BRÜCKNER
MASCHINENBAU

Engineering the future.

The latest in biax innovation

Brueckner Group USA

2025 Customer Days

Brückner R&D Center

From granulate to application – the future starts now!

Packaging films on our pilot line

BOPP

- Barrier
- Pearlized
- ILC
- Special (high seal strength, matt, low shrinkage, stone paper

Mono material
„Ready for recycling“

BOPET

- Barrier
- Yarn grade
- ILC
- Special (white, cavitated)
- sealable

BOPE

- Heat sealable film
- Pearlized
- Metallizable
- For thermoforming

BOPA

- ABC film
- Barrier
- For tropical blister
- For battery pouches

Shrink

- Low, middle & high shrinkage films
- PO based sleeves
- PET based sleeves

Biopolymers

- BOBioPE film
- BOPEF film
- BOPLA film
- BOPHA/PLA film

Technical films on our pilot line

Technical BOPP

- BOPP-C
- S-BOPP-C
  COC-C
- Composite
  Current Collector

Battery separator film

- Evapore process
- Wet process
- PP dry

Technical BOPET

- Solar back sheet
- Current Collector
- TTR films
- Special (isolation, tapes, flexible, printed electronics)

Special

- PTFE
- PVDF
- PEEK
- PMMA
- PPS

High temperature film

Optical BOPET

- Flat panel displays
- Diffuser base film
  DBEF
- Prism base film
- Multilayer
  Reflector film

R&D on our pilot line

Technical Film

- CCCF
- BSF

BOPE

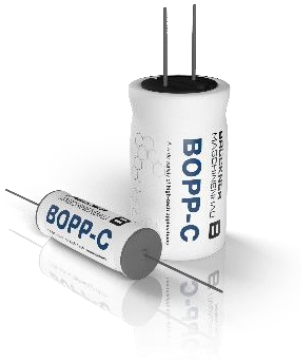
- Line concept
- Heat sealable film
- Pearlized
- Metallizable
- For thermoforming

Biopolymers

- BOBio-film
- BOPHA/PLA film

PCR material

- R-PP/ R-PE
- R-Cycle
- Print CYC
- Plastic Bond
- DecoWraps
- R-PET



ILC BOPP & BOPE

- Metallizable
- Barrier
- Ultra thin

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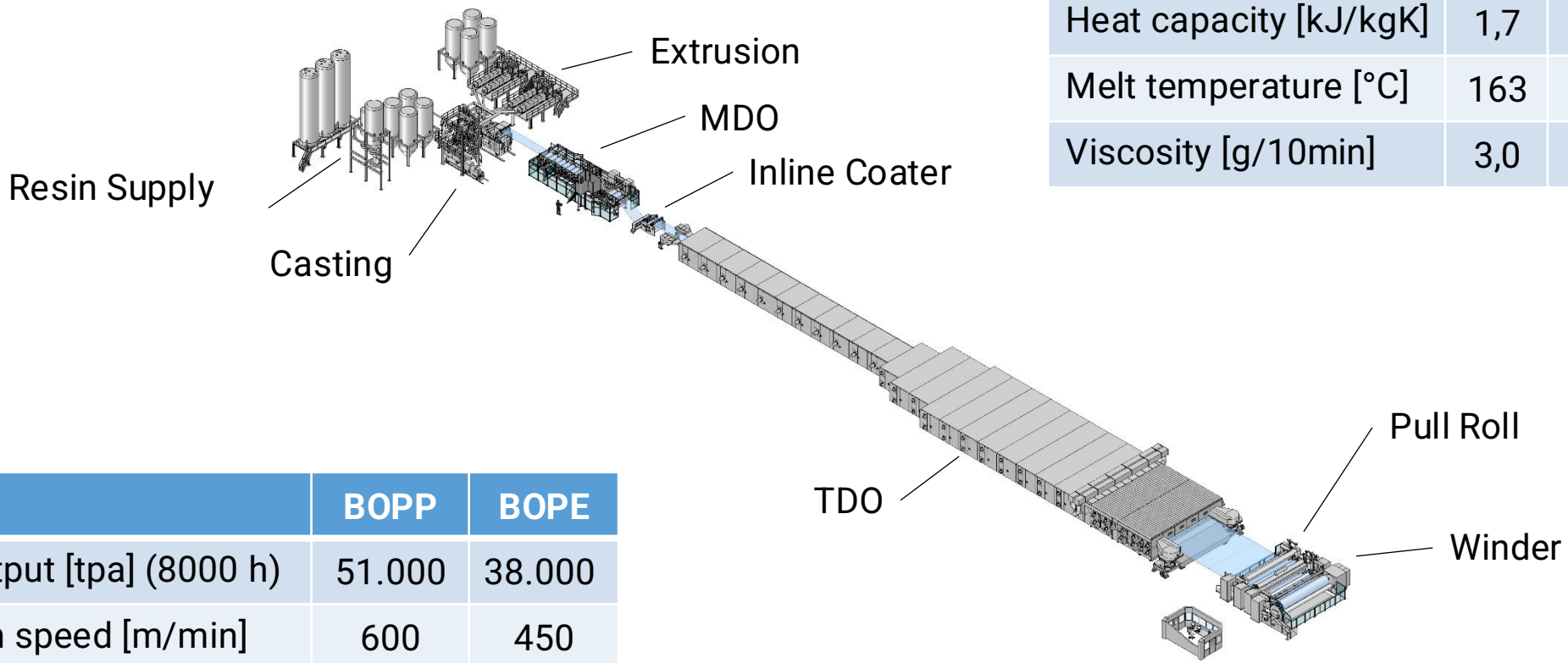
01 BOPE Packaging Film

Main differences between BOPE an BOPP line concepts

	PP	HDPE	LLDPE
Heat capacity [kJ/kgK]	1,7	1,9	2,1
Melt temperature [°C]	163	135	110
Viscosity [g/10min]	3,0	0,9	1,4



	BOPP	BOPE
Annual output [tpa] (8000 h)	51.000	38.000
Production speed [m/min]	600	450
Thickness range [µm]	8 - 60	8 - 60

Development topics

Optimizing properties of BOPE-HD
- Improved haze and clarity
- Enhanced thermal stability

Barrier
- BOPE-ILC
- BOPE-EVOH

New film types
- BOPE white opaque
- BOPE for thermoforming

Sealability of BOPE-LLD:
- Lower sealing temperature
- Increased sealing strength

