SEMI-CRYSTALLINE THERMOPLASTIC BLOCK COPOLYMERS

FIELD OF THE INVENTION

[0001] This invention relates to thermoplastic block copolymers, to compositions comprising such copolymers, and to a process for making such copolymers.

BACKGROUND OF THE INVENTION

[0002] US 2010/0063213 A1 describes gel fiber and film compositions comprised of narrow molecular weight distribution homopolymers, statistical copolymers, block copolymers, and graft copolymers blended with a low molecular weight diluent. However, a need stills exists for polyolefin elastomers with better elastic hysteresis.

SUMMARY OF THE INVENTION

[0003] The present disclosure refers to a semi-crystalline thermoplastic polyolefin block copolymer that combines high tensile strength with other desirable physical properties, such as high elongation at break and/or high elastic recovery. Within the semi-crystalline copolymer, crystalline domains are comprised of isotactic poly(1-butene) (iPB), the A or hard block, while the amorphous or semi-crystalline segment, the B or soft block, is comprised of a copolymer of 1-butene and ethylene or a second alpha-olefin or a terpolymer of 1-butene, ethylene, and a second alpha-olefin. In one example, two A blocks are joined to and separated from one another by the B block, i.e., an ABA block terpolymer or higher order polymer such as an ABAB tetrablock copolymer or ABABA pentablock copolymer. In one example, two B blocks are joined to and separated from one another by the A block, i.e., an BAB block terpolymer or higher order polymer such as an BABA tetrablock copolymer or BABAB pentablock copolymer. The desirable properties of the resulting segmented copolymer are superior to those obtained from blends of the individual blocks.

[0004] In one example the present disclosure refers to a semi-crystalline, thermoplastic polyolefin block copolymer comprising:

(A) A first polyolefin A block comprising isotactic poly(1-butene) (iPB);

(B) A polyolefin B block comprising an ethylene and/or alpha-olefin/1-butene copolymer or terpolymer; and

(C) A second polyolefin A block comprising isotactic poly(1-butene) (iPB);

the A and B blocks bonded to one another to form the polymer in which the first and second polyolefin A blocks are joined to and separated by the polyolefin B block.

[0004a] In one aspect, the present disclosure refers to a semi-crystalline, thermoplastic polyolefin block copolymer comprising:

(A) a first polyolefin A block comprising isotactic poly(1-butene) (iPB);

(B) a polyolefin B block selected from the group consisting of 1-butene/ethylene copolymer, 1-butene/alpha-olefin copolymer, and 1-butene/ethylene/alpha-olefin terpolymer; and

(C) a second polyolefin A block comprising isotactic poly(1-butene) (iPB);

the A and B blocks bonded to one another to form the polymer in which the first and second polyolefin A blocks are joined to and separated by the polyolefin B block.

[0005] In one example the present disclosure refers to a semi-crystalline, thermoplastic polyolefin block copolymer comprising:

(A) A first polyolefin B block comprising an ethylene and/or alpha-olefin/1-butene copolymer or terpolymer;

(B) A polyolefin A block comprising isotactic poly(1-butene) (iPB); and

(C) A second polyolefin B block comprising an ethylene and/or alpha-olefin/1-butene copolymer or terpolymer;

the B and A blocks bonded to one another to form the polymer in which the first and second polyolefin B blocks are joined to and separated by the polyolefin A block.

[0005a] In another aspect, the present disclosure refers to a semi-crystalline, thermoplastic polyolefin block copolymer comprising:

(A) a first polyolefin B block selected from the group consisting of 1-butene/ethylene copolymer, 1-butene/alpha-olefin copolymer, and 1-butene/ethylene/alpha-olefin terpolymer;

(B) a polyolefin A block comprising isotactic poly(1-butene) (iPB); and

(C) a second polyolefin B block selected from the group consisting of 1-butene/ethylene copolymer, 1-butene/alpha-olefin copolymer, and 1-butene/ethylene/alpha-olefin terpolymer;

the B and A blocks bonded to one another to form the polymer in which the first and second polyolefin B blocks are joined to and separated by the polyolefin A block.

[0006] In one example the present disclosure refers to a composition comprising a semi-crystalline, thermoplastic polyolefin block copolymer comprising a minimum block sequence of either ABA or BAB.

[0006a] In another aspect, the present disclosure refers to a composition comprising the semi-crystalline, thermoplastic polyolefin polymer as described herein.

[0006b] In another aspect, the present disclosure refers to an article comprising the composition as described herein.

