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(54) ACOUSTICAL INSULATOR FOR A VEHICLE

(76) Inventors: **Jeffrey A. Tilton**, Prospect, KY (US); **Lee A. Staelgraeve**, Lambertville, MI (US); **Thomas T. Block**, Howell, MI (US)

Correspondence Address:
**OWENS CORNING**
**2790 COLUMBUS ROAD**
**GRANVILLE, OH 43023 (US)**

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(57) **ABSTRACT**

An acoustical and thermal insulator provided which is suitable for use in a vehicle. The insulator includes a nonlaminate acoustical and thermal insulating layer of blend of polymer fibers and natural fibers. The fiber blend provides a lower cost material with similar acoustical, thermal properties. The insulator includes a relatively high density, nonlaminate layer of the fiber blend and/or one or more facing layers constructed from various materials.

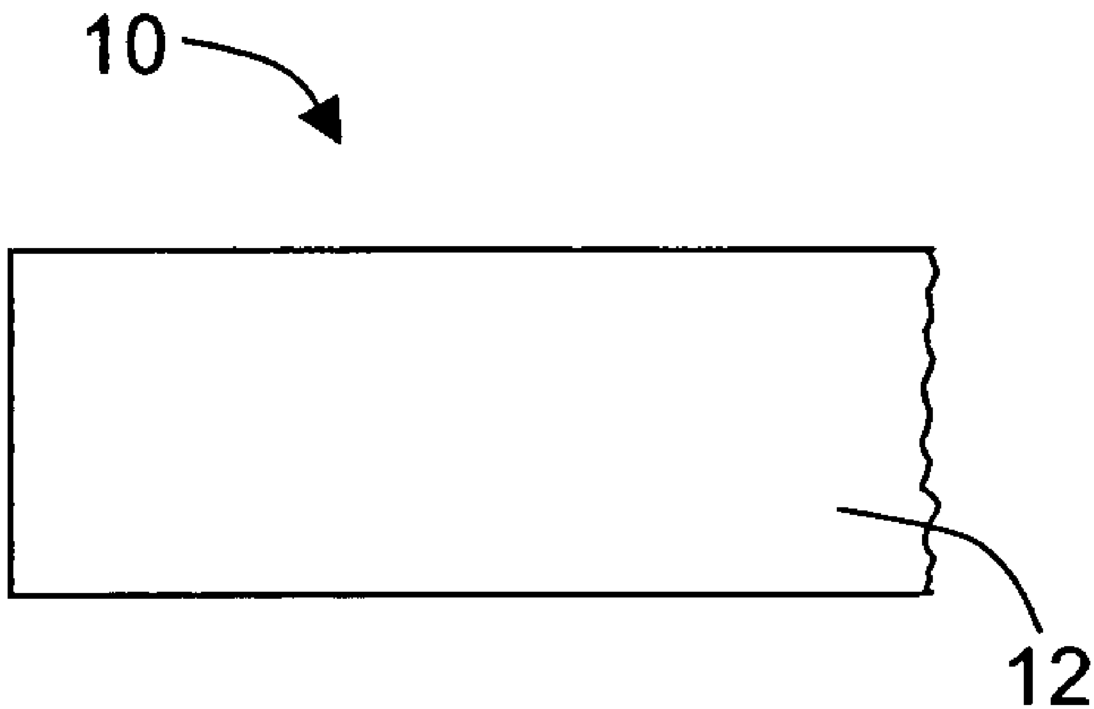


FIG. 1

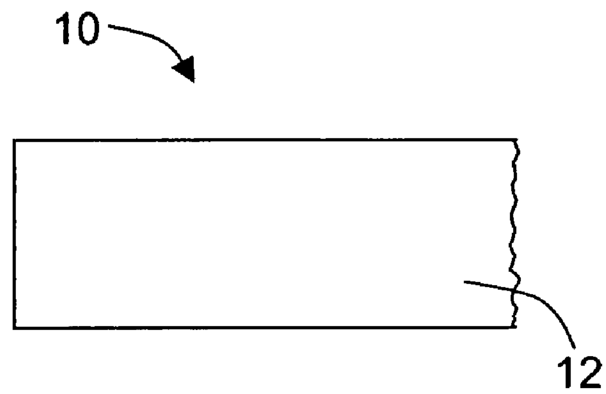



FIG. 2

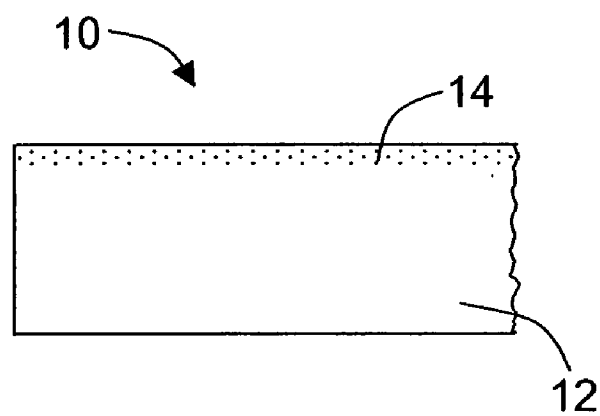



FIG. 3

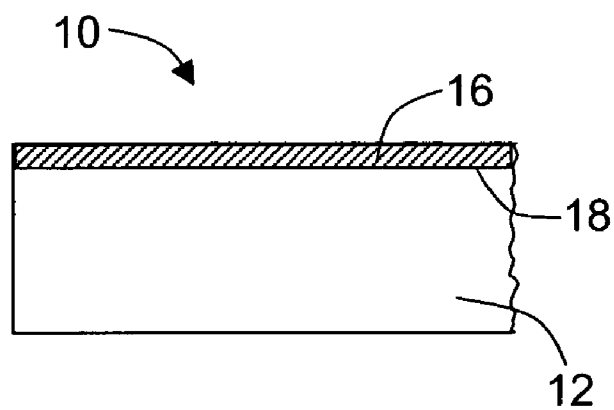


FIG. 4

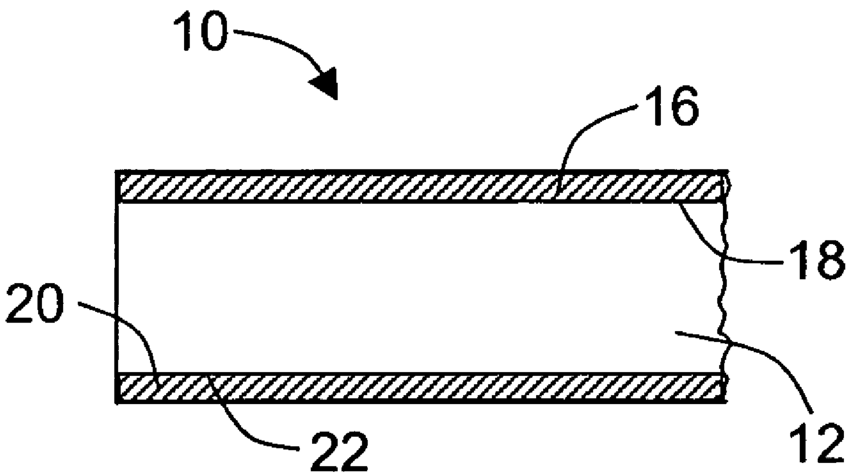



FIG. 5

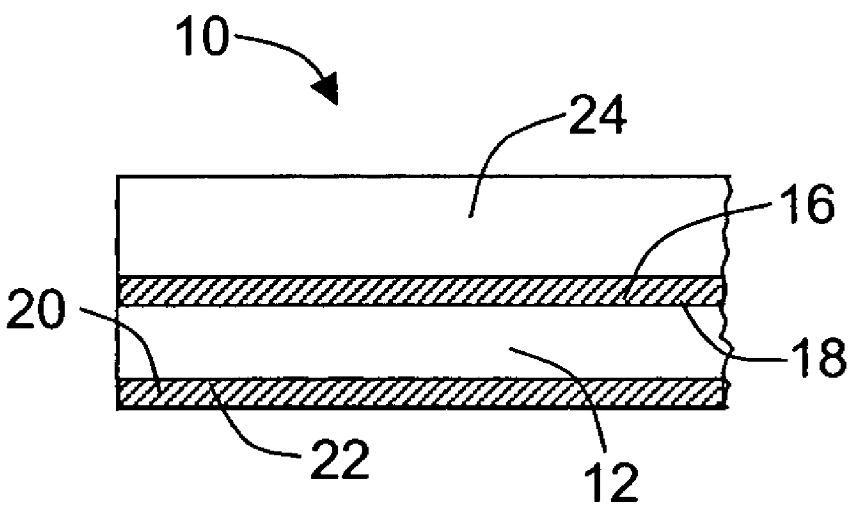
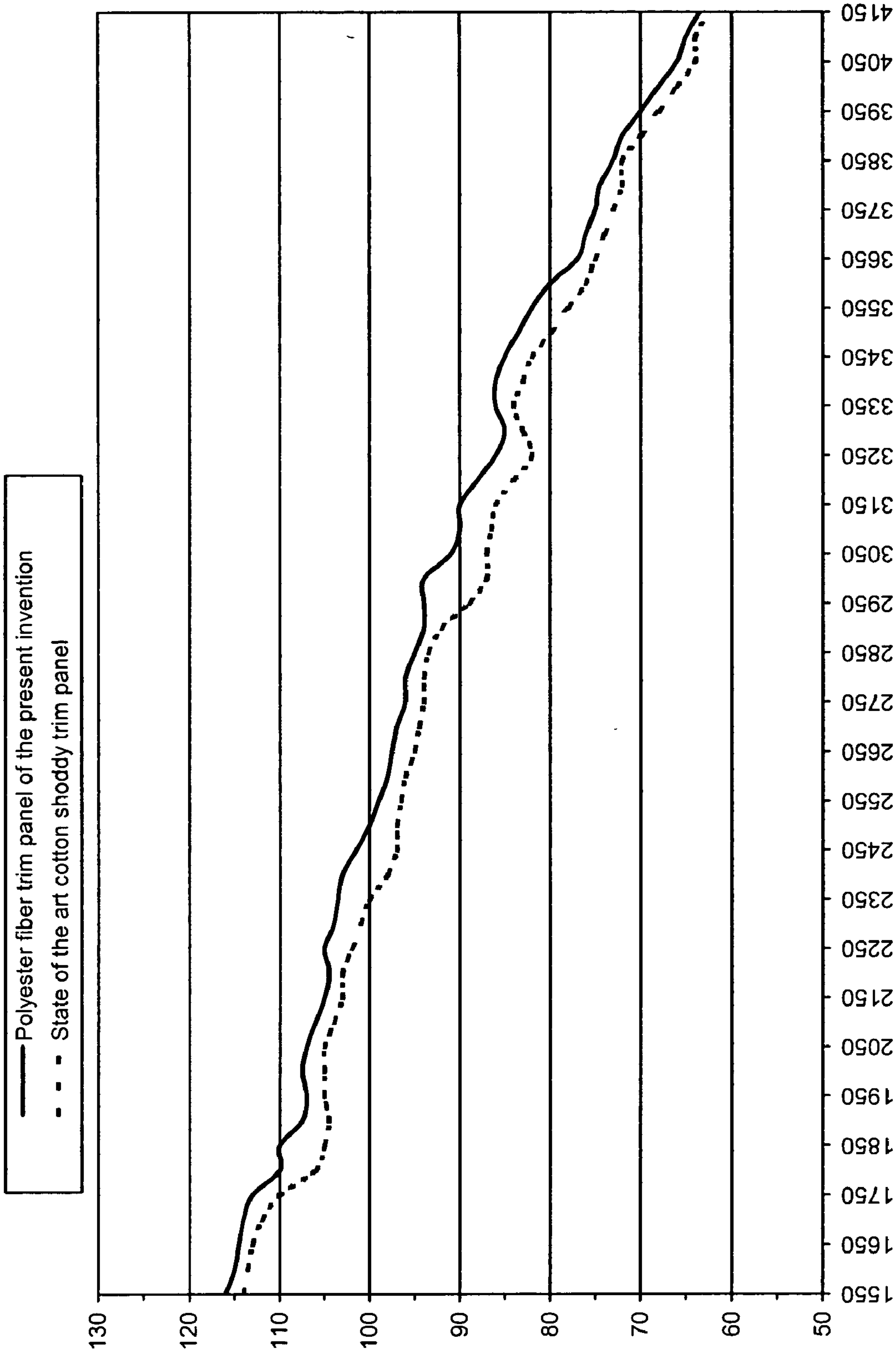


