WHITE PAPER

ExxonMobil

Rethinking flexible film design for simpler solutions and a more efficient value chain

tomorrow's **performance** today

Exceed™ S performance polyethylene (PE) resins deliver industry-leading combinations of stiffness and toughness while being easy to process

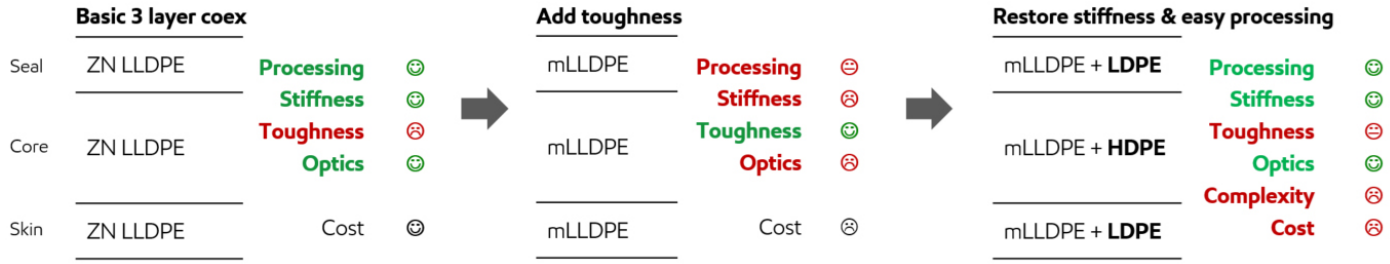
Author:
Tom Miller, Ph.D., Marketing Manager Exceed S performance polyethylene, ExxonMobil
Etienne Lernoux, Senior Principal, ExxonMobil

At a time when modern flexible film design is a story of increasing complexity and compromise for different applications, what if there was a route to simpler solutions? Solutions that restore simplicity without compromising application performance, while creating opportunities for greater efficiency at every step of the value chain. These solutions are now possible thanks to the latest performance polymer family, Exceed™ S performance polyethylene (PE) resins, from ExxonMobil, which enables film producers to rethink flexible film design.

Reducing film complexity

The biggest challenge in producing high performance flexible films for packaging, agricultural and industrial applications is optimizing the balance of stiffness, toughness, and ease of processing. A film designer looking to improve the relatively low toughness of a generic, cost-effective coextruded structure will likely upgrade to metallocene linear low density polyethylene (mLLDPE) – see figure 1. To then make processing easier, low density polyethylene (LDPE) is often added to lower melt pressure and increase melt strength, which can lead to higher output. High-density polyethylene (HDPE) is then often added to make the film stiffer, but this can reduce toughness. So, adding either LDPE or HDPE introduces compromise and increases operational complexity.

Figure 1

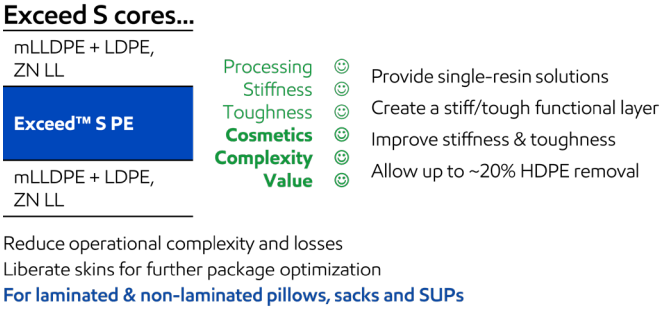


Simpler solutions are now available thanks to Exceed S PE resins. At the forefront of the stiffness/toughness boundary and offering better melt strength and higher output than current mLLDPE resins, Exceed S PE resins enable film designers and engineers to rethink film design for simpler solutions. Now, LDPE and HDPE can either be eliminated or amounts reduced, depending on the needs of the application.

Using Exceed S PE resins in the core of a film formulation creates a single functional layer that delivers the stiffness/toughness backbone needed by the application *(see figure 2)*. The stiffness and toughness are so high, that up to 20 percent HDPE can be removed from the formulation depending on the resins used in the blend.

