



Exceed™ Tough+

Exceed™ Flow

Exceed™ Stiff+

Exceed™

Exxtra™ Seal

# Creating a circular film to film loop: from a recyclable\* full PE barrier packaging solution to a high end heavy duty sack



Recyclable\* and incorporates recycled content



Outstanding oxygen barrier



Tremendous optics



High package integrity

## Challenge

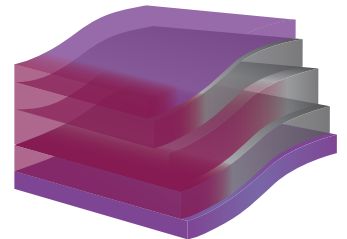
To create a >95% high oxygen barrier pouch - as an alternative to more difficult to recycle multimaterial high oxygen barrier laminates - which can be recycled back into a high-end film application. Thus creating a circular film to film loop.



## MDO-PE film

Thickness: 25µm

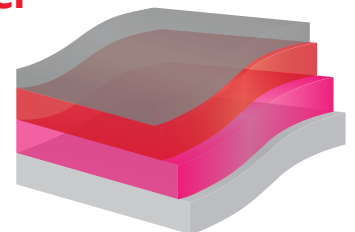
- Exceed™ Tough+ m 0516.ML
- Exceed™ Stiff+ m 0238.MC
- Exceed™ Flow m 0527.MC
- ExxonMobil™ HDPE



## Lamination & barrier coatings layer

Basis weight: 5.4gsm

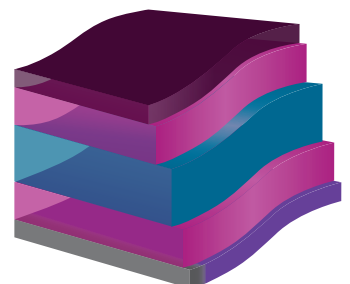
- Vacuum-coated AlOx
- Henkel top coating
- Printing ink
- Henkel PU adhesive



## PE sealant film

Thickness: 120µm

- Exceed™ Tough+ m 0814.ML
- Exceed™ Flow+ m 0938.MC
- Exceed™ Stiff+ m 0926.ML
- Exxtra™ Seal POP 2008.MK
- ExxonMobil™ LDPE



\*Recyclable in the few communities with programs and facilities in place that collect and recycle plastic film



**HOSOKAWA**  
**ALPINE**



# Solution

## Creating the pouch:

Using the latest in polymers and conversion technology and through a unique value chain collaboration, the team was able to create a 96% (by weight) PE pouch with high oxygen barrier and outstanding package integrity.

This blown film was produced with ExxonMobil best-in-class performance polyethylene resins like Exceed™ Stiff+, Exceed™ Tough+ and Exxtra™ Seal and produced on an Alpine 5-layer line with inline Machine Direction Orientation [MDO]. This state of the art MDO technology offers film quality with outstanding processability and optimized flatness.

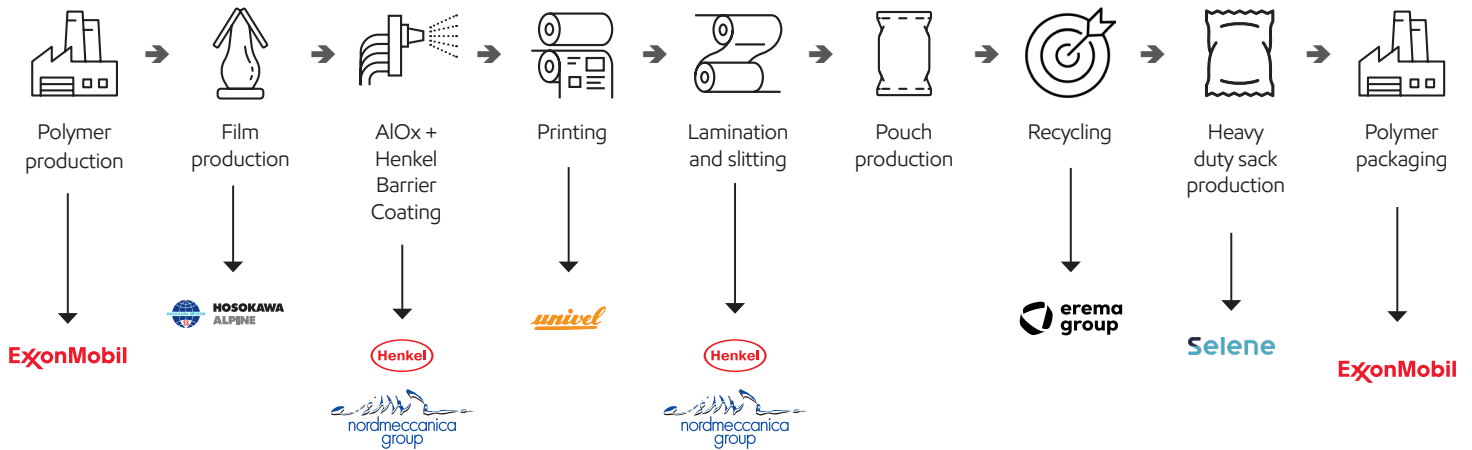
Two extremely thin functional layers were then applied on the MDO-PE to deliver outstanding barrier properties: the first layer consisted of 10 nanometers of uniform and homogeneous aluminium oxide [AlOx], while the second layer consists of 1 micron of Henkel's newly developed Barrier Coating. Both functional layers were applied using Nordmeccanica's Vacuum and Coating technologies [Nordmet 12F Plus / Super Combi 5000].

