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New Solutions for sustainable designs in Extrusion Lamination

Presented by:

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Agenda

- Recycling of barrier film PE – what are the challenges?
- Newcycling® - process to produce high quality recycle LDPE
- Resin and material list
- Evaluation of the recycle LDPE in extrusion lamination
 - Paper/PE/Alu/PE
 - Gel evaluation and analysis
 - Migration analysis of inner PE after storage in reels
- Summary
- Acknowledgement

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Multi-layer packaging is a challenge for traditional mechanical Recycling Processes

The problem

- Post Consumer Recyclates (PCR) from mechanical Recycling have
 - Limited quality concerning gels and color
 - Striking odor and negative sensory properties
 - No legal base to use such recycled PE for food packaging
 - Paper and aluminum are disturbing material in polymer-recycling
- Extended efforts for cleaning and sorting of such waste
 - Can not help to raise the quality sufficiently
 - Bear additional costs not accepted by the market
 - Increase effort to an unreasonable ecological level
- Options = Solvent-Recycling process for polymers or Chemical Recycling



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Multi-layer packaging challenging for Traditional mechanical Recycling Processes



The problem

With commonly used recycling technologies, multi-layer films cannot be recycled properly, as the different plastic layers cannot be separated!



The consequence



The multi-layer film waste is typically burned or recycled to re-granulates with a quality that is only sufficient for a limited range of applications.

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Multi-layer packaging offers many benefits but is a challenge for mechanical recyclers

- Typical film structure for cheese and meat packaging

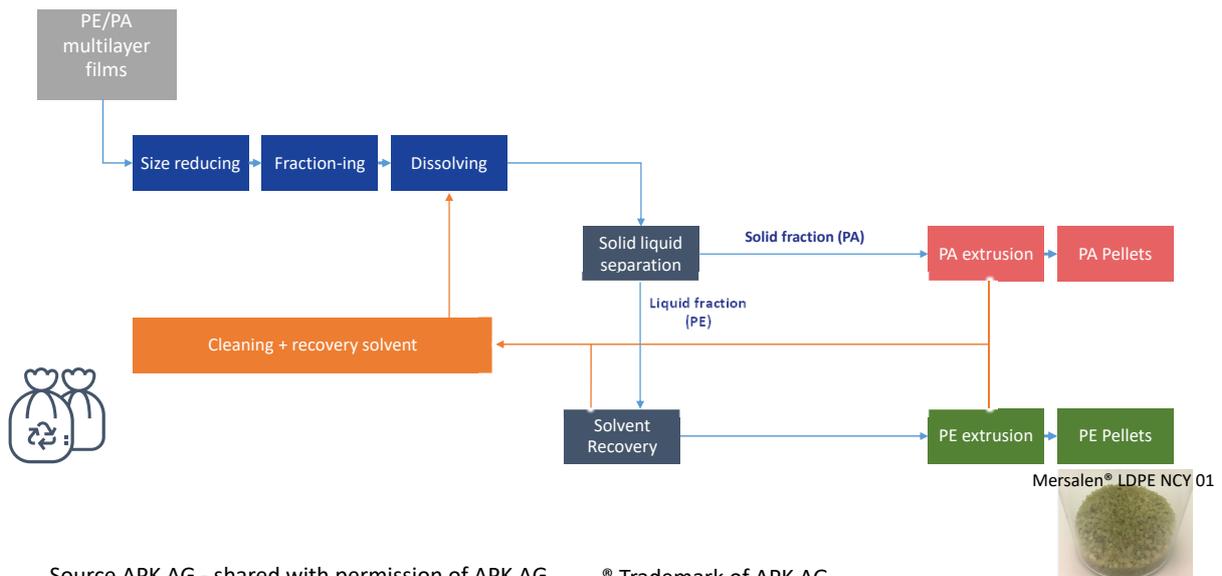


- PE is the outer layer as well as sealant layer
- Tie layer promotes adhesion between unipolar PE and Polar Polyamid layers
- Polyamid layer provides oxygene barrier and toughness to the films
- EVOH provides the high oxygene barrier to increase food shelf life time and reduce food waste

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Newcycling® – Process Overview



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Laminate Paper/PE/Al/PE for flat pouches *Design for Recyclability*

Laminates mixed Paper + Polymer + Aluminium = Worst-Case for Recycling

Solution

- Paper → PP based synthetical paper
- Alu → barrier coated or metalized OPP
- However, no recycle PE at the moment allowed in food packaging

