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(54) **LIGHT REFLECTIVE PROTECTIVE HEADWEAR**

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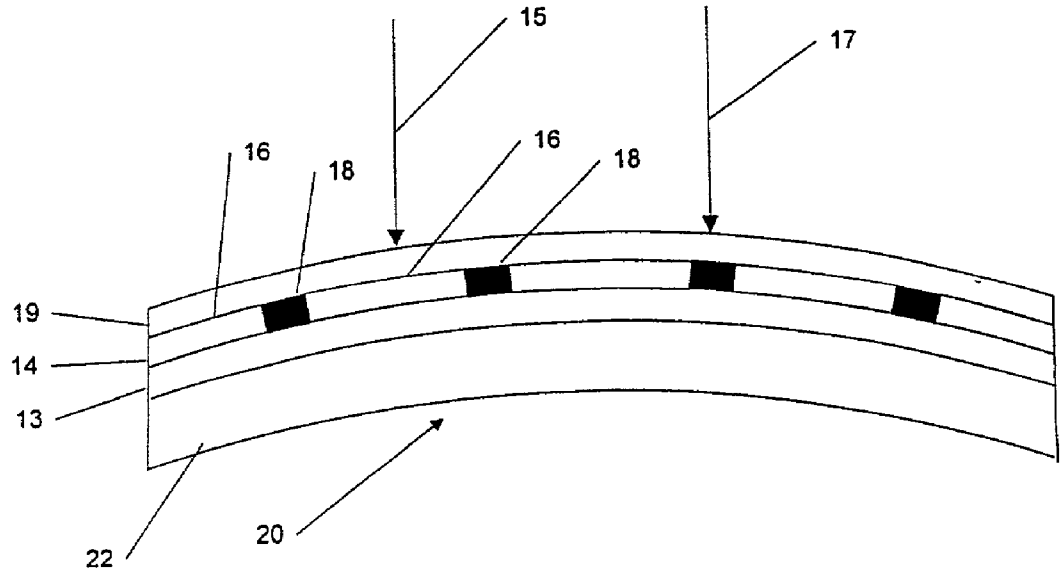
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(52) **U.S. Cl.** **2/422**; 2/410

(57) **ABSTRACT**

Protective headwear (e.g., helmet) is provided with patterned reflective surfaces that are highly reflective and resist rough handling. The reflective surface is produced by sealing a reflective sheet between a base and a cover layer that includes a pattern, to protect the reflective sheet from the environment. The protective headwear can reflect light in different colors. A method for cost-effectively producing reflective objects by injection molding is also provided.