These technologies offer industry leading performance in terms of reliability, uniform laydown, thickness control and energy consumption.

Subsequently, the film was printed with a standard Flexo process by Univel - building on 75 years of groundbreaking solutions for flexible packaging.

In the following step, the MDOPE was laminated with the sealant web on a Nordmeccanica SC 5000 Coating-Laminating machine by using Henkel's customized SL Recyclable adhesives.

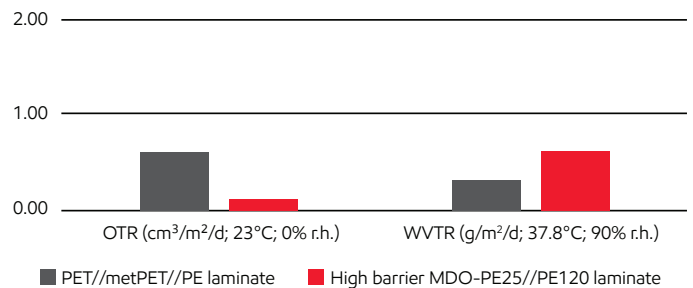
In addition - the end of life pouches were reprocessed by EREMA, the world market and technology leader in plastics recycling systems. EREMA used their extruder system INTAREMA® TVEplus® to produce plastic granules. Out of these recyclates, Selene - with its extensive experience in blown extrusion and recycled granules-produced high-quality Form Fill and Seal [FFS] tubular for Heavy Duty Sacks [HDS]. These HDS were subsequently filled with EVA resin at the Meerhout PE production site.



## Barrier properties:

This pouch incorporates the innovative concept of AlOx and wet top coatings - to produce a very high PE content (96%) pouch while still providing low Oxygen Transmission Rate (OTR) of ~0.14 cm<sup>3</sup>/m<sup>2</sup>/d; and Water Vapour Transmission Rate (WVTR) of ~0.6 g/m<sup>2</sup>/d comparable to multi-material structures, as can be seen in Graph 1.

Graph 1 - Pouch Oxygen and Moisture barrier\*

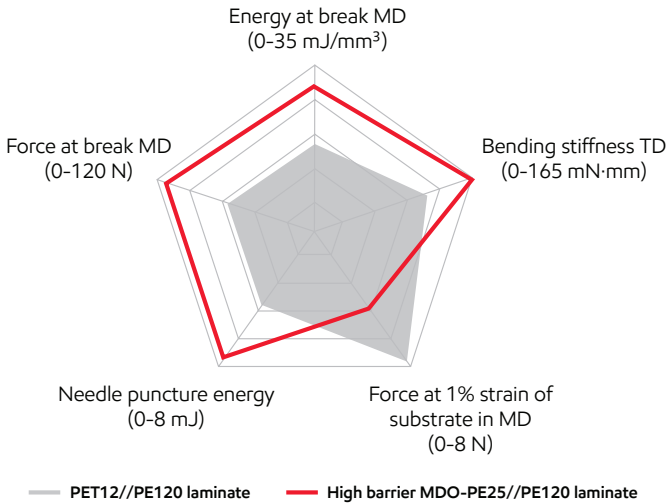


\*All barrier values are to be considered as indicative as they may strongly depend on various parameters and test conditions

