Enhancing the Value of Barrier Film Recycle Streams with Dow’s Compatibilizer Technology
Introducing Effective Recycle Compatibilizer Technology

The Need
Every year, millions of pounds of barrier film scrap are generated globally,* with most being sent to landfills or sold for very little value. Why? Because without a compatibilizer, pelletized barrier film scrap containing polar polymers – such as EVOH or Polyamide – will not finely disperse into the polyolefin matrix for recycle or reuse.

There have been numerous attempts to find an adequate compatibilizer, but all have resulted in poor processability and insufficient optical properties – two critical performance requirements for many converters.

The Answer
With the development of RETAIN™ Polymer Modifiers, a set of distinctive functional polymers, these problems are being successfully addressed, and the sustainability benefits and exceptional economies of recycling barrier scrap into high-quality films may now be realized.

Dow’s innovative recycle compatibilizer technology is based on a reactive, ultra-low viscosity compatibilizer. Reactive groups “coat” the polar components, encapsulating them into micro-domains to enable excellent dispersion. When blended at specified ratios with pelletized barrier film recycle streams, the RETAIN™ polymers allow converters to recycle barrier film trim back into film production without sacrificing optical or physical properties.

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The Benefits

The benefits are many, including potential sustainability aspects and considerable cost savings:

- Opportunity to make better use of recycle stream (versus selling for low value or landfiling)
- May eliminate or reduce costs associated with collecting, packaging, and selling scrap
- Could reduce costs by utilizing scrap for bulk layer

- Potential to meet your company or industry sustainability goals (e.g., “Zero-Landfill” objectives)
- Option to make post-industrial recycle content claims

Theory In Practice

The first products in the new family of RETAIN™ Polymer Modifiers are coming to market now. XUS 69108.01™ Developmental Polymer Modifier is now available and will be commercialized this fall as RETAIN™ 3000 Polymer Modifier. Others are in the pipeline.

Suggested Use

Blend the recycle compatibilizer during repelletizing of the barrier film or during the film production.

Recommended Loading Level

- Compatibilizer should be loaded at 1:1 ratio of compatibilizer to % barrier in scrap.
- Generally, a 2-15% compatibilizer loading is suggested based on:
  - % barrier in scrap
  - % loading in new article
  - critical performance requirements (optics, gels, etc.)

Example: 30% Nylon in scrap, desire to load 50% scrap in core layer = 15% Nylon, 15% Compatibilizer

Processing Conditions

- Drying is critical prior to reprocessing
- Extruder feed zone temperature 60-100˚ C

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Figure 1: Recycle Stream Containing PA

<table>
<thead>
<tr>
<th>CORE LAYER</th>
<th>Recycle stream (containing 30% PA)</th>
<th>Virgin PE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:1</td>
<td>60%</td>
<td>18%</td>
</tr>
<tr>
<td></td>
<td>XUS 69108.01™ Developmental Polymer Modifier</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Recycle stream is 30% nylon</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Recycle to be used at 60% in layer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Add XUS 69108.01™ Polymer Modifier at 18% to recycle stream</td>
<td></td>
</tr>
</tbody>
</table>

Figure 2: Recycle Stream Containing EVOH

<table>
<thead>
<tr>
<th>CORE LAYER</th>
<th>Recycle stream (containing 10% EVOH)</th>
<th>Virgin PE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:1</td>
<td>60%</td>
<td>12%</td>
</tr>
<tr>
<td></td>
<td>XUS 69108.01™ Developmental Polymer Modifier</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Recycle stream is 10% EVOH</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Recycle to be used at 60% in layer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Add XUS 69108.01™ Polymer Modifier at 12% to recycle stream</td>
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</table>
**Gel Reductions**

As shown in Figures 3 and 4 — the series of micro-photos — the use of XUS 69108.01<sup>™</sup> Polymer Modifier significantly reduces gels in films produced from barrier film recycle streams as compared to other options.

The gels seen below in the control films are formed by EVOH and PA particles that have not dispersed into the PE matrix.

**Optical Properties**

As shown in Figures 5 and 6, incorporating XUS 69108.01<sup>™</sup> Polymer Modifier as a compatibilizer in EVOH- and PA-based recycle stream has demonstrated the opportunity to achieve the same clarity as the control film.

**Physical Properties**

As shown in Figures 7 and 8, incorporating XUS 69108.01<sup>™</sup> Polymer Modifier in EVOH- and PA-based recycled content has demonstrated the opportunity to maintain mechanical properties, particularly maintaining or increasing dart values.

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**Figure 3: Transmission Electron Microscopy**

<table>
<thead>
<tr>
<th>No Compatibilizer</th>
<th>Conventional Compatibilizer</th>
<th>XUS 69108.01&lt;sup&gt;™&lt;/sup&gt; Modifier Polymer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large EVOH domains</td>
<td>Bimodal EVOH domains</td>
<td>Small, uniform EVOH domains</td>
</tr>
</tbody>
</table>

**Figure 4: Optical Microscopy**

<table>
<thead>
<tr>
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<th>Conventional Compatibilizer</th>
<th>XUS 69108.01&lt;sup&gt;™&lt;/sup&gt; Modifier Polymer</th>
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</tr>
</tbody>
</table>
Seeing & Feeling is Believing

You can see – and feel – for yourself how films made using RETAIN™ Polymer Modifiers compare to their original counterparts by requesting our film sample cards.

