ABSTRACT
The present invention is a garment having a limited number of insulation panels combined therewith which cover a high percentage of the surface area of the garment. In other words, the present invention uses relatively large insulation panels to cover a large area of the garment for maximum efficiency and insulation to the user. The insulation panels comprise an aerogel material.
GARMENT WITH AEROGEL INSULATION

[0001] This application is based upon U.S. Provisional Application Ser. No. 61/600,278 filed Feb. 17, 2012, the complete disclosure of which is hereby expressly incorporated by this reference.

BACKGROUND

[0002] The present invention relates generally to thermal insulation materials and more particularly to thermal insulation materials for use in various types of garments.

[0003] Aerogels perform well as insulators for both high-temperature and low-temperature or cryogenic insulation. One problem with using insulation materials such as aerogels to help insulate garments is that it has never been possible to manufacture large panels of insulation for incorporation into garments. This results in many small panels being used, which is either inefficient or does not cover a large percentage of the garment.

[0004] There is therefore a need for a garment having a limited number of aerogel insulation panels which cover a high percentage of the surface area of the garment.

SUMMARY

[0005] The present invention is a garment having a limited number of insulation panels combined therewith which cover a high percentage of the surface area of the garment. In other words, the present invention uses relatively large insulation panels to cover a large area of the garment for maximum efficiency and insulation to the user. The insulation panels comprise an aerogel material. In some embodiments the aerogel material is encapsulated in a membrane material. Aerogels perform well as insulators for both high-temperature and low-temperature, or cryogenic, insulation. In some embodiments aerogels include porous cross-linked polymers fabricated by causing monomers in a gel solution to react with each other to form a collection, or sol, of colloidal clusters, with the gel being subsequently replaced with air or other gas to leave a porous, low-density lattice. This most common process by which aerogels are fabricated is known in the art as the sol-gel process. Further, in some embodiments the aerogel insulation layer comprises a carrier material permeated with diffused fragments of aerogel material, thereby providing structural support and protection to the friable aerogel while still allowing the garment to take advantage of insulative properties of the aerogel. Additional modifications and embodiments will be readily apparent to those skilled in the art.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. 1 is a front view of a pair of pants;
[0007] FIG. 2 is a side view of pants showing an insulation panels inside the garment;
[0008] FIG. 3 is a rear view of a jacket showing an insulation panel inside the garment;
[0009] FIG. 4 is a front view of a jacket showing insulation panels inside the garment;
[0010] FIG. 5 is a front view of an insulation panel; and
[0011] FIG. 6 is a front view of an insulation panel.

DETAILED DESCRIPTION

[0012] The present invention is a garment having a limited number of insulation panels combined therewith which cover a high percentage of the surface area of the garment. As discussed below with reference to FIGS. 5 and 6, the insulation panels comprise an aerogel material that may be combined with a membrane material. In some embodiments the aerogel insulation includes porous cross-linked polymers fabricated according to the sol-gel process, with monomers in a gel solution being reacted with each other to form a collection, or sol, of colloidal clusters, and with the gel being subsequently replaced with air or other gas to leave a porous, low-density lattice. Many different types of aerogels are known in the art, including silica-based aerogels, carbon-based aerogels, and aerogels based on aluminum oxide, agar, sulfur, selenium, and other materials. In some embodiments of the present invention, the aerogels used in garments exhibit high surface areas (approximately 400-1000 m.sup.2/g), high porosity (generally at least 50% porosity, and in many cases at least 95% porosity), large pore volume (approximately 3.8 mL/g or higher), and low bulk densities (generally less than 0.3 g/cm.sup.3). In many embodiments, and especially in embodiments with carbon-based aerogels, the aerogel includes pores with a pore diameter of less than 100 nm.

[0013] Although porous and filled with gas, aerogels inhibit convective heat transfer because air cannot circulate through the aerogel lattice. At the same time, aerogels inhibit conductive heat transfer because the gases that fill much of their volume are poor heat conductors. In some applications, the material used as the solid component of the aerogel lattice, such as silica, is also a poor heat conductor, thereby enhancing the aerogel's insulative performance. Further, many aerogels are efficient radiative insulators because the material used as the solid component of the aerogel lattice is itself an absorbent of infrared radiation or other wavelengths. Carbon atoms in carbon-based aerogels, for example, absorb infrared radiation, thereby inhibiting the transfer of thermal radiation.

[0014] Some aerogels include a mixture of solid materials to take advantage of the complimentary insulation-enhancing physical properties of different materials. For example, an aerogel formed from a colloidal mixture of silica and carbon combines the poor heat-conducting properties of silica with the infrared-absorbing properties of carbon, making a silica-carbon aerogel an effective insulating material. Those of skill in the art will appreciate that, in a silica-carbon aerogel, the ratio of silica to carbon in the colloidal mixture and the resulting lattice varies depending upon the properties sought in and the intended use of the particular aerogel. Those of skill in the art will also recognize that other mixtures and other composite aerogels are possible and are known in the art.

