Milliken®
DeltaMax™
Performance Modifiers for Polypropylene

CASE STUDY

STRENGTHENED BY COLLABORATION

ExxonMobil and Milliken Enhance Recycled Polypropylene to Meet Automotive Material Standards

Challenge

Over the past few years, the successful trend of increasing the use of recycled polypropylene (rPP) in non-critical auto parts has driven automotive original equipment manufacturers (OEMs) to turn their attention to high-performance functional parts.

OEMs want to see rPP compounds that meet material demands for impact resistance at various temperatures and stiffness benchmarks. Those compounds must also be designed for fast injection molding cycle times to control costs.

This ask seems reasonable, but the reality was stark: both post-industrial and post-consumer rPP, even when originating from end-of-life vehicle waste, struggle to meet such demanding automotive OEM specifications.

Solution

Milliken & Company and ExxonMobil have a long history of working together. As a leading supplier of transformative chemical solutions that deliver essential performance, Milliken routinely helps brands and converters balance and enhance the properties and processability of mechanically recycled PP. ExxonMobil manages a portfolio of performance products that provide the building blocks to meet growing global demand for essential products, creating innovative products with sustainability benefits.

Critical OEM parts, such as front fascia deflectors, must meet flexural modulus (stiffness), tensile strength, and impact strength specifications, so the rPP formulation had to match these metrics without compromising performance or conversion during the injection-molding process.

Each company brought a unique skill set to help address the challenge. The companies developed trial formulations built around Milliken's DeltaMax® performance modifiers and ExxonMobil's Exact™ polyolefin elastomers (POE). The technical team landed on seven compounding trials using up to 25% Exact™ POE enhanced with DeltaMax and post-consumer rPP containing approximately 15% polyethylene.

The seven test compounds were molded into dumbbell-shaped samples, which were then tested for flexural modulus, tensile strength, and impact strength at 25 °C and at –20 °C, and for melt flow rate (MFR).

Key Benefits

Synergy between Exact POE and DeltaMax® performance modifiers for PP recycling:

- **Maintains high stiffness**
- **Up to 70% higher impact strength**
- **Up to 175% better flow rate**
- **Unlocks new product possibilities**

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Results

The results showed that Notched Charpy impact of 50 kJ/m² at 25°C and 4 kJ/ m² at -20°C could be achieved with a flexural modulus of approximately 900 MPa and a tensile strength largely above target—passing the first hurdle of balancing mechanical performance. The formulation's MFR was improved more than two-fold over the initial rPP compound, which could lead to reduced processing costs and decreased carbon footprint of the final part.

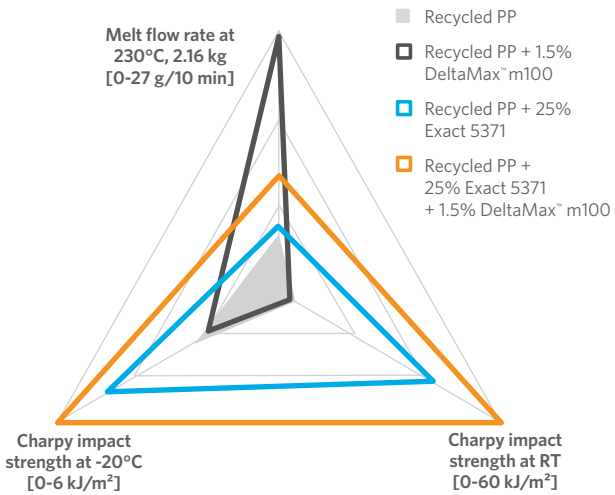
These outstanding results come from the dual formulation enabled by Milliken and ExxonMobil's collaboration:

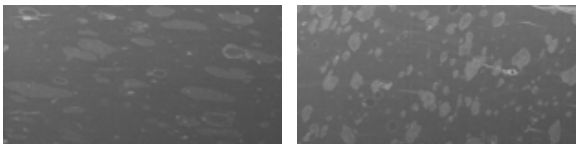
- The rubber-like behavior of Exact™ POE improves impact strength and limits any potential drop in stiffness compared to conventional impact modifiers.
- DeltaMax performance modifiers improve flow rate and boost impact further through compatibilization of the matrix-rubber interface, thus allowing for better particle dispersion and smaller particle size.

"We harnessed the synergy between Exact™ Polyolefin Elastomers and DeltaMax to enable developing critical automotive parts that incorporate post-consumer rPP," shared Dr. Philippe Scheerlinck, Senior Market Development Manager for Milliken's Chemical Business. "Allowing the creation of viable rPP compounds that deliver sustainability benefits across the value chain is a major win, and we're proud to play a role in solving this challenge together with our partners at ExxonMobil."

"Collaboration between Milliken and ExxonMobil is key to unlock opportunities of developing post-consumer rPP in automotive parts," said Sébastien Dessenne, Automotive Program Manager at ExxonMobil. "Creative solutions to boost performance of PP compounds containing post-consumer rPP are highly expected by Automotive OEMs to meet their own sustainability goals and increase the usage of recycled content."

Strength, stiffness and MFR for various recycled PP formulations





Scanning electron microscopy images show more finely dispersed and uniform size of ethylene-based polymeric islands in the recycled PP matrix when modified with Exact POE and DeltaMax performance modifiers (right) compared to unmodified recycled PP (left).

ExxonMobil solutions and properties for recycled PP applications

	Melt flow rate at 230 °C, 2.16 kg (g/10 min)	Density (g/cm³)	Improved impact at RT	Improved impact at -40 °C	Flow rate improve-ment	Balances stiffness and toughness	Compatibilize PP and PE
Exact™ 5171	2.3	0.868	■	■		■	
Exact™ 5371	10	0.868	■	■		■	
Vistamaxx™ 6102	3	0.862	■				■
Vistamaxx™ 6202	20	0.862	■		■		■

Milliken solutions

Deltamax Performance Modifiers	Type
DeltaMax f500	All Purpose Modifier
DeltaMax i300	Impact Enhancer
DeltaMax a200	All Purpose Modifier
DeltaMax m100	Melt Flow Modifier

Contact us for more information
chemical.milliken.com/contactus