The low melt temperature and low melt pressure offered by Exceed S PE resins make them easy to process, eliminating or reducing the need for LDPE, and providing film producers with opportunities for higher output and cost savings.

Figure 2



With the core layer delivering high stiffness and toughness, the skin layers of the film are available to improve other aspects of performance like sealing, hermeticity, optics or haptics that Brand Owners value in the final package. Exceed S PE resins thereby simplify blend formulation while creating opportunities to better optimize film and finished package durability and consumer appeal.

Exceed S PE resins can create the most value when used in the core of 3-layer coextruded structures or the core and sub-skins of coextruded structures with a high layer count. There are a few applications, however, where moving the stiffness/toughness functional layer to the skin creates more value *(see figure 3)*. These are applications that require "must have" performance attributes like:

- Resist blocking and improve heat resistance of hot-filled bag-in-box.
- High amounts of HDPE in the core of heavy duty sacks for creep resistance.
- Incorporating recycled content in the core to provide a sustainability benefit.

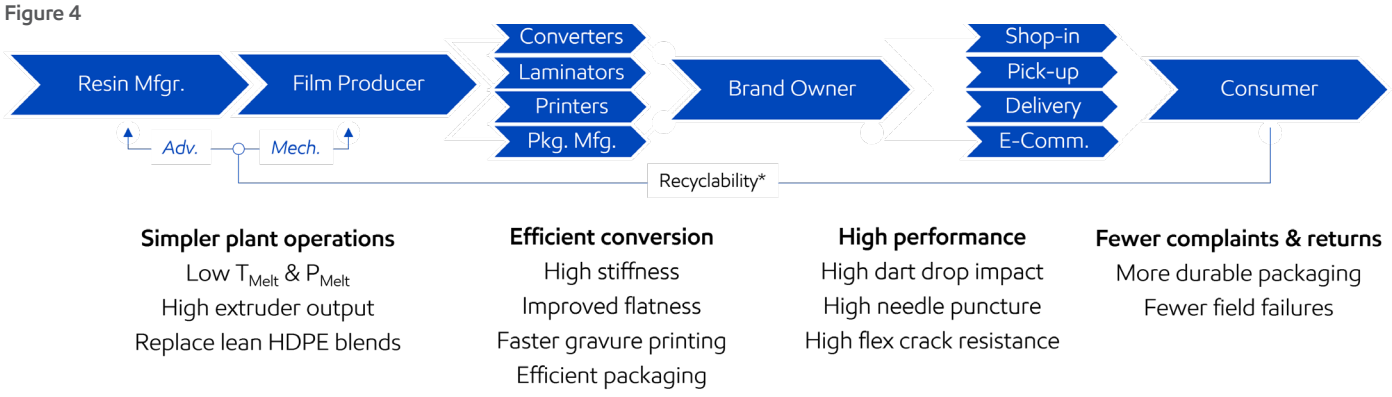
Figure 3

A more efficient value chain

The flexible packaging industry value chain is quite complex, ranging from resin producers to film producers, a multitude of secondary operations to cut, slit, print, laminate, and make packages that Brand Owners sell to consumers through various retail channels.

Offering industry-leading toughness across a wide range of stiffness, Exceed™ S performance polyethylene can create value by simplifying – reducing complexity, scrap, and complaints – at every step of the value chain *(see figure 4).*

Figure 4



*Recyclable in communities with programs and facilities in place that collect and recycle plastic film.

The low melt temperature and low melt pressure offered by Exceed S PE resins make them easy to process and provide opportunities for high output, helping film producers realize cost savings and increase revenue. Also, many lean blends of HDPE in LLDPE can be replaced with a single grade of Exceed S PE resin. Simplified formulations, easier operations, and the potential for fewer coextruded layers, can all contribute to reduced complexity and fewer opportunities for operator mistakes and equipment malfunctions that generate scrap and increase costs.

The inherently high stiffness of Exceed S PE resins can deliver stiffer, less elastic, and less extensible films that should run more efficiently on high-speed gravure printing lines. These same characteristics can also help ensure more accurate indexing and less problematic web tension control on packaging lines, which can lead to lower scrap costs and improved quality.

