

For TIER 1/Part Manufacturer

The improved polyolefin elastomer designs of the ENGAGE™ 11000 series can contribute to more efficient processing of TPO compounds in different ways.

Talc-filled TPO compounds with different filler levels are often produced from high-impact polypropylene resins. In order to meet stringent toughness requirements at -30°C and even lower temperatures, they are further modified with ENGAGE™ polyolefin elastomers. Typically there is a compromise between very high impact resistance and very high flow of the resulting TPO compound.

The new ENGAGE™ 11000 series provides higher rubber efficiency in the TPO, improving compatibility for the rubber components from the polypropylene and the polyolefin elastomer itself. A reduced amount of added polyolefin elastomer helps to improve the compound flow, the use of a higher flow polyolefin elastomer at that reduced addition level can boost the flow properties further. That was demonstrated in an injection molding study carried out by Dow; the results of a filling study are shown in Figure 3.

Another aspect of the polymer design of the ENGAGE™ 11000 series is the combination of a low glass transition range with high temperature melting and crystallization, a feature for all three new products. Figures 1 and 2 give an example and illustrate the DSC* heating and cooling curves of TPO compounds with ENGAGE™ 11547 and ENGAGE™ 8200, both with a similar flow.

Thermal properties of filled TPO compounds

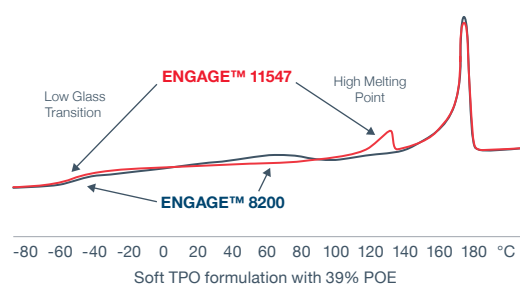


Figure 1: Lower glass transition and higher melting range for ENGAGE™ 11547 compared to ENGAGE™ 8200.

Thermal properties of filled TPO compounds

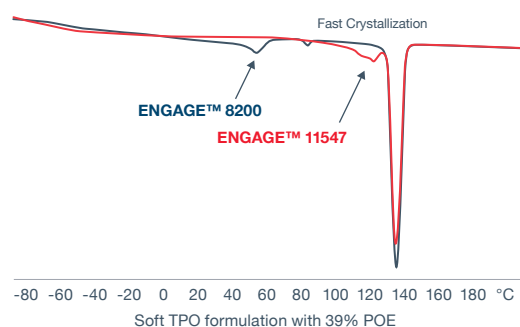


Figure 2: Higher crystallization temperature for ENGAGE™ 11547 compared to ENGAGE™ 8200.

Mold filling study for filled TPO compounds





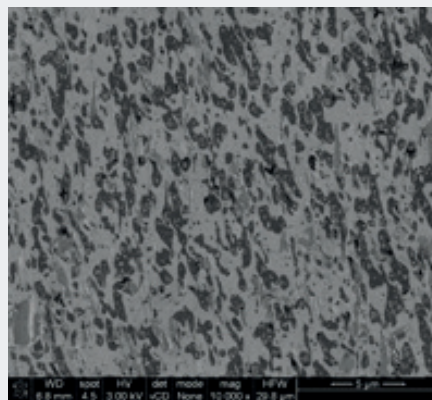
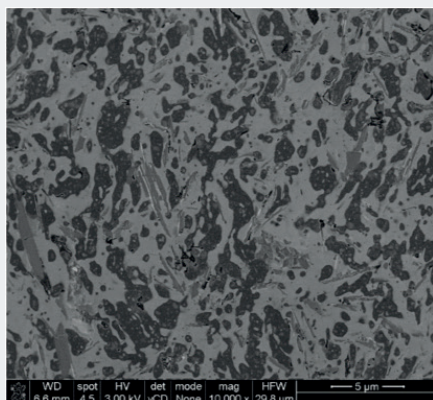
Product name	Melt index at 190°C/2.16kg (g/10 min)	Density (g/cm³)	Max flow at 220°C (mm)	Mold filling study for filled TPO compounds
ENGAGE™ 11567 13.5%	1	0.866	434	
ENGAGE™ 8200 15%	5	0.870	454	
ENGAGE™ 11547 13.5%	5	0.866	457	
ENGAGE™ 11527 13.5%	15	0.866	480	

Figure 3: Improved TPO compound flow for ENGAGE™ 11527 in hard TPO with 20% talc filler, reduced addition level compared to ENGAGE™ 8200 reference.

