FOAM BEAD AND SINTERED FOAM STRUCTURE

BACKGROUND

The present disclosure relates to polyolefin foams, and further polypropylene-based polymer foams. Polyolefin foams are conventionally utilized in footwear components, such as midsole applications. Crosslinked ethylene-based polymers including ethylene vinyl acetate (EVA) copolymer and polyolefin elastomers have traditionally dominated the polyolefin foam market in footwear as they can easily be foamed with a chemical blowing agent. However, chemical blowing agents are known to produce unpleasant odors and contaminate molds.

Furthermore, crosslinked polymer foams are not recyclable because they are thermoset (rather than thermoplastic). Moreover, thermoset crosslinked polymer foam beads cannot be fused together to form a uniform sintered foam structure, such as a foam midsole. Consequently, crosslinked polymer foams are not traditionally prepared using a foam bead process, which utilizes a physical blowing agent.

The art recognizes the need for a polyolefin foam bead, and further a propylene-based polymer foam bead, that exhibits suitable density for foam sole and foam midsole applications. The art also recognizes the need for a polyolefin sintered foam structure, and further a propylene-based polymer sintered foam structure, that exhibits suitable density for foam sole and foam midsole applications. The art further recognizes the need for a polyolefin sintered foam structure, and further a propylene-based polymer sintered foam structure, that exhibits suitable shrinkage for foam sole and foam midsole applications.

SUMMARY

The instant disclosure provides a foam bead. The foam bead contains at least one of the following components: (A) a block composite; and/or (B) a crystalline block composite.

In one aspect, the instant disclosure provides a foam bead comprising at least one of the following components:

(A) a block composite; and/or

(B) a crystalline block composite

wherein (A) refers to a polymer containing three polymer components:

(ai) an ethylene-based polymer (EP) having an ethylene content from 10 mol% to less than 90 mol% (a soft copolymer), based on the total moles of polymerized monomer units in the ethylene-based polymer (EP);

(aii) an alpha-olefin-based polymer (AOP) having an alpha-olefin content of greater than 90 mol% (a hard copolymer), based on the total moles of polymerized monomer units in the alpha-olefin-based polymer (AOP); and

(aiii) a block copolymer having an ethylene block (EB) and an alpha-olefin block (AOB) wherein the ethylene block contains more polymerized ethylene than the alpha-olefin block;

wherein (B) refers to a polymer containing three polymer components:

(bi) a crystalline ethylene based polymer (CEP) having an ethylene content of greater than, or equal to, 90 mol% (a soft polymer of CBC), based on the total moles of polymerized monomer units in the crystalline ethylene-based polymer (CEP);

(bii) a crystalline alpha-olefin based polymer (CAOP) having an alpha-olefin content of greater than 90 mol% (a hard polymer of the CBC), based on the total moles of polymerized monomer units in the crystalline alpha-olefin-based polymer (CAOP); and

(biii) a block copolymer comprising a crystalline ethylene block (CEB) and a crystalline alpha-olefin block (CAOB).

The instant disclosure also provides a sintered foam structure. The sintered foam structure is formed from a composition comprising at least one of the following components: (A) a block composite; and/or (B) a crystalline block composite.

In another aspect, the instant disclosure provides a sintered foam structure formed from a composition comprising at least one of the following components:

(A) a block composite; and/or

(B) a crystalline block composite;

wherein (A) refers to a polymer containing three polymer components:

(ai) an ethylene-based polymer (EP) having an ethylene content from 10 mol% to less than 90 mol% (a soft copolymer), based on the total moles of polymerized monomer units in the ethylene-based polymer (EP);

(aii) an alpha-olefin-based polymer (AOP) having an alpha-olefin content of greater than 90 mol% (a hard copolymer), based on the total moles of polymerized monomer units in the alpha-olefin-based polymer (AOP); and

(aiii) a block copolymer having an ethylene block (EB) and an alpha-olefin block (AOB) wherein the ethylene block contains more polymerized ethylene than the alpha-olefin block;

wherein (B) refers to a polymer containing three polymer components:

(bi) a crystalline ethylene based polymer (CEP) having an ethylene content of greater than, or equal to, 90 mol% (a soft polymer of CBC), based on the total moles of polymerized monomer

units in the crystalline ethylene-based polymer (CEP);

(bii) a crystalline alpha-olefin based polymer (CAOP) having an alpha-olefin content of greater than 90 mol% (a hard polymer of the CBC), based on the total moles of polymerized monomer units in the crystalline alpha-olefin-based polymer (CAOP); and

(biii) a block copolymer comprising a crystalline ethylene block (CEB) and a crystalline alpha-olefin block (CAOB).

