about the rear waist area of a wearer, and the fan component or module 186 can be attached to the belt 206 via attachment or locking mechanism 198.

[0088] FIG. 10 illustrates a front of the disposable surgical gown 101 of FIG. 9 that can be used in conjunction with the visor system 180 of the present invention. The disposable surgical gown includes a front 158 and a rear 160 that can be worn by medical personnel during a surgical procedure, such as an orthopedic surgical procedure or any other procedure where protection from bodily fluids, bone fragments, etc. is desired. The disposable surgical gown 101 has a waist portion 130 defined between a proximal end 154 and a distal end 156, where the proximal end 154 and the distal end 156 define a front panel 102. As shown, the proximal end 154 includes a hood 178 with the visor system 180, while the distal end 156 defines a portion of the gown 101 that is closest to the wearer's feet. As shown in FIG. 10, the hood 178 can be integral with the gown 101 such that the gown 101 and hood 178 form a single garment, where the hood 178 can be sewn to the gown 101 at seam 170. On the other hand, as shown in FIG. 12, in some embodiments, the hood 178 can be a separate component from the surgical gown 101, where the hood 178 can be tucked into the surgical gown 101 inside collar 110. The gown 101 also includes sleeves 104 and cuffs 106. The front panel 102, sleeves 104, and hood 178 can be formed from a laminate of an elastic film and nonwoven materials, as discussed in more detail below. Further, the sleeves 104 can be raglan sleeves, which means that each sleeve 104 extends fully to the collar 110 (see FIG. 12), where a front diagonal seam 164 extends from the underarm up to the collarbone of the wearer and a rear diagonal seam 166 (see FIG. 11) extends from the underarm up to the collarbone of the wearer to attach the sleeves 104 to the front panel 102 and rear panels 120 and 122 of the gown 101. The front diagonal seams 164 and the rear diagonal seams 166 of the sleeves 104 can be sewn to the front panel 102 and rear panels 120 and 122 of the gown. Further, the each sleeve 104 can include a seam 176 that can extend from the underarm area down to the cuff 104, where such sleeves 176 can be seamed thermally so that the sleeves 104 pass ASTM-1671 "Standard Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Blood-Borne Pathogens Using Phi-X174 Bacteriophage Penetration as a Test System."

[0089] FIG. 11 illustrates a rear of the disposable surgical gown 101. The proximal end 154 and the distal end 156

define a first rear panel 120 and a second rear panel 122. The first rear panel 120 and second rear panel 122 can be formed of a laminate of nonwoven materials, as discussed in more detail below. Further, as shown in FIG. 11, the hood 178 can be integral with the gown 101 such that the gown 101 and hood 178 form a single garment, where the hood 178 can be sewn to the gown 101 at seam 170. On the other hand, as shown in FIG. 13, in some embodiments, the hood 178 can be a separate component from the surgical gown 101, where the hood 178 can be tucked into the surgical gown 101 inside collar 110. In addition, as shown in FIGS. 11 and 13, the hood 178 can include a first portion 256 and a second portion 256 as separated by a seam 254, where such the materials used to form the first and second portions 258 materials will be discussed in more detail below, although, in some embodiments, it is to be understood that the hood 178 can be formed entirely of a first material 256. Further, the first rear panel 120 can be sewn to the front panel 102 at a seam 172, while the second rear panel 122 can be sewn to the front panel 102 at a seam 174, where the first rear panel 120 can be ultrasonically bonded to the front panel 102 at seam 172 and the second rear panel 122 can be ultrasonically bonded to the front panel 102 at seam 174, where the ultrasonic bonding results in seams 172 and 174 that have improved liquid barrier protection than sewn seams. For instance, such ultrasonic bonding of the rear panels 120 and 122 to the front panel 102 can result in seams 172 and 174 that can have a hydrohead ranging from about 25 cm to about 100 cm, such as from about 30 cm to about 75 cm, such as from about 40 cm to about 60 cm, while sewn seams only have a hydrohead of about 7 cm, where the hydrohead is determined by providing a clear open-ended tube and clamping the seamed material over the bottom end, filling the tube slowly with water from its top end, and measuring how high the column of water is before water passes through the bottom end of the tube. Further, a rear fastening means 118 such as zipper can be used to secure the gown 101 once it is worn by the wearer. Depending on whether the hood 178 is integral with the gown 101 or separate from the gown 101, the fastening means 118 can extend into the area of the hood 178 (see FIG. 11) or can end at the collar 110 (see FIG. 13).

[0090] FIG. 14 illustrates a cross-sectional view of a first material 200 which can be used to form the front panel 102, the sleeves 104, and the hood 178 of the surgical gown 101 of FIGS. 9-13, where the first material 200 passes ASTM-1671 "Standard Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Blood-Borne Pathogens Using Phi-X174 Bacteriophage Penetration as a Test System." In some embodiments, the entire hood 178 can be formed from the first material 200, while, in other embodiments, as shown in FIGS. 10-13, the first portion 256 of the hood 178, which encompasses the entire hood 178 at the front 158 of the gown 101 and the portion of the hood 178 above seam 254 on the rear of the gown 160 and can be formed from the first material 200, while the second portion 258 of the hood can be formed from a second material 300 as discussed in more detail below. The first material 200 can be a laminate that includes an outer spunbond layer 142, an elastic film 144 containing an first skin layer 144A and a second skin layer 144C with a core layer 144B disposed therebetween, and a spunbond-meltblown-spunbond laminate 146 containing a spunbond layer 146A and a spunbond layer 146C with a meltblown layer 146B disposed therebetween. The outer spunbond layer 142 can form an outer-

facing surface **202** of the front panel **102** on the front **158** of the gown **101**, the sleeves **104**, and the hood **178**, while the spunbond layer **146C** of the SMS laminate **146** can form the body-facing surface or inner-facing surface **204** of the front panel **102** and the sleeves **104** of the surgical gown **101** as well as the hood **178**. As discussed in more detail below, the outer spunbond layer **142** and one or more layers of the SMS laminate **146** can include a slip additive to enhance the softness and comfort of the first material **200**, while one or more layers of the elastic film **144** can include a fluorochemical additive to enhance the barrier performance of the first material **200**. The overall spunbond-film-SMS laminate arrangement of the first material **200** contributes to the moisture vapor breathability of the surgical gown **101** while providing impermeability to air to protect the wearer from exposure to blood, viruses, bacteria, and other harmful contaminants. In other words, the first material **200** allows for an air volumetric flow rate ranging that is less than about 1 standard cubic feet per minute (scfm), such as less than about 0.5 scfm, such as less than about 0.25 scfm, such as less than about 0.1 scfm, such as 0 scfm, as determined at 1 atm (14.7 psi) and 20° C. (68° F.).

[0091] FIG. 15 illustrates a second material **300** that can be used to form the surgical gown **101** of FIGS. 9-13, where the second material **300** can form the first rear panel **120** and the second rear panel **122**. Further, in some embodiments as shown in FIGS. 11 and 13, the second portion **258** of the hood **178** below seam **254** on the rear of the gown **160** can be formed from the second material **300** to provide some breathability to the second or lower portion **258** of the hood **178**. The second material **300** can be a laminate that includes a first spunbond layer **148**, a meltblown layer **150**, and a second spunbond layer **152**. The first spunbond layer **148** can form an outer-facing surface **302** of the first rear panel **120** and the second rear panel **122** of the surgical gown **101**, while the second spunbond layer **152** can form the body-facing surface or inner-facing surface **304** of the first rear panel **120** and the second rear panel **122** of the surgical gown **101**. As discussed in more detail below, the spunbond layers **148** and **152** can include a slip additive to enhance the softness and comfort of the second material **300**, while the overall spunbond-meltblown-spunbond (SMS) laminate arrangement of the second material contributes to the air breathability of the surgical gown **101**.

[0092] The various components of the disposable surgical gown **101** of the personal protection and ventilation system **100** with which the visor system **180** of the present invention can be used are discussed in more detail below. As an initial matter, it is to be understood that any of the spunbond layers, meltblown layers, or elastic film layers of the first material **200** and/or the second material **300** can include pigments to impart the gown **101** with a gray color, which provides anti-glare and light reflectance properties, which, in turn, can provide a better visual field during surgeries or other procedures where operating room lighting can result in poor visual conditions, resulting in glare that causes visual discomfort, and leads to fatigue of operating room staff during surgical procedures.

[0093] For instance, examples of suitable pigments used to arrive at the desired gray pigment for the gown include, but are not limited to, titanium dioxide (e.g., SCC 11692 concentrated titanium dioxide), zeolites, kaolin, mica, carbon black, calcium oxide, magnesium oxide, aluminum hydroxide, and combinations thereof. In certain cases, for instance,

each of the various individual layers of the gown materials **200** and **300** can include titanium dioxide in an amount ranging from about 0.1 wt. % to about 10 wt. %, in some embodiments, from about 0.5 wt. % to about 7.5 wt. %, and in some embodiments, from about 1 wt. % to about 5 wt. % based on the total weight of the individual layer. The titanium dioxide can have a refractive index ranging from about 2.2 to about 3.2, such as from about 2.4 to about 3, such as from about 2.6 to about 2.8, such as about 2.76, to impart the material **200** with the desired light scattering and light absorbing properties. Further, each of the various individual layers of the gown materials **200** and **300** can also include carbon black in an amount ranging from about 0.1 wt. % to about 10 wt. %, in some embodiments, from about 0.5 wt. % to about 7.5 wt. %, and in some embodiments, from about 1 wt. % to about 5 wt. % based on the total weight of the individual layer. The carbon black can have a refractive index ranging from about 1.2 to about 2.4, such as from about 1.4 to about 2.2, such as from about 1.6 to about 2 to impart the material **200** with the desired light scattering and light absorbing properties. Each of the various individual layers of the gown materials **200** and **300** can also include a blue pigment in an amount ranging from about 0.1 wt. % to about 10 wt. %, in some embodiments, from about 0.5 wt. % to about 7.5 wt. %, and in some embodiments, from about 1 wt. % to about 5 wt. % based on the total weight of the individual layer. The combination of the carbon black and blue pigment improves the ability of the nonwoven materials and film of the present invention to absorb light.