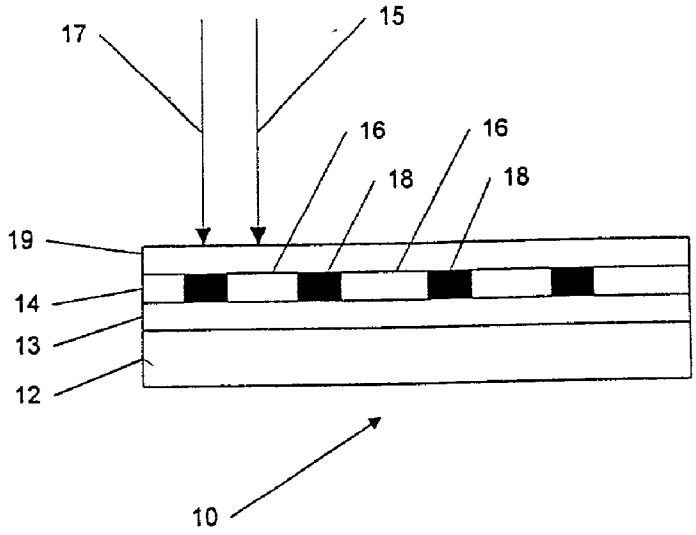


FIG. 1

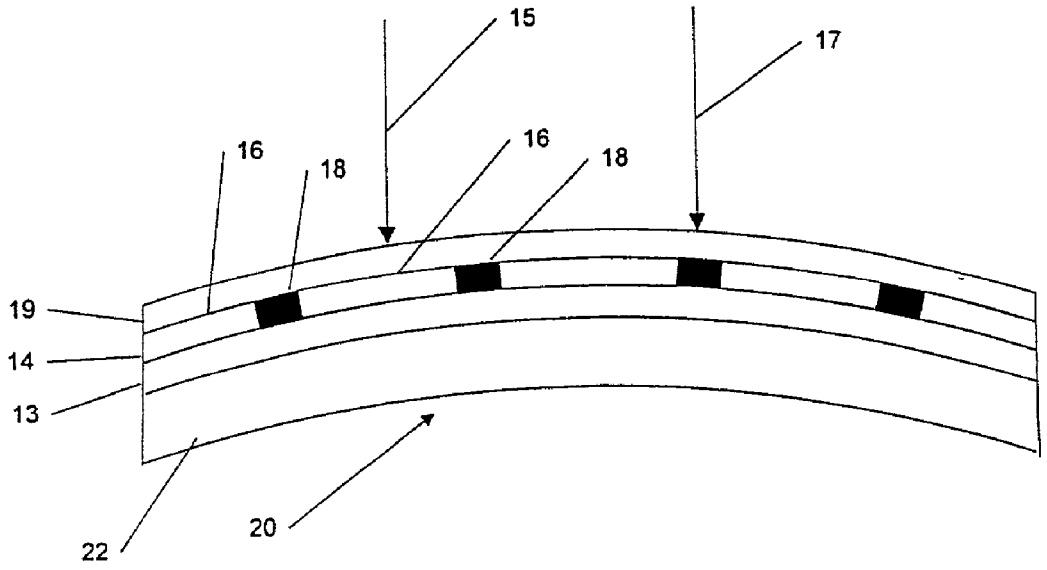


FIG. 2

FIG. 3A

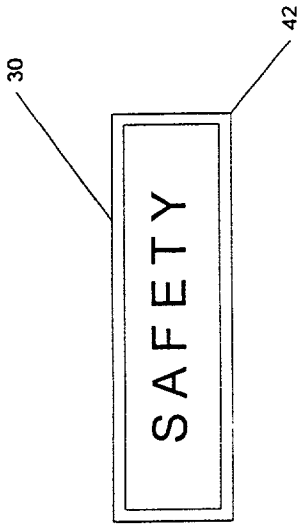


FIG. 3B

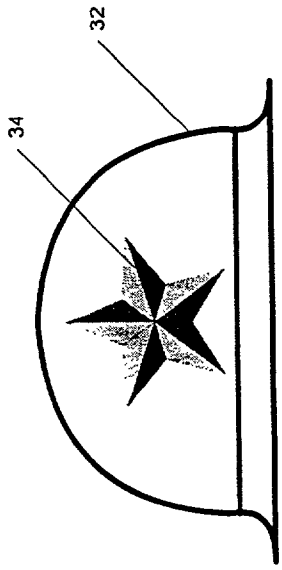
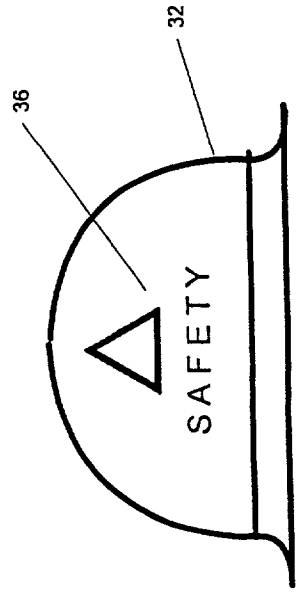