Possibilities to achieve improved BOPE-HD film properties

Blend with MDPE in skins

Optimized HDPE grades or PE blends with COC

PP, PA, EVOH Copolymer skins

Biaxial stretchability
&
Optical/mech. performance

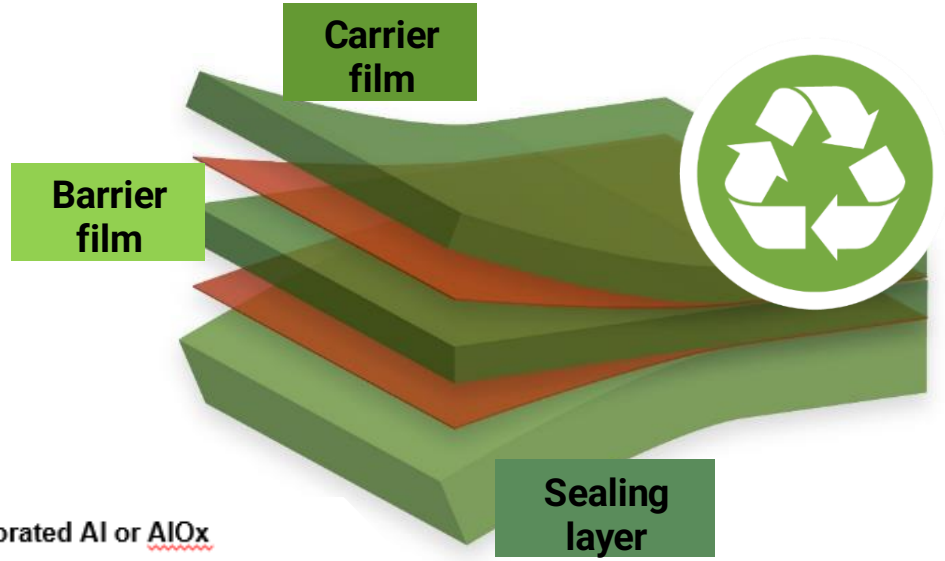
Fully PE-based barrier film with ILC

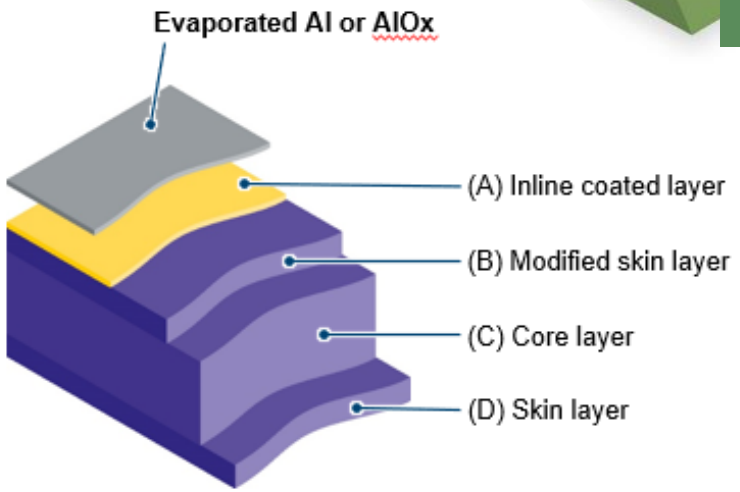
Highlights

- < 0,5% not PE based material
- High, permanent surface tension > 58 dyne
- High barrier after Al metallization:
  - OTR < 0.9 cm³/m² day
  - WVTR < 0.1 g/m² day
- Outstanding metal adhesion > 5 N/15mm

Applications

- Fully PE-based barrier film
- Base film for metallization and barrier coating
- AlOx-coated transparent laminates





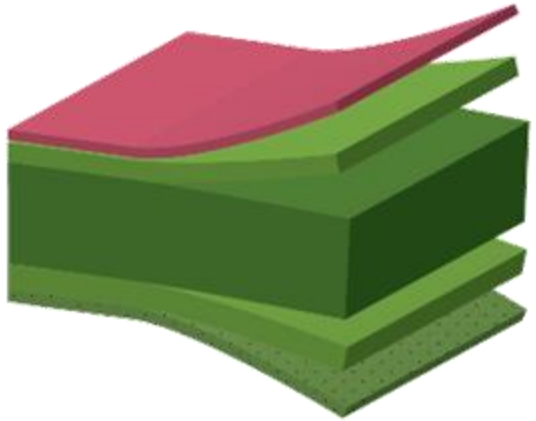
Fully PE-based barrier film with EVOH

Highlights

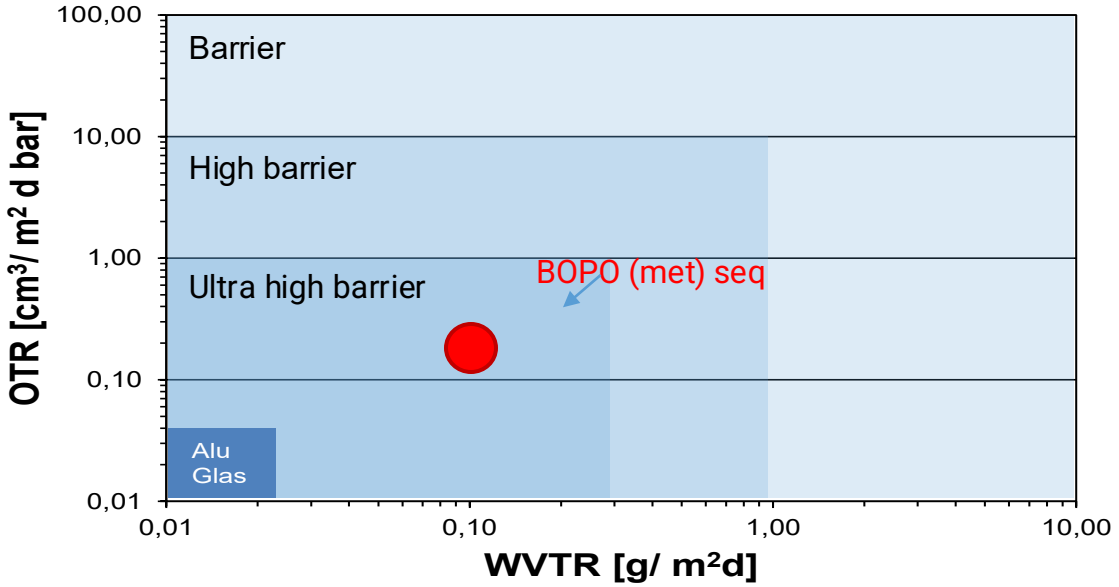
- < 5% not PE based material
- Good optical properties: clarity 95%
- Barrier after Al metallization
  - OTR < 0.2 cm³/m² day
  - WVTR < 0.1 g/m² day
- High metal adhesion > 2.5 N/15mm

Applications

- PE-based barrier film
- Base film for metallization and barrier coating
- Base film for other skin materials (e.g. PA)



(A)	1,3 µm	**EVOH**
(B)	1,2 µm	Adhesive layer
(C)	16,0 µm	HDPE
(D)	1,2 µm	Adhesive layer
(E)	0,8 µm	HDPE + LDPE blend AB + Slip MB



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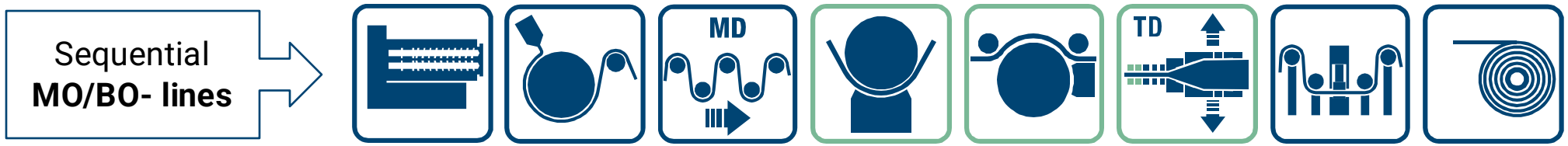
02 Inline coating technology

