CRAY VALLEY
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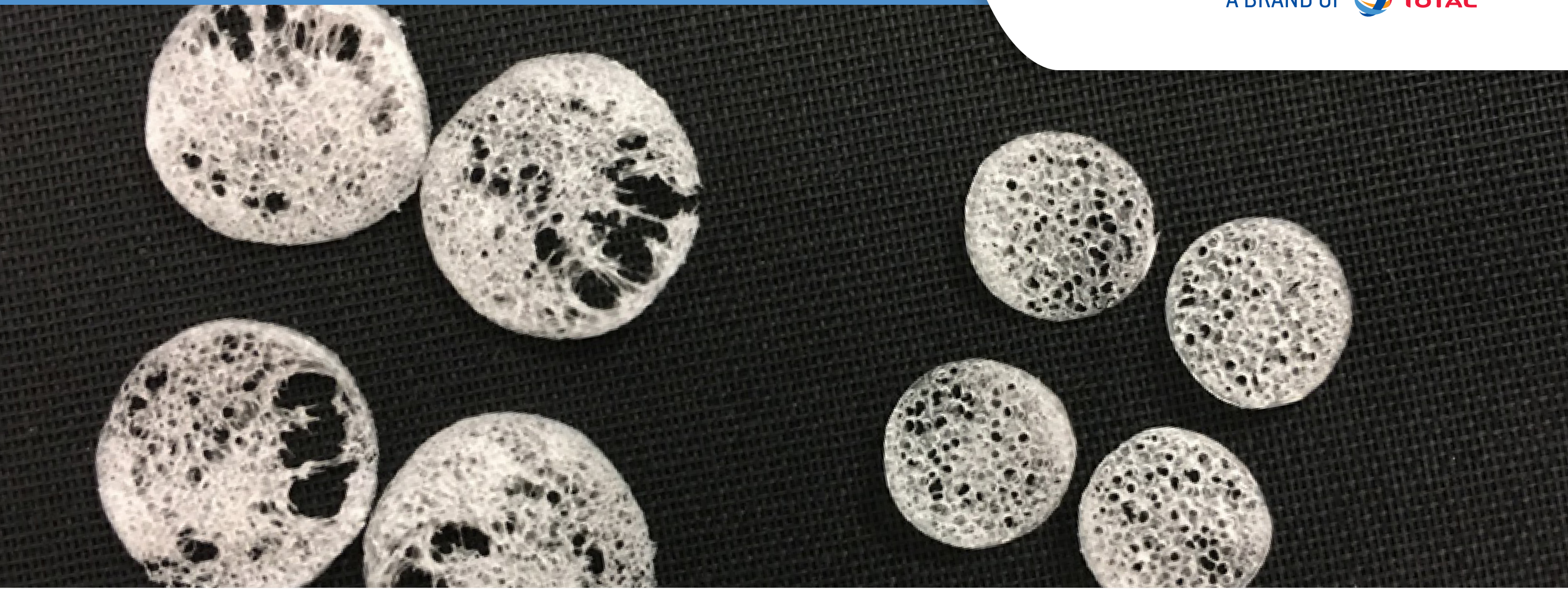

BENEFITS

- Melt strength improvement in extrusion processes
- Extrusion stability in foaming process
- Improved melt stretching and drawing characteristics

TARGET MARKETS/ APPLICATIONS

- Extruded foam
- Thermoforming
- Extrusion coating
- Blow molding
- Blown film
- Melt blown/spun bonded fibers

ADDITIONAL INFO

- **SDS:** Dymalink® 9200 SDS
- **Technical Update:** Dymalink® 9200 for Customizable High-Melt-Strength Polypropylene

Rheological Modification of Polyolefins Using Dymalink® 9200

Description

Polypropylene (PP) is a semi-crystalline polymer with a sharp melting point. Above its melting point, most PP grades exhibit a low melt strength. This limits the use of standard PP in applications where melt stretching or drawing are critical such as extruded foam, blow molding, thermoforming, extrusion coating and profile extrusion.

Traditionally, to overcome the lack of melt strength, high-melt-strength polypropylene (HMS-PP) is added at levels between 10-50%. For extruded foam, the addition levels are even higher. The HMS-PP products are based on the chemical incorporation of high levels of long chain branches chemically linked to the polymer backbone. Other strategies have been proven efficient but introduce large amounts of low-molecular weight by-product into the polymer.

Introduction

Dymalink® 9200 is an acrylate functional zinc salt that reacts with aliphatic polymers to form a carbon-carbon covalent link. The polar zinc cations tend to assemble into ionic clusters within the polymer matrix, promoting the formation of a dynamic network as illustrated in Figure 1. This network promotes melt strength behavior even at very low loadings.

