POLYPROPYLENE IMPACT COPOLYMERS HAVING HIGH MELT FLOW AND IZOD DUCTILITY

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of US Provisional Application Number 61/225,417 filed July 14, 2009.

FIELD OF THE INVENTION

[0001] This invention relates to polypropylene impact copolymers having a high melt flow rate and a high impact strength and further relates to methods of making the impact copolymers.

BACKGROUND OF THE INVENTION

[0002] There is a continuing need for polypropylene heterophasic copolymers with improved properties, notably materials with high melt flow rates and impact characteristics, especially for automotive thermoplastic olefin (TPO) applications, molding, injection molding, thin wall packaging and engineering applications.

[0003] One approach commonly used to achieve polypropylenes with high melt flow rates (MFR) involves chemical treatment, i.e., visbreaking of molten polypropylene heterophasic copolymers. Unfortunately, the resulting visbroken copolymers, also called controlled rheology (CR) polymers, generally need improved impact properties.

BRIEF SUMMARY OF THE DISCLOSURE~~INVENTION~~

[0004] One aspect of the disclosure~~invention~~ provides an impact copolymers ~~that~~ comprise~~ing~~: (a) a continuous phase comprising a propylene-based polymer; and (b) a discontinuous rubber phase comprising a propylene/ethylene copolymer.; ~~T~~The impact copolymers ~~of this aspect of the invention have~~ having an fraction copolymer (Fc, expressed as weight percent (wt. %)) of at least 35, an ethylene content of the rubber fraction (Ec, expressed as weight percent (wt. %)) of at least 38, a melt flow rate of at least 50 g/10 min, and a notched Izod impact strength at 23 °C of at least about 615 J/m (about 11.5 ft-lb/in). In some embodiments, the impact copolymers have a melt flow rate of at least 100 g/10 min. In some embodiments, the impact copolymers have a notched Izod impact strength at 23 °C of at least about 630 J/m (about 11.8 ft-lb/in). In some embodiments the impact copolymers have an Ec of at least 41.

[0005] In some embodiments, the impact copolymers are nucleated. While in other embodiments the impact copolymers are non-nucleated. In particular, the impact copolymers can be non-nucleated and have a melt flow rate of at least 100 g/10 min.

[0006] In some embodiments, the impact copolymers have a visbreaking ratio of at least 3. This includes embodiments wherein the impact copolymers have a visbreaking ratio of at least 5 and further includes embodiments wherein the impact copolymers have a visbreaking ratio of at least 10. In some embodiments the impact copolymers have a visbreaking ratio in the range of 4 to 15.

[0007] In some embodiments, the impact copolymers have a flexural modulus of at least about 758 MPa (110,000 psi). This includes embodiments wherein the impact copolymers have a flexural modulus of at least about 827 MPa.

[0008] In one specific, non-limiting embodiment, the impact copolymer is a nucleated impact copolymer comprising a continuous phase comprising a propylene-based polymer and a discontinuous rubber phase comprising a propylene/ethylene copolymer, wherein the impact copolymer has an Fc of at least 35, an Ec of at least 41, a melt flow rate of at least 55 g/10 min and a notched Izod impact strength at 23 °C of at least 630 J/m (11.8 ft-lb/in). In this embodiment, the nucleated impact copolymer can have a visbreaking ratio of at least 5 and a flexural modulus of at least 882 MPa (128,000 psi). The nucleating agent used to produce this nucleated copolymer can be an organic phosphorous nucleating agent.

[0009] In another specific, non-limiting embodiment, the impact copolymer is a non-nucleated copolymer comprising a continuous phase comprising a propylene-based polymer and a discontinuous rubber phase comprising a propylene/ethylene copolymer comprising at least about 41 wt.% ethylene, wherein the impact copolymer has an Fc of at least 35, an Ec of at least 41, a melt flow rate of at least 100 g/10 min, and a notched Izod impact strength at 23 °C of at least 615 J/m (11.5 ft-lb/in). In this embodiment, the non-nucleated impact copolymer can have a visbreaking ratio of at least 5 and a flexural modulus of at least 772 MPa (112,000 psi). This includes embodiments wherein the non-nucleated impact copolymer has a visbreaking ratio of at least 10.

[0010] Another aspect of the disclosure~~invention~~ provides a methods of making impact copolymers.; t~~T~~he methods comprising~~include~~ compounding a polypropylene impact copolymer with a visbreaking agent at a temperature of at least 210 C to provide a visbroken polypropylene