## Mechanical Properties:

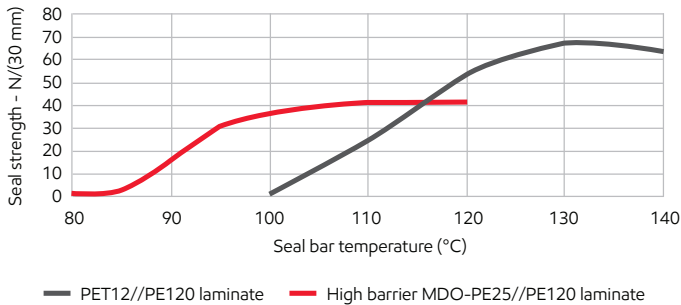
This pouch features the latest PE resin Exceed™ Stiff+ to deliver outstanding package integrity – resulting in a 70% improvement in needle puncture energy and force at break versus comparable multi-material alternatives, while keeping comparable bending stiffness to maintain stand-up ability. These results are quantified in Graph 2.

### Graph 2 - Pouch Mechanical properties



In addition, the pouch features the Exxtra™ Seal plastomers 3-series sealant materials to lower the Seal Initiation Temperature with ~15°C as can be seen in Graph 3.

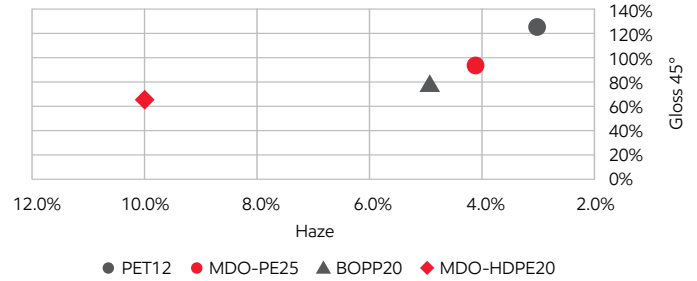
### Graph 3 - Pouch Seal Strength



## Optical properties:

The MDO substrate also does not compromise on shelf-appeal with outstanding gloss (~100%) and low haze (~4%), rivaling the best-in-class PET substrate, as can be seen in Graph 4.

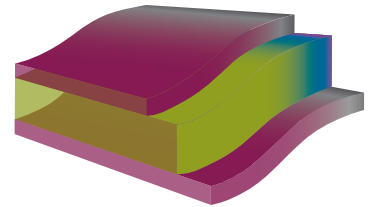
### Graph 4 - MDO Substrate Optical properties



## Creating the Heavy Duty Sack:

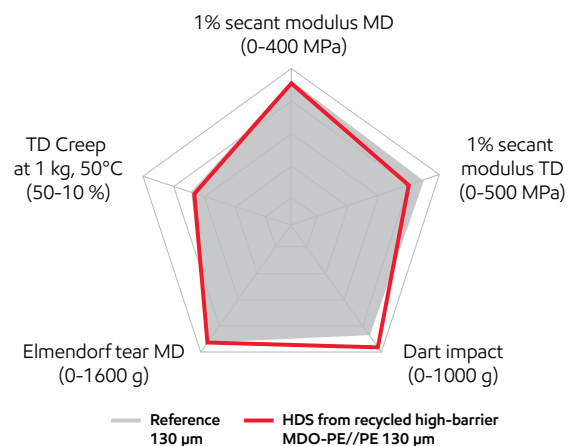
Heavy Duty Sack Film 130 micron

- Exceed™ m 1018
- Exxtra Seal m 1012
- Exceed™ Tough+ m 1019
- ExxonMobil™ HDPE
- Recycled content



The high barrier pouch was subsequently recycled and a new heavy duty sack film was produced with 50% of the pouch recyclate in the film structure. The end-result is an HDS bag which is, thanks to the use of ExxonMobil PE, meeting and in some cases even exceeding the performance of industry reference bags. Graph 5 is showing that key properties like creep, dart and tear of the HDS bag with 50% recyclate are of comparable performance to the HDS bag currently in use at the ExxonMobil Meerhout PE production facility. In addition, Table 1 is showing the outstanding bag drop performance. The HDS incorporating 50% recycled content is meeting the ExxonMobil plant specification\* and even exceeding expectations on the more demanding ExxonMobil staircase method.

### Graph 5 - HDS Mechanical properties



\* ExxonMobil plant specification: FFS bags must pass following bag drop test: 18 bags are randomly taken and dropped from 2m height. 6 bags are dropped on the face, 6 bags dropped on the side and 6 bags dropped on the top.