FIG. 6


Polyester fiber trim panel of the present invention
State of the art cotton shoddy trim panel
130
120
110
100
90
80
70
60
50
1550
1650
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1850
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# ACOUSTICAL INSULATOR FOR A VEHICLE

## CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a Continuation-In-Part of related U.S. application Ser. No. 09/939,284 (Filed Aug. 24, 2001), U.S. Pat. No. ______ the entirety of which is here in incorporated by reference.

## TECHNICAL FIELD AND INDUSTRIAL APPLICABILITY OF THE INVENTION

[0002] The present invention relates generally to the field of acoustical and thermal insulation and, more particularly, to a trim panel insulator for a vehicle including a mixture of polymer and natural fibers.

## BACKGROUND OF THE INVENTION

[0003] Acoustical and thermal insulators and liners for application to vehicles are well known in the art. These insulators typically rely upon both sound absorption, i.e. the ability to absorb incident sound waves and transmission loss, i.e. the ability to reflect incident sound waves, in order to provide sound attenuation. They also rely upon thermal shielding properties to prevent or reduce the transmission of heat from various heat sources (e.g. engine, transmission and exhaust system), to the passenger compartment of the vehicle. Such insulation is commonly employed as an under carpet heat shield and a floor pan insulator.

[0004] Examples of acoustical and thermal insulation in the form of liners are disclosed in a number of prior art patents including U.S. Pat. No. 4,851,283 to Holtrop et al. and U.S. Pat. No. 6,008,149 to Copperwheat. As should be apparent from a review of these two patents, engineers have generally found it necessary to construct such liners from a laminate incorporating (a) one or more layers to provide the desired acoustical and thermal insulating properties and (b) one or more additional layers to provide the desired mechanical strength and rigidity which allow simple and convenient installation as well as reliable and proper functional performance over a long service life.

[0005] While a number of adhesives, adhesive webs and binding fibers have been specifically developed over the years to secure the various layers of the laminates together, laminated shields and insulators have an inherent risk of delamination and failure. The potential is, in fact, significant mainly due to the harsh operating environment to which the shields and insulators are subjected. Many shields and insulators are located near and/or are designed to shield high heat sources such as the engine, transmission and exhaust system. As a result, the shields and insulators are often subjected to temperatures in excess of 200° F. which have a tendency to degrade the adhesives and binders over time.

[0006] Additionally, many shields and insulators are subjected to water from the surface of the roadways which has a tendency to be drawn by capillary action into the interface between the layers of the shields and the insulators. Such water may have a deleterious effect upon the integrity of the adhesive layer over time. This is particularly evident when one considers that water may also include in solution salt or other chemicals from the roadway which are corrosive and destructive.

[0007] A need is therefore identified for a trim panel insulator incorporating an acoustical and thermal insulating layer of natural and polymer fibers capable of providing the desired acoustical and thermal insulating properties. Advantageously, such an insulator also provides the desired mechanical strength and rigidity to allow simple and convenient installation while also providing a long service life characterized by reliable performance. A blend of the natural and polymer fibers also may be characterized such that the insulator may be densified by applying heat to one or both major surfaces.

## SUMMARY OF THE INVENTION

[0008] Accordingly, it is a primary object of the present invention to provide a trim panel insulator for a vehicle. That insulator comprises a low cost blend of natural and polymeric fibers that provide acoustical and thermal insulating layer of polymer fiber selected from a group consisting of polymer and natural fibers including polyester, polypropylene, polyethylene, rayon, nylon and any mixtures thereof and natural fibers of cotton and kenaf and any mixtures thereof. The polymer fibers are preferably bicomponent fibers.

