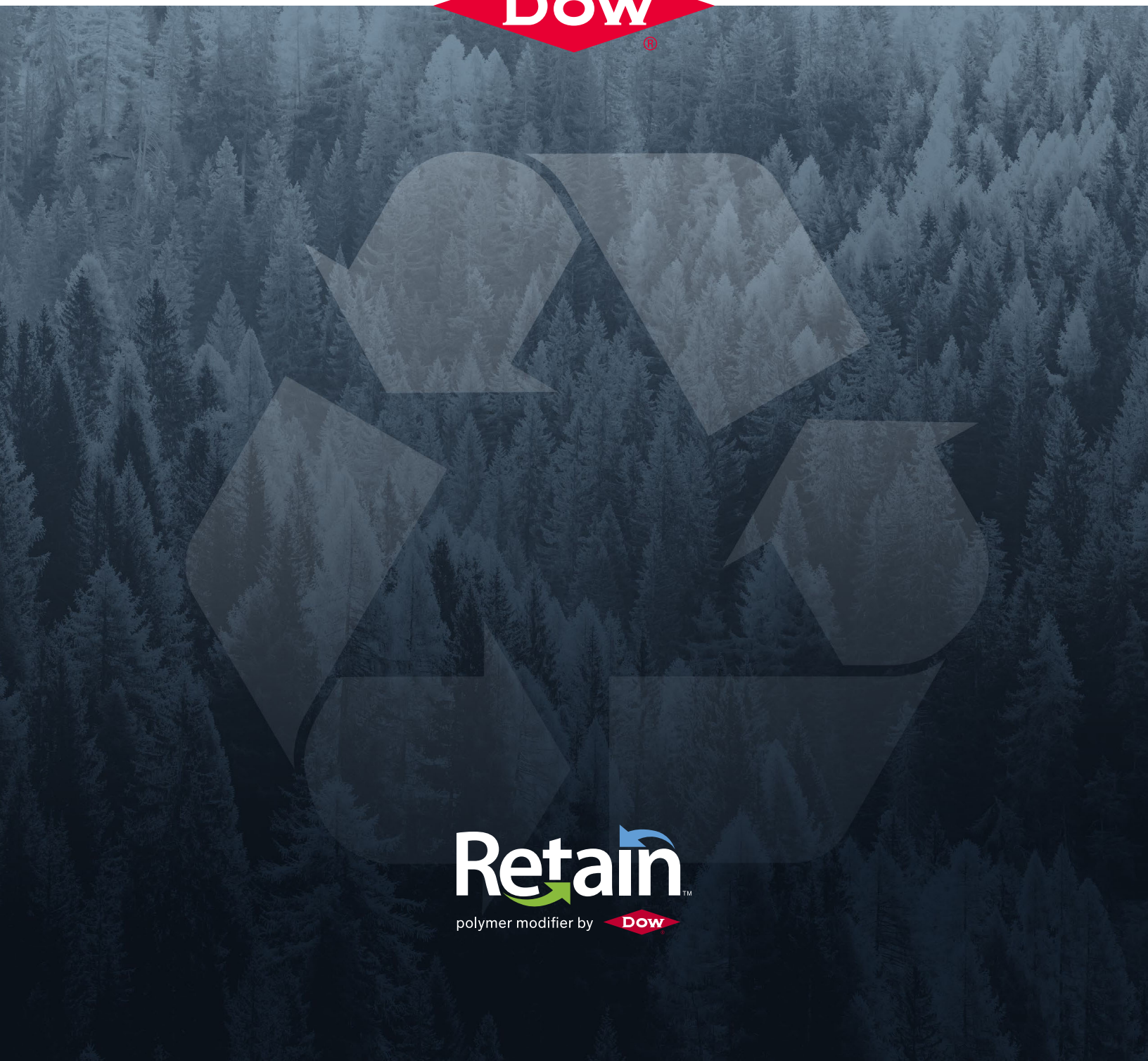
Dow Packaging and Specialty Plastics

Closing the loop on polyolefin-based recycle streams

Enhancing the value of barrier film recycle streams with Dow's compatibilizer technology