[0094] As a result of the incorporation of one or more of the aforementioned pigments into the gown **101** materials, the first material **200** and/or the second material **300** can thus be a sufficient shade of gray to prevent glare. Gray is an imperfect absorption of the light or a mixture of black and white, where it is to be understood that although black, white, and gray are sometimes described as achromatic or hueless colors, a color may be referred to as “black” if it absorbs all frequencies of light. That is, an object that absorbs all wavelengths of light that strike it so that no parts of the spectrum are reflected is considered to be black. Black is darker than any color on the color wheel or spectrum. In contrast, white is lighter than any color on the color wheel or spectrum. If an object reflects all wavelengths of light equally, that object is considered to be white.

[0095] As mentioned above, the front panel **102**, sleeves **104**, and hood **178** (e.g., all of the hood **178** or at least the first portion **256** of the hood **178** as described above) of the gown **101** can be formed from a first material **200**. The first material **200** can be a stretchable elastic breathable barrier material that renders the aforementioned sections of the gown **101** impervious to bodily fluids and other liquids while still providing satisfactory levels of moisture vapor breathability and/or moisture vapor transmission and stretchability. The first material **200** can include a combination of a film, which can serve as the key barrier and elastic component of the surgical gown **101**, and one or more nonwoven layers (e.g., spunbond layers, meltblown layers, a combination thereof, etc.) to provide softness and comfort. The film can be configured to exhibit elastic properties such that the film maintains its fluid barrier characteristics even when elongated in the machine direction by amounts at least as twice as high as currently available gowns such that the gown **101** passes ASTM-1671 “Standard Test Method for

Resistance of Materials Used in Protective Clothing to Penetration by Blood-Borne Pathogens Using Phi-X174 Bacteriophage Penetration as a Test System.” Meanwhile, as a result of the inclusion of the nonwoven layers in conjunction with the elastic film, the overall first material **200** can have an increased bending modulus to achieve the desired pliability and softness which results in a material that is comfortable to the wearer.

**[0096]** As discussed above, in one particular embodiment, the first material **200** can include an outer spunbond layer **142**, a spunbond-meltblown-spunbond laminate **146**, and an elastic film **144** positioned therebetween. The outer spunbond layer **142** can form an outer-facing surface **202** of the front panel **102**, sleeves **104**, and hood **178** of the surgical gown **101**, while one of the spunbond layers of the SMS laminate **146** can form the body-facing surface or inner-facing surface **204** of the front panel **102**, sleeves **104**, and hood **178** of the surgical gown **101**. Further, the outer spunbond layer **142** and one or more layers of the SMS laminate **146** can include a slip additive to achieve the desired softness, while the film **144** can include a fluorochemical additive to increase the surface energy of the elastic film **144** and enhance the ability of the elastic film **144** to serve as a barrier to bodily fluids and tissues, including fatty oils that may be generated during very invasive surgeries as a result of the maceration of fatty tissue. Each of these components of the first material **200** is described in more detail below.

**[0097]** The outer spunbond layer **142** can be formed from any suitable polymer that provides softness, stretch, and pliability to the first material **200**. For instance, the outer spunbond layer **142** can be formed from a semi-crystalline polyolefin. Exemplary polyolefins may include, for instance, polyethylene, polypropylene, blends and copolymers thereof. In one particular embodiment, a polyethylene is employed that is a copolymer of ethylene and an  $\alpha$ -olefin, such as a  $C_3$ - $C_{20}$   $\alpha$ -olefin or  $C_3$ - $C_{12}$   $\alpha$ -olefin. Suitable  $\alpha$ -olefins may be linear or branched (e.g., one or more  $C_1$ - $C_3$  alkyl branches, or an aryl group). Specific examples include 1-butene; 3-methyl-1-butene; 3,3-dimethyl-1-butene; 1-pentene; 1-pentene with one or more methyl, ethyl or propyl substituents; 1-hexene with one or more methyl, ethyl or propyl substituents; 1-heptene with one or more methyl, ethyl or propyl substituents; 1-octene with one or more methyl, ethyl or propyl substituents; 1-nonene with one or more methyl, ethyl or propyl substituents; ethyl, methyl or dimethyl-substituted 1-decene; 1-dodecene; and styrene. Particularly desired  $\alpha$ -olefin co-monomers are 1-butene, 1-hexene and 1-octene. The ethylene content of such copolymers may be from about 60 mole % to about 99 mole %, in some embodiments from about 80 mole % to about 98.5 mole %, and in some embodiments, from about 87 mole % to about 97.5 mole %. The  $\alpha$ -olefin content may likewise range from about 1 mole % to about 40 mole %, in some embodiments from about 1.5 mole % to about 15 mole %, and in some embodiments, from about 2.5 mole % to about 13 mole %.

**[0098]** The density of the polyethylene may vary depending on the type of polymer employed, but generally ranges from 0.85 to 0.96 grams per cubic centimeter (“g/cm<sup>3</sup>”). Polyethylene “plastomers”, for instance, may have a density in the range of from 0.85 to 0.91 g/cm<sup>3</sup>. Likewise, “linear low density polyethylene” (“LLDPE”) may have a density in the range of from 0.91 to 0.940 g/cm<sup>3</sup>; “low density poly-

ethylene” (“LDPE”) may have a density in the range of from 0.910 to 0.940 g/cm<sup>3</sup>; and “high density polyethylene” (“HDPE”) may have density in the range of from 0.940 to 0.960 g/cm<sup>3</sup>. Densities may be measured in accordance with ASTM 1505. Particularly suitable ethylene-based polymers for use in the present invention may be available under the designation EXACT™ from ExxonMobil Chemical Company of Houston, Tex. Other suitable polyethylene plastomers are available under the designation ENGAGE™ and AFFINITY™ from Dow Chemical Company of Midland, Mich. Still other suitable ethylene polymers are available from The Dow Chemical Company under the designations DOWLEX™ (LLDPE) and ATTANE™ (ULDPE). Other suitable ethylene polymers are described in U.S. Pat. No. 4,937,299 to Ewen et al.; U.S. Pat. No. 5,218,071 to Tsutsui et al.; U.S. Pat. No. 5,272,236 to Lai et al.; and U.S. Pat. No. 5,278,272 to Lai, et al., which are incorporated herein in their entirety by reference thereto for all purposes.

**[0099]** Of course, the outer spunbond layer **142** of the first material **200** is by no means limited to ethylene polymers. For instance, propylene polymers may also be suitable for use as a semi-crystalline polyolefin. Suitable propylene polymers may include, for instance, polypropylene homopolymers, as well as copolymers or terpolymers of propylene with an  $\alpha$ -olefin (e.g.,  $C_3$ - $C_{20}$ ) comonomer, such as ethylene, 1-butene, 2-butene, the various pentene isomers, 1-hexene, 1-octene, 1-nonene, 1-decene, 1-undecene, 1-dodecene, 4-methyl-1-pentene, 4-methyl-1-hexene, 5-methyl-1-hexene, vinylcyclohexene, styrene, etc. The comonomer content of the propylene polymer may be about 35 wt. % or less, in some embodiments from about 1 wt. % to about 20 wt. %, in some embodiments, from about 2 wt. % to about 15 wt. %, and in some embodiments from about 3 wt. % to about 10 wt. %. The density of the polypropylene (e.g., propylene/ $\alpha$ -olefin copolymer) may be 0.95 grams per cubic centimeter (g/cm<sup>3</sup>) or less, in some embodiments, from 0.85 to 0.92 g/cm<sup>3</sup>, and in some embodiments, from 0.85 g/cm<sup>3</sup> to 0.91 g/cm<sup>3</sup>. In one particular embodiment, the outer spunbond layer **142** can include a copolymer of polypropylene and polyethylene. The polypropylene can have a refractive index ranging from about 1.44 to about 1.54, such as from about 1.46 to about 1.52, such as from about 1.48 to about 1.50, such as about 1.49, while the polyethylene can have a refractive index ranging from about 1.46 to about 1.56, such as from about 1.48 to about 1.54, such as from about 1.50 to about 1.52, such as about 1.51, to impart the material **200** with the desired light scattering and light absorbing properties.

**[0100]** Suitable propylene polymers are commercially available under the designations VISTAMAXX™ from ExxonMobil Chemical Co. of Houston, Tex.; FINA™ (e.g., 8573) from Atofina Chemicals of Feluy, Belgium; TAFMER™ available from Mitsui Petrochemical Industries; and VERSIFY™ available from Dow Chemical Co. of Midland, Mich. Other examples of suitable propylene polymers are described in U.S. Pat. No. 6,500,563 to Datta, et al.; U.S. Pat. No. 5,539,056 to Yang, et al.; and U.S. Pat. No. 5,596,052 to Resconi, et al., which are incorporated herein in their entirety by reference thereto for all purposes.

**[0101]** Any of a variety of known techniques may generally be employed to form the polyolefins. For instance, olefin polymers may be formed using a free radical or a coordination catalyst (e.g., Ziegler-Natta or metallocene). Metallocene-catalyzed polyolefins are described, for

instance, in U.S. Pat. No. 5,571,619 to McAlpin et al.; U.S. Pat. No. 5,322,728 to Davis et al.; U.S. Pat. No. 5,472,775 to Obijeski et al.; U.S. Pat. No. 5,272,236 to Lai et al.; and U.S. Pat. No. 6,090,325 to Wheat, et al., which are incorporated herein in their entirety by reference thereto for all purposes.

**[0102]** The melt flow index (MI) of the polyolefins may generally vary, but is typically in the range of about 0.1 grams per 10 minutes to about 100 grams per 10 minutes, in some embodiments from about 0.5 grams per 10 minutes to about 30 grams per 10 minutes, and in some embodiments, about 1 to about 10 grams per 10 minutes, determined at 190° C. The melt flow index is the weight of the polymer (in grams) that may be forced through an extrusion rheometer orifice (0.0825-inch diameter) when subjected to a force of 2160 grams in 10 minutes at 190° C., and may be determined in accordance with ASTM Test Method D1238-E.

**[0103]** In addition to a polyolefin, the outer spunbond layer **142** can also include a slip additive to enhance the softness of the outer spunbond layer **142**. The slip additive can also reduce the coefficient of friction and increase the hydrohead of the outer spunbond layer **142** of the front panel **102** and the sleeves **104**. Such a reduction in the coefficient of friction lessens the chance of the gown **101** being cut or damaged due to abrasions and also prevents fluids from seeping through the first material **200**. Instead, at least in part due to the inclusion of the slip additive, fluid that contacts the outer-facing surface **202** of the gown **101** can remain in droplet form and run vertically to the distal end **156** of the gown **101** and onto the floor. The slip additive can also reduce the glare of the first material **200** in the operating room by reducing the light reflectance of the first material and can also render the first material **200** more opaque than the standard gown material when contacted with fats and lipids during surgery, where the standard gown material turns transparent upon contact with fats and lipids, which can result in the wearer having some concern that the barrier properties of a standard gown have been compromised.