[0009] In accordance with one aspect of the present invention the acoustical and thermal insulating layer may include a relatively high density, non-laminate layer of polymer and natural fiber along at least one face thereof. Still further, the insulator may include a first facing layer over a first face of the acoustical and thermal insulating layer. Similarly, a second facing layer may be provided over a second face of the acoustical and thermal insulating layer. Either of the facing layers may be constructed from a material selected from a group consisting of polyester, polypropylene, polyethylene, rayon, ethylene vinyl acetate, polyvinyl chloride, fibrous scrim, metallic foil and mixtures thereof. The acoustical and thermal insulating layer has a density of between about 20-130 g/ft$^2$.

[0010] The benefits and advantages of the present invention will become readily apparent to those skilled in this art from the following description wherein there is shown and described several preferred embodiments of this invention, simply by way of illustration of some of the modes best suited to carry out the invention. As it will be realized, the invention is capable of still other different embodiments and its several details are capable of modification in various, obvious aspects all without departing from the invention. Accordingly, the drawing and descriptions will be regarded as illustrative in nature and not as restrictive.

## BRIEF DESCRIPTION OF THE DRAWING

[0011] The accompanying drawing incorporated in and forming a part of the specification, illustrates several aspects of the present invention, and together with the description serves to explain the principles of the invention. In the drawing:

[0012] **FIG. 1** is a schematic side elevation view of one possible embodiment of the present invention;

[0013] **FIGS. 2-5** are schematic side elevation illustrations of other possible alternative embodiments of the present invention; and

[0014] Reference will now be made in detail to the present preferred embodiment of the invention, an example of which is illustrated in the accompanying drawing.

## DETAILED DESCRIPTION AND PREFERRED EMBODIMENTS OF THE INVENTION

[0015] Reference is now made to **FIG. 1** showing a first embodiment of the insulator **10** of the present invention. The insulator **10** comprises an acoustical and thermal insulating layer **12** of polymer fiber and natural fiber. More specifically, a single, nonlaminated layer **12** is provided with the necessary mechanical strength and rigidity to allow easy installation and the desired acoustical and thermal insulating properties. Advantageously, all of these benefits are achieved in a light weight insulator **10** which may even be used in compact vehicles where fuel economy concerns lead manufacturers to seek weight savings wherever possible. The insulator **10** may, for example, be used as a pillar, door, quarter panel, trunk, roof, wheel house and floor pan liner in a motor vehicle.

[0016] The polymer fiber and natural fiber blend is not foamed and typically is a nonwoven material. The polymer fiber may be polyester, polypropylene, polyethylene, rayon, nylon and any mixtures thereof and the natural fibers of cotton and kenaf and any mixtures thereof. The polymer fibers may also include bicomponent or multicomponent fibers having a first region of a relatively low melting point polymer material and a second region of a relatively higher melting point polymer material. Advantageously, such an insulator **10** has a density of between about 20-130 g/ft$^2$. For example, the acoustical and thermal insulating layer **12** may are made of a fiber blend of up to about 50% natural fibers with a preferred blend being substantially 33% polyester 33% cotton fibers and the bulk being recycled or scrap polymer fibers.

[0017] An insulator **10** made the fiber blend provides a number of advantages. The insulator **10** of the present invention may be cut with a heat knife to give an edge. The insulator **10** can be premolded to accommodate different shapes and sizes and will conform to the size of the installation cavity even when the cavity is uneven. The fiber blend also provides an advantage in that the material costs are substantially reduced with respect to a pure polymer fiber material.

[0018] Further, the insulator **10** of the present invention is dimensionally stable for many applications upon exposure to temperatures up to 450° F. The insulator **10** of the present invention may be free of glass fiber, which may reduce the irritation felt by some installers of the insulator **10**.