Hard TPO Morphology

15% ENGAGE™ 8100 reduced to 13.5% ENGAGE™ 11567



A finer morphology with improved rubber dispersion and smaller domain size can be achieved when using a product from the ENGAGE™ 11000 series. Figure 4 shows an example of a hard TPO with 20% talc filler.

In order to prove the hypothesis – that the development of a well-defined crystallinity as part of the rubber morphology during the injection molding of a TPO part, specifically the faster solidification during the cooling process, can result in reduced cycle times – was tested in an injection molding trial. An ENGEL Duo 700 machine was used to produce test parts with dimensions 920x80x45mm, a part weight of 730g and 2mm wall thickness across a complex geometry. With two injection points conditions were chosen to achieve a maximum flow path of 580mm, at a melt temperature of approximately 220°C. The goal was to study the influence of polyolefin elastomer design on part stability during cooling and demolding, trying to reduce the initial cycle time of 47 seconds.

Figure 4: Finer morphology for ENGAGE™ 11567 compared to ENGAGE™ 8100 (left).

Cooling time (Sample)	15 seconds	13 seconds	11 seconds	9 seconds	7 seconds
ENGAGE™ 11567					
ENGAGE™ 8200					
ENGAGE™ 11547					
ENGAGE™ 11527					

Figure 5: Improved cycle time due to lower cooling time for ENGAGE™ 11527, 11547 and 11567 in hard TPO with 20% talc filler, reduced addition level compared to ENGAGE™ 8200 reference.

TMA Indentation

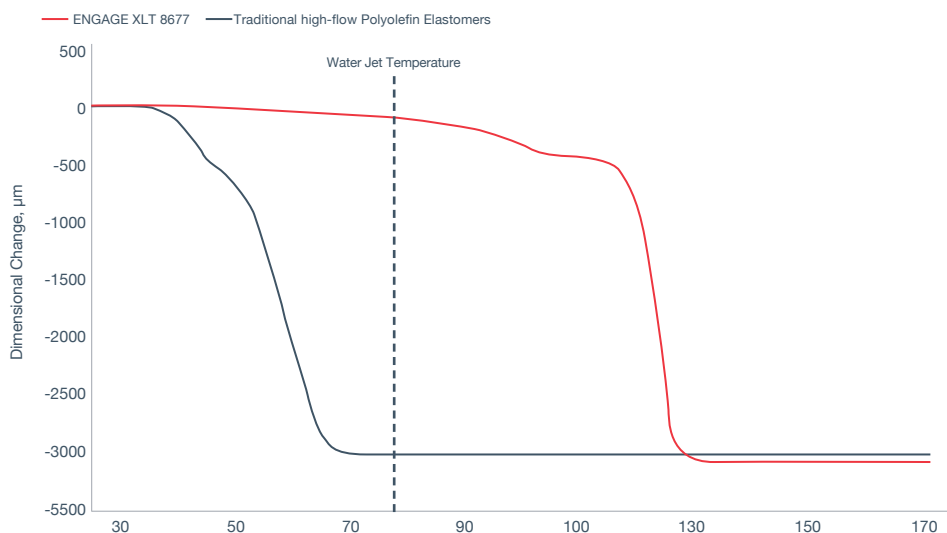


Figure 6: Improved temperature resistance for ENGAGE™ 11000 series with high melting point.

We observed a correlation between cooling time and cycle time and consequently lowered cooling time until the part quality was no longer sufficient. That was the case when ejector marks became visible after reducing the cooling time too much. Results are summarized in Figure 5.