**[0104]** The slip additive can function by migrating to the surface of the polymer used to form the outer spunbond layer **142**, where it can provide a coating that reduces the coefficient of friction of the outer-facing surface **202** of the first material **200**. Variants of fatty acids can be used as slip additives. For example, the slip additive can be erucamide, oleamide, stearamide, behenamide, oleyl palmitamide, stearyl erucamide, ethylene bis-oleamide, N,N'-Ethylene Bis(Stearamide) (EBS), or a combination thereof. Further, the slip additive have a refractive index ranging from about 1.42 to about 1.52, such as from about 1.44 to about 1.50, such as from about 1.46 to about 1.48, such as about 1.47, to impart the material **200** with the desired light scattering and light absorbing properties by reducing the refractive index. The slip additive can be present in the outer spunbond layer **142** in an amount ranging from about 0.1 wt. % to about 4 wt. %, such as from about 0.25 wt. % to about 3 wt. %, such as from about 0.5 wt. % to about 2 wt. % based on the total weight of the outer spunbond layer **142**. In one particular embodiment, the slip additive can be present in an amount of about 1 wt. % based on the total weight of the outer spunbond layer **142**.

**[0105]** In addition to the polyolefin and slip additive, the outer spunbond layer **142** can also include one or more pigments to help achieve the desired gray color of the gown **101**. Examples of suitable pigments include, but are not

limited to, titanium dioxide (e.g., SCC 11692 concentrated titanium dioxide), zeolites, kaolin, mica, carbon black, calcium oxide, magnesium oxide, aluminum hydroxide, and combinations thereof. In certain cases, for instance, the outer spunbond layer **142** can include titanium dioxide in an amount ranging from about 0.1 wt. % to about 10 wt. %, in some embodiments, from about 0.5 wt. % to about 7.5 wt. %, and in some embodiments, from about 1 wt. % to about 5 wt. % based on the total weight of the outer spunbond layer **142**. The titanium dioxide can have a refractive index ranging from about 2.2 to about 3.2, such as from about 2.4 to about 3, such as from about 2.6 to about 2.8, such as about 2.76, to impart the material **200** with the desired light scattering and light absorbing properties. Further, the outer spunbond layer **142** can also include carbon black in an amount ranging from about 0.1 wt. % to about 10 wt. %, in some embodiments, from about 0.5 wt. % to about 7.5 wt. %, and in some embodiments, from about 1 wt. % to about 5 wt. % based on the total weight of the outer spunbond layer **142**. The carbon black can have a refractive index ranging from about 1.2 to about 2.4, such as from about 1.4 to about 2.2, such as from about 1.6 to about 2 to impart the material **200** with the desired light scattering and light absorbing properties. The outer spunbond layer **142** can also include a blue pigment in an amount ranging from about 0.1 wt. % to about 10 wt. %, in some embodiments, from about 0.5 wt. % to about 7.5 wt. %, and in some embodiments, from about 1 wt. % to about 5 wt. % based on the total weight of the individual layer. The combination of the carbon black and blue pigment improves the ability of the outer spunbond layer **142** to absorb light.

**[0106]** Regardless of the specific polymer or polymers and additives used to form the outer spunbond layer **142**, the outer spunbond layer **142** can have a basis weight ranging from about 5 gsm to about 50 gsm, such as from about 10 gsm to about 40 gsm, such as from about 15 gsm to about 30 gsm. In one particular embodiment, the outer spunbond layer **142** can have a basis weight of about 20 gsm (about 0.6 oz/yd).

**[0107]** The elastic film **144** of the first material **200** can be formed from any suitable polymer or polymers that are capable of acting as a barrier component in that it is generally impervious, while at the same time providing moisture vapor breathability to the first material **200**. The elastic film **144** can be formed from one or more layers of polymers that are melt-processable, i.e., thermoplastic. In one particular embodiment, the elastic film **144** can be a monolayer film. If the film is a monolayer, any of the polymers discussed below in can be used to form the monolayer. In other embodiments, the elastic film **144** can include two, three, four, five, six, or seven layers, where each of the layers can be formed from any of the polymers discussed below, where the one or more layers are formed from the same or different materials. For instance, in one particular embodiment the elastic film **144** can include a core layer **144B** disposed between two skin layers, **144A** and **144C**. Each of these components of the film are discussed in more detail below.

**[0108]** First, the elastic film core layer **144B** can be formed from one or more semi-crystalline polyolefins. Exemplary semi-crystalline polyolefins include polyethylene, polypropylene, blends and copolymers thereof. In one particular embodiment, a polyethylene is employed that is a copolymer of ethylene and an  $\alpha$ -olefin, such as a C<sub>3</sub>-C<sub>20</sub>

$\alpha$ -olefin or  $C_3$ - $C_{12}$   $\alpha$ -olefin. Suitable  $\alpha$ -olefins may be linear or branched (e.g., one or more  $C_1$ - $C_3$  alkyl branches, or an aryl group). Specific examples include 1-butene; 3-methyl-1-butene; 3,3-dimethyl-1-butene; 1-pentene; 1-pentene with one or more methyl, ethyl or propyl substituents; 1-hexene with one or more methyl, ethyl or propyl substituents; 1-heptene with one or more methyl, ethyl or propyl substituents; 1-octene with one or more methyl, ethyl or propyl substituents; 1-nonene with one or more methyl, ethyl or propyl substituents; ethyl, methyl or dimethyl-substituted 1-decene; 1-dodecene; and styrene. Particularly desired  $\alpha$ -olefin comonomers are 1-butene, 1-hexene and 1-octene. The ethylene content of such copolymers may be from about 60 mole % to about 99 mole %, in some embodiments from about 80 mole % to about 98.5 mole %, and in some embodiments, from about 87 mole % to about 97.5 mole %. The  $\alpha$ -olefin content may likewise range from about 1 mole % to about 40 mole %, in some embodiments from about 1.5 mole % to about 15 mole %, and in some embodiments, from about 2.5 mole % to about 13 mole %.

**[0109]** Particularly suitable polyethylene copolymers are those that are “linear” or “substantially linear.” The term “substantially linear” means that, in addition to the short chain branches attributable to comonomer incorporation, the ethylene polymer also contains long chain branches in the polymer backbone. “Long chain branching” refers to a chain length of at least 6 carbons. Each long chain branch may have the same comonomer distribution as the polymer backbone and be as long as the polymer backbone to which it is attached. Preferred substantially linear polymers are substituted with from 0.01 long chain branch per 1000 carbons to 1 long chain branch per 1000 carbons, and in some embodiments, from 0.05 long chain branch per 1000 carbons to 1 long chain branch per 1000 carbons. In contrast to the term “substantially linear”, the term “linear” means that the polymer lacks measurable or demonstrable long chain branches. That is, the polymer is substituted with an average of less than 0.01 long chain branch per 1000 carbons.

**[0110]** The density of a linear ethylene/ $\alpha$ -olefin copolymer is a function of both the length and amount of the  $\alpha$ -olefin. That is, the greater the length of the  $\alpha$ -olefin and the greater the amount of  $\alpha$ -olefin present, the lower the density of the copolymer. Although not necessarily required, linear polyethylene “plastomers” are particularly desirable in that the content of  $\alpha$ -olefin short chain branching content is such that the ethylene copolymer exhibits both plastic and elastomeric characteristics—i.e., a “plastomer.” Because polymerization with  $\alpha$ -olefin comonomers decreases crystallinity and density, the resulting plastomer normally has a density lower than that of a polyethylene thermoplastic polymer (e.g., LLDPE), which typically has a density (specific gravity) of from about 0.90 grams per cubic centimeter ( $g/cm^3$ ) to about 0.94  $g/cm^3$ , but approaching and/or overlapping that of an elastomer, which typically has a density of from about 0.85  $g/cm^3$  to about 0.90  $g/cm^3$ , preferably from 0.86 to 0.89. For example, the density of the polypropylene (e.g., propylene/ $\alpha$ -olefin copolymer) may be 0.95 grams per cubic centimeter ( $g/cm^3$ ) or less, in some embodiments, from 0.85 to 0.92  $g/cm^3$ , and in some embodiments, from 0.85  $g/cm^3$  to 0.91  $g/cm^3$ . Despite having a density similar to elastomers, plastomers generally exhibit a higher degree of crystallinity, are relatively non-tacky, and may be formed into pellets that are non-adhesive-like and relatively free flowing.

**[0111]** Preferred polyethylenes for use in the present invention are ethylene-based copolymer plastomers available under the designation EXACT™ from ExxonMobil Chemical Company of Houston, Tex. Other suitable polyethylene plastomers are available under the designation ENGAGE™ and AFFINITY™ from Dow Chemical Company of Midland, Mich. An additional suitable polyethylene-based plastomer is an olefin block copolymer available from Dow Chemical Company of Midland, Mich. under the trade designation INFUSE™, which is an elastomeric copolymer of polyethylene. Still other suitable ethylene polymers are low density polyethylenes (LDPE), linear low density polyethylenes (LLDPE) or ultralow linear density polyethylenes (ULDPE), such as those available from The Dow Chemical Company under the designations ASPUN™ (LLDPE), DOWLEX™ (LLDPE) and ATTANET™ (ULDPE). Other suitable ethylene polymers are described in U.S. Pat. No. 4,937,299 to Ewen, et al., U.S. Pat. No. 5,218,071 to Tsutsui et al., U.S. Pat. No. 5,272,236 to Lai et al., and U.S. Pat. No. 5,278,272 to Lai, et al., which are incorporated herein in their entirety by reference thereto for all purposes.