One step towards sustainability

Inline coating process layout



Inline coating delivers many advantages for the film and the converting:

- Wet chemical coating (water based) on polymeric films (PET, PP, PE, …)
- Coating process before film TD-orientation (drying & crosslinking in preheating zone)
- Primer (nm-scale) for further converting steps (metallizing, printing, laminating)
- ILC process fully integrated in production line

Overview: ILC highlights and R&D projects

Barrier Solutions

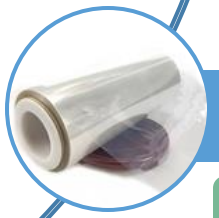
- High Barrier Films
- Transparent Barrier Films
- UHB-Film (ILC)*
- Barrier without Met.*

Printing Primer

- Primer for Waterbased Inks
- Primer for Solventbased Inks
- Primer for UV Inks

De-Inking Primer

- Wash-Off Primer (ILC)*

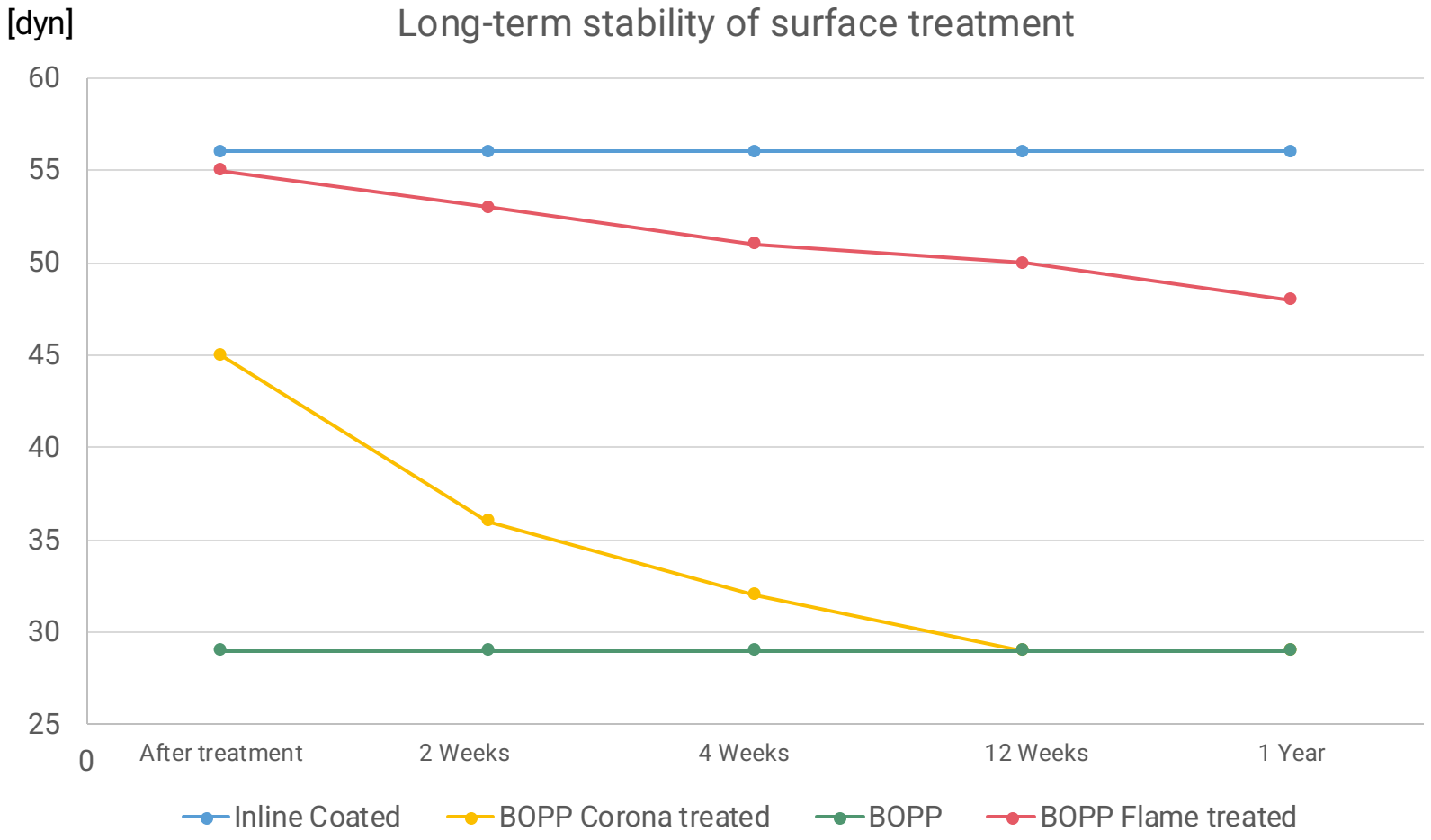


Special Applications

- Anti-Fog Coatings
- Anti-Static Coatings
- Hotmelt / Seal Coatings*

*R&D status

Chemical treatment for printing applications



Coating formulations for different printing methods:

- Water-/solvent based
- UV-curable inks

Barrier improvement coatings

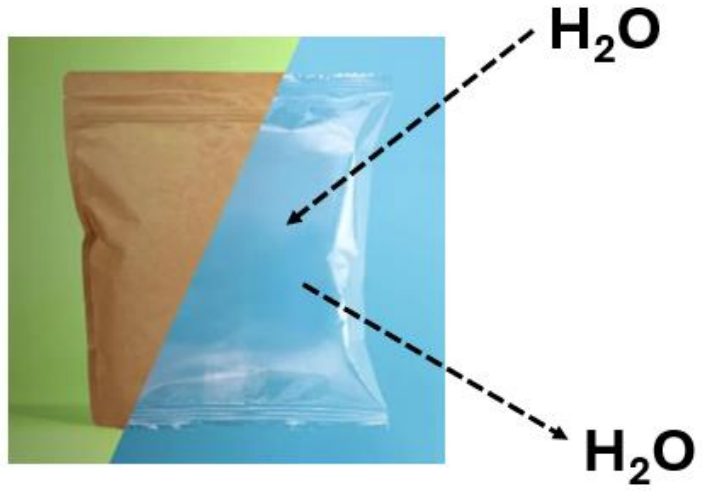
Metallized 5µ BOPP-ILC films for lamination against paper

- Ultra-thin BOPP-ILC films can strongly improve the H_2O barrier
- High barrier improvement (OTR and WVTR close to UHB films)
- Outstanding grease barrier (e.g. PET food packaging)

New packaging solutions possible:

Ultra-thin BOPP-ILC film covers all required barrier functions

Paper thickness can be reduced significantly without missing the <5% foreign material target



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03 Implementation of PCR material in biax films

Influence of PCR (printed / unprinted packaging waste)

