A protective mask system and a method of manufacturing a foam/fabric mask face shield having a three-dimensional geometry. The mask system has a lens frame and a compression-molded composite sheet, which is formed by multiple layers. The method includes the steps of forming a composite sheet from two or more layers, heating the composite sheet, and compression molding the composite sheet into the three-dimensional geometry of the face shield. The composite sheet can be formed by the lamination of two or more layers. The layers can be bonded together by a bonding agent, can be heat bonded, or can be laminated together by other means.
FORMING COMPOSITE SHEET

HEATING COMPOSITE SHEET

COMPRESSION MOLDING TO FORM FACE SHIELD

FIG. 1

FIG. 2
MATERIALS SELECTION

LAMINATION

PRE-CUT COMPOSITE SHEET

PRE-FORMING COMPOSITE SHEET

HEAT COMPOSITE SHEET UNTIL MALLEABLE

COMPRESSION MOLDING

REMOVE FACE SHIELD FROM MOLD

ASSEMBLE FACE SHIELD TO ADJACENT COMPONENTS

ASSEMBLE REMAINING COMPONENTS

PRE-CUT INDIVIDUAL LAYERS

SECONDARY FINISHING PROCESS

FIG. 3
FIG. 4
PROTECTIVE MASK SYSTEM AND METHOD OF MANUFACTURE

RELATED APPLICATION


FIELD OF THE INVENTION

[0002] The present invention relates to a protective head gear and more particularly, to a protective mask system incorporated with structural fabric to the head gear, adapted to provide protection and comfort for people engaging in physical activities, such as paintball battle games.

ART BACKGROUND

[0003] A wide variety of protective head gears such as masks are available for use in activities where physical danger to the head of the user is inherent. An example of such an activity is the game of paintball where players try to hit their opponents by projecting paintballs in a battle-like environment. Despite the recreational nature of the games, paintballs are projected at high enough speed to injure the players, if they are hit at the head or eyes. In order to protect the player's head, components are designed to protect various parts of the head such as the eyes, nose, forehead, cheeks and ears. These components are assembled to form a mask.

[0004] A conventional mask typically has a lens, a lens frame (or goggle), and a face shield. The face shield can also be divided into a section for the mouth and cheek areas, and two sections covering the left and right ears. The lens sits on or inside of the goggle, and the assembly is then attached to the face shield to form the mask. An elastic strap assembly, comprising of attachment features, is then attached to the mask. A user will then wear the mask over the head, with the elastic strap providing tension on the back of the head, thus securing the mask on the head.

[0005] The lens, goggle and the face-shield are traditionally made from plastic by the injection molding process. The assembled lens and goggle is then attached to the face shield with tabs and mating tab retention holes. Some manufacturers, in order to simplify the production and assembly processes, have proposed the fabrication of a one-piece lens frame and face shield. The lens will then attach to the lens frame/face shield piece to form the mask. Also, in order to create a more unique look and feel to the mask, certain areas are secondarily injected in the mold with a different plastic material and/or color.

[0006] Whether the lens frame and face shield are assembled separately or made in one complete piece, injection molded plastic remains the primary material used in the fabrication of the face-shield area. The use of such plastic over a large volume makes the mask heavy and rigid, which causes discomfort to the user over a period of time during their activities.

[0007] Some manufacturers have incorporated the use of stamped sheet foam material or synthetic rubber such as neoprene in their masks. An example is the Proflex series by JT USA. Even though such material is light and can be cheaply made without the need for injection molded plastics, they are less structural than plastics and so are limited to use in the rear areas of the face shield, which comes in contact with the head and ears and are thus supported without the need for them to be as structural as other parts of the face shield.

[0008] Also, it is apparent that the colors of paintball masks colors are determined by the color of the plastic resins being injection molded, or the color of the foam material. Secondary printing processes are required in order to incorporate multiple colors or print patterns (such as a camouflage pattern) onto the mask, which adds considerable cost to manufacturing.

[0009] Another disadvantage of a conventional mask is that plastic do not absorb perspiration from the face. Over time, perspiration sticking onto plastic inner surfaces of the face shield adds further discomfort to the player.