The rapid crystallization of the rubber phase enables TPO compounds that require less cooling and can be processed at reduced cycle time. For a total cycle time of 40 to 45 seconds under the given conditions we achieved around 10% reduction due to faster cooling.

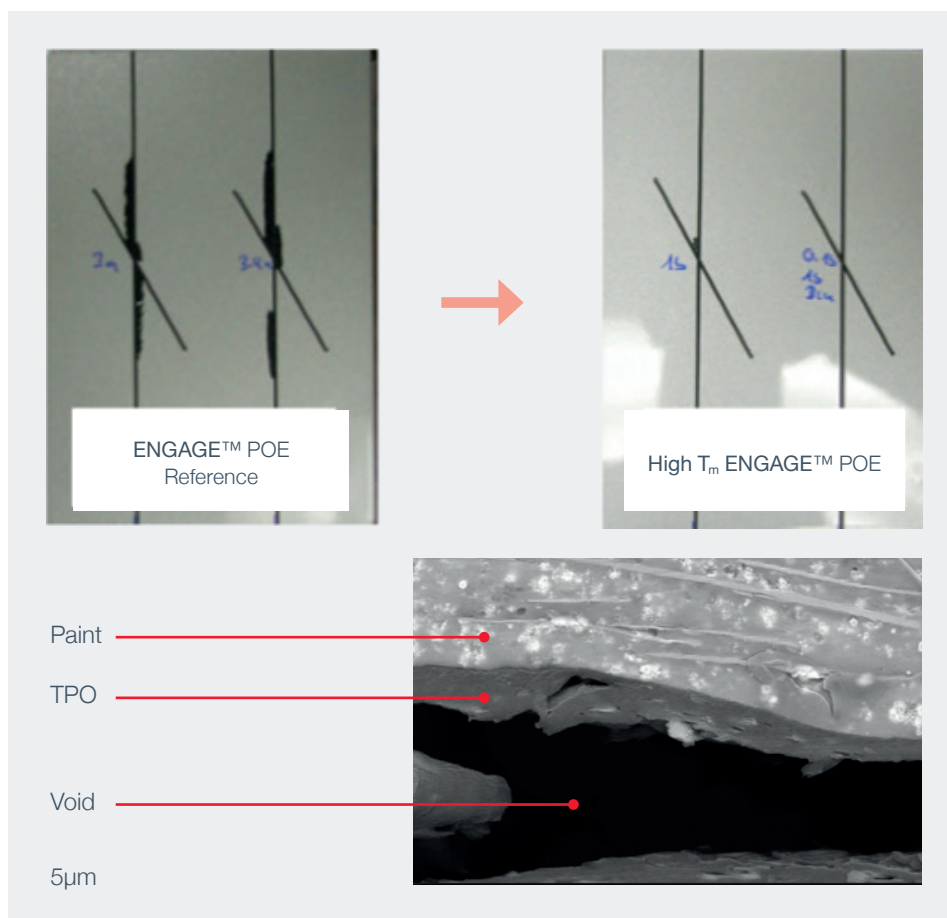


Figure 7: Improved paint adhesion for TPO compounds using ENGAGE™ Polyolefin Elastomer with high melting point.

Improved paintability with the ENGAGE™ 11000 series

After injection molding many TPO parts are painted with two-layer or three layer systems. One of the reasons to continue three layer painting is the difficulty to pass most stringent paint adhesion requirements, typically tested in a water jet test under defined conditions. Figure 6 illustrates how the temperature resistance of ENGAGE™ polyolefin elastomers correlates with their melting temperature.

The well-dispersed crystallinity and high melting temperature of the ENGAGE™ 11000 series can provide significantly improved paint adhesion as part of a TPO compound. Figure 7 shows results of a water jet testing for painted TPO parts. The micrograph shows the intact interface between paint layer and TPO after the test.

The improved paint adhesion with the next generation impact modifiers from the ENGAGE™ 11000 series opens up opportunities for two layer paint systems and more efficiency in the painting step of car manufacturing.



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Form number: 777-094c-01 -EMP

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