Film with 30% PCR - household waste, printed

Film with 30% PCR - high purity, unprinted

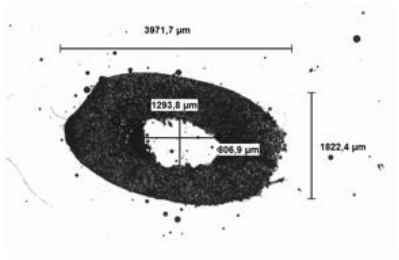
- Even lightly printed waste results in a hazy and not transparent film, no matter of the ink system
- Big influence of the waste stream on properties of the film, e.g. mechanical and optical properties

rPP quality: influence of printing ink-systems

BOPP with NC-based printing inks

outgassing during recycling

white film → brown rPP



pellets with gas cavities

not suitable for BOPP-production

BOPP with PU-based printing inks

easy recycling without outgassing

Stable colour („white stays white“)

good stretchability

suitable for BOPP-production,
good film quality

Production of rBOPP with up to 90% rPP

Successfull joint project with leading floral packaging supplier Decowraps:

- pre-tests in Brueckner laboratory, laboratory extrusion, stretching frame
- successful pre-test at pilot line
- stable mass production of rBOPP film with up to 90% rPP content on Brueckner production line

Precondition for high-quality rBOPP: high quality PCR-rPP

- very defined input waste stream
- only unprinted monomaterial PP-packaging
- low content of impurities

© Decowraps

rBOPP with high mechanical properties and good optical appearance

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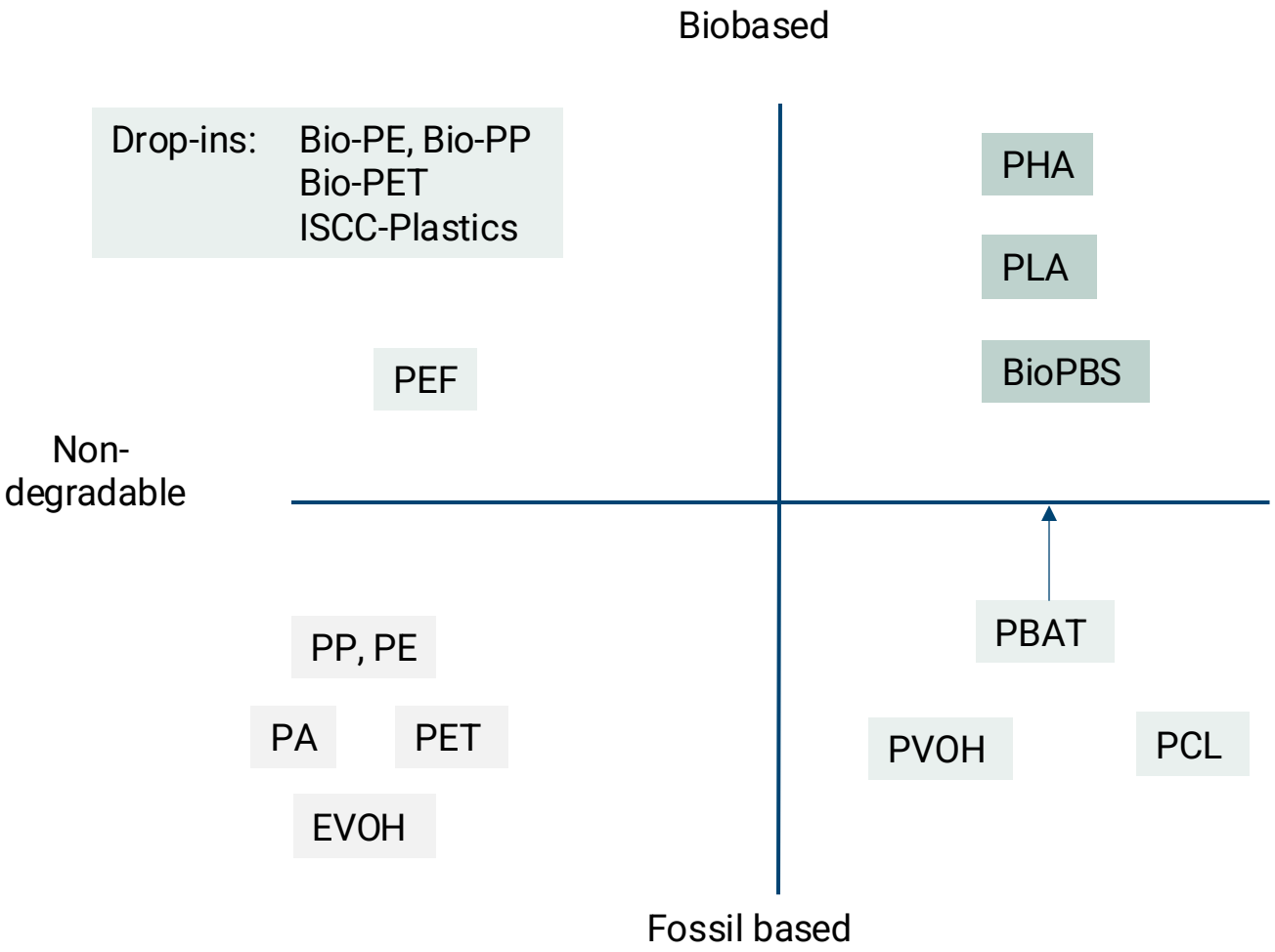
04 Biopolymers for biax films

From renewable resources / biodegradable



Biodegradable (industrially)

TREND

PLA-PHA-blends

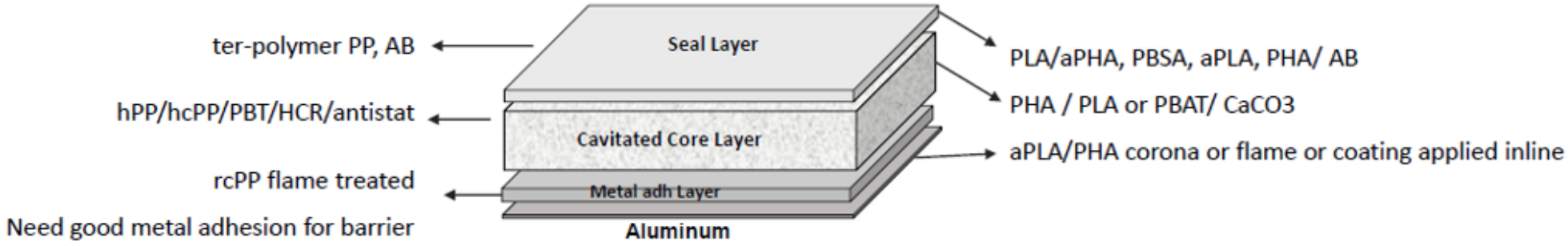
Home compostable

Cooperation along the entire value chain @ Brückner Technology Center

Project PepsiCo: home compostable & biodegradable

Oriented Polypropylene (OPP)

Biodegradable film



Polymers needed	Worldwide suppliers
hPP - Homopolymer PP	10
rcPP -Random copolymer	8
hcPP High Crystalline PP	4
Slip/Antiblock master batch	6
Commercial film suppliers	>100

Polymers needed	Worldwide suppliers
PHA	3
PLA	2
PBSA/PBAT	2
Slip/Antiblock master batch	2
Commercial film suppliers of PLA	4

Biopolymers must be versatile to match existing product specifications

Source: Pepsico – 3rd PHA World Congress 2023

Project PepsiCo: typical film properties

Heat sealable packaging film BOPP 20µm (met.)