[0019] In a first alternative embodiment shown in **FIG. 2**, the insulator **10** also comprises a nonlaminate acoustical and thermal insulating layer **12** of a polymer fiber selected from polyester, polyester, polypropylene, polyethylene, rayon, nylon and any mixtures thereof, and natural fibers of cotton and kenaf and any mixtures thereof. The layer **12** also includes a relatively high density, nonlaminate or unitary layer **14** of that polymer fiber along at least one face thereof. The formation of the relatively high density, nonlaminate layer **14** of polymer fiber may be completed in accordance with the process described in detail in co-pending U.S. Pat. No. 6,572,723, entitled "Process For Forming A Multi-Layer, Multi-Density Composite Insulator", filed Jun. 30, 2000. The full disclosure of this document is incorporated herein by reference.

[0020] The fiber blend may be formed into a blanket material and formed into insulator parts in a continuous operation from continuous webs of the fiber blend or alternatively the blanket material may be precut to a desired shape and subsequently fabricated into insulator parts/

[0021] Heat and pressure are applied to the fiber blend by first and second molding elements, such as platens or rollers. The first molding element is heated to a temperature above the softening temperature of the polymer fiber in the blanket material while in a low density zone the material is maintained below the softening temperature of the polymer fibers. It is possible to apply heated platens or rollers to opposite sides of the blanket material to form first and second densified areas while maintaining a low density area therebetween. Typically, the temperature used to densify the material is between 200-400.degree. F. and more typically between 200-275.degree. F.

[0022] Pressure is applied at a level between substantially 0.5-100.0 psi for approximately 10-90 seconds and more typically approximately 15-45 seconds. The densified section of the blanket may be compressed between approximately 10-95% and more typically 50-90% when applying the pressure in order to complete the molding process.

[0023] In accordance with another aspect of the present invention, the process for forming a multilayer composite insulator comprises the steps of forming an insulator precursor by positioning a layer of the blanket material adjacent a facing layer, applying heat and pressure to facing layer and so that the applied heat and pressure mold the blanket to a desired shape with a first facing layers adhered to a densified layer of the blanket. This is done to provide a first zone of relatively high density in the blanket material adhered to a facing layer with a second zone of relatively low density.

[0024] In accordance with yet another aspect of the present invention, the process for forming a multilayer composite insulator comprises the steps of forming an insulator precursor by positioning a layer of the blanket material between first and second facing layers, applying heat and pressure to the opposing sides of the blanket material and so that the applied heat and pressure mold the blanket to a desired shape with first and second facing layers adhered to densified layers of the blanket. This is done to provide first and second zones of relatively high density in the blanket material with a third zone of relatively low density there between.

[0025] In accordance with yet another aspect of the present invention, the blanket material may contain bicomponent or multicomponent polymer fibers. The fiber blanket is formed at a temperature higher than softening point of the low melting point polymer and lower than the softening point of the high melting point material. This enables the higher melting point material to maintain its mechanical properties while the lower melting point material softens to adhere the fibers of the blanket material.

[0026] The process further may include controlled cooling of the molded precursor to set the insulator in the desired shape. Advantageously, the present process allows one to reliably and efficiently form a multilayer, multidensity composite insulator of enhanced acoustical and/or thermal insulating properties at a reduced overall cost.

[0027] Advantageously, the high density layer **14** will not delaminate from the layer **12** under the environmental conditions to which the vehicle and the insulator are subjected. The high density layer **14** also adds structural integrity and strength to the insulator **10** which aids significantly in handling and fitting the part during installation. The high density layer **14** is also more aesthetically pleasing. Still further, for many applications the high density layer **14** eliminates the need to provide an additional facing layer of another type of material such as a scrim. This serves to eliminate any potential failure of the insulator **10** due to delamination. It also results in an insulator **10** made exclusively from a single material that is, therefore, readily recyclable. Further, since the layer **14** may be formed with a hot platen during the molding of the insulator **10** to its desired shape, no additional processing step is required. This reduces production cost relative to an insulator with a facing since such a facing must be adhered to the acoustical and thermal insulating layer **12** in a separate processing step.

[**0028**] In yet another embodiment shown in **FIG. 3**, the insulator **10** includes a nonlaminate acoustical and thermal insulating layer of polymer fiber **12** (e.g. a nonwoven material) selected from a group consisting of polyester, a combination of polyester and fiberglass, polypropylene and any mixtures thereof in combination with a facing layer **16** over a first face **18** of the acoustical and thermal insulating layer. The facing may be present in one or more layers. Facing materials commonly employed include polyester, rayon, polyethylene, polypropylene, ethylene vinyl acetate, polyvinyl chloride, fibrous scrim, metallic foil and mixtures thereof. For example, a facing of ethylene vinyl acetate or polyvinyl chloride may have a density of about 0.2-2.0 $lbs/ft^2$.

