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[54] **FOAMED SHEET FOR MAKING STIFFENING ELEMENTS**
6 Claims, No Drawings

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[56] **References Cited**

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ABSTRACT: A novel sheet material particularly useful in formation of a stiffening structure for incorporation into shoe counters and the like, the structure comprising a foam sheet and a fabric sheet adherent thereon, the foamed sheet being formed of a thermoplastic elastomer and accounting for the major part of the thickness of the completed element.

FOAMED SHEET FOR MAKING STIFFENING ELEMENTS

RELATED APPLICATION

This application is a continuation-in-part of U.S. application Ser. No. 847,724 filed Aug. 5, 1969, by Addison W. Closson, Jr., and entitled "Foamed Stiffener Element." SUMMARY OF THE INVENTION

There are numerous applications in the fabrication of wearing apparel which require stiffening and support means in order to reinforce or strengthen some particular section of the apparel. Among the most important applications of such stiffening elements are those encountered in the manufacture of shoes, sneakers, pumps, slippers and other such footwear. For example, such stiffening units are especially important in the construction of an ordinary back part of a shoe. In general, it is desirable that such components be light, withstand reasonable temperatures as may be encountered in their ordinary use, and have a degree of resilience and strength which will add to the comfort of the wearer of the shoe. These advantages are preferably obtained without the addition of any excessive weight to the shoe, and a reduction in weight would be desirable.

In the selection of a material of construction for forming such elements, particular care must be given not only to the resilience but to the formability of the material from which the element is to be constructed; thus the material cannot be so temperature and pressure-resistant that it is not formable into a shaped stiffening element by thermal and pressure means. On the other hand, the material of construction should be washable to satisfy many applications, and thus should be able to withstand temperatures of at least from 140° F. to 150° F. as encountered in a typical laundry machine. The Vicat softening point is an appropriate criterion of the heat resistance of the polymer.

Although the above considerations are generally important, they become particularly important in footwear-making operations wherein a sole is molded, by thermal injection molding techniques, to a shoe upper comprising the stiffening element therein. In such a situation, there is often an undesirable and unsightly "bulge" caused by pressure from the flange at the top of the mold cavity which appears where the heel and the sole meet. This bulge not only detracts from the appearance of the footwear, but also affects the merchantability of the footwear.

Up until the present time, such reinforcing elements as shoe counters have been made of a number of sheet materials most notably calendered rubber rag stock materials or rubber saturated textiles and fiber. These materials have generally been formed into 0.055-inch thick counters. This thickness is customary because rubber rag stock materials are not resilient enough in lesser thicknesses. However, with the advent of improved materials, this thickness has not necessarily reflected a real need in terms of reinforcing strength. Thus, present shoe manufacturing techniques utilize a considerable quantity of material in such reinforcing applications, but this quantity of material is in fact not really required nor—as applicant has found in instant invention—particularly desirable.

SUMMARY OF THE INVENTION

Therefore, it is a principal object of the present invention to provide an improved stiffening or reinforcing sheet element for use in the manufacture of apparel, but especially for use in footwear.

Another object of the invention is to provide a new lightweight, resilient, and self-adherent stiffening element.

A further object of the invention is to provide a novel stiffening element that will shape easily under heat but will not degrade when subjected to temperatures of 140° F. and above in washing apparatus.

Other objects of the invention will be obvious to those skilled in the art on reading the instant specification.

The above objects have been substantially obtained by the construction of a novel thermoformable stiffening structure

especially useful for shaping and incorporation into shoe counters and the like. The structure comprises a foam sheet formed of an elastomeric thermoplastic and a fabric sheet laminated thereon, the foam sheet accounting for the major part of the thickness of the completed element.

The foam sheet is formed of a polymeric foam material. Preferred for use are thermoplastic elastomers, most advantageously, a copolymer of ethylene and vinyl acetate having from 2, but most advantageously from about 5 to 27 percent by weight of vinyl-acetate derived mer-units therein. One such material is that sold under the trade name Alathon 3130 by E. I. DuPont de Nemours and Co., Inc. This material contains about 12 percent vinyl acetate units and has been found preferable to material containing over about 18 percent such units because the latter materials have undesirably low softening points for many applications. Other useful thermoplastic elastomers include styrene-butadiene rubber such as that sold under the trade name Kraton by Shell Chemical Company, thermoplastic polyurethane elastomers, the ionomer sold under the trade designation Surlyn by E. I. DuPont de Nemours and Co., Inc., and the chlorinated polyethylene sold under the trade designation Tyrin by Dow Chemical Company, the chlorosulfonated polyethylene sold under the trade designation Hypalon by DuPont, and the like. This list will suggest to those skilled in the art the wide variety of thermoplastic polymers which may be utilized in the process of the invention; thus, the list is to be considered illustrative only and not limiting with respect to the particular materials that can be used to form the stiffening elements of the invention. Such polymers must be resilient as well and thermoformable and their use in shoe stiffeners is largely dependent on this fact.