[0007] In another aspect, the present disclosure refers to a process for making a semi-crystalline, thermoplastic polyolefin ABA block copolymer, the process comprising the steps of:

(A) Feeding 1-butene to a high pressure reactor under polymerization conditions to produce a first A block of isotactic poly(1-butene) (iPB);

(B) Adding ethylene and/or a second alpha-olefin to the reactor under copolymerization conditions to form a B block of a 1-butene/ethylene copolymer, a 1-butene/alpha-olefin copolymer, or a 1-butene/ethylene/alpha-olefin terpolymer which is attached to the first A block to form an AB block copolymer; and

(C) Stopping the addition of ethylene and/or the second alpha-olefin, and continue feeding 1-butene to the reactor under polymerization conditions to form a second A block of iPB which is attached to the B block to form the ABA block copolymer.

[0008] In another aspect, the present disclosure refers to a process for making the semi-crystalline, thermoplastic polyolefin BAB block copolymer, the process comprising the steps of:

(A) Feeding 1-butene and ethylene and/or a second alpha-olefin to a reactor under copolymerization conditions to form a first B block of a 1-butene/ethylene

What is claimed is:

1. A semi-crystalline, thermoplastic polyolefin block copolymer comprising:

(A) a first polyolefin A block comprising isotactic poly(1-butene) (iPB);

(B) a polyolefin B block selected from the group consisting of 1-butene/ethylene copolymer, 1-butene/alpha-olefin copolymer, and 1-butene/ethylene/alpha-olefin terpolymer; and

(C) a second polyolefin A block comprising isotactic poly(1-butene) (iPB);

the A and B blocks bonded to one another to form the polymer in which the first and second polyolefin A blocks are joined to and separated by the polyolefin B block.

2. A semi-crystalline, thermoplastic polyolefin block copolymer comprising:

(A) a first polyolefin B block selected from the group consisting of 1-butene/ethylene copolymer, 1-butene/alpha-olefin copolymer, and 1-butene/ethylene/alpha-olefin terpolymer;

(B) a polyolefin A block comprising isotactic poly(1-butene) (iPB); and

(C) a second polyolefin B block selected from the group consisting of 1-butene/ethylene copolymer, 1-butene/alpha-olefin copolymer, and 1-butene/ethylene/alpha-olefin terpolymer;

the B and A blocks bonded to one another to form the polymer in which the first and second polyolefin B blocks are joined to and separated by the polyolefin A block.

3. The semi-crystalline, thermoplastic polyolefin polymer of claim 1 or 2 in which the polyolefin B block has a glass transition temperature (T_g) of less than -20 °C.

4. The semi-crystalline, thermoplastic polyolefin polymer of claim 1 or 2 in which the polyolefin B block comprises ethylene and 1-butene.

5. A composition comprising the semi-crystalline, thermoplastic polyolefin polymer of any of the preceding claims.

6. An article comprising the composition of claim 5.

7. The article of claim 6 in the form of an injected molded part, or a cast or blown film.

8. A process for making a semi-crystalline, thermoplastic polyolefin ABA block copolymer, the process comprising the steps of:

(A) feeding 1-butene to a high pressure reactor under polymerization conditions to produce a first A block of isotactic poly(1-butene) (iPB);

(B) adding ethylene and/or a second alpha-olefin to the reactor under copolymerization conditions to form a B block of a 1-butene/ethylene copolymer, a 1-butene/alpha-olefin copolymer, or a 1-butene/ethylene/alpha-olefin terpoylmer which is attached to the first A block to form an AB block copolymer; and

(C) stopping the addition of ethylene and/or the second alpha-olefin, and continue feeding 1-butene to the reactor under polymerization conditions to form a second A block of iPB which is attached to the B block to form the ABA block copolymer.

9. A process for making the semi-crystalline, thermoplastic polyolefin BAB block copolymer, the process comprising the steps of:

(A) feeding 1-butene and ethylene and/or a second alpha-olefin to a reactor under copolymerization conditions to form a first B block of 1-butene/ethylene copolymer, a 1-butene/alpha-olefin copolymer, or a 1-butene/ethylene/alpha-olefin terpolymer;

(B) stopping the addition of ethylene and the second alpha-olefin, and continue feeding 1-butene to the reactor under polymerization conditions to form an A block of isotactic poly(1-butene) (iPB) which is attached to the B block to form a BA block copolymer; and

(C) restarting the addition of ethylene and/or a second alpha-olefin to the reactor under copolymerization conditions to form a second B block of a 1-butene/ethylene, a 1-butene/alpha-olefin copolymer, or a 1-butene/ethylene/alpha-olefin terpolymer which is attached to the A block to form the BAB block copolymer.

10. The process of claim 8 or 9 in which the polyolefin B block has a glass transition temperature (T_g) of less than -20 °C.

11. The process of claims 8-10 in which the polyolefin B block comprises ethylene and 1-butene.

12. The semi-crystalline, thermoplastic polyolefin polymer of claim 1 or 2 in which the polyolefin B block contains from 30 wt% to 80 wt% of 1-butene.

13. The process of claim 8 or 9 in which the polyolefin B block contains from 30 wt% to 80 wt% of 1-butene.