Retain™ polymer modifier by Dow

Introducing effective recycle compatibilizer technology

The situation

The food industry is increasingly using barrier packaging to improve a product's shelf life. However, the trims and scraps of these barrier films are not easy to recycle due to the incompatibility of polar and non-polar polymers present in the films. This means that barrier film converters end up giving the scraps away at practically no value, as they are not able to reuse them. At the same time, film converters are paying more attention to resource management and waste reduction at their facilities to increase their profitability.

The solution

Thanks to RETAIN™ Polymer Modifiers from Dow, barrier film converters will be able to recycle up to 100% of their scrap. The cost of the upgraded scrap will be at least 15% less than the cost of virgin polyethylene, without sacrificing optical or mechanical performance.

Seeing a need

Every year, millions of metric tons 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 (PA) – 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.

Finding an answer

With the development of RETAIN™ Polymer Modifiers, a distinctive functional polymer, these problems are being successfully addressed, and the sustainability benefits and exceptional economics 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 polymer. 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™ modifiers allow converters to recycle barrier film trim back into film production without sacrificing optical or mechanical properties.

Retain™
polymer modifier by DOW

ABUSE BARRIER OPTICS

*Dow estimate per overall barrier figures from Barrier Materials 2012-2015 Market Report, Allied Development, 2013.

The benefits

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

- The opportunity to make better use of recycle streams (versus giving scraps away for almost no value or sending to landfills).
- Reducing costs - the upgraded scrap will be at least 15% less than the cost of virgin polyethylene raw material.
- Meeting converters' and industry sustainability goals; aiming to reach zero waste to landfill objectives.