Resiliency is inherent in elastomers, i.e. as defined in Hackh's Chemical Dictionary (4th Edition). Such elastomers will have a relatively large angle of permanent deformation and the vinyl acetate/ethylene copolymers are especially advantageous in this respect. This resilience combined with the exceptionally good adhesive properties of vinyl acetate at processing temperatures make it in an ideal material for use in shoe applications. It is to be noted that the ionic cross-linked materials are useful as thermoplastics and, therefore, are useful. Conventionally cross-linked or vulcanized materials like polyurethane resins and vulcanized rubbers are not generally useful in forming sheets according to the invention. Polystyrene, although thermoplastic, is typical of a polymer that is insufficiently resilient and elastomeric to be of use in forming sheets according to the invention.

It is particularly important that a polymer system be selected which provides the necessary degree of comfort and resilience without the need of plasticizers. This is true because shoe stiffeners are subjected to such varied conditions of temperature and humidity, during wear and washing, that plasticizers tend to be leached out—or in some way made ineffective—during the life of the shoe. Moreover, the migration of plasticizer to the outer surface of a plastic article is considerably more of a problem when that article is in the shape of a foam.

By "plasticizer" is meant that class of relatively low molecular weight materials called "external" plasticizers, not agents causing internal plastication by modifying the chemical nature of the polymer itself.

The fabric which can be used in the present invention includes any fabric, woven or unwoven, natural or synthetic, which is known to the clothing industry as suitable for use in wearing apparel. The use of this fabric is partially aesthetic and, in most cases, the element would be useful for stiffening purposes even if the fabric were not utilized. Nevertheless, because foam has an improved moisture vapor transmission characteristic over the reinforcing materials known to the art, it has been found that the presence of the fabric layers plays a role in distributing, i.e. wicking, moisture over the entire surface of the foam and thereby enhances still further the moisture vapor transmission characteristics of the element and improves the comfort of the apparel being reinforced.

Moreover, it has been discovered that the foamed material laminated to a fabric substrate can serve advantageously as liners. This is important because it means the product of the invention can be used to form integral stiffening and lining structures. For example, it can be used to form a single piece serving the function of both a shoe liner and a heel stiffening element.

In general, the foam useful in the present invention will contain from about 20 percent to 90 percent by volume of voids. Lower void volumes do not have any advantage over regular plastic film; higher void volumes tend to result in materials of insufficient strength. In a typical application, a film 0.045 inch thick will be laminated to cloth 0.013 inch thick. The lamination process will usually compress the laminate being formed to a thickness of from 0.05 to 0.055 inch in thickness. Sheets over about 0.10 inch are not generally useful for a number of reasons, including the self-insulating character of such a sheet when it is being formed into a shaped stiffener article.

It will be noted that a great reduction in weight of polymer used in a given stiffener is achieved as a result of the high void volume. Moreover, when a stiffening element according to the invention is incorporated into a shoe in a hot molding process (such as, for example, that process whereby the fabric-type upper used in the manufacture of sneakers is molded to the sole or polymeric section of a sneaker), then the resilience afforded by the presence of the foam in the back part of the sneaker effectively reduces or eliminates the unsightly bulge which has formerly been a problem in sneakers and other footwear formed by this molding technique.

In typical practice, a thermoplastic material, for example, the preferred copolymer of ethylene and vinyl acetate, will be extruded in a thin sheet onto a continuous web of fabric. Blowing agents will be contained in the extruded formulas which will provide the desired amount of gas release and expansion of the thermoplastic material as it comes out of the extruder die (or on the subsequent activation) and is carried along on the cloth web. Alternatively, freon gas can be introduced into the metering section of the extruder to serve as the blowing agent. Cross-linked polymer systems are not generally within the scope of the invention. However, if one wishes to selectively cross-link a thin band of polymer adjacent the surface thereof to facilitate the "sueding" by abrasion techniques, such cross-linking may be carried out without unduly interfering with the resilience or thermoformability of the sheet.