FIG. 3C



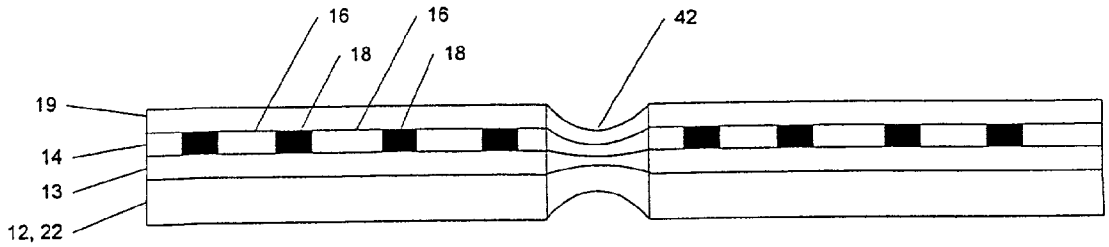


FIG. 4

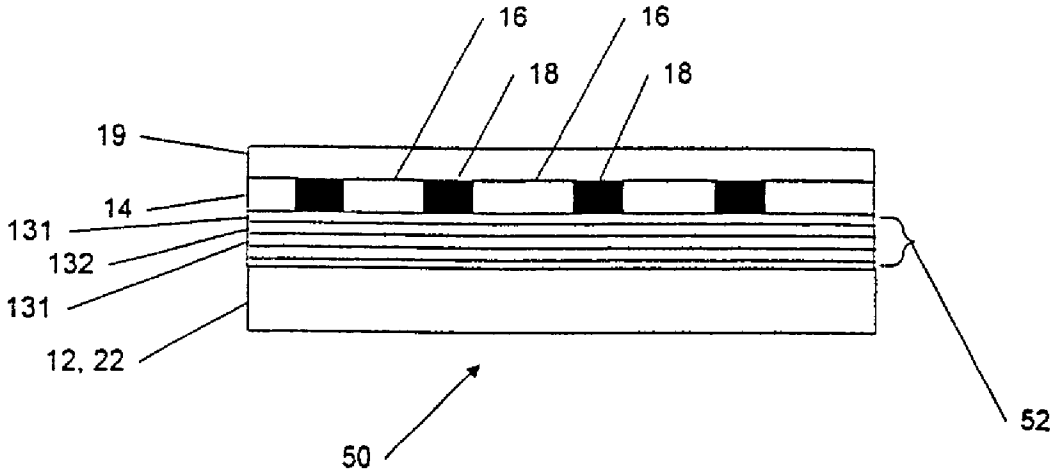

16
16
18
18
19
14
131
132
131
12, 22
50
52

FIG. 5

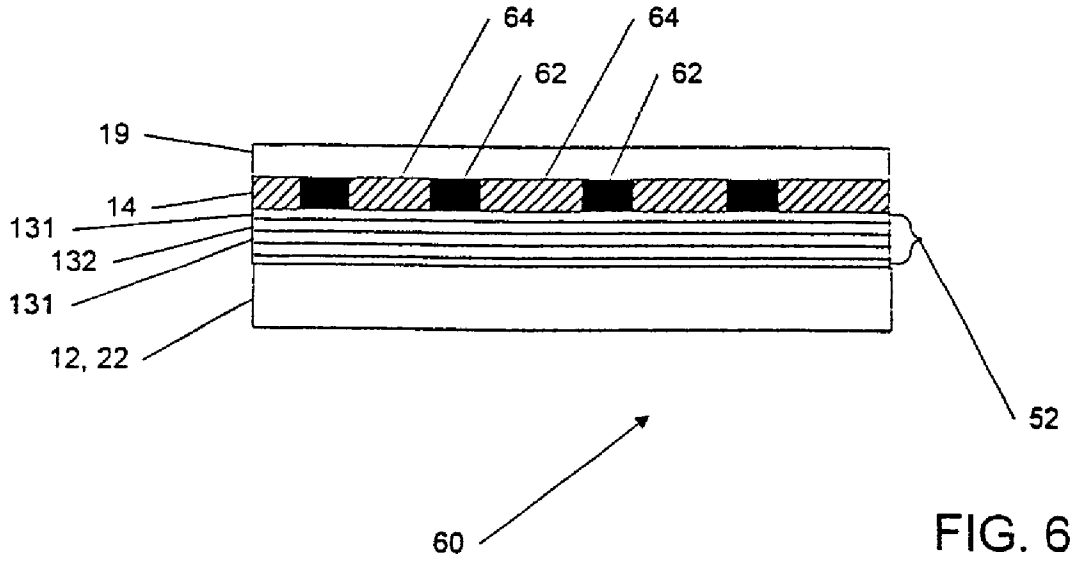

64
64
62
62
19
14
131
132
131
12, 22
60
52

FIG. 6

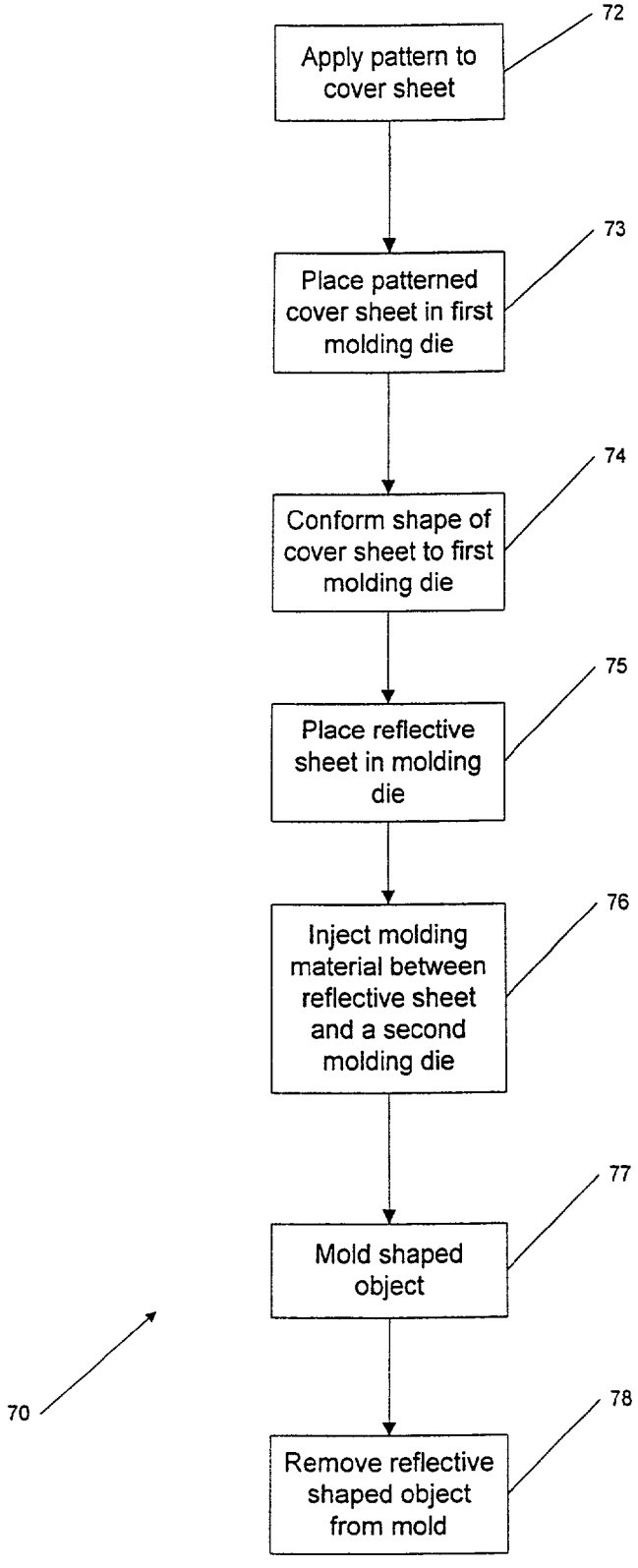

72
Apply pattern to cover sheet
73
Place patterned cover sheet in first molding die
74
Conform shape of cover sheet to first molding die
75
Place reflective sheet in molding die
76
Inject molding material between reflective sheet and a second molding die
77
Mold shaped object
78
Remove reflective shaped object from mold
70