There are two options (for PA and EVOH), and they are both free for the asking. Both documents present comparative data and side-by-side film samples representing an original and a compatibilized film.

To get yours, just ask your Dow sales or TS&D professional for the folder(s) you want.

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**Figure 5:** Comparative optical properties of PA-based barrier film recycle streams (using XUS 69108.01 Polymer Modifier as the compatibilizer)*

**Figure 6:** Comparative optical properties of EVOH-based barrier film recycle streams (using XUS 69108.01 Polymer Modifier as the compatibilizer)*

**Figure 7:** Comparative physical properties of PA-based barrier recycle streams (using XUS 69108.01 Polymer Modifier as the compatibilizer)**

**Figure 8:** Comparative physical properties of EVOH-based barrier film recycle streams (using XUS 69108.01 Polymer Modifier as the compatibilizer)**

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*2 mil films; Control PE Film: Contains 30% PA6; Film with no Recycle Compatibilizer: DOWLEX™ 2056G/Control PE Film with 30% PA6/DOWLEX™ 2056G (15:70:15); Film with Recycle Compatibilizer 1:1 Ratio: DOWLEX™ 2056G/77% Control PE Film with 30% PA6 + 23% Recycle Compatibilizer/DOWLEX™ 2056G (15:70:15); Data per Dow Tests; Additional information available upon request; Typical properties, not to be construed as specifications.

**2 mil films; Control PE Film: Contains 10% EVOH; Film with no Recycle Compatibilizer: DOWLEX™ 2056G/Control PE Film with 10% EVOH/DOWLEX™ 2056G (15:70:15); Film with Recycle Compatibilizer 2:1 Ratio: DOWLEX™ 2056G/84% Control PE Film with 10% EVOH + 16% Recycle Compatibilizer/DOWLEX™ 2056G (15:70:15); Data per Dow Tests; Additional information available upon request; Typical properties, not to be construed as specifications.

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Commercial and developmental products in the family of RETAIN™ Polymer Modifiers are now available for trials. To assist you in achieving optimum results, Dow offers two trial options:

1. Provide Dow with your film scrap and we will run trials at the Pack Studios facilities (Freeport, Texas) and present the results using a range of mix ratios.

2. Order a sample and your Dow TS&D professional will help to determine the best scrap-to-compatibilizer ratio based on your existing barrier recycle stream and desired results.

Samples Are Ready. Make arrangements through your Dow sales or TS&D representative to choose the option you prefer. We look forward to sharing this exciting technology with you.
Coming Soon:

Innovative Acrylic Bead Technology for Matte Coatings

A New Family Member for SEALUTION™ Peel Polymers

**Opulux.**

**Sealution.**

In our next *Packed with Performance* newsletter, we’ll introduce an exciting new product that brings an innovative acrylic bead technology to the marketplace. **OPULUX™ Optical Finishes** represents new technology delivered in coating form through the design of highly engineered uniform acrylic beads in combination with acrylic-based carrier emulsion technology.

Designed for excellent wear and abrasion resistance on packaging films and label surfaces, these engineered acrylic beads are delivered in aqueous form for coating using conventional application technologies and equipment such as gravure coating.

The use of this acrylic bead technology and polymer design can help package makers and brand owners create distinctive, luxurious finishes for packaging and labels that provide a soft touch with a rich matte look. Conversely, its ability to create a “natural” matte finish allows packages to convey the perception of natural ingredients that consumers are increasingly seeking.

Dow is pleased to announce that a new offering in the family of SEALUTION™ Peel Polymers is imminent. SEALUTION™ 220 Peel Polymer will be available for sale before the end of the year.

Look for more details about this new product in the coming weeks, including an upcoming *Peek at Performance* email and a *Packed with Performance* overview. Additionally, an official announcement will be made during Pack Expo.

**Plan Now for Pack Expo**

November is rapidly approaching, and your friends at Dow are busy planning another excellent time for you in Chicago. We hope you’ll make time to visit us as we bring “The Pack Studios Experience” to McCormick Place.

**The Pack Studios Experience**

While Pack Studios is represented by physical locations around the world, truly, Pack Studios exists wherever ideas are shared. That’s exactly the concept we’re promoting in Chicago, as we invite you to mingle, meet, and see for yourself all that Dow is doing to Collaborate, Innovate, and Accelerate within the developmental process.

**#Pack Talks**

As a hallmark of Pack Studios’ roster of industry professionals aligned to assist our customers, Dow will present the #Pack Talks informational presentations as part of Pack Expo.

**Your Exclusive Get-away**

As always, your visit will offer all of the exclusive benefits of your relationship with Dow – complimentary breakfasts, lunches, happy hours, refreshments, plus comfy seating for lounging and private conference rooms for meetings. Business and pleasure all in one convenient location!

**Hope to See You in Chicago**

We hope you’ll come and enjoy The Pack Studios Experience at Pack Expo.

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