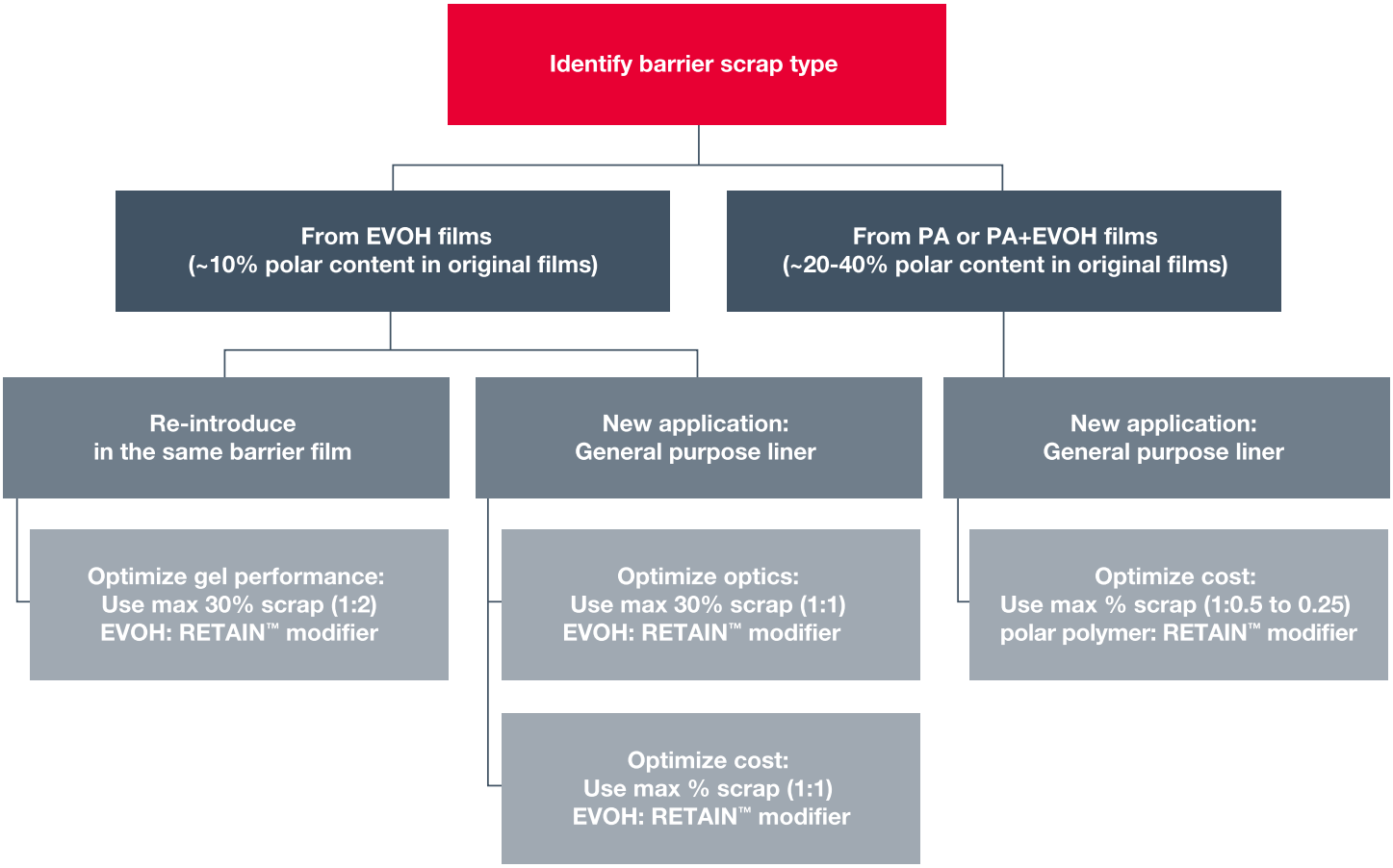
Theory in practice

RETAIN™ 3000 Polymer Modifier, the first product in the family of RETAIN™ compatibilizers, is now commercially available. Additional products are in the pipeline to provide recyclability of other barrier films, beyond EVOH and PA.

RETAIN™ 3000 Polymer Modifier has been trialed with exceptional results, allowing converters to recycle barrier films (trims and scrap) into new films without sacrificing optical or mechanical properties.

The amount of compatibilizer required varies based on the percent of barrier polymer present (% EVOH and/or % PA) in the original barrier film, as well as the target mechanical and optical properties of the new packaging structure. Figure 1 below demonstrates the guidelines to use RETAIN™ Polymer Modifiers based on the type of barrier scrap and new target applications.

Figure 1: Guidelines based on type of barrier scrap and new target application



Guidelines based on type of barrier scrap and new target application

Suggested use

Processing conditions:

Blend RETAIN™ Polymer Modifier into pelletized barrier scraps during new film production; preferably into a core layer of coextruded film.

Moisture of pelletized barrier scraps should not exceed 800 ppm.

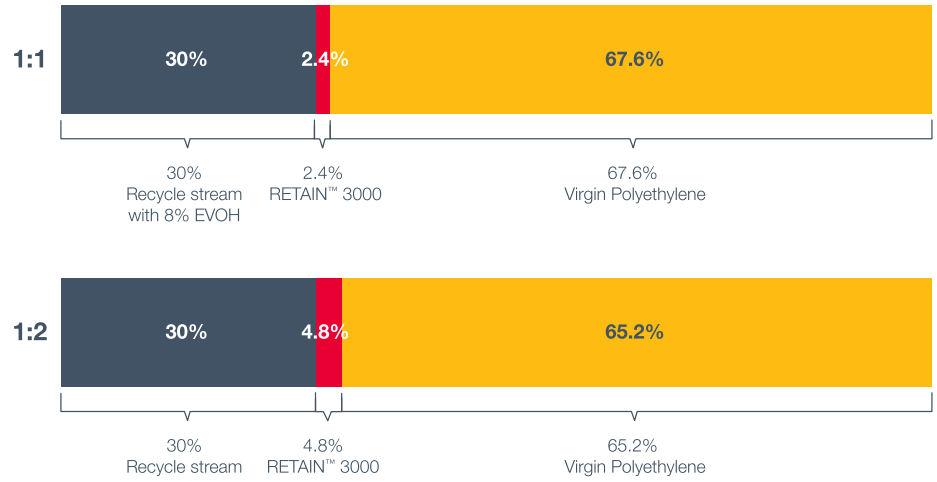
Extruder feed zone temperature should be between 60-100°C.