For typical 20µm BOPP packaging film

Modulus	MD: ~2000 N/mm²
	TD: ~3600 N/mm²
Tensile strength	MD: ~150 MPa
	TD: ~275 MPa
Thermal shrinkage 130°C, 5min	**MD <4 %** **TD <1 %**
Haze	**1-2 %**
Clarity	~98 %
Puncture resistance*	220-700 N/15mm
Seal initiation temperature	90°C-110°C
Heat seal strength	3.0 N/15 mm
Oxygen transmission rate	15-20 cc/m²/day
Water vapour transmission rate	**~0.1 g/m²/day**

BOPHA/PLA barrier + heat sealable film 20µm (met.)

For BOPHA/ PLA (70% PHA in total structure)

Modulus	MD: ~2600 N/mm²
	TD: ~2500 N/mm²
Tensile strength	MD: ~50 MPa
	TD: ~75 MPa
Thermal shrinkage 120°C, 5min	**MD 3-7%** **TD <2.6-10,0 %**
Haze	**20-30 %**
Clarity	82-85 %
Puncture resistance*	175 N/mm
Seal initiation temperature	90°C
Heat seal strength	12 N/15mm **(Thick skin)**
Oxygen transmission rate	**<1 cc/m²/day**
Water vapour transmission rate	**0.6-1.2 g/m²/day**

* Source: Pepsico

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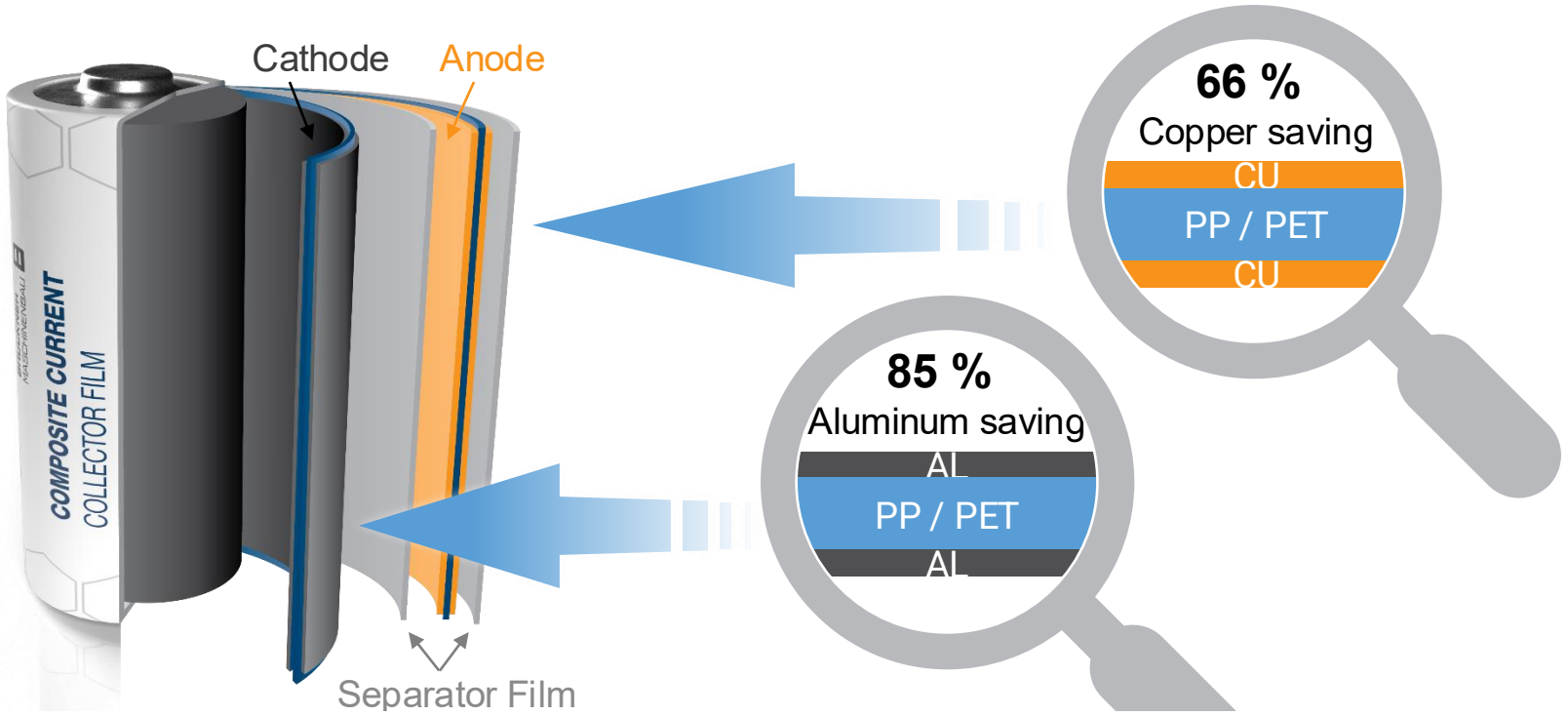
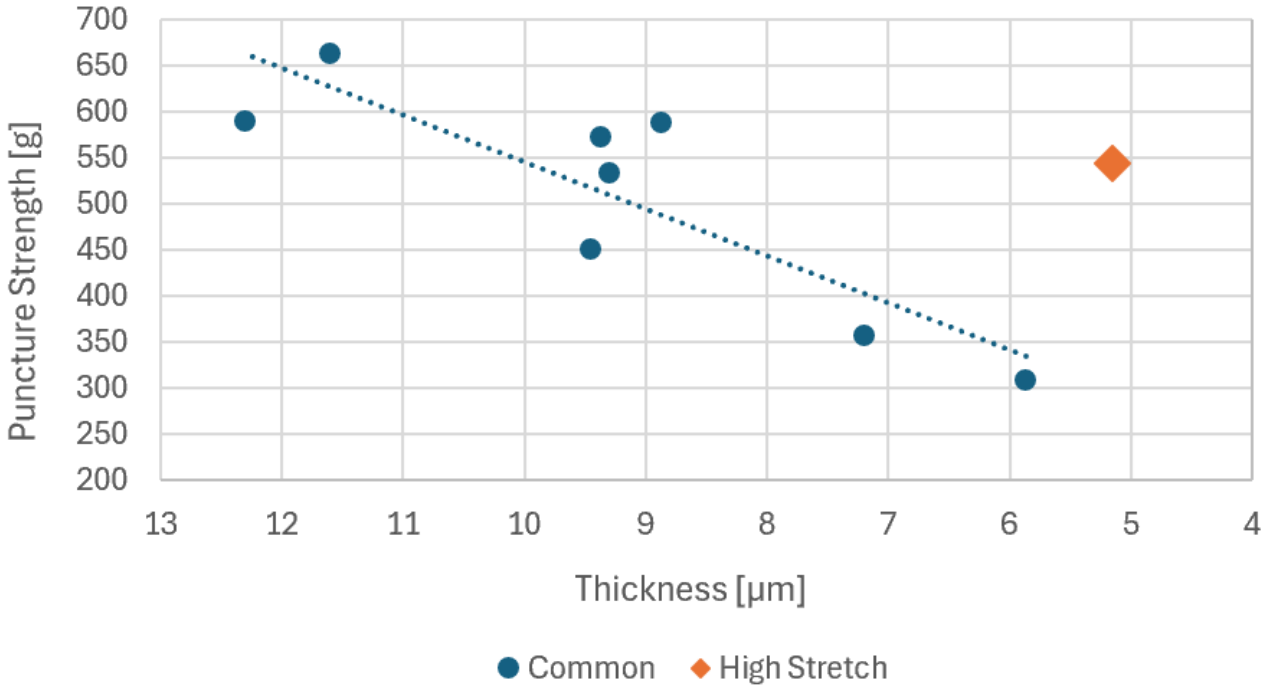
05 Technical films for batteries

