Milliken®

DeltaMax®

Performance Modifiers for Polypropylene

CASE STUDY

Enhancing recycled polypropylene performance and processability

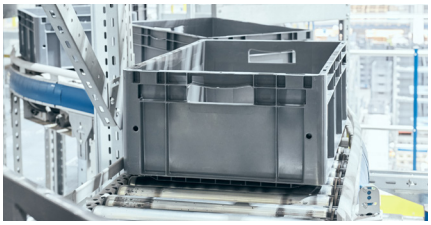
Challenge

Post-consumer recycled (PCR) polypropylene (PP) frequently has low impact strength combined with average stiffness, and often contains non-PP polymer contaminants which can further affect its properties. Many end-use applications for recycled PP, however, including pails and buckets, and larger containers for Home and Garden and DIY goods, require a higher impact and better stiffness-impact balance than is typically available in the market.

Milliken & Co.'s Chemical Business has grown into a leading supplier of advanced additives, colorants, and specialty and reactive silicone-based intermediates and fine chemicals. Brand owners and converters are using Milliken's plastic additives portfolio to help balance and enhance the properties and processability of mechanically recycled PP.

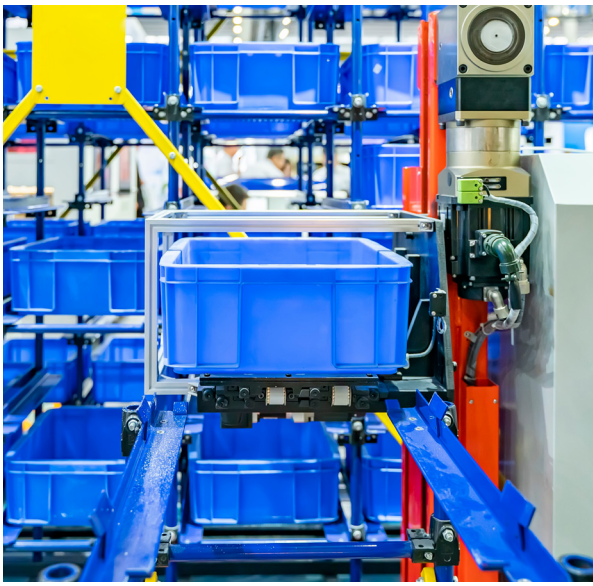
While flow modifiers can be used to enhance melt flow rate (MFR) and reduce injection molding conversion costs, it is often at the expense of impact strength. And while impact strength can be enhanced using standard rubber-like impact polymer modifiers, this is often at the expense of stiffness.

Milliken and ExxonMobil collaborated on the development of a solution which would meet the market's requirements. Working together, the companies developed trial formulations that included DeltaMax performance modifiers from Milliken and Exact™ polyolefin elastomers (POE) from ExxonMobil.



Solution

To help achieve the target impact resistance balanced with the right stiffness and melt flow, 2.5% to 7% of Exact POE were added to a formulation which included DeltaMax performance modifiers.



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**

ExxonMobil

milliken.com

ExxonMobil

Milliken

DeltaMax®

Performance Modifiers for Polypropylene

Three compounding trials were conducted. Compounds were molded into dumbbell-shaped samples which were then tested for flexural modulus (stiffness), impact strength and MFR.

Exhibiting rubber-like characteristics, Exact™ POE help improve the impact strength of recycled PP while maintaining a desired level of stiffness for enhanced product properties. DeltaMax performance modifiers increase flow rate for improved processability and can further boost impact strength, especially when used in combination with Exact POE.

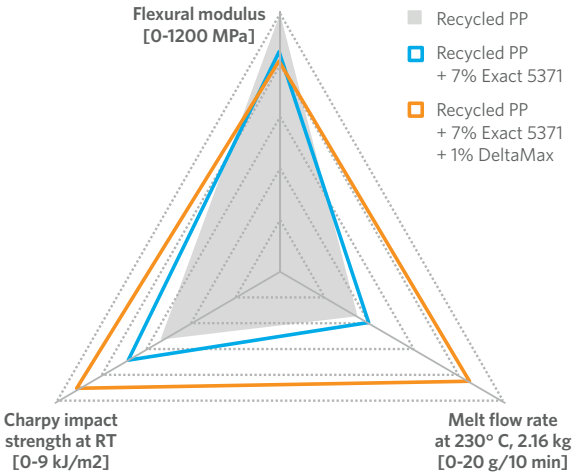
"Working collaboratively, we developed and tested a solution that included recycled PP with Exact POE and DeltaMax performance modifiers in the formulation," said Dr. Philippe Scheerlinck, Senior Market Development Manager, Milliken & Company. "Compared with other market reference polymer modifiers, tests proved that the solution delivers a unique combination of enhanced impact strength and high melt flow for excellent processability, while stiffness is maintained."

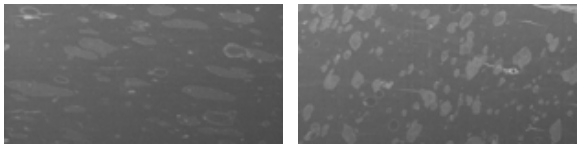
Results

Combining Exact POE with DeltaMax performance modifiers offer recycled PP producers and converters the potential to shorten injection molding production cycle times, while making high quality parts with an exceptional stiffness- impact balance.

"The final solution broadens the potential use of recycled PP to more demanding applications, while production output can be increased and cost savings realized through the use of recycled PP," said Scheerlinck. "It just shows the results that collaboration can deliver, and we look forward to helping our value chain customers develop sustainable solutions for a range of demanding applications."

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

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

Please contact your Milliken representative for further product information including chemical registrations, food contact status, and other regulatory details.
PLEASE NOTE: As each customer's use of our product may be different, information we provide, including without limitation, recommendations, test results, samples, care/labeling/processing instructions or marketing advice, is provided in good faith but without warranty and without accepting any responsibility/liability. Each customer must test and be responsible for its own specific use, further processing, labeling, marketing, etc. All sales are exclusively subject to our standard terms of sale posted at www.milliken.com/terms (all additional/different terms are rejected) unless explicitly agreed otherwise in a signed writing.