Recommended loading level:

RETAIN™ Polymer Modifier should be loaded as suggested on Figures 2 and 3 based on:

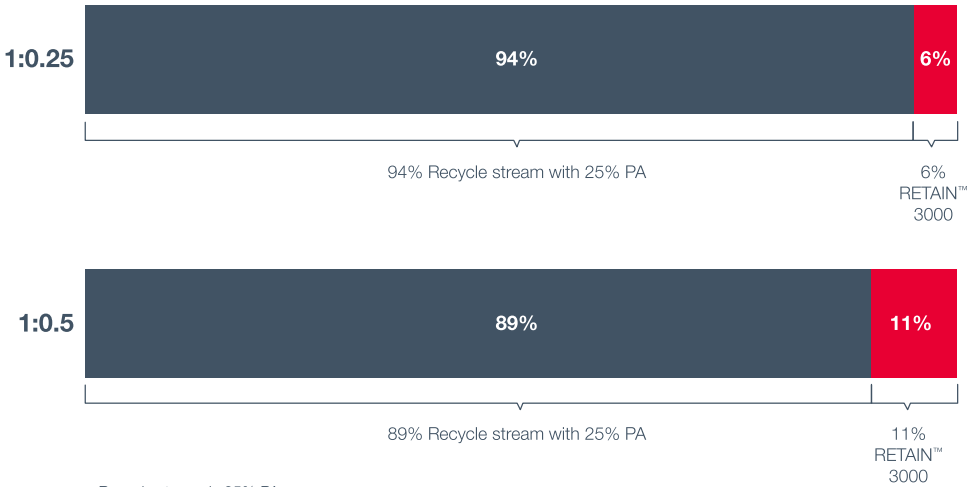
- % of polar polymer present on original barrier scrap
- % loading in new film
- critical performance requirements (gels, optics, mechanical properties)

Figure 2: Loading suggestions for recycle stream containing EVOH



- Recycle stream is 8% EVOH
- Recycle to be used at 30% in layer
- Add RETAIN™ 3000 at 2.4-4.8% to recycle stream
- (1:1 to 2) EVOH : RETAIN™ Polymer Modifier

Figure 3: Loading suggestions for recycle stream containing PA or PA/EVOH



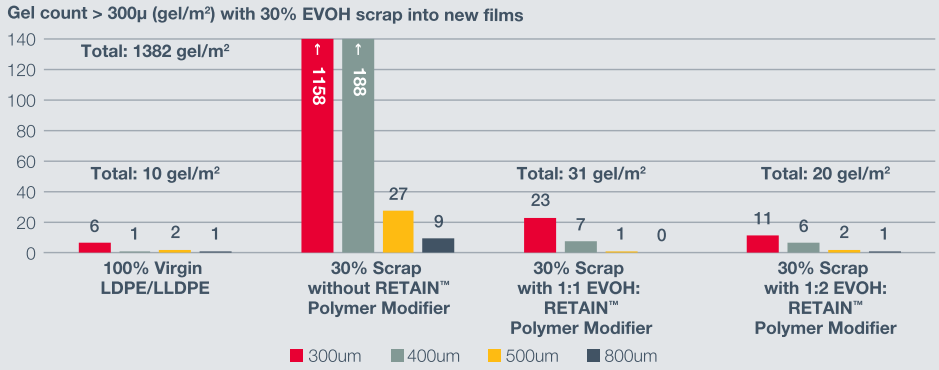
- Recycle stream is 25% PA
- Recycle to be used at maximum % in layer
- Add RETAIN™ 3000 at 6-11% to recycle stream
- (1:0.25 to 0.5) PA: RETAIN™ Polymer Modifier (similar for PA/EVOH)