**[0112]** Of course, the elastic film core layer 144B of the present invention is by no means limited to ethylene polymers. For instance, propylene plastomers may also be suitable for use in the film. Suitable plastomeric propylene polymers may include, for instance, polypropylene homopolymers, copolymers or terpolymers of propylene, copolymers of propylene with an  $\alpha$ -olefin (e.g.,  $C_3$ - $C_{20}$ ) comonomer, such as ethylene, 1-butene, 2-butene, the various pentene isomers, 1-hexene, 1-octene, 1-nonene, 1-decene, 1-undecene, 1-dodecene, 4-methyl-1-pentene, 4-methyl-1-hexene, 5-methyl-1-hexene, vinylcyclohexene, styrene, etc. The comonomer content of the propylene polymer may be about 35 wt. % or less, in some embodiments from about 1 wt. % to about 20 wt. %, in some embodiments from about 2 wt. % to about 15 wt. %, and in some embodiments from about 3 wt. % to about 10 wt. %. Preferably, the density of the polypropylene (e.g., propylene/ $\alpha$ -olefin copolymer) may be 0.95 grams per cubic centimeter ( $g/cm^3$ ) or less, in some embodiments, from 0.85 to 0.92  $g/cm^3$ , and in some embodiments, from 0.85  $g/cm^3$  to 0.91  $g/cm^3$ .

**[0113]** Suitable propylene polymers are commercially available under the designations VISTAMAXX™ (e.g., 6102), a propylene-based elastomer from ExxonMobil Chemical Co. of Houston, Tex.; FINA™ (e.g., 8573) from Atofina Chemicals of Feluy, Belgium; TAFMER™ available from Mitsui Petrochemical Industries; and VERSIFY™ available from Dow Chemical Co. of Midland, Mich. Other examples of suitable propylene polymers are described in U.S. Pat. No. 5,539,056 to Yang, et al., U.S. Pat. No. 5,596,052 to Resconi, et al., and U.S. Pat. No. 6,500,563 to Datta, et al., which are incorporated herein in their entirety by reference thereto for all purposes. In one particular embodiment, the elastic film core layer 144B includes polypropylene. The polypropylene can have a refractive index ranging from about 1.44 to about 1.54, such as from about 1.46 to about 1.52, such as from about 1.48 to about 1.50, such as about 1.49 to help impart the material 200 with the desired light scattering and light absorbing properties.

**[0114]** Any of a variety of known techniques may generally be employed to form the semi-crystalline polyolefins. For instance, olefin polymers may be formed using a free radical or a coordination catalyst (e.g., Ziegler-Natta). Preferably, the olefin polymer is formed from a single-site

coordination catalyst, such as a metallocene catalyst. Such a catalyst system produces ethylene copolymers in which the comonomer is randomly distributed within a molecular chain and uniformly distributed across the different molecular weight fractions. Metallocene-catalyzed polyolefins are described, for instance, in U.S. Pat. No. 5,272,236 to Lai et al., U.S. Pat. No. 5,322,728 to Davis et al., U.S. Pat. No. 5,472,775 to Obijeski et al., U.S. Pat. No. 5,571,619 to McAlpin et al., and U.S. Pat. No. 6,090,325 to Wheat, et al., which are incorporated herein in their entirety by reference thereto for all purposes. Examples of metallocene catalysts include bis(*n*-butylcyclopentadienyl)titanium dichloride, bis(*n*-butylcyclopentadienyl)zirconium dichloride, bis(cyclopentadienyl)scandium chloride, bis(indenyl)zirconium dichloride, bis(methylcyclopentadienyl)titanium dichloride, bis(methylcyclopentadienyl) zirconium dichloride, cobaltocene, cyclopentadienyltitanium trichloride, ferrocene, hafnocene dichloride, isopropyl(cyclopentadienyl, -1-flourenyl) zirconium dichloride, molybdocene dichloride, nickelocene, niobocene dichloride, ruthenocene, titanocene dichloride, zirconocene chloride hydride, zirconocene dichloride, and so forth. Polymers made using metallocene catalysts typically have a narrow molecular weight range. For instance, metallocene-catalyzed polymers may have polydispersity numbers ( $M_w/M_n$ ) of below 4, controlled short chain branching distribution, and controlled isotacticity.

**[0115]** The melt flow index (MI) of the semi-crystalline polyolefins may generally vary, but is typically in the range of about 0.1 grams per 10 minutes to about 100 grams per 10 minutes, in some embodiments from about 0.5 grams per 10 minutes to about 30 grams per 10 minutes, and in some embodiments, about 1 to about 10 grams per 10 minutes, determined at 190° C. The melt flow index is the weight of the polymer (in grams) that may be forced through an extrusion rheometer orifice (0.0825-inch diameter) when subjected to a force of 5000 grams in 10 minutes at 190° C., and may be determined in accordance with ASTM Test Method D1238-E.

**[0116]** In addition to a polyolefin such as polypropylene, the elastic film core layer **144B** can also include a fluorochemical additive to increase the surface energy of the elastic film **144**, which, in turn, increases the imperviousness of the elastic film **144** to bodily fluids and biologic materials such as fatty oils that may be generated during very invasive surgeries. One example of a fluorochemical additive contemplated for use in the core layer **144B** is a fluoroalkyl acrylate copolymer such as Unidyne® TG from Daikin. The fluorochemical additive can have a refractive index that is less than about 1.4 in order to lower the refractive index of the elastic film core layer **144B**. For instance, the fluorochemical additive can have a refractive index ranging from about 1.2 to about 1.4, such as from about 1.22 to about 1.38, such as from about 1.24 to about 1.36. Without intending to be limited by any particular theory, it is believed that the fluorochemical additive segregates to the surface of the polyolefin film, where a lower refractive index region is formed, which enhances light scattering of the film as compared to films that are free of a fluorochemical additive. Regardless of the particular fluorochemical additive utilized, the fluorochemical additive can be present in the elastic film core layer **144B** in an amount ranging from about 0.1 wt. % to about 5 wt. %, such as from about 0.5 wt. % to about 4 wt. %, such as from about 1 wt. % to about 3 wt. % based on the total weight of the elastic film core layer **144B**. In one

particular embodiment, the fluorochemical additive can be present in an amount of about 1.5 wt. % based on the total weight of the elastic film core layer **144B**.

**[0117]** In one embodiment, the elastic film core layer **144B** can also include a filler. Fillers are particulates or other forms of material that may be added to the film polymer extrusion blend and that will not chemically interfere with the extruded film, but which may be uniformly dispersed throughout the film. Fillers may serve a variety of purposes, including enhancing film opacity and/or breathability (i.e., vapor-permeable and substantially liquid-impermeable). For instance, filled films may be made breathable by stretching, which causes the polymer to break away from the filler and create microporous passageways. Breathable microporous elastic films are described, for example, in U.S. Pat. No. 5,932,497 to Morman, et al., U.S. Pat. Nos. 5,997,981, 6,015,764, and 6,111,163 to McCormack, et al., and U.S. Pat. No. 6,461,457 to Taylor, et al., which are incorporated herein in their entirety by reference thereto for all purposes. Examples of suitable fillers include, but are not limited to, calcium carbonate, various kinds of clay, silica, alumina, barium carbonate, sodium carbonate, magnesium carbonate, talc, barium sulfate, magnesium sulfate, aluminum sulfate, zeolites, cellulose-type powders, kaolin, mica, carbon, calcium oxide, magnesium oxide, aluminum hydroxide, pulp powder, wood powder, cellulose derivatives, chitin and chitin derivatives. In one particular embodiment, the filler in the core layer **144B** can include calcium carbonate, which can provide the elastic film **144**, and thus the material **200**, with light scattering and light absorbing properties to help reduce glare, particularly after stretching the calcium carbonate-containing core layer **144B**, which further increases the opacity and increases the light scattering of the material **200**. For instance, the calcium carbonate (or any other suitable filler) can have a refractive index ranging from about 1.60 to about 1.72, such as from about 1.62 to about 1.70, such as from about 1.64 to about 1.68, such as about 1.66, to impart the material **200** with the desired light scattering and light absorbing properties. In certain cases, the filler content of the film may range from about 50 wt. % to about 85 wt. %, in some embodiments, from about 55 wt. % to about 80 wt. %, and in some embodiments, from about 60 wt. % to about 75 wt. % of the elastic film core layer **144B** based on the total weight of the elastic film core layer **144B**.

**[0118]** Further, the elastic film core layer **144B** can also include one or more pigments to help achieve the desired gray color of the gown **101**. Examples of suitable pigments include, but are not limited to, titanium dioxide (e.g., SCC 11692 concentrated titanium dioxide), zeolites, kaolin, mica, carbon black, calcium oxide, magnesium oxide, aluminum hydroxide, and combinations thereof. In certain cases, for instance, the elastic film core layer **144B** can include titanium dioxide in an amount ranging from about 0.1 wt. % to about 10 wt. %, in some embodiments, from about 0.5 wt. % to about 7.5 wt. %, and in some embodiments, from about 1 wt. % to about 5 wt. % based on the total weight of the core layer **144B**. The titanium dioxide can have a refractive index ranging from about 2.2 to about 3.2, such as from about 2.4 to about 3, such as from about 2.6 to about 2.8, such as about 2.76, to impart the material **200** with the desired light scattering and light absorbing properties. Further, the elastic film core layer **144B** can also include carbon black in an amount ranging from about 0.1 wt. % to about 10 wt. %, in some embodiments, from about 0.5 wt. % to about 7.5 wt. %.

%, and in some embodiments, from about 1 wt. % to about 5 wt. % based on the total weight of the core layer **144B**. The carbon black can have a refractive index ranging from about 1.2 to about 2.4, such as from about 1.4 to about 2.2, such as from about 1.6 to about 2 to impart the material **200** with the desired light scattering and light absorbing properties. The elastic film core layer **144B** can also include a blue pigment in an amount ranging from about 0.1 wt. % to about 10 wt. %, in some embodiments, from about 0.5 wt. % to about 7.5 wt. %, and in some embodiments, from about 1 wt. % to about 5 wt. % based on the total weight of the individual layer. The combination of the carbon black and blue pigment improves the ability of the elastic film core layer **144B** to absorb light.