[0015] In some embodiments, the aerogel insulation layer comprises a carrier material permeated with diffused fragments of aerogel material. In many embodiments, diffusing the aerogel within a carrier material provides structural support and protection to the friable aerogel while still allowing the therapeutic garment to take advantage of insulative properties of the aerogel. Further, diffusing the aerogel within a carrier material allows the aerogel insulation layer to be available in the form of a continuous sheet or roll that is amenable to conventional textile cutting and fabrication techniques, including the use of a die cutting machine. Thus, diffusing the aerogel within a carrier material in many cases enhances the ease with which the aerogel insulation layer is incorporated into a garment during the fabrication process. Also, diffusing the friable aerogel within a carrier material in many embodiments reduces the production of dust from the aerogel—dust
being a common drawback of the use of aerogels, a drawback that has prevented their use in many applications to date. [0016] In some embodiments the carrier material is a polymeric material suitable for supporting and holding diffused aerogel fragments; in some embodiments, the carrier material includes fabrics or materials such as a polyester, polyethylene, or polyurethane substance. In some embodiments, the carrier material is a carbon felt or a similar carbon-based fibrous material suitable for supporting and holding diffused aerogel fragments. In some embodiments, the aerogel is directly adhered or attached to the carrier material. In some embodiments, the carrier material is a gel within which the diffused aerogel fragments are suspended.

[0017] The present invention may be used with any type of garment, including shorts, shirts, hats and gloves. Embodiments for various applications are illustrated in FIGS. 1-4. Specifically, FIGS. 1 and 2 show pants including one insulation panel F in each leg. FIGS. 3 and 4 show a garment for a jacket having more than five insulation panels (A-E). Other embodiments may include a vest (not shown) having three or less insulation panels.

[0018] As discussed above, one of the important features of the invention is its ability to use a small number of insulation panels to cover a large area of each garment. In some embodiments, as few as one panel may be used in a single garment. In most embodiments, several panels are used, but typically no more than five panels are used in a single garment. In one preferred embodiment, the insulation panel(s) cover(s) at least 25% of the total surface area of the garment. In another preferred embodiment, the insulation panel(s) cover(s) at least 60% of the total surface area of the garment. In yet another preferred embodiment, the insulation panel(s) cover(s) at least 75% of the total surface area of the garment thereby providing the user with maximum insulation with a minimal number of panels.

[0019] The insulation panels can be incorporated into the garments in various methods. They can be sewn into the seams, sewn or welded directly to fabrics, or attached in other means to either the inner or outer shells of the garments. The insulation panels may be adhered directly to fabrics to form either the inner or outer shell of the garment. The insulation panels may be sandwiched between fabric layers to form the garment or placed inside pockets created in the garment in a manner that is similar to inserting pads inside the pockets of a football player’s pants. In this embodiment the aerogel panel need not be physically secured to the garment by sewing, welding, or other means as long as the panels remains within the pockets. The insulation panels may be adhered to fabrics on both sides forming a garment that has only one layer. The aerogel may be encapsulated into various types of membranes or structures such as but not limited to the other laminate materials. The aerogel may be incorporated into other composites such as neoprene to avoid the need encapsulate. In such cases there would be no need for additional fabrics. The aerogel may be adhered to stretch materials to allow a compression fit to the wearer. No minimum or maximum layers of fabrics are required such that it can be a single layer of material containing aerogel. In some embodiments, the insulation panels may have a “flange” around the aerogel insulation to allow incorporation or attachment to the garments. In some embodiments, insulation panels can be attached to each other to form the garment.

[0020] FIGS. 5 and 6 show the insulation panels apart from a garment. FIG. 5 shows a panel adapted to be combined with the rear portion of a vest or jacket. FIG. 6 shows a panel adapted to be combined with the sleeve of a shirt, jacket or coat. The small voided square is the area that falls inside the elbow pocket of the sleeve. As shown, the insulation panels generally comprise two materials combined with each other. The first material is the aerogel material E, G and the second material is a membrane H. The membrane encapsulates the aerogel material E, G. The membrane H is the material which provides the “flange” around the aerogel material E, G that is sewn to the garment’s fabric in some embodiments. The aerogel material E, G is generally cut to the same shape as the membrane H.

[0021] In other embodiments, the aerogel material E, G is combined directly with the garment’s fabric without first being encapsulated within a membrane H.

[0022] While the present invention has been illustrated by description of several embodiments and while the illustrative embodiments have been described in detail, it is not the intention of the applicant to restrict or in any way limit the scope of the appended claims to such detail. Those familiar with the art will recognize that other embodiments of the present invention exist, including, but not limited to, garments for warming and/or cooling a hand or hands; garments for warming and/or cooling a foot or feet; garments for warming and/or cooling the head; a wrap or other garment for warming and/or cooling the kidneys; wraps or other garments for warming and/or cooling specific muscles, organs, or body parts; and garments for warming and/or cooling pets or animals.

What is claimed is as follows:

1. A wearable garment having an area, said garment comprising:
   - between one and five aerogel insulation panels combined with the garment;
   wherein the aerogel insulation panels cover at least 25% of the surface area of the garment.
2. The garment of claim 1 wherein the insulation panels cover at least 60% of the surface area of the garment.
3. The garment of claim 1 wherein the insulation panels cover at least 75% of the surface area of the garment.
4. The garment of claim 1 wherein the aerogel insulation panels are sewn to the garment.
5. The garment of claim 1 wherein the aerogel insulation panels are welded to the garment.
6. The garment of claim 1 further comprising pockets, and the aerogel insulation panels are secured within the pockets without being otherwise physically fastened to the garment.

7. The garment of claim 1 wherein the garment is a jacket.
8. The garment of claim 1 wherein the garment is pants.
9. The garment of claim 1 wherein the garment is a vest.
10. A wearable garment having an area, said garment comprising:
    - an aerogel insulation panel combined with the garment;
    - a pocket, wherein said aerogel insulation panel is secured within the pocket without being otherwise physically fastened to the garment.
11. A wearable garment having an area, said garment comprising:
    - between one and five aerogel insulation panels combined with the garment;
    - a pocket, wherein said aerogel insulation panel is secured within the pocket without being otherwise physically fastened to the garment;
    wherein the aerogel insulation panels cover at least 60% of the surface area of the garment.

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