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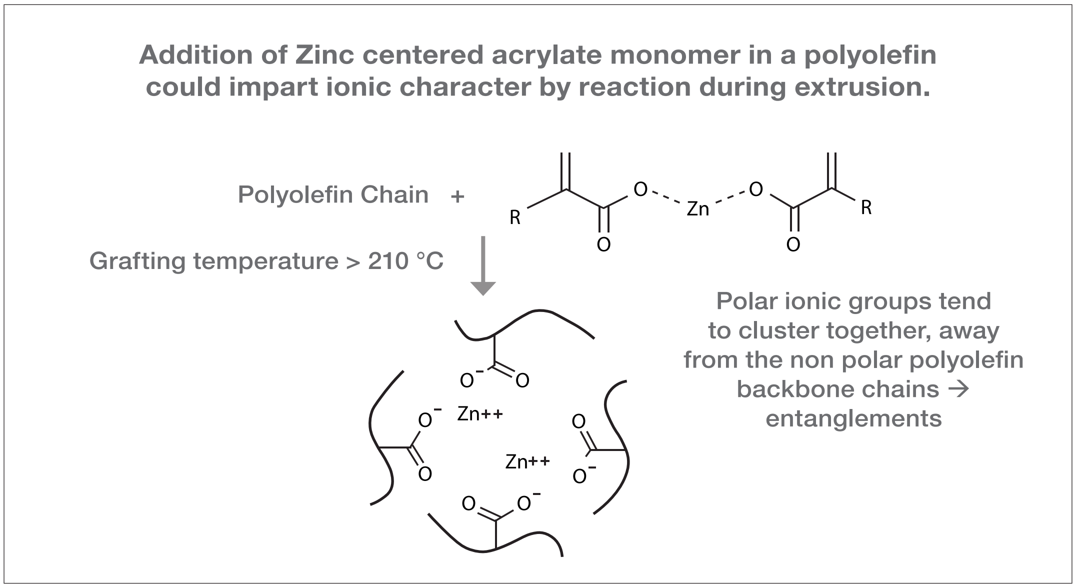


Figure 1: Schematic of the ionic cross-linking system.

Experimental

A 25 MFI PP copolymer and a 2.8 MFI PP homopolymer were compounded with various levels of Dymalink in a 20 mm Brabender twin-screw extruder with the following temperature profile from inlet to die: 20 - 190 - 200 - 210 - 210 - 210 °C. The extrudate was pelletized, then tested using a 25 mm parallel plate geometry on a TA Instruments DHR-2. Frequency sweeps were measured at 190 °C. Storage moduli (G') and loss moduli (G") were calculated from these curves. A lower crossover frequency indicates more entanglements (higher relaxation times). Figure 2 is an example of the rheological graph generated by this method.

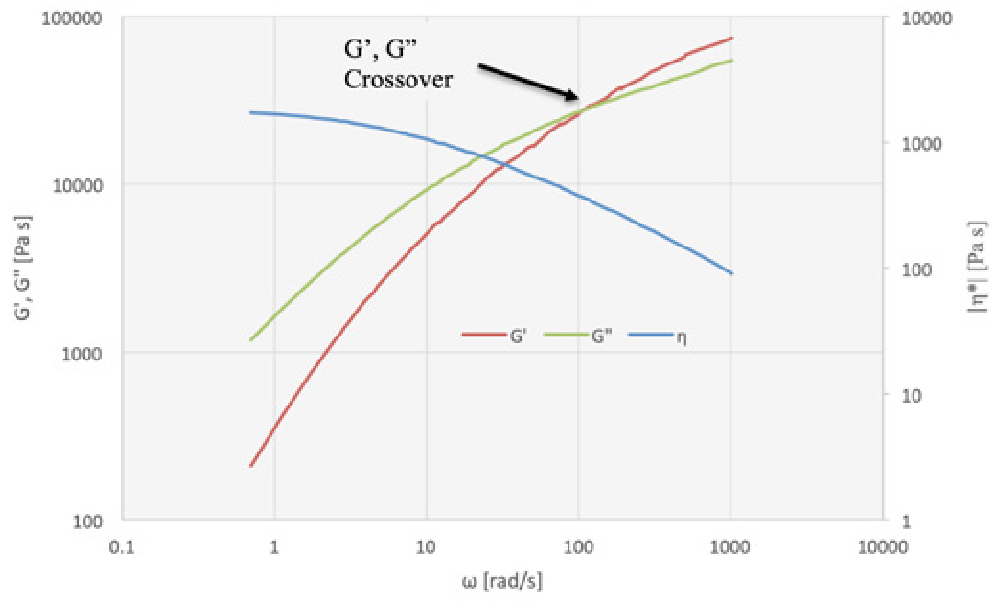


Figure 2: Rheologic graph of showing storage modulus (G'), loss modulus (G") and complex viscosity (|η*|).