**[0119]** Further, like the elastic film core layer **144B**, the elastic film skin layers **144A** and **144C** that sandwich the elastic film core layer **144B** can also be formed from one or more semi-crystalline polyolefins. Exemplary semi-crystalline polyolefins include polyethylene, polypropylene, blends and copolymers thereof. In one particular embodiment, a polyethylene is employed that is a copolymer of ethylene and an  $\alpha$ -olefin, such as a  $C_3$ - $C_{20}$   $\alpha$ -olefin or  $C_3$ - $C_{12}$   $\alpha$ -olefin. Suitable  $\alpha$ -olefins may be linear or branched (e.g., one or more  $C_1$ - $C_3$  alkyl branches, or an aryl group). Specific examples include 1-butene; 3-methyl-1-butene; 3,3-dimethyl-1-butene; 1-pentene; 1-pentene with one or more methyl, ethyl or propyl substituents; 1-hexene with one or more methyl, ethyl or propyl substituents; 1-heptene with one or more methyl, ethyl or propyl substituents; 1-octene with one or more methyl, ethyl or propyl substituents; 1-nonene with one or more methyl, ethyl or propyl substituents; ethyl, methyl or dimethyl-substituted 1-decene; 1-dodecene; and styrene. Particularly desired  $\alpha$ -olefin comonomers are 1-butene, 1-hexene and 1-octene. The ethylene content of such copolymers may be from about 60 mole % to about 99 mole %, in some embodiments from about 80 mole % to about 98.5 mole %, and in some embodiments, from about 87 mole % to about 97.5 mole %. The  $\alpha$ -olefin content may likewise range from about 1 mole % to about 40 mole %, in some embodiments from about 1.5 mole % to about 15 mole %, and in some embodiments, from about 2.5 mole % to about 13 mole %.

**[0120]** Particularly suitable polyethylene copolymers are those that are “linear” or “substantially linear.” The term “substantially linear” means that, in addition to the short chain branches attributable to comonomer incorporation, the ethylene polymer also contains long chain branches in the polymer backbone. “Long chain branching” refers to a chain length of at least 6 carbons. Each long chain branch may have the same comonomer distribution as the polymer backbone and be as long as the polymer backbone to which it is attached. Preferred substantially linear polymers are substituted with from 0.01 long chain branch per 1000 carbons to 1 long chain branch per 1000 carbons, and in some embodiments, from 0.05 long chain branch per 1000 carbons to 1 long chain branch per 1000 carbons. In contrast to the term “substantially linear”, the term “linear” means that the polymer lacks measurable or demonstrable long chain branches. That is, the polymer is substituted with an average of less than 0.01 long chain branch per 1000 carbons.

**[0121]** The density of a linear ethylene/ $\alpha$ -olefin copolymer is a function of both the length and amount of the  $\alpha$ -olefin. That is, the greater the length of the  $\alpha$ -olefin and

the greater the amount of  $\alpha$ -olefin present, the lower the density of the copolymer. Although not necessarily required, linear polyethylene “plastomers” are particularly desirable in that the content of  $\alpha$ -olefin short chain branching content is such that the ethylene copolymer exhibits both plastic and elastomeric characteristics—i.e., a “plastomer.” Because polymerization with  $\alpha$ -olefin comonomers decreases crystallinity and density, the resulting plastomer normally has a density lower than that of a polyethylene thermoplastic polymer (e.g., LLDPE), which typically has a density (specific gravity) of from about 0.90 grams per cubic centimeter ( $\text{g/cm}^3$ ) to about  $0.94 \text{ g/cm}^3$ , but approaching and/or overlapping that of an elastomer, which typically has a density of from about  $0.85 \text{ g/cm}^3$  to about  $0.90 \text{ g/cm}^3$ , preferably from 0.86 to 0.89. For example, the density of the polyethylene plastomer may be  $0.91 \text{ g/cm}^3$  or less, in some embodiments from about  $0.85 \text{ g/cm}^3$  to about  $0.90 \text{ g/cm}^3$ , in some embodiments, from  $0.85 \text{ g/cm}^3$  to  $0.88 \text{ g/cm}^3$ , and in some embodiments, from  $0.85 \text{ g/cm}^3$  to  $0.87 \text{ g/cm}^3$ . Despite having a density similar to elastomers, plastomers generally exhibit a higher degree of crystallinity, are relatively non-tacky, and may be formed into pellets that are non-adhesive-like and relatively free flowing.

**[0122]** Preferred polyethylenes for use in the present invention are ethylene-based copolymer plastomers available under the designation EXACT™ from ExxonMobil Chemical Company of Houston, Tex. Other suitable polyethylene plastomers are available under the designation ENGAGE™ and AFFINITY™ from Dow Chemical Company of Midland, Mich. An additional suitable polyethylene-based plastomer is an olefin block copolymer available from Dow Chemical Company of Midland, Mich. under the trade designation INFUSE™, which is an elastomeric copolymer of polyethylene. Still other suitable ethylene polymers are low density polyethylenes (LDPE), linear low density polyethylenes (LLDPE) or ultralow linear density polyethylenes (ULDPE), such as those available from The Dow Chemical Company under the designations ASPUN™ (LLDPE), DOWLEX™ (LLDPE) and ATTANE™ (ULDPE). Other suitable ethylene polymers are described in U.S. Pat. No. 4,937,299 to Ewen, et al., U.S. Pat. No. 5,218,071 to Tsutsui et al., U.S. Pat. No. 5,272,236 to Lai et al., and U.S. Pat. No. 5,278,272 to Lai, et al., which are incorporated herein in their entirety by reference thereto for all purposes.

**[0123]** Of course, the elastic film skin layers **144A** and **144C** of the present invention are by no means limited to ethylene polymers. For instance, propylene plastomers may also be suitable for use in the film. Suitable plastomeric propylene polymers may include, for instance, polypropylene homopolymers, copolymers or terpolymers of propylene, copolymers of propylene with an  $\alpha$ -olefin (e.g.,  $C_3$ - $C_{20}$ ) comonomer, such as ethylene, 1-butene, 2-butene, the various pentene isomers, 1-hexene, 1-octene, 1-nonene, 1-decene, 1-undecene, 1-dodecene, 4-methyl-1-pentene, 4-methyl-1-hexene, 5-methyl-1-hexene, vinylcyclohexene, styrene, etc. The comonomer content of the propylene polymer may be about 35 wt. % or less, in some embodiments from about 1 wt. % to about 20 wt. %, in some embodiments from about 2 wt. % to about 15 wt. %, and in some embodiments from about 3 wt. % to about 10 wt. %. The density of the polypropylene (e.g., propylene/ $\alpha$ -olefin copolymer) may be 0.95 grams per cubic centimeter ( $\text{g/cm}^3$ ) or less, in some embodiments, from 0.85 to  $0.92 \text{ g/cm}^3$ , and in some embodiments, from  $0.85 \text{ g/cm}^3$  to  $0.91 \text{ g/cm}^3$ . In

one particular embodiment, the elastic film skin layers **144A** and **144C** can include a copolymer of polypropylene and polyethylene. The polypropylene can have a refractive index ranging from about 1.44 to about 1.54, such as from about 1.46 to about 1.52, such as from about 1.48 to about 1.50, such as about 1.49, while the polyethylene can have a refractive index ranging from about 1.46 to about 1.56, such as from about 1.48 to about 1.54, such as from about 1.50 to about 1.52, such as about 1.51, to impart the material **200** with the desired light scattering and light absorbing properties.

[0124] Suitable propylene polymers are commercially available under the designations VISTAMAXX™ (e.g., 6102), a propylene-based elastomer from ExxonMobil Chemical Co. of Houston, Tex.; FINA™ (e.g., 8573) from Atofina Chemicals of Feluy, Belgium; TAFMER™ available from Mitsui Petrochemical Industries; and VERSIFY™ available from Dow Chemical Co. of Midland, Mich. Other examples of suitable propylene polymers are described in U.S. Pat. No. 5,539,056 to Yang, et al., U.S. Pat. No. 5,596,052 to Resconi, et al., and U.S. Pat. No. 6,500,563 to Datta, et al., which are incorporated herein in their entirety by reference thereto for all purposes.

[0125] Any of a variety of known techniques may generally be employed to form the semi-crystalline polyolefins. For instance, olefin polymers may be formed using a free radical or a coordination catalyst (e.g., Ziegler-Natta). Preferably, the olefin polymer is formed from a single-site coordination catalyst, such as a metallocene catalyst. Such a catalyst system produces ethylene copolymers in which the comonomer is randomly distributed within a molecular chain and uniformly distributed across the different molecular weight fractions. Metallocene-catalyzed polyolefins are described, for instance, in U.S. Pat. No. 5,272,236 to Lai et al., U.S. Pat. No. 5,322,728 to Davis et al., U.S. Pat. No. 5,472,775 to Obiieski et al., U.S. Pat. No. 5,571,619 to McAlpin et al., and U.S. Pat. No. 6,090,325 to Wheat, et al., which are incorporated herein in their entirety by reference thereto for all purposes. Examples of metallocene catalysts include bis(*n*-butylcyclopentadienyl)titanium dichloride, bis(*n*-butylcyclopentadienyl)zirconium dichloride, bis(cyclopentadienyl)scandium chloride, bis(indenyl)zirconium dichloride, bis(methylcyclopentadienyl)titanium dichloride, bis(methylcyclopentadienyl) zirconium dichloride, cobaltocene, cyclopentadienyltitanium trichloride, ferrocene, hafnocene dichloride, isopropyl(cyclopentadienyl, -1-fluorenyl) zirconium dichloride, molybdocene dichloride, nickelocene, niobocene dichloride, ruthenocene, titanocene dichloride, zirconocene chloride hydride, zirconocene dichloride, and so forth. Polymers made using metallocene catalysts typically have a narrow molecular weight range. For instance, metallocene-catalyzed polymers may have polydispersity numbers ( $M_w/M_n$ ) of below 4, controlled short chain branching distribution, and controlled isotacticity.

[0126] The melt flow index (MI) of the semi-crystalline polyolefins may generally vary, but is typically in the range of about 0.1 grams per 10 minutes to about 100 grams per 10 minutes, in some embodiments from about 0.5 grams per 10 minutes to about 30 grams per 10 minutes, and in some embodiments, about 1 to about 10 grams per 10 minutes, determined at 190° C. The melt flow index is the weight of the polymer (in grams) that may be forced through an extrusion rheometer orifice (0.0825-inch diameter) when

subjected to a force of 5000 grams in 10 minutes at 190° C., and may be determined in accordance with ASTM Test Method D1238-E.

[0127] In addition, it is noted that the elastic film skin layers **144A** and **144C** are free of the fluorochemical additive that is present in the elastic film core layer **144B**. As a result, the skin layers **144A** and **144C** have a higher refractive index than the elastic film core layer **144B**, as the fluorochemical additive tends to lower the refractive index of the core layer **144B**. The resulting difference in refractive indices at the interfaces between the core layer **144B** and the skin layers **144A** and **144C** of the elastic film **144** is thought to enhance light scattering, which can result in a high level of opacity and a low level of light reflection (e.g., reduced glare).

