PROCESS FOR PRODUCING FOAM ARTICLE

BACKGROUND

[0001] Foam is widely used in consumer products such as footwear to provide a user with a degree of comfort and support during use. Foam contributes to weight reduction in footwear and reduced production costs compared to using non-foamed materials. Incumbent foam production methods such as injection phylon foaming and crosslinked injection foam molding require significant amounts of manual intervention to assemble separate footwear components. These conventional foam production processes also generate significant amounts of undesirable foam scrap.

[0002] Therefore, the art recognizes the need for improved processes for the production of foam articles, and in particular, for the production of foam articles in the footwear industry. Further recognized is the need for improved processes for the automated production of foam midsoles in combination with other components of a shoe.

SUMMARY

[0003] The present disclosure provides a process. In an example, the process includes providing a foamable composition. The foamable composition includes an ethylene-based elastomer, a blowing agent, and a peroxide. The process includes heating the foamable composition to form a pliable formulation. The pliable formulation has (i) a viscosity (0.1 rad/s at 180°C) from greater than 70,000 Pa.s to 2,000,000 Pa.s**,** (ii) a tan delta (0.1 rad/s at 180°C) from 0.2 to less than 2**,** (iii) a strain hardening index greater than 2.5 to 6, and (iv) an extensional viscosity (1 s^{-1} at 180°C) from greater than 400,000 Pa-s to 7,000,000 Pa-s. The process includes introducing the pliable formulation into a mold having an expandable mold cavity and unidirectionally expanding the expandable mold to form a crosslinked foam article. The process includes cooling, in the expanded mold, the crosslinked foam article; and removing the crosslinked foam article from the expandable mold.

[0003a] In one aspect, there is provided a process comprising: providing a foamable composition comprising an ethylene-based elastomer that is an ethylene/α-olefin multi-block copolymer consisting of hard segments and soft segments, a blowing agent, and a peroxide; heating the foamable composition to form a pliable formulation having (i) a viscosity (0.1 rad/s at 180°C) from greater than 70,000 Pa.s to 2,000,000 Pa.s**,** (ii) a tan

delta (0.1 rad/s at 180°C) from 0.2 to less than 2**,** (iii) a strain hardening index greater than 2.5 to 6, (iv) an extensional viscosity (1 s^{-1} at 180°C) from greater than 400,000 Pa-s to 7,000,000 Pa-s; introducing the pliable formulation into a mold having an expandable mold cavity; unidirectionally expanding the expandable mold to form a crosslinked foam article; and cooling, in the expanded mold, the crosslinked foam article; and removing the crosslinked foam article from the expandable mold; and forming a crosslinked foam article having an average aspect ratio from 1.7 to 1.9.

DEFINITIONS

[0004] All references to the Periodic Table of the Elements herein shall refer to the Periodic Table of the Elements, published and copyrighted by CRC Press, Inc., 2003. Also, any references to a Group or Groups shall be to the Group or Groups reflected in this Periodic Table of the Elements using the IUPAC system for numbering groups. Unless

CLAIMS

1. A process comprising:

providing a foamable composition comprising an ethylene-based elastomer that is an ethylene/α-olefin multi-block copolymer consisting of hard segments and soft segments, a blowing agent, and a peroxide;

heating the foamable composition to form a pliable formulation having

(i) a viscosity (0.1 rad/s at 180°C) from greater than 70,000 Pa.s to 2,000,000 Pa.s**,**

(ii) a tan delta (0.1 rad/s at 180°C) from 0.2 to less than 2**,**

(iii) a strain hardening index greater than 2.5 to 6,

(iv) an extensional viscosity (1 s^{-1} at 180°C) from greater than 400,000 Pa-s to 7,000,000 Pa-s;

introducing the pliable formulation into a mold having an expandable mold cavity;

unidirectionally expanding the expandable mold to form a crosslinked foam article; and

cooling, in the expanded mold, the crosslinked foam article; and

removing the crosslinked foam article from the expandable mold; and

forming a crosslinked foam article having an average aspect ratio from 1.7 to 1.9.

2. The process of claim 1 comprising removing, before the expanding, air from the mold cavity.

3. The process of any of claims 1-2 comprising

forming a crosslinked foam article having

(i) an average cell size 150 microns to 275 microns, or

(ii) a density (with skin) from 0.170 g/cc to 0.250 g/cc, or

(iii) a compression set (24 hr) 5% to less than 10%, or

(iv) a Shore A hardness 10 to 25, or

(v) a rebound resilience from 30% to 50%.

4. The process of claim 3 comprising

providing a foamable composition comprising

from 88 wt% to 90 wt% of an ethylene-based elastomer that is an ethylene/octene multi-block copolymer having a density from 0.870 g/cc to 0.890 g/cc and a melt index from 1.0 g/10 min to 5.0 g/10 min,

a chemical blowing agent, and

from 0.5 wt% to 3.0 wt% of an organic peroxide;

first heating the foamable composition to form a pliable formulation having

(i) a viscosity (0.1 rad/s at 180°C) from greater than 70,000 Pa.s to 2,000,000 Pa.s**,**

(ii) a tan delta (0.1 rad/s at 180°C) from 0.2 to less than 2**,**

(iii) a strain hardening index greater than 2.5 to 6,

(iv) an extensional viscosity (1 s^{-1} at 180°C) from greater than 400,000 Pa-s to 7,000,000 Pa-s;

second heating the pliable formulation;

introducing the pliable formulation into a mold having an expandable mold cavity;

closing the mold and third heating the pliable formulation in the closed mold;

opening the mold and unidirectionally expanding in the z-axis only the expandable mold to form a crosslinked foam article; and

forming a crosslinked foam article having

(i) an average cell size 150 microns to 275 microns, and

(ii) an average aspect ratio from 1.7 to 1.9, and

(iii) a density (with skin) from 0.170 g/cc to 0.250 g/cc, and

(iv) a compression set (24 hr) 5% to less than 10%, and

(v) a Shore A hardness 10 to 25, and

(vi) a rebound resilience from 30% to 50%.

5. The process of any of claims 1-4 comprising

first heating the foamable composition at a temperature of 110°C for 15 minutes to form the pliable formulation.

6. The process of claim 5 comprising

second heating the pliable formulation in an oven at a temperature of 110°C for 15 minutes.

7. The process of any of claims 4-6 comprising

placing a pre-foamed part in the mold cavity;

introducing the pliable formulation in direct contact with the pre-foamed part; and

forming a crosslinked foam article directly onto the pre-foamed part.