Concept of Composite Current Collector Film



- Even adding polymers makes LI-Cells lighter, safer and more efficient
- Improvement of metal adhesion of BOPP films is subject to current development activities

BSF evolution of Thickness and Punkture Strength



Thickness		µm	x	
Thickness Tolerance	MD	%	< 3,5	3.1)
(2-Sigma Value)	TD	%	< 3,5	3.1)
Tensile Strength	MD	N/mm²	>180*	ASTM D 882
	TD	N/mm²	>180*	ASTM D 882
Elongation at Break	MD	%	< 250	ASTM D 882
	TD	%	< 250	ASTM D 882
Puncture Strength		g	> 400*	ASTM D 3763
Porosity		%	40 ± 6	BMS TT 2.2
Gurley		s	160 ± 50	ASTM D 726
Thermal Shrinkage	MD	%	< 3.5*	BMS TT 2.1
	TD	%	< 1*	BMS TT 2.1

- To increase the energy density of the batteries, the separator films must also become thinner and thinner.
- Alongside lifetime and fast charging, battery safety has become an important issue for car manufacturers.

World‘s best environment for the development of new film types

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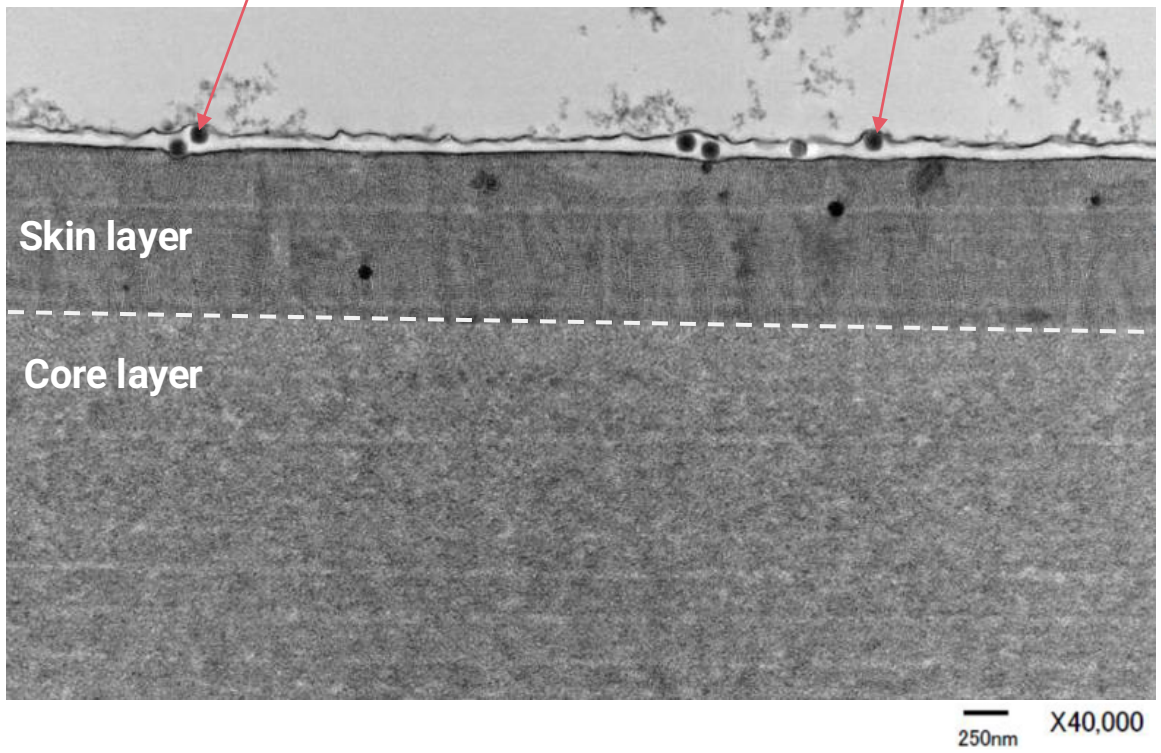
Substitution of conventional AB-solutions

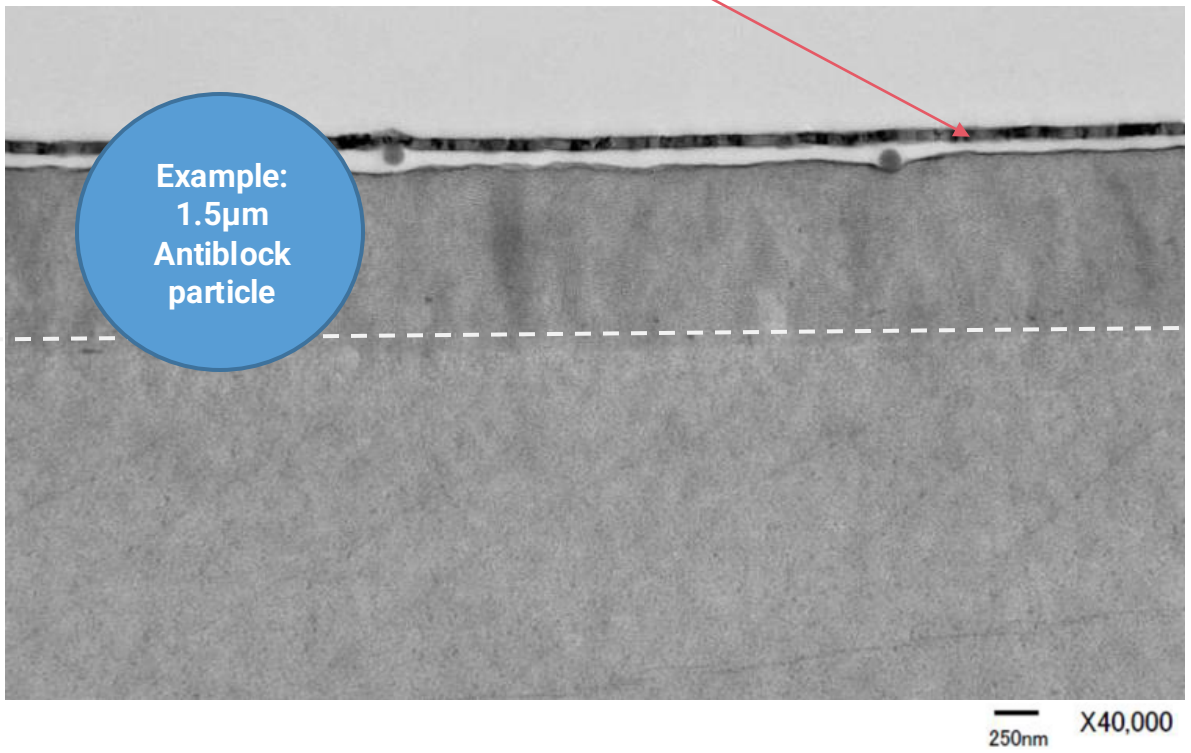
Layer Crosscut (ILC BOPP)