EVOH-based barrier film recycle streams

Gel reduction

As shown in Figure 4, the total gel area, as well as the size of gels, is significantly reduced when RETAIN™ Polymer Modifier is added as a dry blend to re-pelletized barrier scraps containing EVOH as a polar polymer. Using a higher ratio of EVOH to the RETAIN™ modifier (1:2) for the new target application results in gel quality that allows for the replacement of virgin polyethylene on the same barrier film or for demanding lamination applications.

Figure 4: Comparative gel performance of EVOH based barrier film recycle streams*

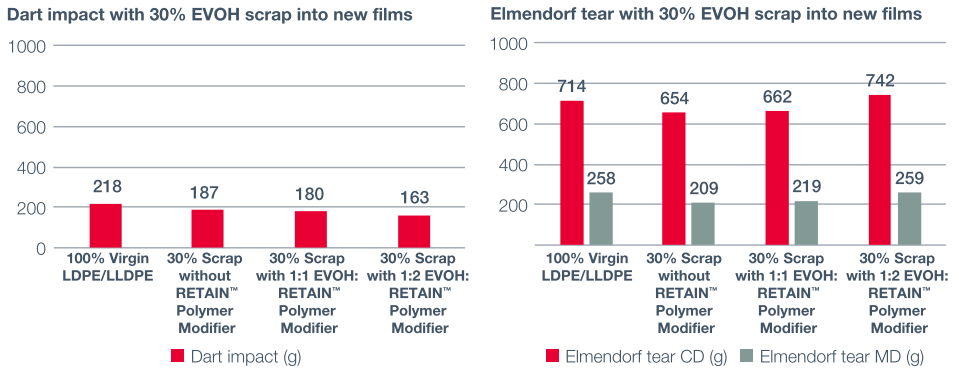


- 50µ films fabricated with 30% scrap barrier films containing 8% EVOH
- 100% Virgin LDPE/LLDPE = reference film
- 30% scrap without RETAIN™ Polymer Modifier = 30% scrap + 70% LDPE/LLDPE
- 30% scrap with 1:1 EVOH : RETAIN™ Polymer Modifier = 30% scrap + 2.4% RETAIN™ 3000 + 67.6 LDPE/LLDPE
- 30% scrap with 1:2 EVOH : RETAIN™ Polymer Modifier = 30% scrap + 4.8% RETAIN™ 3000 + 65.2 LDPE/LLDPE

Mechanical properties

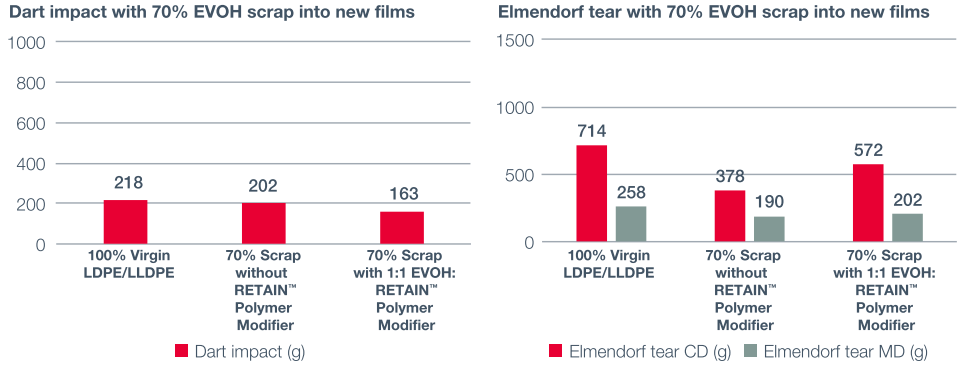
Figures 5 and 6 exhibit the mechanical properties which can be tailored depending on the final film application by using barrier scraps in the core layer.