[0010] Further, it is apparent to one ordinarily skilled in the art of mold-making that fabrication of a plastic injection mold for the mask is challenging, due to the size and complexity of a typical mask design. There are several features in a typical mask that cannot be reached or created with a simple “core-and-cavity” type of mold. These features are commonly referred to as “undercuts,” which require multiple “sliders” in the mold to access. Moreover, masks often have integrated air-vents for ventilation. It is also apparent to people skilled in the art of mold-making that the plurality of air-vents creates further difficulty in making sure all parts of the mold, i.e., core, cavity and sliders, close to form a tight fit without plastic over-flowing into the vents.

SUMMARY OF THE INVENTION

[0011] The invention is directed to a novel protective head gear system with the use of alternative materials for masks, specifically foam and/or fabric, and methods of assembling the masks.

[0012] Foam and fabric is significantly lighter than injection-molded plastics of a similar volume. Although a piece of foam or fabric by itself is not inherently or naturally structural, a three-dimensional geometry can be formed by compressing and heating a composite sheet from two or more layers.

[0013] Alternatively, multiple pieces of foam/fabric material can be stitched together so that the resulting form is able to hold a three-dimensional geometry. The shape of each of the sub-pieces is calculated so that when the adjacent edges of each piece is sewn together, the end result is a form that mimics the shape of the face shield (just like the construction of shoes).

[0014] It will also be apparent to one ordinarily skilled in the art that molds for compression forming are simpler to fabricate than molds for injection molding. This will help lower overall tooling costs in production of the masks.

[0015] Various patterns and colors can be incorporated onto the mask simply with the choice of patterned fabric used for the composite sheet, without the need for a secondary printing process to create a similar color effect. For example, a camouflage printed fabric material can be used for the outward facing top layer of the composite sheet to create a camouflage-patterned mask.
In accordance with one aspect, the present invention provides a method of manufacturing a foam/fabric mask face shield having a three-dimensional geometry. The method includes the steps of forming a composite sheet from two or more layers, heating the composite sheet, and compression molding the composite sheet into the three-dimensional geometry of the face shield. The composite sheet can be formed by the lamination of two or more layers. The layers can be bonded together by a bonding agent, can be heat bonded, or can be laminated together by other means.

It is preferable that one or more of the layers forming the composite sheet includes a thermo-formable material. In one preferred embodiment, the composite sheet comprises a first layer of thermoplastic foam and a second layer of thermoplastic urethane (TPU), preferably in the form of a TPU film. The thermoplastic foam can be, for example, ethylene vinyl acetate (EVA) foam. A third layer of fabric can be interposed between the first and second layers. Suitable fabrics can include a mesh fabric formed from nylon, polyester, poly-cotton, cotton, acetate, or acrylic.

The composite sheet can also comprise a first layer of cloth material, a second layer of thermoplastic foam, and a third layer of cloth material. The cloth material can be formed from felt, wool, fur, hair, polyester, nylon, cotton, acetate, or acrylic. In one embodiment, the composite sheet can be formed by needle punching the first, second, and third layers to thread the fibers forming the cloth material of the first and third layer through the second layer, thereby coupling the three layers together.

In accordance with a further aspect of the present invention, the step of compression molding has the steps of positioning the composite sheet in a first mold member having a mold cavity and compressing the composite sheet in the mold cavity with a second mold member. The composite sheet can be heated prior to positioning the composite sheet into the first mold member, or after the composite sheet is positioned in the first mold member, for example when the composite sheet is positioned in the mold cavity of the first mold member. The composite sheet can be compression molded into separate sections which are assembled after molding to form the face shield. Alternatively, the composite sheet can be compression molded into a seamless, unitary face shield that requires minimal assembly for completion.

A method of manufacturing a mask in accordance with the present invention has the steps of constructing a face shield by forming a substantially planar composite sheet from two or more layers, heating the composite sheet, and compression molding the composite sheet into the three-dimensional geometry of the face shield.

In accordance with another aspect of the invention, the mask can be assembled by stitching the compression molded face shield to the lens frame or other components of the mask by aligning the profile of the face shield to the adjacent similar profile on of the mask components.

In one preferred embodiment, the face shield can be attached to the lens frame by using fasteners. Screw bosses can be molded into the plastic parts for engaging the screws. In another preferred embodiment, tabs and mounting tab retention holes can be used such that the various parts can be detached from one another for replacement or cleaning purposes.