FIG. 7

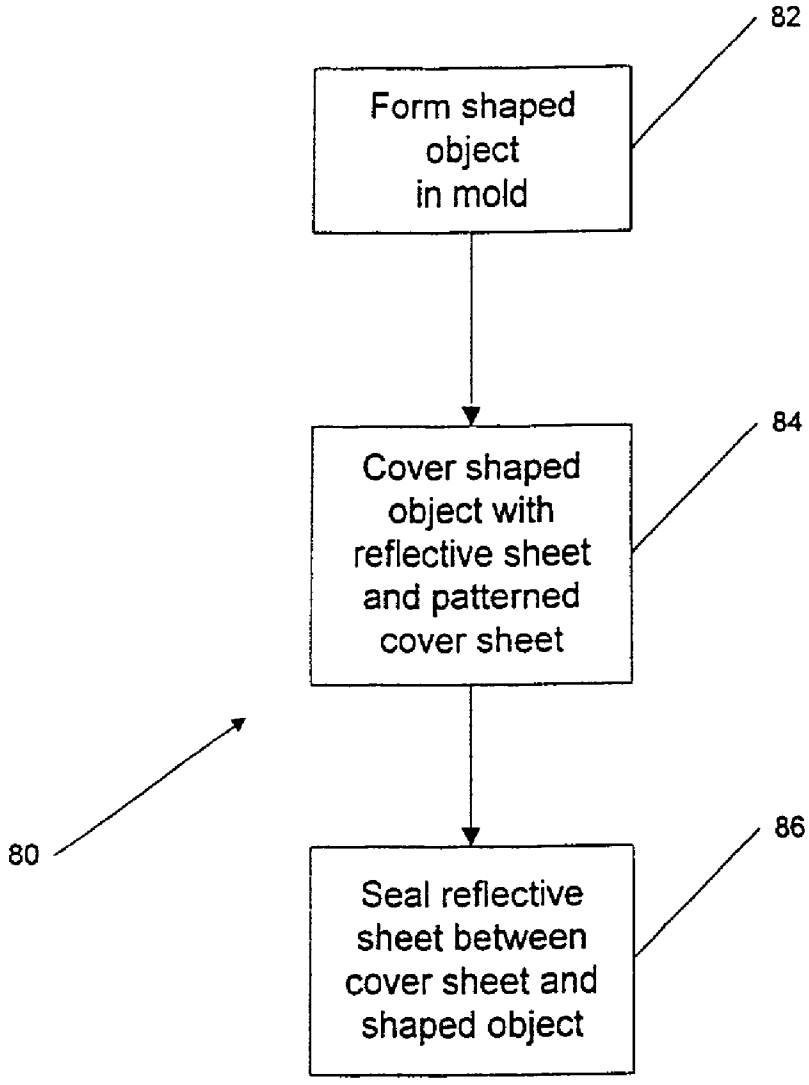

82
Form shaped object in mold
84
Cover shaped object with reflective sheet and patterned cover sheet
80
86
Seal reflective sheet between cover sheet and shaped object

FIG. 8

LIGHT REFLECTIVE PROTECTIVE HEADWEAR

FIELD OF THE INVENTION

[0001] The invention relates to protective headwear, for example, a helmet that reflects light.

BACKGROUND OF THE INVENTION

[0002] One conventional approach for producing a light-reflective object includes attaching a number of reflective decals formed on a paper or plastic base to the surface of these objects, for example with an adhesive. In other approaches, a reflective material is sprayed directly onto the object, for example through a patterned mask, or a desired pattern of the reflective material is formed and is then sewn on a fabric. The object is then covered with the fabrics. The reflective material can also be sewn directly onto the object.

[0003] The conventional approaches described above suffer from a number of disadvantages. One disadvantage is that the reflectivity of these surfaces can degrade prematurely since the reflective material is, in most cases, directly exposed to the environment, i.e., the ambient air, moisture, sunlight and dust. For example, if the reflective surfaces are formed of thin metal coatings, for example, silver or aluminum, such coatings tend to oxidize in air causing their reflectivity characteristics to degrade rapidly. An unprotected reflective surface can also be easily damaged and/or scratched upon contact with other objects, for example, when used in harsh environments, such as at a construction site. Reflective surfaces that are produced by spraying a reflective paint on the object, tend to have poor reflectivity and produce less vibrant colors.

[0004] Using an adhesive to attach reflecting decals on objects requires a large number of processing steps, such as printing, cutting and attaching. Thus, this approach is not cost-effective. Cutting and sewing is also required when the decals are attached to fabrics.

SUMMARY OF THE INVENTION

[0005] The invention relates to protective headwear having a light-reflecting surface with high reflectivity. In one aspect of the invention, the protective headwear includes a shell member having a molded base; a cover sheet, covering the molded base, with a pattern defined by areas that are transparent to the optical radiation passing through the cover sheet and other areas that are opaque to the optical radiation and a reflective sheet sealed between the molded base and the cover sheet from the environment.

[0006] Embodiments of this aspect of the invention may include one or more of the following features. The patterned structure can be formed directly on the cover sheet. Alternatively, the protective headwear may further include a separate patterned sheet that is arranged between the cover sheet and the reflective sheet. The cover sheet is preferably made of a plastic that is impervious to air and moisture. The reflective sheet can be a metal foil or a plastic sheet that is coated with a reflective metal. The reflective sheet can also have the form of a reflective dielectric stack. The reflective sheet and the cover sheet can have spectrally selective optical characteristics. The base can be in the form of a shaped object, for example a helmet made by injection molding from polyurethane. The pattern can be an ornamental design, a logo and the like.

[0007] In another aspect, the invention provides a method of manufacturing protective headwear, for example a helmet, by placing a patterned cover sheet in first molding die to shape the cover sheet in the shape of the die. A reflective sheet is placed on the shaped patterned cover sheet and molding material is injected between the reflective sheet and a second molding die to form the shaped object. The reflective sheet is thereby sealed between the cover sheet and the molded shaped object.

[0008] In another aspect of the invention, a method of manufacturing light-reflecting objects includes first forming a shaped object and then covering the shaped object, in succession, with a reflective sheet and a patterned cover sheet.