[0128] In any event, regardless of the number of layers present in the elastic film **144** and regardless of the specific polymer or polymers and additives used to form the elastic film **144**, the elastic film **144** can have a basis weight ranging from about 5 gsm to about 50 gsm, such as from about 10 gsm to about 40 gsm, such as from about 15 gsm to about 30 gsm. In one particular embodiment, the elastic film **144** can have a basis weight of about 20 gsm (about 0.6 osy).

[0129] The first material **200** also includes an SMS laminate **146** that is attached to the skin layer **144C** of the elastic film **144**. One of the spunbond layers **146C** of the SMS laminate **146** can form the inner-facing surface **204** of the first material **200** of the gown **101**, which is used to form the front panel **102** on the front **158** of the gown **101**, the sleeves **104** and the hood **178**. Further, it is to be understood that the spunbond layer **146A**, which is adjacent the skin layer **144C**, the spunbond layer **146C**, and the meltblown layer **146B** disposed therebetween can be formed from any of the polymers (e.g., polyolefins) mentioned above with respect to the outer spunbond layer **142**. In other words, the SMS laminate **146** can be formed from any suitable polymer that provides softness, stretch, and pliability to the first material **200**.

[0130] In one particular embodiment, the SMS laminate **146** can include a first spunbond layer **146A** and a second spunbond layer **146C**, where the spunbond layers **146A** and **146C** can be formed from any suitable polymer that provides softness, stretch, and pliability to the first material **200**. For instance, the spunbond layers **146A** and **146C** can be formed from a semi-crystalline polyolefin. Exemplary polyolefins may include, for instance, polyethylene, polypropylene, blends and copolymers thereof. In one particular embodiment, a polyethylene is employed that is a copolymer of ethylene and an  $\alpha$ -olefin, such as a  $C_3$ - $C_{20}$   $\alpha$ -olefin or  $C_3$ - $C_{12}$   $\alpha$ -olefin. Suitable  $\alpha$ -olefins may be linear or branched (e.g., one or more  $C_1$ - $C_3$  alkyl branches, or an aryl group). Specific examples include 1-butene; 3-methyl-1-butene; 3,3-dimethyl-1-butene; 1-pentene; 1-pentene with one or more methyl, ethyl or propyl substituents; 1-hexene with one or more methyl, ethyl or propyl substituents; 1-heptene with one or more methyl, ethyl or propyl substituents; 1-octene with one or more methyl, ethyl or propyl substituents; 1-nonene with one or more methyl, ethyl or propyl substituents; ethyl, methyl or dimethyl-substituted 1-decene; 1-dodecene; and styrene. Particularly desired  $\alpha$ -olefin co-monomers are 1-butene, 1-hexene and 1-octene. The ethylene content of such copolymers may be from about 60 mole % to about 99 mole %, in some embodiments from about 80 mole % to about 98.5 mole %, and in some



embodiments, from about 87 mole % to about 97.5 mole %. The  $\alpha$ -olefin content may likewise range from about 1 mole % to about 40 mole %, in some embodiments from about 1.5 mole % to about 15 mole %, and in some embodiments, from about 2.5 mole % to about 13 mole %.

[0131] The density of the polyethylene may vary depending on the type of polymer employed, but generally ranges from 0.85 to 0.96 grams per cubic centimeter ( $\text{g/cm}^3$ ). Polyethylene “plastomers”, for instance, may have a density in the range of from 0.85 to 0.91  $\text{g/cm}^3$ . Likewise, “linear low density polyethylene” (“LLDPE”) may have a density in the range of from 0.91 to 0.940  $\text{g/cm}^3$ ; “low density polyethylene” (“LDPE”) may have a density in the range of from 0.910 to 0.940  $\text{g/cm}^3$ ; and “high density polyethylene” (“HDPE”) may have density in the range of from 0.940 to 0.960  $\text{g/cm}^3$ . Densities may be measured in accordance with ASTM 1505. Particularly suitable ethylene-based polymers for use in the present invention may be available under the designation EXACT™ from ExxonMobil Chemical Company of Houston, Tex. Other suitable polyethylene plastomers are available under the designation ENGAGE™ and AFFINITY™ from Dow Chemical Company of Midland, Mich. Still other suitable ethylene polymers are available from The Dow Chemical Company under the designations DOWLEX™ (LLDPE) and ATTANE™ (ULDPE). Other suitable ethylene polymers are described in U.S. Pat. No. 4,937,299 to Ewen et al.; U.S. Pat. No. 5,218,071 to Tsutsui et al.; U.S. Pat. No. 5,272,236 to Lai et al.; and U.S. Pat. No. 5,278,272 to Lai, et al., which are incorporated herein in their entirety by reference thereto for all purposes.

[0132] Of course, the spunbond layers 146A and 146C of the first material 200 are by no means limited to ethylene polymers. For instance, propylene polymers may also be suitable for use as a semi-crystalline polyolefin. Suitable propylene polymers may include, for instance, polypropylene homopolymers, as well as copolymers or terpolymers of propylene with an  $\alpha$ -olefin (e.g.,  $\text{C}_3$ - $\text{C}_{20}$ ) comonomer, such as ethylene, 1-butene, 2-butene, the various pentene isomers, 1-hexene, 1-octene, 1-nonene, 1-decene, 1-undecene, 1-dodecene, 4-methyl-1-pentene, 4-methyl-1-hexene, 5-methyl-1-hexene, vinylcyclohexene, styrene, etc. The comonomer content of the propylene polymer may be about 35 wt. % or less, in some embodiments from about 1 wt. % to about 20 wt. %, in some embodiments, from about 2 wt. % to about 15 wt. %, and in some embodiments from about 3 wt. % to about 10 wt. %. The density of the polypropylene (e.g., propylene/ $\alpha$ -olefin copolymer) may be 0.95 grams per cubic centimeter ( $\text{g/cm}^3$ ) or less, in some embodiments, from 0.85 to 0.92  $\text{g/cm}^3$ , and in some embodiments, from 0.85  $\text{g/cm}^3$  to 0.91  $\text{g/cm}^3$ . In one particular embodiment, the spunbond layers 146A and 146C can each include a copolymer of polypropylene and polyethylene. The polypropylene can have a refractive index ranging from about 1.44 to about 1.54, such as from about 1.46 to about 1.52, such as from about 1.48 to about 1.50, such as about 1.49, while the polyethylene can have a refractive index ranging from about 1.46 to about 1.56, such as from about 1.48 to about 1.54, such as from about 1.50 to about 1.52, such as about 1.51, to impart the material 200 with the desired light scattering and light absorbing properties.

[0133] Suitable propylene polymers are commercially available under the designations VISTAMAXX™ from ExxonMobil Chemical Co. of Houston, Tex.; FINA™ (e.g., 8573) from Atofina Chemicals of Feluy, Belgium; TAF-

MER™ available from Mitsui Petrochemical Industries; and VERSIFY™ available from Dow Chemical Co. of Midland, Mich. Other examples of suitable propylene polymers are described in U.S. Pat. No. 6,500,563 to Datta, et al.; U.S. Pat. No. 5,539,056 to Yang, et al.; and U.S. Pat. No. 5,596,052 to Resconi, et al., which are incorporated herein in their entirety by reference thereto for all purposes.

[0134] Any of a variety of known techniques may generally be employed to form the polyolefins. For instance, olefin polymers may be formed using a free radical or a coordination catalyst (e.g., Ziegler-Natta or metallocene). Metallocene-catalyzed polyolefins are described, for instance, in U.S. Pat. No. 5,571,619 to McAlpin et al.; U.S. Pat. No. 5,322,728 to Davis et al.; U.S. Pat. No. 5,472,775 to Obijeski et al.; U.S. Pat. No. 5,272,236 to Lai et al.; and U.S. Pat. No. 6,090,325 to Wheat, et al., which are incorporated herein in their entirety by reference thereto for all purposes.

[0135] The melt flow index (MI) of the polyolefins may generally vary, but is typically in the range of about 0.1 grams per 10 minutes to about 100 grams per 10 minutes, in some embodiments from about 0.5 grams per 10 minutes to about 30 grams per 10 minutes, and in some embodiments, about 1 to about 10 grams per 10 minutes, determined at 190° C. The melt flow index is the weight of the polymer (in grams) that may be forced through an extrusion rheometer orifice (0.0825-inch diameter) when subjected to a force of 2160 grams in 10 minutes at 190° C., and may be determined in accordance with ASTM Test Method D1238-E.

[0136] In addition to a polyolefin, the spunbond layers 146A and 146C can each include a slip additive to enhance the softness of the spunbond layers 146A and 146C. The slip additive can also reduce the glare of the first material 200 in the operating room by reducing the light reflectance of the first material and can also render the first material 200 more opaque than the standard gown material when contacted with fats and lipids during surgery, where the standard gown material turns transparent upon contact with fats and lipids, which can result in the wearer having some concern that the barrier properties of a standard gown have been compromised.

[0137] Variants of fatty acids can be used as slip additives. For example, the slip additive can be erucamide, oleamide, stearamide, behenamide, oleyl palmitamide, stearyl erucamide, ethylene bis-oleamide, N,N'-Ethylene Bis(Stearamide) (EBS), or a combination thereof. Further, the slip additive have a refractive index ranging from about 1.42 to about 1.52, such as from about 1.44 to about 1.50, such as from about 1.46 to about 1.48, such as about 1.47, to impart the material 200 with the desired light scattering and light absorbing properties by reducing the refractive index. The slip additive can be present in each of the first spunbond layer 146A and the second spunbond layer 146C in an amount ranging from about 0.25 wt. % to about 6 wt. %, such as from about 0.5 wt. % to about 5 wt. %, such as from about 1 wt. % to about 4 wt. % based on the total weight of the particular spunbond layer 146A or 146C. In one particular embodiment, the slip additive can be present in an amount of about 2 wt. % based on the total weight of the particular spunbond layer 146A or 146C.