It is also apparent that the use of structural fabric/foam described above can be used to create additional accessorius parts to the mask, such as a head cover. Examples of a conventional mask comprising of a head cover is the Headshield by JT USA, where an extra injection molded piece is attached to the mask to provide protection against paintball projectiles shot from above the head. Using the method of structural fabric/foam by compression molding and/or stitching pieces of foam/fabric/composite compression molded fabric, a structural head gear can be achieved without the need for the costly plastic injection molding.

BRIEF DESCRIPTION OF THE DRAWINGS

Additional advantages and objects of the present invention will now be described, by way of example only, with reference to the attached Figures, wherein:

FIG. 1 is an exemplary flow chart illustrating a method of manufacturing a mask face shield according to the teachings of the present invention;

FIG. 2 illustrates a multi-layer composite sheet used to construct a mask shield according to the teachings of the present invention;

FIG. 3 is an exemplary flow chart illustrating a method of manufacturing masks according to the teachings of the present invention;

FIG. 4 illustrates a front ¼ view of the complete mask of the present invention;

FIG. 5a illustrates two half portions of the face shield of FIG. 4;

FIG. 5b illustrates an exploded view of the assembled face shield of FIG. 5a and the lens frame;

FIG. 6a illustrates an exploded view of an alternative embodiment of a mask assembly;

FIG. 6b illustrates the assembled mask with parts illustrated in FIG. 6a;

FIG. 7a illustrates an exploded view of another alternative embodiment of a mask assembly;

FIG. 7b illustrates the assembled mask with parts illustrated in FIG. 7a;

FIG. 8 illustrates an assembly method whereby the mask parts can be detached from one another.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The present invention provides methods for manufacturing mask face shields and, in general, masks in which a multi-layer composite sheet is heat activated to become malleable and then placed in a mold. The mold is used to compress the composite sheet into a desired three-dimensional geometry to form the composite face shield. The resultant composite face shield can be joined to a lens frame, or goggle, as well as other mask components, to complete the construction of the mask. The manufacturing methods of the present invention simplify mask construction, reduce manufacturing costs, and provide flexibility for the construction of the face shield, and thus mask. The use of certain colored or patterned fabric allows the mask to have a wide
A variety of advantageous colors and patterns without secondary printing processes such as silk-screening as in the conventional process.

A second advantageous aspect of the invention involves the stitching of various pieces of foam, fabric or multi-layered composite sheet as described earlier, or a combination of the above to create a three-dimensional geometry to form the face shield. This face shield can be joined to the lens frame, as well as other mask components, to complete the construction of the mask.

A method of manufacturing a mask face shield in accordance with the first advantageous aspect of the present invention is generally illustrated in the flowchart of FIG. 1. A substantially planar composite sheet is formed from two or more layers of material, step 102. The substantially planar sheet is heat activated to become malleable, step 104. Once heated, the substantially planar composite sheet is compression molded into the desired three-dimensional geometry face shield, step 106.

FIG. 2 illustrates an exemplary substantially planar composite sheet 200. It is preferable for one of the layers forming the composite sheet 200 to include a thermoplastic material that becomes malleable (formable) when heated above a specific temperature. The thermoplastic material can be, for example, a thermoplastic material, although other thermo-formable materials may be used. Thermoplastic materials are desirable because, when heated above a characteristic activation temperature, thermoplastic materials become malleable and, upon cooling below the activation temperature, thermoplastic materials set and maintain the desired form and shape. Exemplary thermoplastic materials include, but are not limited to, thermoplastic urethanes and polyurethanes, ethylene vinyl acetate (EVA).

Compression forming process and methodology has been in use, for example in the unrelated and non-analogous footwear manufacturing process, as disclosed by US Patent Publication No. 20020012784.