Furthermore, the product of the invention may be made by forming an aqueous emulsion of a polymer and blowing agent, coating it on the substrate and then heating to dry the emulsion and activate the blowing agent. Other means for forming the product of the invention include the use of organisol or plastisol compositions containing gas-forming agents, coating them on the paper and subsequently heating them to activate the blowing agents and remove a suitable quantity of the plasticizing agents. Still another processing technique is to calendar a thermoplastic formulation, with the resultant sheet to a substrate, and then activate a blowing agent in the formulation by subsequent heating.

It is within the scope of the invention to add such adjuvants as fillers, pigments, antioxidants, and reinforcing agents to the polymer composition. However, the addition of such materials is not critical to the practice of the invention. In this connection, it may be noted that it is particularly advantageous to add moisture vapor permeable fillers (such as ionomer powder, the sparingly cross-linked ionomers known to the art, modified cellulosic powder, cork, and other such materials known to the art) to the composition in order to enhance the moisture vapor permeability thereof.

ILLUSTRATIVE WORKING EXAMPLE

IN order to point out more fully the nature of the present invention, the following specific example is given as an illustration embodiment of the novel process and products of the invention.

A formulation is prepared by dry blending, in a typical tumbling-type blender, the following ingredients:

	By Weight
Blowing agent	0.6
Zinc stearate	0.6
Ethylene vinyl acetate copolymer pellets	98.8

The blowing agent is that sold under the trade designation Kempore 200 by National Polychemicals, Inc. The copolymer is that sold by DuPont under the trade designation Alathon 3130.

The material so formulated is extruded from a 6-inch extruder having a rear barrel temperature of 450° F. and a die temperature of about 350° F. The extruded sheet is removed from the extruder in the form of a foamed sheet about 0.055 inch thick and 40 inches wide. The takeoff speed is approximately 5 feet per minute. The extruded sheet has a mass of about 1.3 lbs. per square yard. About 4 inches in front of the extruder die, the aforesaid foamed sheet is wedded to a drilling fabric having a 2.7 yards per pound weight. The finished product has a thickness of about 0.055 inch. It is adhesive free; that is there is no adhesive at the interface between the polymer and fabric to interfere with the flexible nature of the sheet.

The product, the preparation of which has been described above, is utilized to form quarter-stiffening elements of a typical design, known in the art, to be useful in sneakers. These counterstiffening elements are stitched into the backpart section of the upper, or fabric, sections of sneaker and then joined according to the well-known Desma injection molding process, to the sole section of the sneakers to form the completed shoe.

The injection molding operation is carried out at molding temperatures cycling between 150° F. and 240° F. for a 1.5-minute cycle on a Desma Werke Injection Molding Machine. A commercially available, poly (vinyl chloride) base, sold composition supplied by B. F. Goodrich Co., under the trade designation, Pliovic, is utilized in this operation. Despite the use of the extra-thick counter (of 0.060 inch thickness), the sneakers formed by this process exhibit no bulge.

When the same operation is carried out with 0.060-inch thick counter stiffeners made of conventional rag-stock rubber, a noticeable and unsightly bulge results. Furthermore, 1.5 minutes of heat at 150° F. is not enough time and temperature to cure a rubber rag stock formula.

Another major advantage of the foamed thermoplastic stiffening unit is that it eliminates the back seam ridge. This ridge is formed at the place where the quarters are stitched together and is normally covered with an overlay of tape. Frequently, after washing, the tape comes loose and allows this ridge to show through the lining of the shoe. The foamed thermoplastic stiffener is compressible when hot and allows the seam ridge to embed itself in the thickness of the counter and thereby eliminate the possibility of its subsequent shadowing through the lining. This feature of the stiffener improves the looks and comfort of the shoe.

It is, of course, to be understood that the foregoing example is intended to be illustrative, and that various changes can be made in the ingredients, proportions and conditions set forth therein without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. A thermoformable, moisture vapor permeable reinforcing sheet element suitable for forming shoe stiffeners and consisting essentially of a first layer of fabric and a second layer of ethylene-vinyl acetate copolymer foam, said copolymer foam being of from about 5 to 12 percent vinyl acetate content, being substantially free from external plasticizers, and containing 20 percent to 90 percent by volume of voids, said layers bonded together without the aid of extraneous adhesives.

2. A thermoformable sheet element as defined in claim 1 wherein said laminate is from 0.5 to 0.10 inches in thickness.

3. A sheet element as defined in claim 1 wherein said fabric is a drilling fabric.

4. A sheet element as defined in claim 2 wherein said fabric is a drilling fabric.

5. A sheet element as defined in claim 1 wherein the Vicat softening point of the foamed thermoplastic is over 140° F.

6. A sheet element as defined in claim 3 wherein said thickness of said sheet element is below about 0.10 inch.

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