Figure 5: Comparative physical performance of EVOH based barrier film recycle streams 30% scrap barrier films*



- 50µ films fabricated with 30% scrap barrier films containing 8% EVOH
- 100% Virgin LDPE/LLDPE = Reference Film
- 30% scrap without RETAIN™ Polymer Modifier = 30% scrap + 70% LDPE/LLDPE
- 30% scrap with 1:1 EVOH : RETAIN™ Polymer Modifier = 30% scrap + 2.4% RETAIN™ 3000 + 67.6 LDPE/LLDPE
- 30% scrap with 1:2 EVOH : RETAIN™ Polymer Modifier = 30% scrap + 4.8% RETAIN™ 3000 + 65.2 LDPE/LLDPE

Figure 6: Comparative physical performance of EVOH based barrier film recycle streams 70% scrap barrier films*



- 50µ films fabricated with 70% scrap barrier films containing 8% EVOH
- 100% Virgin LDPE/LLDPE = Reference Film
- 70% scrap without RETAIN™ Polymer Modifier = 70% scrap + 30% LDPE/LLDPE
- 70% scrap with 1:1 EVOH : RETAIN™ Polymer Modifier = 70% scrap + 5.6% RETAIN™ 3000 + 24.4 LDPE/LLDPE

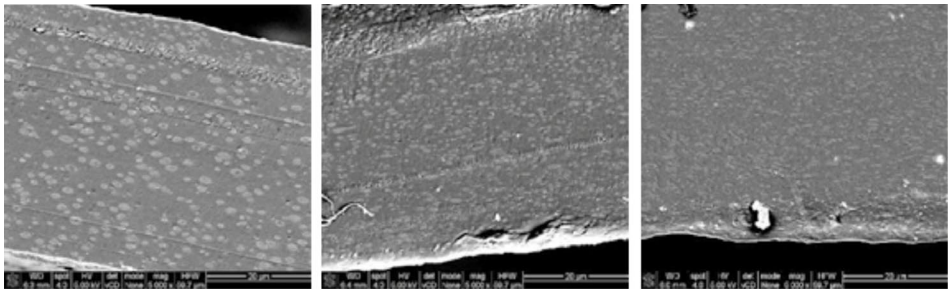
*Dow test, additional information available upon request; typical properties, not to be constructed as specifications

PA- and PA/EVOH-based barrier film recycle streams

Microscopy

As shown in Figure 7, which shows a series of Scanning Electron Microscopy (SEM), the use of RETAIN™ Polymer Modifier significantly enhances the miscibility of the polar polyamide into the non-polar polyolefin from barrier film recycle streams as compared to structures without RETAIN™ Polymer Modifier.

Figure 7: Comparative scanning electron microscopy of PA-based barrier film recycle*



Film with recycle compatibilizer (1:0.25 PA: RETAIN™)

Film with no recycle compatibilizer

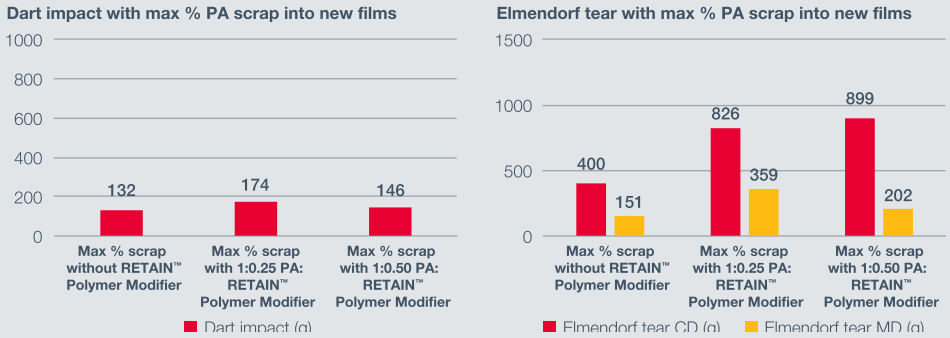
Film with recycle compatibilizer (1:0.5 PA: RETAIN™)