[**0029**] In yet another alternative embodiment shown in **FIG. 4**, the shield or insulator **10** comprises a nonlaminate acoustical and thermal insulating layer **12** of the fiber blend as described above in combination with a first facing layer **16** covering a first face **18** thereof and a second facing layer **20** covering a second, opposite face **22** thereof. The second facing layer **20** may be constructed from the same or a different material as the first facing layer **16**. The first and second facing layers **16**, **20** may be attached to the layer **12** by means of an appropriate adhesive, adhesive web or a heat activated binder fiber in accordance with practices well known to those skilled in the art.

[**0030**] In accordance with another aspect of the present invention, the acoustical and thermal insulating layer **12** may include any appropriate form of coloring or pigment in order to provide a desired color that substantially approximates the color of the first and/or the second facing layers **16**, **20**. In fact, the layer **12** and the facings **16**, **20** may be colored to substantially match the paint color of the vehicle if desired. This provides significant aesthetic benefits. Specifically, when the insulator **10** is molded under heat and pressure in order to nest within a cavity in the vehicle, the insulator is often subjected to deep drawing at one or more points. This deep drawing has a tendency to spread the weave of a fabric facing **16**, **20** thereby exposing a portion of the underlying face **18**, **22** to light. If the acoustical and thermal insulating layer **12** does not substantially match the color of the facing layer **16**, **20** this creates an undesirable color variation in these deep draw areas. In contrast, by matching the color of the layer **12** with the facing layers **16**, **20**, this color variation may be substantially eliminated.

[**0031**] It should further be appreciated that during use the facing layer **16**, **20** may become snagged or subjected to a partial tear exposing some of the face of the underlying acoustical and thermal insulating layer **12**. Once again, by matching the color of the layer **12** with the facing layers **16**, **20**, any color variation is substantially eliminated and one's attention is not as readily drawn to the damaged area. Accordingly, an overall improved aesthetic appearance is maintained over the service life of the insulator **10**.

[**0032**] In summary, numerous benefits result from employing the concepts of the present invention. A trim panel insulator **10** constructed in accordance with the teachings of the present invention provides a unique combination of low cost, mechanical strength and rigidity as well as thermal and acoustical properties which are consistently and reliably maintained over a long service life even when installed in the proximity of a high temperature heat source such as a catalytic converter. In one of the embodiments of the present invention, a relatively high density, nonlaminate layer **14** is provided which aids in handling, is aesthetically pleasing and maintains the full recycleability of the insulator.

[**0033**] The foregoing description of a preferred embodiment of the invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed. Obvious modifications or variations are possible in light of the above teachings. For example, the insulator **10** could include a relatively high density nonlaminate layer **14** on both opposing faces and/or along the edges of the insulator. Additionally, an insulator **10** with one or more high density, nonlaminate layers **14** could also include one or more facings **16**, **20** if required to meet acoustical, thermal, structural and/or aesthetic performance requirements of a particular application.

[**0034**] The embodiment was chosen and described to provide the best illustration of the principles of the invention and its practical application to thereby enable one of ordinary skill in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. All such modifications and variations are within the scope of the invention as determined by the appended claims when interpreted in accordance with the breadth to which they are fairly, legally and equitably entitled.

[**0035**] The invention of this application has been described above both generically and with regard to specific embodiments. Although the invention has been set forth in what is believed to be the preferred embodiments, a wide variety of alternatives known to those of skill in the art can be selected within the generic disclosure. The invention is not otherwise limited, except for the recitation of the claims set forth below.

I claim:

**1**. An acoustical and thermal insulator, comprising:

a single, multidensity nonlaminate acoustical and thermal insulating layer formed of a combination of polymeric and natural fibers, wherein said acoustical and thermal insulating layer includes a first processed surface formed by the application of heat to a first surface of said acoustical and thermal insulating layer, said first processed surface having a higher density than an adjacent portion of said insulating layer.