Continuing to refer to FIG. 2, the exemplary composite sheet 200 comprises a first layer 202 of thermoplastic foam, such as EVA foam, and a second layer 204 of thermoplastic urethane (TPU). Other thermoplastic foams include, but are not limited to, polyethylene foam and polypropylene foam. In a preferred embodiment, a third layer 206 of fabric can be interposed between the first layer 202 and the second layer 204. The fabric is preferably a mesh material formed from fabrics such as nylon, polyester, poly-cotton, cotton, acetate, or acrylic. The second layer 204 of TPU and the underlying third layer 206 of mesh fabric are selected to provide the face shield, as well as the resultant mask, with a moisture and wear resistant outer layer. The first layer 202 of thermoplastic foam is selected to provide the composite sheet, as well as the resultant face shield, with an insulative inner layer. The amount of insulation can depend on the thickness and density of the thermoplastic foam selected. Thus, the combination of layers forming the composite sheet 200 provide the composite sheet, as well as the face shield formed therefrom, with a variety of properties.

One skilled in the art will appreciate that the composite sheet 200 is not limited to three layers as illustrated in FIG. 2 and described above. Any number of layers can be used, depending on the desired properties of the face shield being constructed. For example, the thickness, hardness, density, or color, etc. of the composite sheet 200 can be varied by changing, adding, removing, or moving layers of the composite sheet 200. Likewise, the degree of water resistance, thermal protection, ventilation and abrasion and wear resistance can be varied.

For example, in an alternate embodiment, the composite sheet 200 can include an additional layer of a thermoset material, such as a thermoset urethane, over the second layer 204 of TPU. The additional layer of thermoset material can provide increased abrasion resistance and increased flexibility to the composite sheet and the molded composite face shield.

Although it is preferable that the composite sheet be die-cut and rough formed prior to molding, it should be understood that the die-cutting step and the rough forming step are optional steps. In other words, once the composite sheet is formed, the composite sheet can be immediately heated and compressed, without proceeding with either or both of these steps.

Prior to, or during, the step of compression molding the composite sheet, the composite sheet is preferably heated so that composite sheet becomes malleable or formable, step 312. Heating of the composite sheet can occur within the compression mold by, for example, heating the mold core and/or cavity. Alternatively, the composite sheet can be heated prior to placement within the mold cavity by other heating means. In the case of a composite sheet formed using thermoplastic materials, the composite sheet is heated to or above the heat activation temperature of the thermoplastic material.

Referring to FIG. 3, the heated composite sheet is compression molded within the mold, step 314. Compression molding can occur by pressing or forcing the mold core into contact with the composite sheet within the mold cavity. Alternative compression molding techniques can also be used. For example, a vacuum source can be coupled to the mold cavity to apply a vacuum force to the under side of the composite sheet. Likewise, positive fluid pressure can be used independently or in cooperation with the compression provided by projection to compress the composite sheet. As can be appreciated by those skilled in the art, various compression methods are available for compression molding in a general sense.

After compression molding, the molded composite sheet is cooled to allow the materials forming the composite sheet to set in the molded shape. After cooling, the composite sheet is removed from the mold cavity, step 316. Any excess material can be trimmed from the molded face shield and ventilation holes can be punched-out, cut away, or otherwise removed from the face shield, step 318. Eyellet holes or holes for securing by screws and/or tabs can be added to the composite face shield if desired.

Continuing to refer to the FIG. 3, the completed composite face shield can now be assembled with other adjacent mask components, step 320, such as the lens frame. This assembly can involve stitching the composite face shield to matching seam lines of the lens frame, or other assembly methods such as the use of screws as described in
FIG. 8. One skilled in the art will appreciate that additional or fewer steps, or other alternative assembly methods may be necessary depending on the mask being manufactured. After assembling the face shield to the lens frame, the lens and lens strap can now be assembled to complete the mask, step 322.

[0049] A typical assembled mask 400 is illustrated in FIG. 4. The mask 400 has a lens frame 401, a lens 402 that is attached to the lens frame 401, a face shield 404 and an elastic strap assembly 406. The elastic strap assembly 406 has common strap fastening features which those skilled in the art will be familiar with. The face shield 404 will typically have a plurality of front air vents 410 and a plurality of side air vents 408 on both left and right sides of the mask to provide improved ventilation and air circulation.

[0050] Reference is now turned to FIGS. 5a and 5b. The face shield 404 is a combination of two symmetrical left half 500 and right half 502 compression molded pieces as shown in FIG. 5a. These two halves are stitched together at the matching seams 504 and 506 to form the complete face shield 508 in FIG. 5b. The face shield 508 is then stitched to the lens frame 510 along the matching seams 512 and 514. Lens 402 and strap assembly 406 is then added to the assembled lens frame 510 and face shield 508 to form the complete mask assembly 400.