- 50µ films fabricated with > 90% scrap barrier films containing 25% PA
- Max % scrap without RETAIN™ Polymer Modifier = 94% scrap + 6 % LDPE
- Max % scrap with 1:0.25 PA: RETAIN™ Polymer Modifier = 94% scrap – 6% RETAIN™ 3000
- Max % scrap with 1:0.50 PA: RETAIN™ Polymer Modifier = 89% scrap – 11% RETAIN™ 3000

Mechanical properties

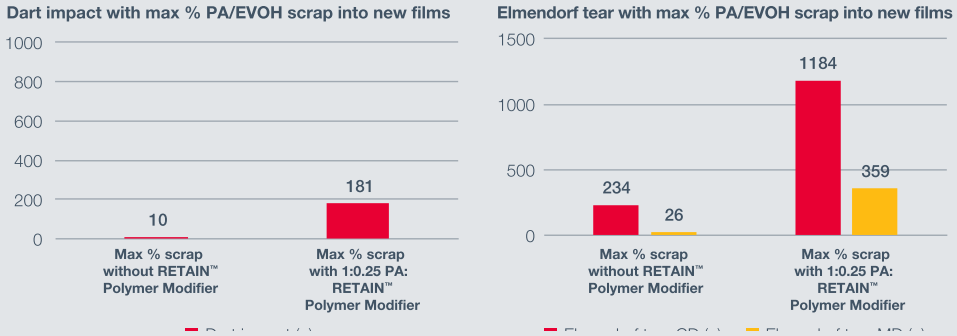
Figures 8 and 9 demonstrate that RETAIN™ Polymer Modifier has the opportunity to improve the mechanical properties of barrier films, particularly improving dart and Elmendorf tear values at a high percentage of scrap incorporation into a new film applications.

Figure 8: Comparative physical performance of PA-based barrier film recycle streams*



- 50µ films fabricated with > 90% scrap barrier films containing 25% PA
- Max % scrap without RETAIN™ Polymer Modifier = 94% scrap + 6 % LDPE
- Max % scrap with 1:0.25 PA: RETAIN™ Polymer Modifier = 94% scrap – 6% RETAIN™ 3000
- Max % scrap with 1:0.50 PA: RETAIN™ Polymer Modifier = 89% scrap – 11% RETAIN™ 3000

Figure 9: Comparative physical performance of PA/EVOH-based barrier film recycle streams*



- 50µ films fabricated with > 90% scrap barrier films containing 37% PA/EVOH
- Max % scrap without RETAIN™ Polymer Modifier = 100% scrap
- Max % scrap with 1:0.25 PA: RETAIN™ Polymer Modifier = 92% scrap – 8% RETAIN™ 3000

*Dow test, additional information available upon request; typical properties, not to be constructed as specifications

Prove it for yourself at Pack Studios

To assist you in achieving optimum results, Dow Technical Service & Development professionals will help you determine the best scrap-to-compatibilizer ratio, based on your barrier recycle stream composition and desired results. We can even test your formulations at Pack Studios – and maybe discover other options.

Ask your Dow sales or TS&D representative for information about products samples, trials, and taking advantage of all Pack Studios offers.

pack STUDIOS

We look forward to sharing this exciting technology with you.

Enhance the value of barrier scrap while making a positive impact towards your sustainability goals.

Contact a Dow representative today to learn more. For more information please visit www.dow.com/packaging.

For more information about Dow, visit **www.dow.com/about.** To contact a Dow representative, visit **www.dow.com/contact**.

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