Coated layer with Nanoparticles

Nanoparticles

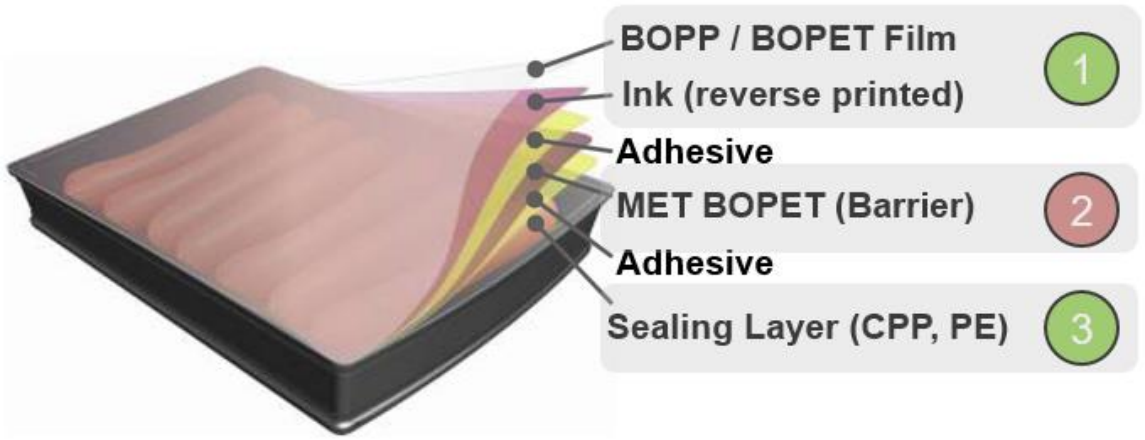


Vacuum metallisation

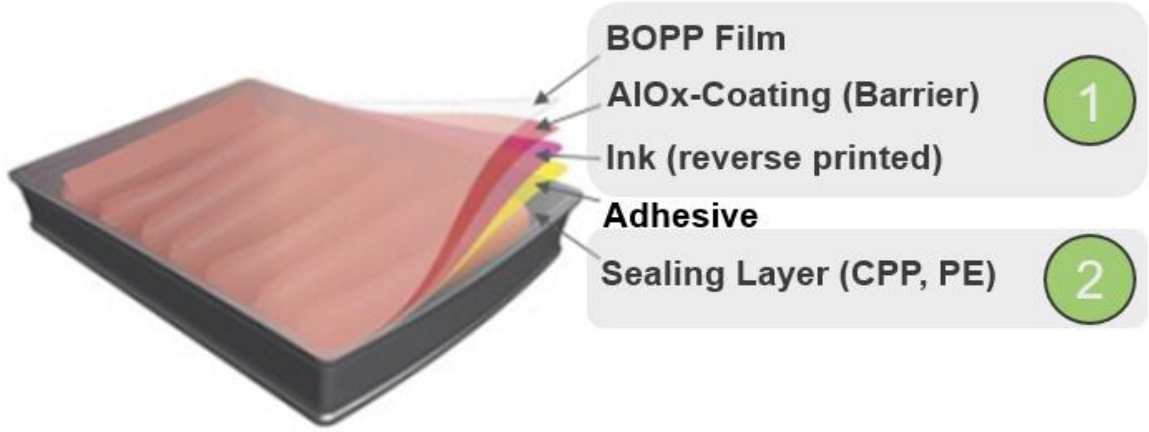


Sustainable structures: monomaterial packaging

Commercial 3-Ply Laminate



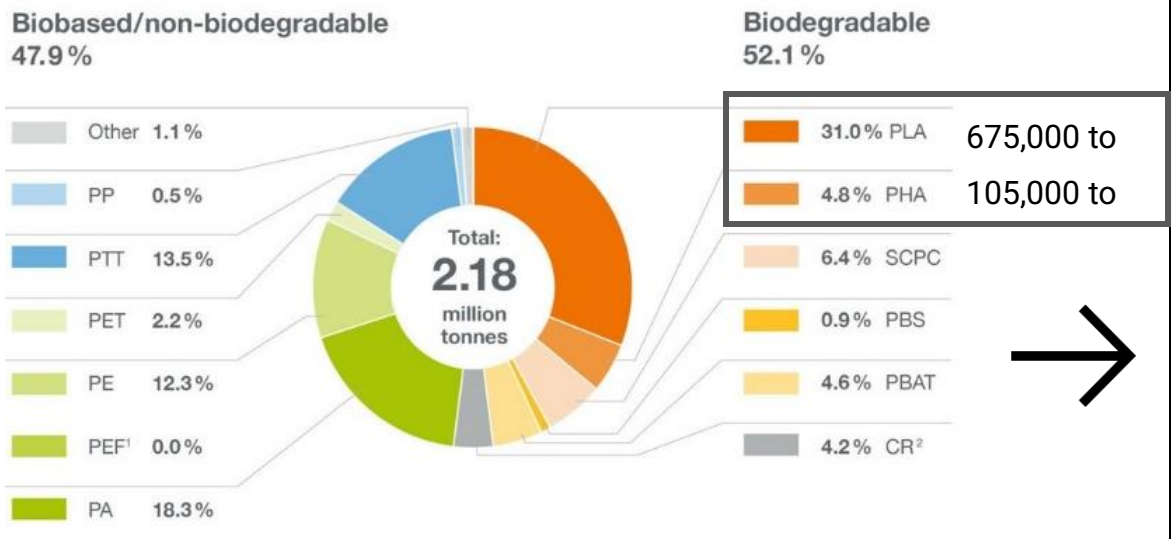
2-Ply Laminate – consists of PO



Improved barrier values of BOPP ILC films enable new packaging structures (monomaterial)

Production capacities

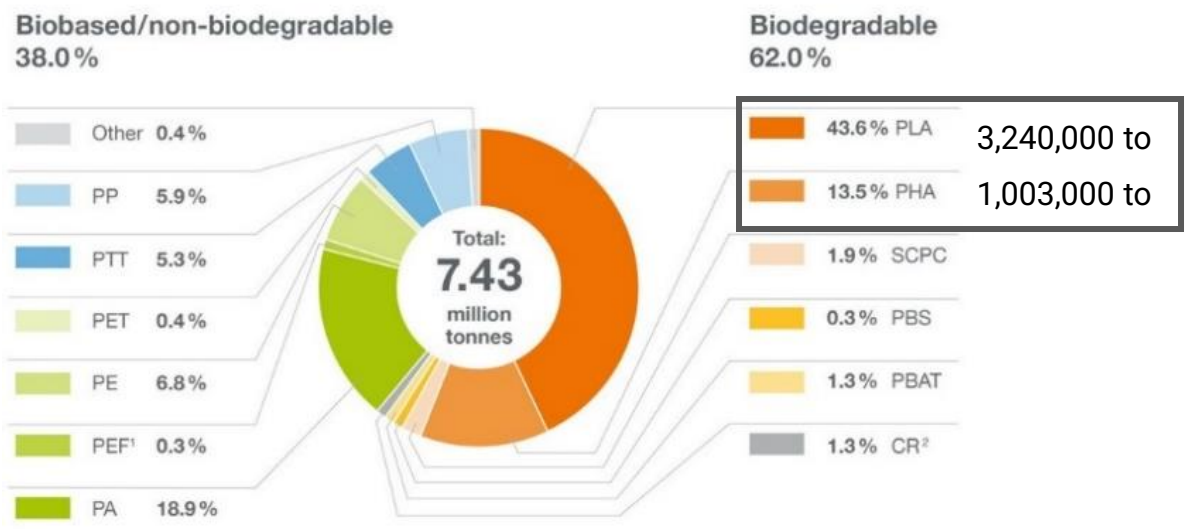
Global production capacities bioplastics (2023)