Inherently high dart drop impact, puncture, and flex-crack resistance all contribute to improved film performance. Plus, the ability to create stiff, tough, core layers can enable the use of lower density or other higher-performance skins that further improve package bag drop survivability, enable faster sealing rates, improve clarity and gloss, or enhance package feel.

The result can be more durable polyethylene packaging that can be recycled mechanically or by advanced recycling*. This packaging can also better resist breaking or leaking during transportation to, or during use by, the consumer. For e-commerce, for example, this can mean fewer product complaints and returns, which can help reduce the cost associated with refunds or supplying replacement products.

Collaborate for success

Exceed S PE resins provide converters and the downstream value chain with industry-leading resin solutions that deliver among the highest levels of performance currently available on the market today. Working collaboratively, ExxonMobil can help film converters and brand owners maximize the value they can gain for their applications using simplified resin solutions. Applications in which Exceed S PE resins have demonstrated significant value include:

In **non-laminated pillow pouches** (liquid filled), Exceed S PE resins used in the core layer can deliver comprehensive improvements in package performance compared to a market reference film:

- Package toughness and durability can be maximized.
- HDPE can be eliminated or reduced while high stiffness and toughness is maintained.
- Melt temperature and pressure can be reduced, which may help improve output
- Lower density sealants can be used in the skins to speed-up heat-sealing operations.

In **laminated PE//PE pillow pouches** (liquid and solid filled), Exceed S PE resins used in the sealant web maximize packaging performance by enhancing toughness and durability compared to a market reference film:

- A single-resin core paired with low density skins maintain laminate stiffness, enhance dart impact, and facilitate fast sealing times.
- Outstanding bag drop performance increases the chances of package survivability, potentially enabling the use of larger packages, and promoting the use of full-PE packaging for more aggressive contents.

In **hot-filled bag-in-box liquid packaging**, Exceed™ S performance polyethylene used in the skin layers can deliver comprehensive improvements in packaging performance compared to a market reference film:

- Delivers premium, next-level flex crack resistance.
- Reduces blocking by providing a higher seal initiation temperature (SIT).
- Potential increase in hot liquid packaging line speeds due to more heat-resistant bags.

In two different classes of **heavy duty bags for non-resin applications**, Exceed S PE resins used in the core and skins produce a more rugged film, compared to market reference films:

25 kg industrial and agricultural bags

- High dart impact, MD tear and stiffness required for bagged products like potting soil sold directly off of pallets at DIY stores.
- Combination of excellent tear and stiffness with less blending and less HDPE added.

Up to 50 kg industrial and agricultural fertilizer-type bags

- Premium dart and tear required for rough handling in the field.
- Outstanding dart impact, tear and stiffness with significantly less HDPE added.

In **agricultural silo bags**, Exceed S PE resins can deliver elevated performance compared to a market reference film:

- Exceed S PE resins in the core and skins enhance MD tear, TD creep resistance, dart impact, and needle puncture performance in a film that is 6% thinner.
- Using Exceed S PE resins in the core and Exceed XP PE resins in the skins offers near-comparable improvements in performance, a 13% thinner film, and potentially higher output.

Currently, three grades of Exceed™ S PE resins are commercially available to complement ExxonMobil's broad portfolio of Exceed™ XP, Exceed™, and Enable™ performance polyethylene. Our commercial and technical experts are collaborating with over 75 converters globally to bring a broad range of applications to market that are only possible thanks to the unique value that Exceed S PE resins deliver.

Data from tests performed by or on behalf of ExxonMobil.

Why ExxonMobil PE? Why today?

tomorrow's **performance** today

What some might view as solutions that will only happen in the future, ExxonMobil PE is making possible today – through our innovative and reliable products, collaborative approach, technology leadership and support, and our unmatched global supply and resources. Why wait for tomorrow to advance your business today? Learn more about how we're helping our customers create more sustainable solutions now. Contact your ExxonMobil PE representative and begin experiencing tomorrow's performance today.

To learn more about how ExxonMobil's Exceed™ S solutions can help converters rethink and simplify film design, please visit:
exxonmobilchemical.com/pe

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