**2**. The insulator of claim 1, wherein said acoustical and thermal insulating layer has a weight per unit area of between about 20-130 g/ft$^2$.

**3**. The insulator of claim 1, further comprising a first facing layer over the first processed surface of said acoustical and thermal insulating layer, said first facing layer being constructed from a material selected from a group consisting of polyester, rayon, polyethylene, polypropylene, ethylene vinyl acetate, polyvinyl chloride, fibrous scrim, metallic foil and mixtures thereof.

**4**. The insulator of claim 3, wherein said acoustical and thermal insulating layer and said first facing layer are approximately the same color.

**5**. The insulator of claim 1, further comprising, a second processed surface formed by the application of heat to a second surface of said acoustical and thermal insulating layer, said second processed having a higher density than an adjacent portion of said insulating layer.

**6**. The insulator of claim 5, further comprising a second facing layer over said second processed surface, said second facing layer selected from a group consisting of polyester, rayon, polyethylene, polypropylene, ethylene vinyl acetate, polyvinyl chloride, fibrous scrim, metallic foil and mixtures thereof.

**7**. An insulator panel, comprising:

a single, nonlaminate acoustical and thermal insulating layer including a mixture of polymer and natural fibers, wherein said acoustical and thermal insulating layer includes a first densified surface being formed by the application of heat to a first surface of said acoustical and thermal insulating layer, said first densified surface having a higher density than an adjacent portion of said insulating layer.

**8**. The insulator panel of claim 7, wherein the polymer fibers are selected from the group consisting essentially of polyester, polypropylene, polyethylene, rayon, nylon and any mixtures thereof.

**9**. The insulator panel of claim 7, wherein the natural fibers are selected from the group consisting essentially of cotton, hemp and kenaf and any mixtures thereof.

**10**. The insulator of claim 7, further comprising a first facing layer over the first densified surface.

**11**. The insulator of claim 10, wherein said first facing layer is selected from the group consisting of polyester, rayon, polyethylene, polypropylene, ethylene vinyl acetate, polyvinyl chloride, fibrous scrim, metallic foil and mixtures thereof.

**12**. The insulator of claim 7, further comprising, a second densified surface being formed by the application of heat to a second surface said second densified surface having a higher density than an adjacent portion of said insulating layer.

**13**. The insulator of claim 12, including a second facing layer over said second densified surface.

**14**. The insulator of claim 7, wherein said acoustical and thermal insulating layer has a weight per unit area of between about 20-130 g/ft$^2$.

**15**. A process for forming a multilayer insulator, comprising the steps of:

forming an insulator precursor of polymer and natural fibers, said polymer fibers being selected from the group consisting essentially of polyester, polypropylene, polyethylene, rayon, nylon and mixtures thereof and said natural fibers being selected from the group consisting essentially of cotton, hemp, kenaf and mixtures thereof.

applying heat to a first major surface of said insulator precursor;

applying pressure to said insulator precursor whereby said applied heat and said applied pressure mold said insulator precursor to a desired shape while also providing said precursor with a first zone having a first density (A) adjacent said first major surface and a second zone having a second density (B) adjacent said first zone.

**16**. The process of claim 15, wherein said heat and said pressure are applied by a first molding element and wherein said first molding element is heated to provide a first temperature in said first zone above a softening temperature characteristic of said polymer fiber.

**17**. The process of claim 15, further comprising the step of:

applying heat applying a second major surface of said insulator precursor to provide said precursor with a third zone having a third density (C) adjacent said second major surface and a second zone having a second density (B) adjacent said third zone.

**18**. The process of claim 17, wherein said heat and said pressure are applied by a first and second molding elements and wherein said first and second molding elements are heated to provide a temperature above a softening temperature characteristic of said polymer fiber.

**19**. The process of claim 15, wherein said pressure is sufficient to compress said insulator precursor between approximately 10-95% when applying said pressure.

**20**. The process of claim 15, wherein said pressure is sufficient to compress said insulator precursor between approximately 50-90% when applying said pressure.

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