675,000 to

105,000 to

Global production capacities bioplastics (2028)



3,240,000 to

1,003,000 to

- Demand for biobased polymers will rise by **17% every year** until 2028
- By 2023, PLA-capacities rose by 50%
- **But: Biopolymer capacities ca. 1% of global plastics production**

Source: Nova-Institut

Project PepsiCo – main findings

Achieved

- Homecompostability certification for single BOPHA-PLA with ≥70% PHA-content achieved
- BOPHA-PLA film formulations for print-, barrier- and sealing webs available
- First printed BOPHA-PLA-based laminates for packaging trials available at Pepsico
- LISIM process offers additional possibilities regarding biax processing & film properties
- ILC is feasible!
- Next to pilot line trials @ Brueckner several successful semi-industrial production line trials
- PepsiCo‘s vision is supported by several BO-film producers

Challenges

- Homecompostability certification for printed BOPLA-PHA high barrier laminates in progress
- WVTR is close to requirements, but needs to be improved further
- All parameters from extrusion to winder need to be newly evaluated, also converting steps
- Acceptance of new home-compostable BOPHA-PLA packaging structures by endusers

Commitment of Brückner to circular economy

Active participation in various projects with partners from full supply chain, e.g.

R-Cycle:

Is a Joint project for collection and sensor-readable markings of recycling-relevant data along the entire supply chain

PrintCYC:

Is a joint project to analyze the influence of printing ink systems on quality of recyclates

PlasticBOND:

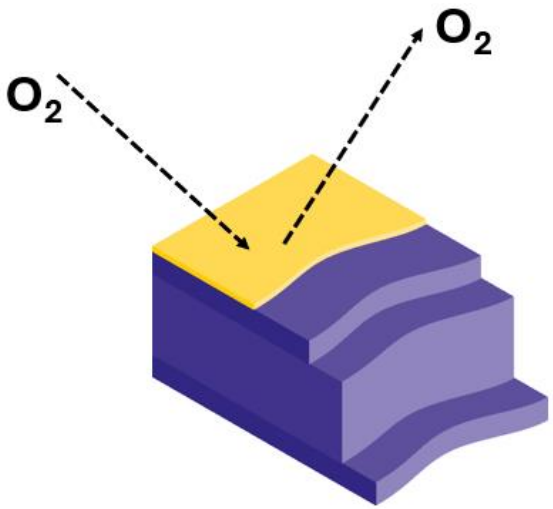
Is a joint project to increase recyclability of plastic products and reuse of PCR-material

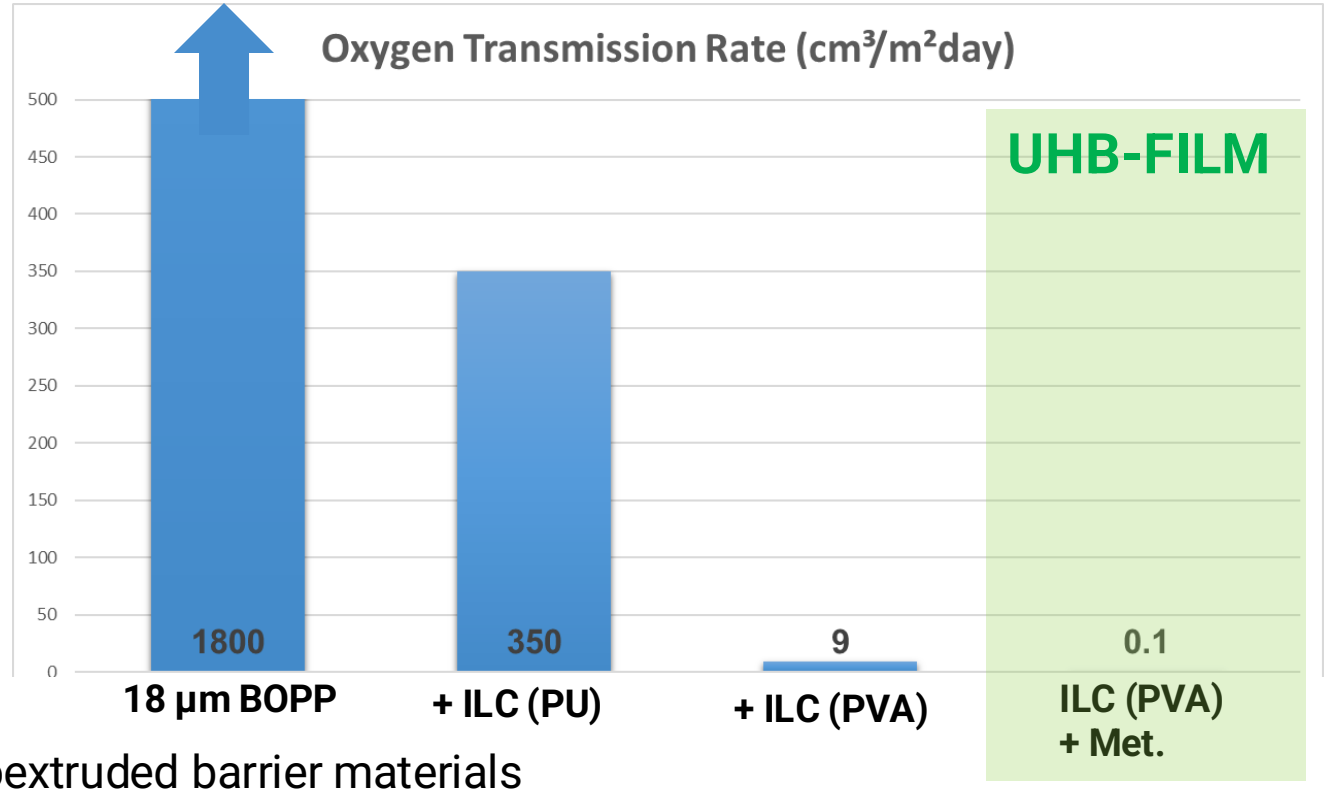
Cooperation projects with film producers and producers of PCR-PP and PCR-PE-material on suitability for BOPP- / BOPE-production

Inline Coating Technology

R&D: Latest Developments

- Significant Improvement of Oxygen Barrier





- Ultra High Barrier Films **without** coextruded barrier materials