[0009] Embodiments of these methods may include one or more of the following features. The reflective sheet is sealed between the shaped object and the cover sheet, for example, by applying heat and pressure between the shaped object and the cover sheet. The pattern is defined by areas that are transparent to the optical radiation passing through the cover sheet and by other areas that are opaque to the optical radiation. The pattern can also be defined by a separate patterned sheet placed between the cover sheet and the reflective sheet. The light-reflecting object can be a molded helmet that is preferably made of polyurethane.

[0010] Additional features and advantages of the present invention will be apparent from the following description of preferred embodiments and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] **FIG. 1** shows an embodiment of the reflective object according to the invention;

[0012] **FIG. 2** shows another embodiment of the reflective object according to the invention;

[0013] **FIGS. 3A** to **3**C show examples of applications for the reflective objects;

[0014] **FIG. 4** shows another embodiment of the reflective object with a lateral seal;

[0015] **FIGS. 5 and 6** show other embodiments of the reflective object; and

[0016] **FIGS. 7 and 8** are flow diagrams of methods for producing the reflective object.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] In the drawings, identical elements or elements performing identical functions are indicated with identical reference numerals.

[0018] Referring to **FIG. 1, a** reflective object **10** includes a base **12** that is made of a material impervious to moisture, such as metal or plastic and preferably polyurethane. The base **12** can be rigid or flexible. Overlaying the base **12** are, in succession, a reflective sheet **13**, a patterned sheet **14** and a transparent cover sheet **19**. The cover sheet **19** is preferably made of a plastic material that is essentially impervious to air and moisture. The reflective sheet **13** includes a plastic sheet coated with a highly reflective metal, such as aluminum, silver or gold, or other suitable material with a high index of refraction. The patterned sheet **14** need not be a

separate sheet, but can be printed on or embossed onto the transparent cover sheet **19**. The patterned sheet **14** includes areas **18** that are opaque to light passing through the transparent cover sheet **19**, and areas **16** that are transparent to the light. The transparent areas **16** and opaque areas **18**, in aggregate, form a desired pattern or design. The opaque areas and the transparent areas can be colored, i.e., the areas can reflect and/or transmit selected spectral ranges of the light striking the surface of the object.

[**0019**] When light **15**, **17** passes through the transparent cover sheet **19**, the opaque areas **18** of patterned sheet **14** prevent a portion of the light **17** from reaching the reflective sheet **13**, so that little, if any, light is reflected. On the other hand, light **15** that passes through the transparent areas **16** of the patterned sheet **14** and reaches the reflective sheet **13**, is reflected by the reflective sheet **13**. As a result, from the perspective of a viewer facing the transparent cover sheet **19**, the opaque areas **18** appear dark, whereas the transparent areas **16** reflect the light and appear bright. In other words, the viewer sees a pattern having a shape that is defined by the shape of the transparent areas **16**.

[**0020**] Referring now to **FIG. 2**, in another embodiment of the invention, the reflective object is a shaped object, e.g., a molded object **22**, such as a molded helmet, a sculptured sign and the like. The shaped object is preferably made from a material that is impervious to air and moisture.

[**0021**] Referring to **FIGS. 3A** to 3C, illustrative examples of various reflective objects having base **10** or shaped base **31** of **FIG. 1A and 1B** are shown. **FIG. 3A** shows a warning sign **30** with reflective lettering and/or a reflective background. In this embodiment, the base **12**, the reflective sheet **13**, the patterned sheet **14**, and the transparent cover sheet **19** are preferably sealed along the lateral edges **42**, as also illustrated more particularly in **FIG. 4**. This design prevents air and moisture from the environment from reaching the reflective sheet **13**.

[**0022**] Referring to **FIGS. 3B and 3C**, a reflective object is a protective helmet **32**, for example a safety helmet (e.g., a bicycle or motorcycle helmet or a construction helmet) is shown. The reflective pattern applied to the helmet **32** can have the form of an ornamental design **34** (**FIG. 3B**) or a descriptive label and/or a logo **36** (**FIG. 3C**). The helmet **32** can be produced, for example, by an injection molding process, as described below.