[0051] FIG. 6a illustrates another preferred embodiment of the assembly and method. The goggle 600 is a one-piece molded part comprising of the lens frame 604 and an extended nose/bridge area 606. The compression molded composite face shield comprising the left half 601 and right half 602 can be stitched directly to the goggle 600 without having to be stitched to each other first. The left half composite face shield 601 is stitched along the seam 608 to the goggle 600 along the matching seam 610. Similarly, the right half composite face shield 602 is stitched to the goggle 600 along the matching seam 614. FIG. 6b illustrates the complete mask assembly 616 after attaching the lens 318 and strap assembly 620.

[0052] FIG. 7a illustrates yet another preferred mask assembly and method. Unlike the previous embodiments described above, the mask assembly has a uni-body composite face shield 702. In order for the face shield 702 to be compression molded in one piece, features that may present “undercuts” in the compression mold are excluded in the compression molding process. Thus, the rear portion of the face shield 702 that provides support to the ears are separated into two portions, namely the left ear piece 704 and right ear piece 706. The ear pieces 704 and 706 can be injection-molded plastic pieces, or compression-molded similar in construction to the composite face shields described earlier. The left ear piece 704 is then stitched to the face shield along the seams 708 and 710. The right ear piece 706 is similarly stitched to the face shield along the seams 712 and 714. The face shield 702 is then stitched to the lens frame 716. FIG. 7b illustrates the complete assembled mask 722, after attaching the lens 718 and strap assembly 720.

[0053] FIG. 8 shows another method of assembling the mask 80 together other than stitching. The lens frame 800 has screw bosses 810 located on the inside. The bosses align themselves with holes 823 in the compression molded mask 820, which is sandwiched by a framing 840 that provides some structure when the screws 850 are screwed in. On the other hand, the screw 850 and boss 810 method can be replaced by tabs and tab retention holes (not shown). In this case, the screws 850 are replaced by tabs, and the bosses 810 on the lens frame are replaced by tab retention holes. In this manner, the mask can then be disassembled, which will otherwise be permanently assembled if stitching is used instead. Of course, as will become apparent to those skilled in the art, there are other methods of assembling the mask.

[0054] The mask system and methods of manufacturing a mask face shield in accordance with the present invention provide numerous advantages over conventional mask manufacturing methods. The present invention permits the construction of a light-weight composite face shield. This results in a reduction of manufacturing costs by minimizing tooling procedures significantly. The compression molding processes of the present invention permit the creation of more comfortable mask by allowing the face shield to be light-weight and moisture absorbent.

[0055] Surface variances can be molded into either side, i.e., inside or outside, of the composite face shield to enhance the aesthetic appearance and the functionality of the composite face shield. For example, the ventilation holes on the composite face shield can be replaced by perforated plastic pieces that are assembled to the face shield by stitching or other methods. The areas on the face shield covered by the perforated pieces can then be entirely cut out, using the perforation on the plastic piece as ventilation holes.

We claim:

1. A protective mask system with a 3-D geometry for users engaging in physical sporting activity, comprising:
   a lens frame, said lens frame having a rim; a mask formed by at least one composite sheet, said composite sheet comprising at least two layers of material heated and compression-molded into a predetermined 3-D shape, said mask forming a trimmed edge for attaching to the rim of said lens frame.

2. A mask system of claim 1, wherein said composite sheet has an outward facing top layer, and said outward facing top layer has a predetermined pattern for the outward facing top layer.

3. A protective mask system of claim 2, wherein said layers are bonded together by one of the following methods:
   by lamination; by bonding agent; by heat bonded.

4. A protective mask system of claim 3, wherein said layers comprise:
   a layer of thermoplastic foam; a layer of with thermoplastic urethane (TPU) film; a layer of fabric being inserted between the foam and TPU film.

5. A protective mask system of claim 4, wherein said layer of fabric is one of:
   a mesh material formed from one of nylon, polyester, poly-cotton, cotton, acetate, and acrylic.
6. A protective mask system of claim 4, wherein said thermo-formable foam is one of polyethylene foam and polypropylene foam.