In Progress

- Assuring packaging-processes on many established lines (FFS Flat-Pouch)
- Assuring reliable filling (Opening + closing + sealing of pouches)
- Assuring reliable opening of pouch = horizontal tearing

Goal

Laminate fit for existing EndOfLife-scenarios (EOL) – **EOL target = free of paper, OPT, (O)PA and alu**



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Material List

Resin /Material	Code	Description	Characteristic Properties
Mersalen® LDPE NCY 01	NCY 01	Recycle LDPE (PIR, future PCR)	MI (2.16 kg) 0.9-1.6 g/10; min; density 0.92 g/cc
AGILITY™ EC 7000	LDPE 1	T- LDPE for extrusion coating	MI (2.16 kg) 3.9 g/10 min; density 0.918 g/cc
LDPE PT 7007	LDPE 2	A-LDPE for extrusion coating	MI (2.16 kg) 7.5 g/10 min; density 0.918 g/cc
RETAIN™ 3000	Compatibilizer	Compatibilizer for PA and EVOH in PE	Addition level 3-5 %
SynPap 40		Synthetical paper 40 g/m2	Density 0.7 g/cc
Paper		40 g/m2	
Aluminium foil		8 µm	

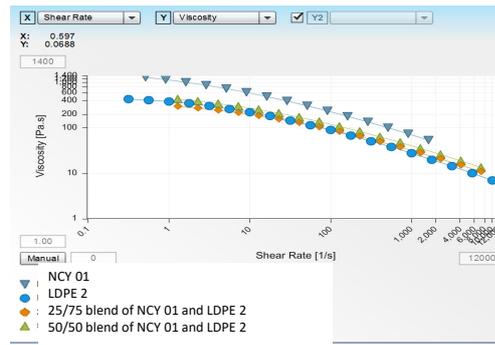
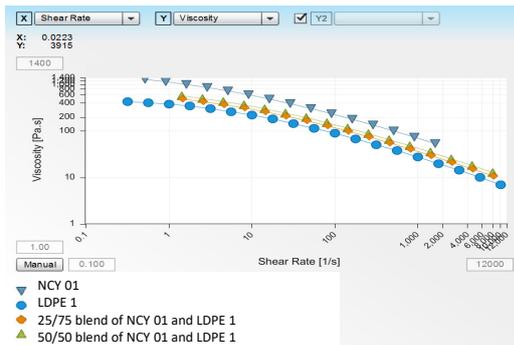
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Rheology pre-trials

- Compounds for rheology analysis
 - 25/75 NCY 01 / LDPE 1 & 2
 - 50/50 NCY 01/ LDPE 1 & 2

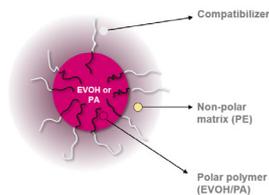


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Extrusion lamination quality of recycling PE blends

Blend selections

- 30/70% NCY01 / LDPE 1
- 30/70% NCY01 / LDPE 2



Adding 5% compatibilizer for PA compatibilization in PE did not change the gel content.

- Gels are not PA
- Most of the gels are non homogenized low viscosity NCY 01 not creating defects
- At higher shear conditions most of the gels disappear
- Running paper/ 30/70% NCY01 / LDPE 1/ Alu / PE laminate at high shear rate showed a good quality – few gels only!



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Hot Stage Microscopy Analysis of the remaining gels

- Some gels had dark centers -> analyzed in hot stage microscopy
- Gels are caused by non melting non-PE film particles



Image Name: 359329155_
 Stage: 35933
 Sample: 010570.260C
 For Reference Use
 Calibration: Light
 Lens: 1.00x 1019 / 30x
 Transmission



Image Name: 359329167_
 Stage: 35933
 Sample: 010570.260C
 Calibration: Light
 Lens: 1.00x 1019 / 30x
 Transmission
 200 μm

Scale:

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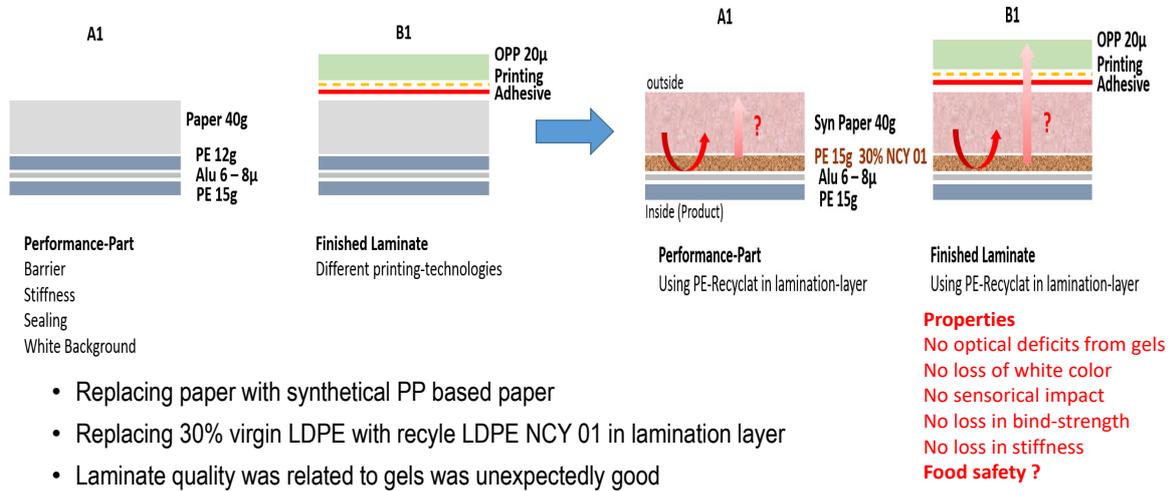
EC processing data

Run Cond.	Unit	30/70 blend NCY 01 / LDPE 1	50/50 blend NCY 01 / LDPE 2	30/70 blend NCY 01 / LDPE 2
Neck-in 25g/m ² 100 m/min	mm	163	135	130
NI 15g/m ² 100 m/min	mm	156	122	117
Draw Down	m/min	350	265	250

- Neck-in for the recycle LDPE blends is manageable for both LDPE 1 & 2 blends with NCY 01
- Draw-down capabilities allow to run at coating weight of minimal 10 g/m²

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Design for Sustainability – feasibility study

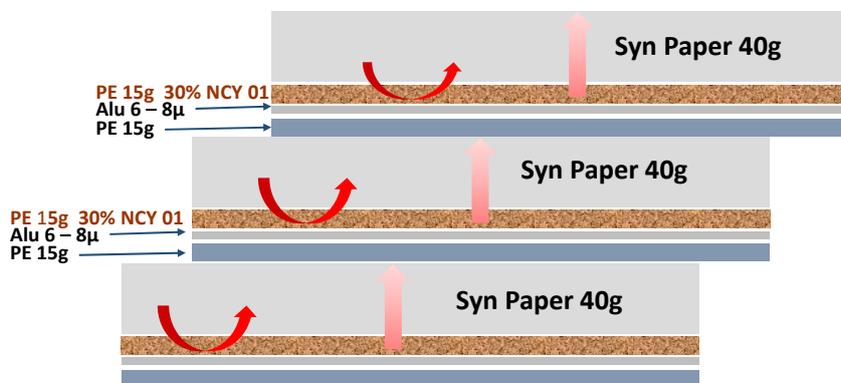


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Laminate Syn Pap/PE/Al/PE for flat pouches

Migration analysis after storage of reels shows acceptable results

Contact of outer and inner layer in reels
= risk for migration and transfer



Analysis of Migration after storage of laminate in reels:

Migrations screening (worst case)
measured on inner PE side (24h 60 °C):

Concentration in µg/dm²
Extraction with 95% Ethanol:

Aliphatic hydrocarbon	16
Tris(2,4-di-tert-butylphenyl)	
Phosphite (AO)	14

Concentration in µg/dm²
Extraction with Isooctane:

Aliphatic hydrocarbon	10
Tris(2,4-di-tert-butylphenyl)	
Phosphite (AO)	30
Octadecyl-3-(3,5-di-tert. butyl-4 hydroxyphenyl)-propionate (AO)	14

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Summary

- Use of up to 50% recycle LDPE (NCY 01) in LDPE blends for extrusion coating and lamination possible.
- Low amount of gels in final laminate
 - Gels analysed in the molten web were identified as high MW and some contamination
- Low worst case migration components
 - Food approval testing pending

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Acknowledgement

- I would like to thank APK AG for the permission to share information on their Newcycling® LDPE grade
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- Many thanks to the Dow Horgen Packstudio Extrusion Coating team Armin Baserga, Claudio Boldo and Silvan Stirnimann
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Questions?

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