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a Differential Scanning Calorimetry (DSC) heating curve for the sample pellets in accordance with an embodiment of the present disclosure.

Figure 2 is a scanning electron microscope (SEM) micrograph of Ex 5 Structure.

Figure 3 is a scanning electron microscope (SEM) micrograph of CS 1 Structure.

Figure 4 is a graph showing the correlation between octene content versus elution temperature of improved comonomer content distribution analysis (iCCD) for random ethylene

CLAIMS

We claim:

1. A foam bead comprising at least one of the following components:

(A) a block composite; and/or

(B) a crystalline block composite

wherein (A) refers to a polymer containing three polymer components:

(ai) an ethylene-based polymer (EP) having an ethylene content from 10 mol% to less than 90 mol% (a soft copolymer), based on the total moles of polymerized monomer units in the ethylene-based polymer (EP);

(aii) an alpha-olefin-based polymer (AOP) having an alpha-olefin content of greater than 90 mol% (a hard copolymer), based on the total moles of polymerized monomer units in the alpha-olefin-based polymer (AOP); and

(aiii) a block copolymer having an ethylene block (EB) and an alpha-olefin block (AOB) wherein the ethylene block contains more polymerized ethylene than the alpha-olefin block;

wherein (B) refers to a polymer containing three polymer components:

(bi) a crystalline ethylene based polymer (CEP) having an ethylene content of greater than, or equal to, 90 mol% (a soft polymer of CBC), based on the total moles of polymerized monomer units in the crystalline ethylene-based polymer (CEP);

(bii) a crystalline alpha-olefin based polymer (CAOP) having an alpha-olefin content of greater than 90 mol% (a hard polymer of the CBC), based on the total moles of polymerized monomer units in the crystalline alpha-olefin-based polymer (CAOP); and

(biii) a block copolymer comprising a crystalline ethylene block (CEB) and a crystalline alpha-olefin block (CAOB).

2. The foam bead of claim 1 comprising (A) the block composite.

3. The foam bead of claim 1 or claim 2 comprising (B) the crystalline block composite.

4. The foam bead of any one of claims 1-3, wherein the foam bead has a weight ratio of (A) the block composite and (B) the crystalline block composite of from 0.25:1.0 to 4.0:1.0.

5. The foam bead of any one of claims 1-4, wherein the foam bead has two melting peaks.

6. The foam bead of any one of claims 1-5, wherein the foam bead has a first melting peak ($Tm1^{FB}$) and a second melting peak ($Tm2^{FB}$), and the difference between $Tm1^{FB}$ and $Tm2^{FB}$ is greater than, or equal to, 20°C.

7. A sintered foam structure formed from a composition comprising at least one of the following components:

(A) a block composite; and/or

(B) a crystalline block composite;

wherein (A) refers to a polymer containing three polymer components:

(ai) an ethylene-based polymer (EP) having an ethylene content from 10 mol% to less than 90 mol% (a soft copolymer), based on the total moles of polymerized monomer units in the ethylene-based polymer (EP);

(aii) an alpha-olefin-based polymer (AOP) having an alpha-olefin content of greater than 90 mol% (a hard copolymer), based on the total moles of polymerized monomer units in the alpha-olefin-based polymer (AOP); and

(aiii) a block copolymer having an ethylene block (EB) and an alpha-olefin block (AOB) wherein the ethylene block contains more polymerized ethylene than the alpha-olefin block;

wherein (B) refers to a polymer containing three polymer components:

(bi) a crystalline ethylene based polymer (CEP) having an ethylene content of greater than, or equal to, 90 mol% (a soft polymer of CBC), based on the total moles of polymerized monomer units in the crystalline ethylene-based polymer (CEP);

(bii) a crystalline alpha-olefin based polymer (CAOP) having an alpha-olefin content of greater than 90 mol% (a hard polymer of the CBC), based on the total moles of polymerized monomer units in the crystalline alpha-olefin-based polymer (CAOP); and

(biii) a block copolymer comprising a crystalline ethylene block (CEB) and a crystalline alpha-olefin block (CAOB).

8. The sintered foam structure of claim 7, wherein the sintered foam structure has a foam density of less than 0.20 g/cc; and a linear shrinkage (70°C/40 minutes) of less than, or equal to, 1.0%.

9. The sintered foam structure of claim 7 or claim 8 comprising (A) the block composite.

10. The sintered foam structure of claim 7 or claim 8 comprising (B) the crystalline block composite.

11. The sintered foam structure of any one of claims 7-10, wherein the sintered foam structure has a Type C Tear from 4.5 N/mm to 15 N/mm; and an average stress at break greater than, or equal to, 0.50 MPa.