[**0023**] As seen in **FIG. 4**, the reflective sheet **13** can advantageously be hermetically sealed against the environment with a seam **42**. For example, a molding machine or a sealing press (not shown) can apply pressure and/or heat between the cover sheet and the base along predetermined seams **42** to encapsulate the reflective sheet between the base and the cover sheet. In this way, large sheets with several objects **32** can be manufactured on a base **12** in a single manufacturing process. The sheets are then cut along the seams **42** to separate the individual objects which are now sealed along their respective marginal edges. Alternatively, the base **12** and the shaped object **22**, respectively, and the reflective sheet **13** can also be sealed between the cover sheet **19** and the base **12** or the shaped object **22** by applying heat and/or pressure over the surface area of the base or the shaped object and **19**.

[**0024**] Referring now to **FIG. 5**, in another embodiment, a reflective object **50** includes a reflective sheet **52** in the form of a multilayer dielectric stack. In this case, the reflective sheet **52** is formed of a sequence of thin alternating dielectric layers **131**, **132**, wherein consecutive layers have a different index of refraction. When a dielectric stack **52** of this type is illuminated, the stack **52** selectively reflects one or more colors of the light. The color depends on the thickness and the index of refraction of the thin sheets and on their arrangement with respect to each other, as is known in the art. The specific color or colors can also depend on the direction from which the object is viewed. A dielectric stack **52** can have a significantly higher reflectivity than a single reflective sheet **13**. The reflective sheet **52** can also include holograms (not shown).

[**0025**] Referring now to **FIG. 6, a** reflective object **60** can be designed to reflect more than one color of the light striking the object. For example, when the thickness and refractive index of the thin layers **131**, **132** are properly dimensioned, the dielectric stack **52** can be designed to reflect, for example, the red and blue spectral range of the light. Since the red and blue reflected colors add to form a green color, the transparent areas **64** appear green while the opaque areas **62** appear dark, as described above. However, the optical properties of the patterned sheet **14** and/or of the transparent cover sheet **19** can also be made color-selective, i.e., these sheets can function as optical filters. For example, the areas **62** of sheet **14** can be designed to absorb the red portion of the light and will therefore transmit only the blue portion of the red and blue light reflected by the dielectric stack **52**. The areas **62** will therefore appear blue in reflection. Likewise, the areas **64** of sheet **14** can be designed to absorb the blue portion of the reflected light and will therefore transmit only the red portion of the light. The areas **64** will therefore appear blue in reflection. The cover sheet **19** can also have a spectrally selective light transmission. In other words, the reflective sheet **52**, the patterned sheet **14** and cover sheet **19** can be designed to have different optical properties. Consequently, these sheets can be combined to produce a variety of different colors. The invention can therefore provide colorful reflective objects that can be produced in a simple manner.

[**0026**] Referring now to **FIG. 7, a** process **70** for manufacturing a molded shaped object **20** (**FIG. 2**) with a reflective pattern is described. A printed pattern of desired shape and color is applied to a transparent cover sheet **19**, step **72**. Alternatively, as described above, instead of applying the pattern directly to the cover sheet **19**, a patterned sheet **14** can be placed on the cover sheet **19**. The transparent cover sheet **19** and the patterned sheet **14** are then placed in a first molding die (not shown), with the pattern or the patterned sheet **14** facing away from the molding die, step **73**. The combination formed by the cover sheet **19** and the patterned sheet **14** is then molded to conform to the shape of the molding die, using high temperature and vacuum techniques, step **74**. The reflective sheet **13**, **52** is placed on top of the molded patterned sheet **14**, step **75**, and a plastic molding material, e.g., polyurethane, is injected between a second molding die (not shown) and the reflective sheet **13**, step **76**. The shaped object is formed by applying heat and pressure to the mold, step **77**. The reflective shaped object **20**, e.g., the helmet **32**, which now includes the reflective pattern on its outer surface, is removed from the mold, step **78**.

[0027] Referring now to **FIG. 8**, in an alternate process **80**, a shaped object **22, 32** is initially formed in a molding machine (not shown), step **82**. The shaped object **22, 32** is then covered with, in that order, the reflective sheet **13, 52** and the patterned cover sheet **19**, step **84**. As mentioned above, instead of forming a pattern on the cover sheet **19**, a separate patterned sheet **14** can be inserted between the cover sheet **19** and the reflective sheet **13, 52**. The reflective sheet **13** is then sealed between the cover sheet **19** and the shaped object **22, 32** to protect the reflective sheet **13** against the environment, step **86**.

[0028] It is to be understood that the embodiments and variations shown and described above are illustrative of the principles of this invention only and that various modifications may be implemented by those skilled in the art without departing from the scope and spirit of the invention.