The G', G" crossover frequency is an indication of melt strength. When Dymalink 9200 is reacted into PP (210 °C) the G', G" crossover frequency decreases. This suggests that Dymalink is creating an ionic network in the modified PP. Tables 1 and 2 compare the Dymalink modified PPs to a blend of PP with 20% commercial HMS PP. Compounds containing low levels of Dymalink impart more melt strength than blends containing HMS PP. This is the case for both PP copolymer and PP homopolymer compositions as shown in Table 1 and Table 2 respectively.

Table 1: G', G" crossover frequency of a PP copolymer at 190 ˚C.

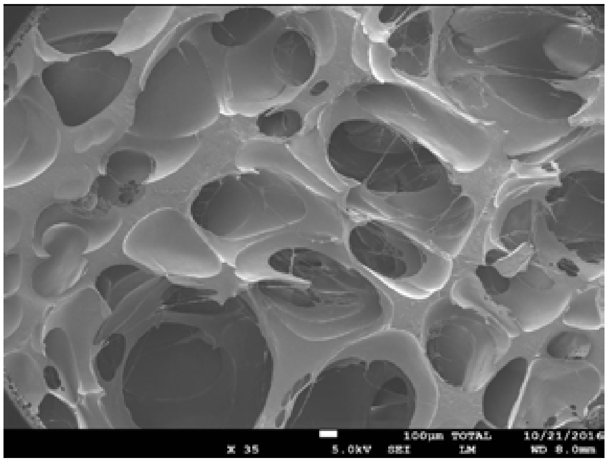
	G', G" crossover frequency rad/s
PPC 9760 (25 MFI)	248
1% DL9200	205
2% DL9200	200
3% DL9200	167
20% HMS PP	180

Table 2: G', G" crossover frequency of a PP homopolymer at 190 ˚C.

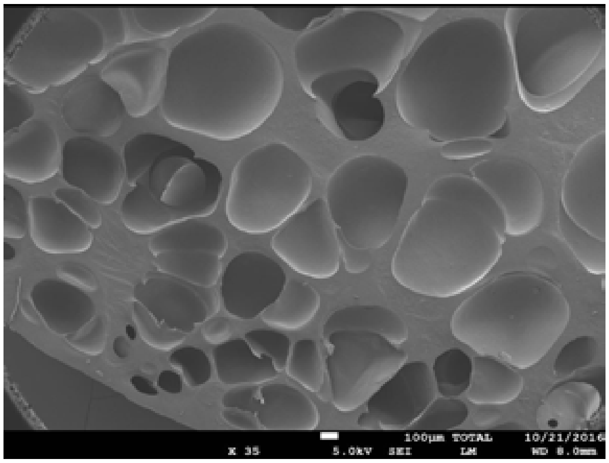
	G', G" crossover frequency rad/s
PPH 3371 (2.8 MFI)	36.7
1% DL9200	16.1
2% DL9200	15.8
3% DL9200	15.0
4% DL9200	14.3
20% HMS PP	16.4

Physical Foaming

To demonstrate the effect of Dymalink on melt strength, a physical foam trial was performed. Extrusion-grade PP (3.5 MFI) was compounded with and without 1% Dymalink 9200. Materials were processed on a single screw extruder at 240 °C (465 °F) with a static mixer feeding CO_2 liquid at 130 bar (1900 PSI). Compared to the control, the Dymalink sample exhibited a smooth surface appearance with better foam morphology, indicating successful foaming. The compound without Dymalink has poor cell morphology, indicated by open cell content, irregular cell sizes, and poor surface morphology. The cell structure of the Dymalink sample is homogenous with good closed cell content. Figure 3 shows SEM images of the material without and with Dymalink respectively.



SEM image of conventional PP processed with 0.6 mL/min CO_2 at 130 bar die pressure.



SEM image of conventional PP modified with 1% Dymalink® 9200 processed with 0.6 mL/min CO_2 at 130 bar die pressure.

Figure 3: SEM images of cell structure of foamed PP without and with Dymalink® 9200.

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Summary

The addition of Dymalink® 9200 to conventional PP improves its melt strength, allowing for improved processability in conversion operations such as extruded foam, thermoforming, extrusion coating, blow molding, and profile extrusion. An example of this effect was illustrated for extruded foam. Low-level addition of Dymalink to PP homopolymer leads to more homogenous cell structure and good closed cell content. Dymalink 9200 allows converters flexibility to tailor compounds to their specific end use needs versus the use of conventional HMS-PP in foaming applications. These materials are now commercially available globally.

About TOTAL Cray Valley

TOTAL Cray Valley is the premier global supplier of specialty chemical additives, hydrocarbon specialty chemicals, and liquid and powder tackifying resins used as ingredients in adhesives, rubbers, polymers, coatings, and other materials. TOTAL Cray Valley has pioneered the development of these advanced technologies, introducing hundreds of products that enhance the performance of products in energy, printing, packaging, construction, tire manufacturing, electronics, and other demanding applications.

For more information, please visit **www.crayvalley.com**.

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