[0138] In addition to the polyolefin and slip additive, the spunbond layers 146A and 146C can also include one or more pigments to help achieve the desired gray color of the gown 101. Examples of suitable pigments include, but are

not limited to, titanium dioxide (e.g., SCC 11692 concentrated titanium dioxide), zeolites, kaolin, mica, carbon black, calcium oxide, magnesium oxide, aluminum hydroxide, and combinations thereof. In certain cases, for instance, each of the spunbond layers **146A** or **146C** can include titanium dioxide in an amount ranging from about 0.1 wt. % to about 10 wt. %, in some embodiments, from about 0.5 wt. % to about 7.5 wt. %, and in some embodiments, from about 1 wt. % to about 5 wt. % based on the total weight of the particular spunbond layer **146A** or spunbond layer **146C**. The titanium dioxide can have a refractive index ranging from about 2.2 to about 3.2, such as from about 2.4 to about 3, such as from about 2.6 to about 2.8, such as about 2.76, to impart the material **200** with the desired light scattering and light absorbing properties. Further, each of the spunbond layers **146A** or **146C** can also include carbon black in an amount ranging from about 0.1 wt. % to about 10 wt. %, in some embodiments, from about 0.5 wt. % to about 7.5 wt. %, and in some embodiments, from about 1 wt. % to about 5 wt. % based on the total weight of the particular spunbond layer **146A** or spunbond layer **146C**. The carbon black can have a refractive index ranging from about 1.2 to about 2.4, such as from about 1.4 to about 2.2, such as from about 1.6 to about 2 to impart the material **200** with the desired light scattering and light absorbing properties. In addition, each of the spunbond layers **146A** or **146C** can also include a blue pigment in an amount ranging from about 0.1 wt. % to about 10 wt. %, in some embodiments, from about 0.5 wt. % to about 7.5 wt. %, and in some embodiments, from about 1 wt. % to about 5 wt. % based on the total weight of the individual layer. The combination of the carbon black and blue pigment improves the ability of the spunbond layers **146A** or **146C** to absorb light.

[0139] The meltblown layer **146B** of the spunbond-meltblown-spunbond second material **300** can also be formed from any of the semi-crystalline polyolefins discussed above with respect to the first spunbond layer **146A** and the second spunbond layer **146C** of the first material **200**. In one particular embodiment, the meltblown layer **146B** can be formed from 100% polypropylene.

[0140] Regardless of the specific polymer or polymers and additives used to form the SMS laminate **146**, the SMS laminate **146** can have a basis weight ranging from about 5 gsm to about 50 gsm, such as from about 10 gsm to about 40 gsm, such as from about 15 gsm to about 30 gsm. In one particular embodiment, the SMS laminate **146** can have a basis weight of about 22 gsm (about 0.65 osy).

[0141] Despite the use of a front panel **102**, sleeves **104**, and hood **178** (e.g., all of the hood **178** or at least the first portion **256** of the hood **178** as described above) that are formed from an air impermeable but moisture-vapor breathable first material **200**, the amount of heat that becomes trapped can be uncomfortable to the wearer. As such, the present inventor has discovered that the placement of a highly breathable and air permeable first rear panel **120** and second rear panel **120** formed from a second material **300** in the rear **160** of the gown **101** can facilitate the dissipation of trapped humidity and heat between the gown **101** and the wearer. Further, in some embodiments, a second portion **258** of the hood **178** below seam **254** at the rear **160** of the gown **101** can optionally be formed from the second material **300**.

[0142] In one particular embodiment, the second material **300** can be in the form of a spunbond-meltblown-spunbond (SMS) laminate that has enhanced air breathability in order

to facilitate removal of trapped heated air and moisture from the gown **101**. For instance, the second material **300** allows for an air volumetric flow rate ranging from about 20 standard cubic feet per minute (scfm) to about 80 scfm, such as from about 30 scfm to about 70 scfm, such as from about 40 scfm to about 60 scfm, as determined at 1 atm (14.7 psi) and 20° C. (68° F.). In one particular embodiment, the second material **300** allows for an air volumetric flow rate of about 45 scfm. Because the first rear panel **120**, the second rear panel **122**, and lower or second portion **256** of the hood **178** below seam **254** at the rear **160** of the gown **101** can be formed from the air breathable second material **300**, the heat and humidity that can build up inside the space between the gown **101** and the wearer's body can escape via convection and/or by movement of air as the movement of the gown materials **200** and **300** changes the volume of space between the gown **101** and the wearer's body. Further, the SMS laminate used to form the second material **300** can have a basis weight ranging from about 20 gsm to about 80 gsm, such as from about 25 gsm to about 70 gsm, such as from about 30 gsm to about 60 gsm. In one particular embodiment, the second material **300** can have a basis weight of about 40 gsm (about 1.2 osy).

[0143] The various layers of the second material **300** are discussed in more detail below.

[0144] The first spunbond layer **148** and second spunbond layer **152** of the second material **300** can be formed from any suitable polymer that provides softness and air breathability to the second material **300**. For instance, the first spunbond layer **148** and the second spunbond layer **152** can be formed from a semi-crystalline polyolefin. Exemplary polyolefins may include, for instance, polyethylene, polypropylene, blends and copolymers thereof. In one particular embodiment, a polyethylene is employed that is a copolymer of ethylene and an  $\alpha$ -olefin, such as a C<sub>3</sub>-C<sub>20</sub>  $\alpha$ -olefin or C<sub>3</sub>-C<sub>12</sub>  $\alpha$ -olefin. Suitable  $\alpha$ -olefins may be linear or branched (e.g., one or more C<sub>1</sub>-C<sub>3</sub> alkyl branches, or an aryl group). Specific examples include 1-butene; 3-methyl-1-butene; 3,3-dimethyl-1-butene; 1-pentene; 1-pentene with one or more methyl, ethyl or propyl substituents; 1-hexene with one or more methyl, ethyl or propyl substituents; 1-heptene with one or more methyl, ethyl or propyl substituents; 1-octene with one or more methyl, ethyl or propyl substituents; 1-nonene with one or more methyl, ethyl or propyl substituents; ethyl, methyl or dimethyl-substituted 1-decene; 1-dodecene; and styrene. Particularly desired  $\alpha$ -olefin co-monomers are 1-butene, 1-hexene and 1-octene. The ethylene content of such copolymers may be from about 60 mole % to about 99 mole %, in some embodiments from about 80 mole % to about 98.5 mole %, and in some embodiments, from about 87 mole % to about 97.5 mole %. The  $\alpha$ -olefin content may likewise range from about 1 mole % to about 40 mole %, in some embodiments from about 1.5 mole % to about 15 mole %, and in some embodiments, from about 2.5 mole % to about 13 mole %.

[0145] The density of the polyethylene may vary depending on the type of polymer employed, but generally ranges from 0.85 to 0.96 grams per cubic centimeter ("g/cm<sup>3</sup>"). Polyethylene "plastomers", for instance, may have a density in the range of from 0.85 to 0.91 g/cm<sup>3</sup>. Likewise, "linear low density polyethylene" ("LLDPE") may have a density in the range of from 0.91 to 0.940 g/cm<sup>3</sup>; "low density polyethylene" ("LDPE") may have a density in the range of from 0.910 to 0.940 g/cm<sup>3</sup>; and "high density polyethylene"

("HDPE") may have density in the range of from 0.940 to 0.960 g/cm<sup>3</sup>. Densities may be measured in accordance with ASTM 1505. Particularly suitable ethylene-based polymers for use in the present invention may be available under the designation EXACT™ from ExxonMobil Chemical Company of Houston, Tex. Other suitable polyethylene plastomers are available under the designation ENGAGE™ and AFFINITY™ from Dow Chemical Company of Midland, Mich. Still other suitable ethylene polymers are available from The Dow Chemical Company under the designations DOWLEX™ (LLDPE) and ATTANE™ (ULDPE). Other suitable ethylene polymers are described in U.S. Pat. No. 4,937,299 to Ewen et al.; U.S. Pat. No. 5,218,071 to Tsutsui et al.; U.S. Pat. No. 5,272,236 to Lai, et al.; and U.S. Pat. No. 5,278,272 to Lai, et al., which are incorporated herein in their entirety by reference thereto for all purposes.

[0146] Of course, the first spunbond layer **148** and the second spunbond layer **152** of the second material **300** are by no means limited to ethylene polymers. For instance, propylene polymers may also be suitable for use as a semi-crystalline polyolefin. Suitable propylene polymers may include, for instance, polypropylene homopolymers, as well as copolymers or terpolymers of propylene with an  $\alpha$ -olefin (e.g., C<sub>3</sub>-C<sub>20</sub>) comonomer, such as ethylene, 1-butene, 2-butene, the various pentene isomers, 1-hexene, 1-octene, 1-nonene, 1-decene, 1-undecene, 1-dodecene, 4-methyl-1-pentene, 4-methyl-1-hexene, 5-methyl-1-hexene, vinylcyclohexene, styrene, etc. The comonomer content of the propylene polymer may be about 35 wt. % or less, in some embodiments from about 1 wt. % to about 20 wt. %, in some embodiments, from about 2 wt. % to about 15 wt. %, and in some embodiments from about 3 wt. % to about 10 wt. %. The density of the polypropylene (e.g., propylene/ $\alpha$ -olefin copolymer) may be 0.95 grams per cubic centimeter (g/cm<sup>3</sup>) or less, in some embodiments, from 0.85 to 0.92 g/cm<sup>3</sup>, and in some embodiments, from 0.85 g/cm<sup>3</sup> to 0.91 g/cm<sup>3</sup>. In one particular embodiment, the spunbond layers **148** and **152** can each include a copolymer of polypropylene and polyethylene. The polypropylene can have a refractive index ranging from about 1.44 to about 1.54, such as from about 1.46 to about 1.52, such as from about 1.48 to about 1.50, such as about 1.49, while the polyethylene can have a refractive index ranging from about 1.46 to about 1.56, such as from about 1.48 to about 1.54, such as from about 1.50 to about 1.52, such as about 1.51, to impart the material **300** with the desired light scattering and light absorbing properties.

[0147] Suitable propylene polymers are commercially available under the designations VISTAMAXX™ from ExxonMobil Chemical Co. of Houston, Tex.; FINA™ (e.g., 8573) from Atofina Chemicals of Feluy, Belgium; TAFMER™ available from Mitsui Petrochemical Industries; and VERSIFY™ available from Dow Chemical Co. of Midland, Mich. Other examples of suitable propylene polymers are described in U.S. Pat. No. 6,500,563 to Datta, et al.; U.S. Pat. No. 5,539,056 to Yang, et al.; and U.S. Pat. No. 5,596,052 to Resconi, et al., which are incorporated herein in their entirety by reference thereto for all purposes.