7. A protective mask system of claim 3, wherein said mask comprises additional vents at predetermined locations thereon for receiving perforated plastic pieces for ventilation purposes.

8. A protective mask system of claim 3, wherein said layers comprise:

   a first layer of cloth material;
   a second layer of thermoplastic foam, and
   a third layer of cloth material, where the cloth material is one of the following: felt, wool, fur, hair, polyester, nylon, cotton, acetate, and acrylic.

9. A protective mask system of claim 7, wherein said mask is made of an integral body of the composite sheet, said protective mask further comprising:

   a left ear protection piece and a right ear protection piece, each being made of one of injection-molded plastic pieces and compression-molded fabric pieces, adapted to be stitched to the mask.

10. A protective mask system of claim 7, wherein said lens frame is fastened to said mask using one of stitching, screws/scrub bosses and tabs/mounting tab retention holes.

11. A method of making a protective mask system for users engaged in active physical sports, said mask system comprising a face shield and a lens frame, the face shield having a desired 3-D geometry, the method comprising:

   forming a substantially planar composite sheet from a plurality of layers;
   heating the composite sheet;
   compression molding the composite sheet into a desired 3-D geometry for the face shield;
   attaching the lens frame to the compression-molded composite sheet.

12. The method of claim 11, wherein the lens frame is fastened to the compression-molded composite sheet by at least one of stitching, screws/scrub bosses and tabs/mounting tab retention holes.

13. The method of claim 12, wherein said composite sheet of the plurality of layers is formed by one of the following:

   by lamination;
   by a bonding agent;
   by heat bonded.

14. The method of claim 13, wherein the composite sheet comprises:

   a first layer of thermo-formable material;
   a second layer of thermoplastic urethane, and
   a third layer of mesh fabric interposed between the first and second layers.

15. The method of claim 13, wherein the composite sheet comprises:

   at least two layers of cloth material;
   a layer of thermoplastic foam interposed in-between the layers of cloth material,
   wherein said layers are needled punched and threaded together.

16. The method of claim 14, wherein one of said first and second layers has predetermined pattern and color.

17. The method of claim 15, wherein one of said layers of cloth material has predetermined pattern and color.

18. The method of claim 16, wherein said composite sheet is compression molded by the following:

   positioning said composite sheet in a first mold member, said mold member having a cavity;
   compressing said composite sheet in the cavity with a second mold member;
   heating said composite sheet one of before positioning into said first mold member and after positioning to said first mold member.

19. A protective mask system with a 3-D geometry, comprising:

   a lens frame, said lens frame having a rim;
   a mask, said mask having a predetermined three-dimensional shape, said mask comprising a plurality of layers of material heated and compression-molded into said three-dimensional shape, at least one of said plurality of layers being a thermo-formable material.

20. A protective mask system of claim 19, wherein said lens frame is attached to said mask using one of stitching, screws/scrub bosses and tabs/mounting tab retention holes.

21. A protective mask system of claim 19, wherein said composite sheet has an outward facing top layer, and said outward facing top layer has a predetermined pattern for the outward facing top layer.

22. A protective mask system of claim 20, wherein said 3-D mask comprises additional openings at predetermined locations thereon for receiving perforated plastic pieces for ventilation purposes.

23. A protective mask system of claim 22, wherein said layers are bonded together by one of the following methods:

   by lamination;
   by a bonding agent;
   by heat bonded.

24. A protective mask system of claim 23, wherein said layers comprise:

   a layer of thermoplastic foam;
   a layer of with thermoplastic urethane (TPU) film;
   a layer of fabric being inserted between the foam and TPU film.

25. A protective mask system of claim 24, wherein said fabric is one of:

   a mesh material formed from one of nylon, polyester, poly-cotton, cotton, acetate, and acrylic.

26. A protective mask system of claim 24, wherein said thermo-formable foam is one of polyethylene foam and polypropylene foam.

27. A protective mask system of claim 26, wherein said mask comprises additional indentations at predetermined locations thereon for receiving perforated plastic pieces for ventilation purposes.
28. A protective mask system of claim 23, wherein said layers comprise:

- a first layer of cloth material;
- a second layer of thermoplastic foam, and
- a third layer of cloth material, where the cloth material is one of the following: felt, wool, fur, hair, polyester, nylon, cotton, acetate, and acrylic.

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