We claim:

1. Protective headwear to be worn by a wearer, the article of headwear comprising:

a shell member having an internal volume sized and shaped to receive the head of a wearer, said shell member including:

a molded base;

a cover sheet including a pattern defined by areas that are transparent to optical radiation passing through the cover sheet and other areas that are opaque to the optical radiation, wherein the cover sheet is contiguous and substantially covers the base,

a contiguous reflective sheet arranged between the base and the cover sheet and sealed between the base and the cover sheet.

2. The protective headwear according to claim 1, wherein the cover sheet includes a patterned sheet defining the transparent and opaque areas, with the patterned sheet arranged between the cover sheet and the reflective sheet.

3. The protective headwear according to claim 1, wherein at least one of the base and the cover sheet is made of plastic.

4. The protective headwear according to claim 3, wherein the plastic is substantially impervious to at least one of air and moisture.

5. The protective headwear according to claim 1, wherein the reflective sheet comprises a metal.

6. The protective headwear according to claim 1, wherein the reflective sheet selectively reflects a spectral range of the optical radiation.

7. The protective headwear according to claim 1, wherein the cover sheet selectively transmits a spectral range of the optical radiation.

8. The protective headwear according to claim 1, wherein the molded base is made of polyurethane.

9. The protective headwear according to claim 1, wherein the reflective sheet is a dielectric stack.

10. The protective headwear according to claim 1, wherein at least one of the transparent areas and the opaque areas have spectrally selective optical characteristics.

11. The protective headwear according to claim 10, wherein the spectrally selective optical characteristics include light transmission at least two different colors.

12. The protective headwear according to claim 1, wherein the pattern defines an ornamental design.

13. The protective headwear according to claim 1, wherein the pattern defines a logo.

14. The protective headwear according to claim 1, wherein the pattern defines an alphanumeric pattern.

15. A method for producing protective headwear that reflects optical radiation, the method comprising:

placing in a first molding die defining an outer shape of the protective headwear a patterned cover sheet having areas that are transparent to the optical radiation passing through the cover sheet and other areas that are opaque to the optical radiation, and shaping the cover sheet to conform to the outer shape;

placing a reflective sheet on the shaped cover sheet;

injecting a molding material between the reflective sheet and a second molding die that faces the reflective sheet and defines an inner shape of the protective headwear; and

molding the molding material to form the protective headwear,

the reflective sheet being sealed between the cover sheet and the protective headwear.

16. The method according to claim 15, wherein the molding material is polyurethane.

17. The method according to claim 15, wherein the patterned cover sheet comprises a transparent cover sheet and a patterned sheet in contact with the cover sheet.

18. The method according to claim 15, wherein at least portions of the pattern selectively transmit a spectral range of the optical radiation.

19. The method according to claim 15, wherein the reflective sheet selectively reflects a spectral range of the optical radiation.

20. An article for reflecting optical radiation comprising:

a base;

a cover sheet including a pattern defined by areas that are transparent to the optical radiation passing through the cover sheet and other areas that are opaque to the optical radiation, wherein the cover sheet is contiguous and substantially covers the base,

a contiguous reflective sheet arranged between the base and the cover sheet and sealed between the base and the cover sheet.

21. The object according to claim 20, wherein the base is a shaped object.

22. The object according to claim 21, wherein the shaped object is a molded object.

23. The object according to claim 22, wherein the molded object is made of polyurethane.

24. The object according to claim 21, wherein the shaped object is a protective head cover.

25. A method for producing a shaped object reflecting optical radiation, comprising the steps of:

placing a patterned cover sheet having areas that are transparent to the optical radiation passing through the cover sheet and other areas that are opaque to the optical radiation, in a first molding die and shaping the cover sheet to conform to the shape of the first molding die;

placing a reflective sheet on the shaped cover sheet; and

injecting a molding material between the reflective sheet and a second molding die facing the reflective sheet to form the shaped object,

wherein the reflective sheet is sealed between the cover sheet and the shaped object.

26. A method for producing a reflective shaped object comprising the steps of:

forming a shaped object;

covering the shaped object with a reflective sheet;

covering the reflective sheet with a cover sheet that includes a pattern having areas that are transparent to the optical radiation passing through the cover sheet and other areas that are opaque to the optical radiation,

so that the reflective sheet is sealed between the shaped object and the cover sheet.

27. The method according to claim 26, wherein the pattern is provided on a patterned sheet arranged between the cover sheet and the reflective sheet.

28. The method according to claim 26, wherein the cover sheet is made of plastic.

* * * * *