COMBINING POLYETHYLENE AND POLYPROPYLENE: ENHANCED PERFORMANCE WITH PE/*I*PP MULTIBLOCK POLYMERS

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Polypropylene, also know as polypropene is a form of plastic just as polyethylene is. What separates polypropylene from polyethylene for starters is the fact that polypropylene can be molded in essence becoming pliable above a certain temperature. When it cools it will return to its solid state. Polypropylene can be used not only as a structural plastic, but it can be used as a fiber. It also has a high melting point, which differentiates it from polyethylene. One area where polyethylene has over polypropylene is that polyethylene is more stable. Polypropylene has the advantage that it can take repeated motions such as being a hinge. A hinge made out of polypropylene can be opened and closed many many times, and hold up just fine. This is known as having "good resistance to fatigue"

Polypropylene can be combined with other materials, as can polyethylene. Rubber, for example, can be added to make it more pliable. One of the exciting additives that is added to polypropylene are minerals. These minerals allow a polypropylene sheet to become a synthetic paper. Synthetic paper is essentially plastic paper. It can be easily printed on. It can be folded, hot stamped, die cut, sewn and more. Best of all it is environmentally friendly! All of a sudden polypropylene is transformed into a slew of products. Synthetic paper made from polypropylene is used to make banners, membership cards, maps, menus, phone cards, signs, tags, floor graphics, counter mats, and booklets. The list goes on from here! What is outstanding about synthetic paper is that is durable, tear and water resistant!

Polyethylene (PE) and isotactic polypropylene (iPP) are the two most widely used commodity plastics and thus make up a large fraction of the waste stream. However, the two plastics will not mix together, which limits options for dealing with mixed waste and decreases the value of recycled products. Eagan et al. report the synthesis of multiblock copolymers of iPP and PE by using a selective polymer initiator. The high-molecular-weight blocks could be used to reinforce the interface between iPP and PE and allow blending of the two polymers.

Polyethylene (PE) and isotactic polypropylene (iPP) constitute nearly 2/3 of the world's plastic. Despite their similar hydrocarbon makeup, the polymers are immiscible with one another. Thus, common grades of PE and iPP do not adhere or blend, creating challenges for recycling these materials. Synthesized PE/iPP multiblock copolymers using an isoselective alkene polymerization initiator. These polymers can weld common grades of commercial PE and iPP together, depending on the molecular weights and architecture of the block copolymers. Interfacial compatibilization of phase-separated PE and iPP with tetrablock copolymers enables morphological control, transforming brittle materials into mechanically tough blends.

Polyethylene (PE) and isotactic polypropylene (*i*PP) are the two most abundantly produced plastics worldwide. More than 70 million and 50 million metric tons of PE and *i*PP, respectively, are produced annually [1]. The vast majority of PE and *i*PP are prepared using heterogeneous chromium and titanium catalysts [2]. Heterogeneous olefin polymerization catalysts have a multitude of active sites, each with their own reactivity differences that give rise to polymers of different molecular weights (MW), MW distributions, and microstructures [3]. In the case of PE and *i*PP, these differences and their phase separation inhibit interfacial adhesion and erode the mechanical properties of melt blends [4]. Roughly 5% of the value is retained when these plastics are recycled, typically into lower-value products as a result of sorting expenses and degraded physical properties [5]. Compatibilizers open opportunities for upcycling recovered PE/*i*PP into equal- or higher-value materials with lower sorting costs [6, 7]. Because PE and *i*PP are of great economic importance (more than ~$200 billion in annual sales, worldwide), strategies to combine these materials may have considerable potential to affect sustainability and the economy.

Single-site metallocene catalysts have been developed and commercialized to produce polyolefins with a more uniform molecular composition [8]. These polymers demonstrate distinct physical properties from their heterogeneous counterparts, such as the ability to form interfacial welds [9]. Many nonmetallocene single-site catalysts have also been developed, some of which demonstrate living character for olefin polymerization as well as precise control over the MW, stereochemistry, and architecture of the resulting polymer [10, 11].

Today a catalyst system is developed capable of synthesizing semicrystalline PE/iPP multiblock copolymers with precise control over block length and architecture. These macromolecules form strong interfaces with commercial PE and iPP when properly designed. Two molecular mechanisms are proposed to explain the MW dependence of diblock copolymer adhesion and the behavior of tetrablock copolymers with relatively short blocks. The interfacial strength translates into control over morphology and mechanical toughness in melt blends of commercial PE and iPP, blends that are otherwise brittle at a ratio typically found in municipal waste streams.

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