**Table 1 - Bag Drop Measurements**

Drop Height	Drop Position	bag 1	bag 2	bag 3	bag 4
1m	F (flat)	Pass	Pass	Pass	Pass
	S (seal)	Pass	Pass	Pass	Pass
	G (gusset)	Pass	Pass	Pass	Pass
2m	F	Pass	Pass	Pass	Pass
	S	Pass	Pass	Pass	Pass
	G	Pass	Pass	Pass	Pass
3m	F	Pass	Pass	Pass	Pass
	S	Pass	Pass	Pass	Pass
	G	Pass	Pass	Pass	Pass
4m	F	Pass	Pass	Pass	Pass
	S	Pass	Pass	Pass	Pass
	G	Pass	Pass	Pass	Pass
5m	F	Pass	Pass	Pass	Pass
	S	Pass	Pass	Pass	Pass
	G	Pass	Pass	Pass	Fail
6m	F	Pass	Pass	Pass	
	S	Pass	Fail	Pass	
	G	Fail		Pass	

ExxonMobil Staircase test method: each bag is dropped from the same height (1m) in 3 different drop positions (on flat side / on seal side / on gusset). If the bag survives the drops, the same bag is then dropped from an increased height (2m) in 3 different drop positions. If the bag survives, the height is again increased (3m, etc.) until the bag fails. 6m height is the maximum height available on the drop equipment at ExxonMobil.

In summary, this unique value chain collaboration has shown it is possible to create a >95% PE stand up pouch (without compromising on functionality or shelf-appeal), which can be recycled into a high-end HDS bag exceeding the most stringent requirements.

Test item	Test method
Oxygen transmission rate (OTR)	ExxonMobil test method
Water-vapor transmission rate (WVTR)	ExxonMobil test method
Tensile properties on film at room temperature	ExxonMobil test method
Dart drop impact resistance by free falling dart: method A and B	based on ASTM D-1709-16æ1
Puncture - needle test	ExxonMobil test method
Heat seal strength at RT	ExxonMobil test method
Bag drop test	ExxonMobil test method
Bending stiffness	ExxonMobil test method
Haze	based on ASTM D-1003-13
Gloss 45°	ExxonMobil test method
Elmendorf tear	based on ASTM D1922
Creep resistance at elevated temperature	ExxonMobil test method

Contact us for more information: [exxonmobilchemical.com/pe](http://exxonmobilchemical.com/pe)

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## What's new: ExxonMobil Signature Polymers

All our polymers are now positioned under a single portfolio brand: Signature Polymers. The aim is to simplify our product architecture and naming to improve portfolio navigation for you. We would like to stress that our commitment to high quality products remains the same, it is the names that change. Everything else remains the same. We will be making these modifications over the next six months so you will see both old and new grade names highlighted during that time.

Here's a quick overview of brands and grade names that have changed in this document:

Legacy commercial name	New commercial name
Exceed™ XP 8656ML	Exceed™ Tough+ m 0516.ML
Enable™ 4002MC	Exceed™ Stiff+ m 0238.MC
Enable 2705MC	Exceed™ Flow m 0527.MC
Exceed XP 8784ML	Exceed Tough+ m 0814.ML
Enable 4009MC	Exceed™ Flow+ m 0938.MC
Exceed™ S 9243ML	Exceed Stiff+ m 0926.ML
Exact™ 3237	Exxtra™ Seal POP 2008.MK
Exceed™ 1018	Exceed m 1018
Exceed 1012	Exxtra Seal m 1012
Exceed XP 8318	Exceed Tough+ m 1019

Some of our existing Exceed, Achieve, Paxon and premium PP/HD grades have moved to Exceed brand; most existing Enable grades have moved to Exceed Flow[+]; most of our existing Exceed XP grades have moved to Exceed Tough[+]; most of our existing Exceed S grades have moved to Exceed Stiff[+]. More details here [https://www.exxonmobilchemical.com/en/brands/signature-polymers/exceed\\_high\\_performance\\_polymers](https://www.exxonmobilchemical.com/en/brands/signature-polymers/exceed_high_performance_polymers) or contact your ExxonMobil representative to know more.

Want to see what's changed in our portfolio? Go to [exxonmobilchemical.com/sptransform](https://www.exxonmobilchemical.com/sptransform)