[0148] Any of a variety of known techniques may generally be employed to form the polyolefins. For instance, olefin polymers may be formed using a free radical or a coordination catalyst (e.g., Ziegler-Natta or metallocene). Metallocene-catalyzed polyolefins are described, for instance, in U.S. Pat. No. 5,571,619 to McAlpin et al.; U.S.

Pat. No. 5,322,728 to Davis et al.; U.S. Pat. No. 5,472,775 to Obiieski et al.; U.S. Pat. No. 5,272,236 to Lai et al.; and U.S. Pat. No. 6,090,325 to Wheat, et al., which are incorporated herein in their entirety by reference thereto for all purposes.

[0149] The melt flow index (MI) of the polyolefins may generally vary, but is typically in the range of about 0.1 grams per 10 minutes to about 100 grams per 10 minutes, in some embodiments from about 0.5 grams per 10 minutes to about 30 grams per 10 minutes, and in some embodiments, about 1 to about 10 grams per 10 minutes, determined at 190° C. The melt flow index is the weight of the polymer (in grams) that may be forced through an extrusion rheometer orifice (0.0825-inch diameter) when subjected to a force of 2160 grams in 10 minutes at 190° C., and may be determined in accordance with ASTM Test Method D1238-E.

[0150] In addition to a polyolefin, the first spunbond layer **148** and the second spunbond layer **152** can also include a slip additive to enhance the softness of the first spunbond layer **148** and the second spunbond layer **152**. The slip additive can also reduce the coefficient of friction and increase the hydrohead of the first spunbond layer **148** and the second spunbond layer **152** of the first rear panel **120** and second rear panel **122**. Such a reduction in the coefficient of friction lessens the chance of the gown **101** being cut or damaged due to abrasions and also prevents fluids from seeping through the second material **300**. Instead, at least in part due to the inclusion of the slip additive, fluid that contacts the outer-facing surface **302** of the gown **101** can remain in droplet form and run vertically to the distal end **156** of the gown **101** and onto the floor. The slip additive can also reduce the glare of the second material **300** in the operating room by reducing the light reflectance of the first material and can also render the second material **300** more opaque than the standard gown material when contacted with fats and lipids during surgery, where the standard gown material turns transparent upon contact with fats and lipids, which can result in the wearer having some concern that the barrier properties of a standard gown have been compromised.

[0151] The slip additive can function by migrating to the surface of the polymer used to form the first spunbond layer **148** and/or the second spunbond layer **152**, where it can provide a coating that reduces the coefficient of friction of the outer-facing surface **302** and/or body-facing surface or inner-facing surface **304** of the first material **300**. Variants of fatty acids can be used as slip additives. For example, the slip additive can be erucamide, oleamide, stearamide, behenamide, oleyl palmitamide, stearyl erucamide, ethylene bis-oleamide, N,N'-Ethylene Bis(Stearamide) (EBS), or a combination thereof. Further, the slip additive can have a refractive index ranging from about 1.42 to about 1.52, such as from about 1.44 to about 1.50, such as from about 1.46 to about 1.48, such as about 1.47, to impart the material **200** with the desired light scattering and light absorbing properties. The slip additive can be present in the first spunbond layer **148** and/or the second spunbond layer **152** of the second material **300** in an amount ranging from about 0.25 wt. % to about 6 wt. %, such as from about 0.5 wt. % to about 5 wt. %, such as from about 1 wt. % to about 4 wt. % based on the total weight of the first spunbond layer **148** and/or the second spunbond layer **152**. In one particular embodiment, the slip additive can be present in an amount

of about 2 wt. % based on the total weight of the first spunbond layer **148** and/or the second spunbond layer **152**.

**[0152]** In addition to the polyolefin and slip additive, the spunbond layers **148** and **152** can also include one or more pigments to help achieve the desired gray color of the gown **101**. Examples of suitable pigments include, but are not limited to, titanium dioxide (e.g., SCC 11692 concentrated titanium dioxide), zeolites, kaolin, mica, carbon black, calcium oxide, magnesium oxide, aluminum hydroxide, and combinations thereof. In certain cases, for instance, each of the spunbond layers **148** or **152** can include titanium dioxide in an amount ranging from about 0.1 wt. % to about 10 wt. %, in some embodiments, from about 0.5 wt. % to about 7.5 wt. %, and in some embodiments, from about 1 wt. % to about 5 wt. % based on the total weight of the particular spunbond layer **148** or **152**. The titanium dioxide can have a refractive index ranging from about 2.2 to about 3.2, such as from about 2.4 to about 3, such as from about 2.6 to about 2.8, such as about 2.76, to impart the material **200** with the desired light scattering and light absorbing properties. Further, each of the spunbond layers **148** or **152** can also include carbon black in an amount ranging from about 0.1 wt. % to about 10 wt. %, in some embodiments, from about 0.5 wt. % to about 7.5 wt. %, and in some embodiments, from about 1 wt. % to about 5 wt. % based on the total weight of the particular spunbond layer **148** or spunbond layer **152**. The carbon black can have a refractive index ranging from about 1.2 to about 2.4, such as from about 1.4 to about 2.2, such as from about 1.6 to about 2 to impart the material **300** with the desired light scattering and light absorbing properties. In addition, each of the spunbond layers **148** or **152** can also include a blue pigment in an amount ranging from about 0.1 wt. % to about 10 wt. %, in some embodiments, from about 0.5 wt. % to about 7.5 wt. %, and in some embodiments, from about 1 wt. % to about 5 wt. % based on the total weight of the individual layer. The combination of the carbon black and blue pigment improves the ability of the spunbond layers **148** or **152** to absorb light.

**[0153]** The meltblown layer **150** of the spunbond-meltblown-spunbond second material **300** can also be formed from any of the semi-crystalline polyolefins discussed above with respect to the first spunbond layer **148** and the second spunbond layer **152** of the second material **300**. In one particular embodiment, the meltblown layer **150** can be formed from 100% polypropylene.

**[0154]** The cuffs **106** and collar **110** (if present) of the disposable surgical gown **101** of the present invention can be formed from a woven or knit material that is air breathable, soft, and extensible. The collar **110** can also be water repellant. In one particular embodiment, the collar **110** and the cuffs **104** can be formed from a knit polyester. Because the material from which the collar **110** is formed is extensible, the collar **110** can stretch and conform to a wearer's particular neck dimensions to lay flat against the wearer's neck and prevent any gapping of the collar **110**, which could allow bone fragments, blood splatter, and other biologic materials to come into contact with the wearer. In any event, the collar **110** can be sewn to the front panel **102**, sleeves **104**, first rear panel **120**, and second rear panel **122** with a polyester thread. Further, the cuffs **106** can be formed from the same material as the collar **110**, as discussed above. In addition, the cuffs **106** can be sewn to the sleeves **104** with a polyester thread.

**[0155]** In addition to the surgical gown **101** discussed above, it is also to be understood that the personal protection and ventilation system **100** with which the visor system **180** of the present invention can be used can also include a helmet **190** with an optional light source **188**, an air tube **184**, and a belt **206** with an attached fan **182** and power source (e.g., battery **216**) as described in detail above with reference to FIG. 9.

**[0156]** The present invention has been described both in general and in detail by way of examples. These and other modifications and variations of the present invention may be practiced by those of ordinary skill in the art, without departing from the spirit and scope of the present invention. In addition, it should be understood that aspects of the various embodiments may be interchanged both in whole or in part. Furthermore, those of ordinary skill in the art will appreciate that the foregoing description is by way of example only, and is not intended to limit the invention so further described in such appended claims.

What is claimed is:

1. A visor system for a personal protection system, the visor system comprising:

a base film; and

a first removable film mechanically bonded to an outer-facing surface of the base film via a first plurality of mechanical bond points, wherein gaps are present between adjacent mechanical bond points.

2. The visor system of claim 1, wherein the first removable film includes a tab, wherein the tab facilitates removal of the first removable film from the base film.

3. The visor system of claim 1, wherein the base film and the first removable film are transparent.

4. The visor system of claim 1, wherein the base film comprises a polyester or a polycarbonate.

5. The visor system of claim 1, wherein the first removable film comprises a polyester or a polycarbonate.

6. The visor system of claim 1, wherein the first plurality of mechanical bond points are ultrasonic bond points.

7. The visor system of claim 1, wherein the gaps permit penetration of ethylene oxide gas between the base film and the first removable film.

8. The visor system of claim 1, wherein the base film defines a perimeter and the first removable film defines a perimeter, wherein the perimeter of the first removable film is contained completely within the perimeter of the base film.

9. The visor system of claim 8, wherein the first plurality of mechanical bond points are located about the perimeter of the first removable film.

10. The visor system of claim 1, further comprising a second removable film, wherein the second removable film is mechanically bonded to the first removable film via a second plurality of mechanical bond points, wherein gaps are present between adjacent mechanical bond points.

11. The visor system of claim 10, wherein the second removable film includes a tab, wherein the tab facilitates removal of the second removable film from the first removable film.

12. The visor system of claim 10, wherein the second removable film is transparent.

13. The visor system of claim 10, wherein the second removable film comprises a polyester or a polycarbonate.

14. The visor system of claim 10, wherein the second plurality of mechanical bond points are ultrasonic bond points.

15. The visor system of claim 10, wherein the gaps permit penetration of ethylene oxide gas between the first removable film and the second removable film.

16. The visor system of claim 10, wherein the base film defines a perimeter and the second removable film defines a perimeter, wherein the perimeter of the second removable film is contained completely within the perimeter of the base film.

17. The visor system of claim 16, wherein the second plurality of mechanical bond points are located about the perimeter of the second removable film.

18. The visor system of claim 1, wherein the visor system is ethylene oxide gas sterilized.

19. A surgical hood comprising the visor system of claim 1, wherein the surgical hood and the visor system are ethylene oxide gas sterilized.

20. A surgical gown comprising an integrated surgical hood and the visor system of claim 1, wherein the surgical gown, the integrated surgical hood, and the visor system are ethylene oxide gas sterilized.

21. A personal protection system including a surgical gown and a separate surgical hood comprising the visor system of claim 1, wherein the personal protection system is ethylene gas sterilized in a single package.

\* \* \* \* \*