



Value Chain Led Product Innovation

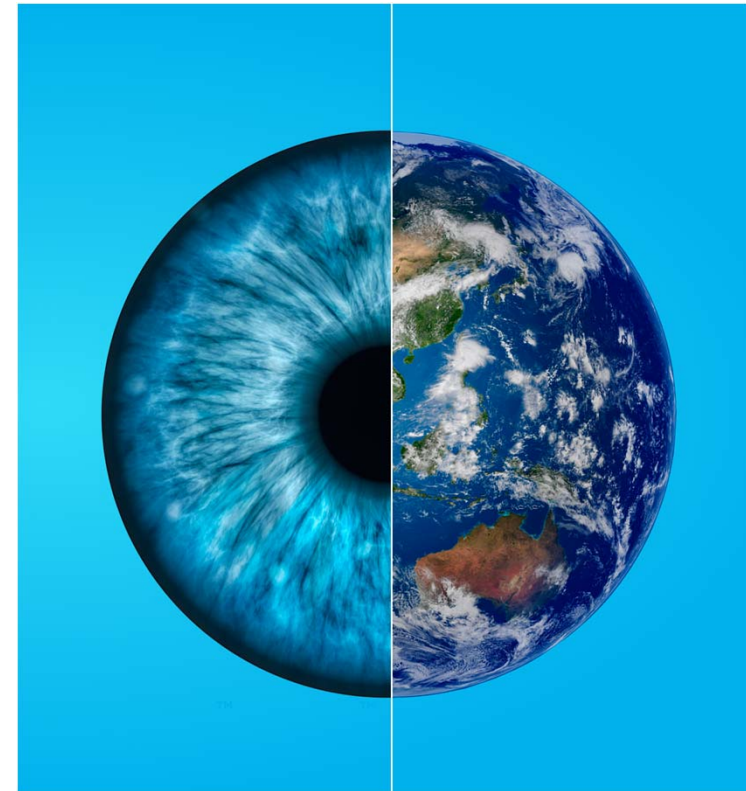
PLANTIC™ Sustainable Barrier

Partnership for a unique paper-based high barrier recyclable pouching option

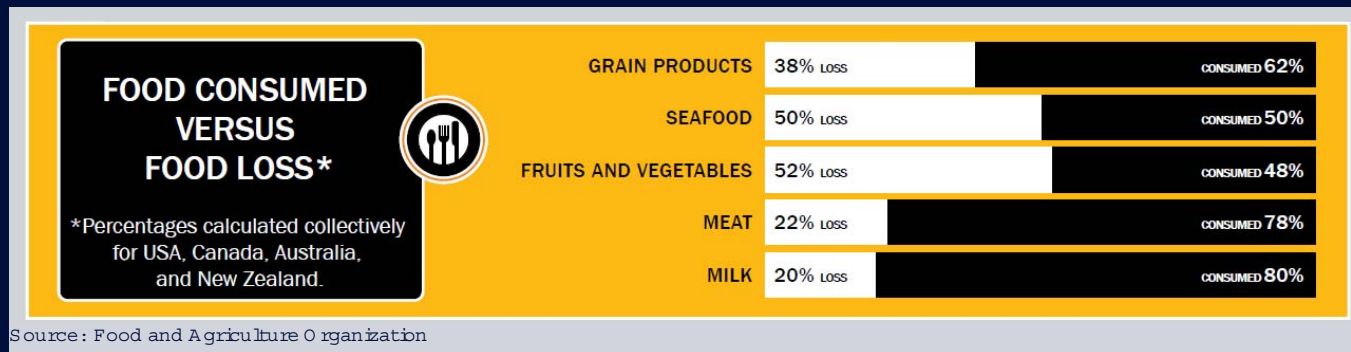
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Possible starts here

Westlake

Presented by:
David Chacon



Food Waste or Shelf-Life Extension



- Over 1/3 of all food produced globally goes to waste at a value of \$1 trillion and 1.3 billion tons of waste
- The world's nearly one billion hungry could be fed on less than 25% of the food wasted in the US, UK and Europe
- An area larger than China is used to grow food that is never eaten
- 25% of the world's fresh water supply is used to grow food that is never eaten
- 2.3 billion people are joining the planet by 2050 which will require a 60% to 70% increase in global food production; or we can just stop throwing food away...

The PLANTIC™ Story

Challenges & Opportunities



Early Days

- Commenced Commercial Operations in 2003 to Commercialize a Technology
- Co-Operative Research Center for International Food Packaging



Acquisition

- Acquired by Kuraray in 2015
- Expands portfolio of sustainable high barrier resins
- Increases R&D spend for product support and innovation



IP Space

- Global patent families
- Provides exclusive use of high amylose starch for plastic articles globally



Production

- Primary film manufacturing and product development in Melbourne, VIC
- Primary resin manufacturing and application development in Houston, TX
- Fundamental R&D in Kurashiki Japan





THE SOURCE

General Business

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Day 1



Day 3



Day 5



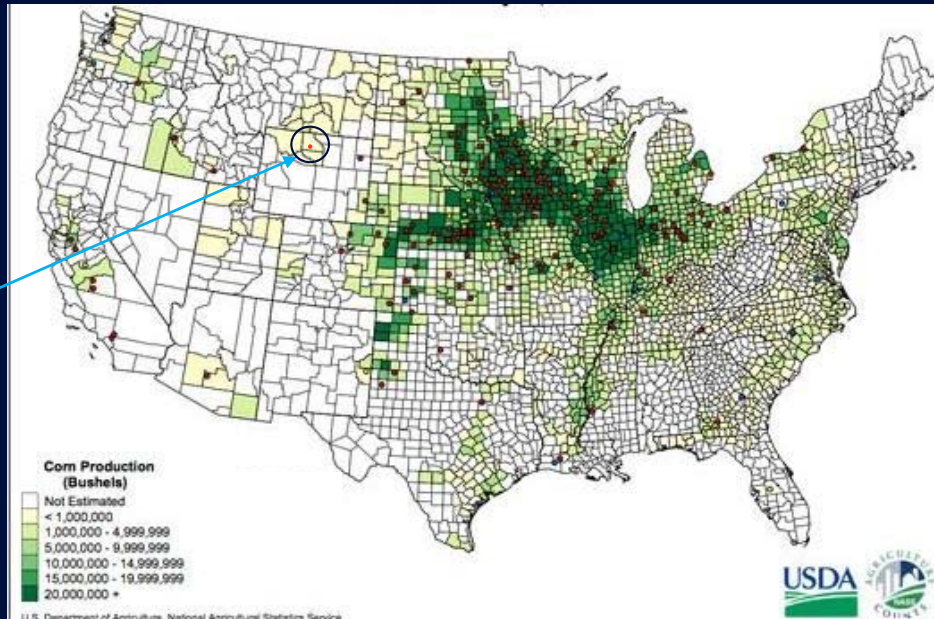
Day 8

"TPS natural polymer" formed by
extrusion coating or extrusion film
lamination

A high barrier thermoplastic made from starch

- Special amylose and amylopectin starch
- Indirect food contact approval in EU, US, Asia, Mercosur and ANZ (China in progress)

Corn Production Map, USA



Land required to grow ALL OF the worlds' barrier packaging = 174 miles²

Natural Polymers

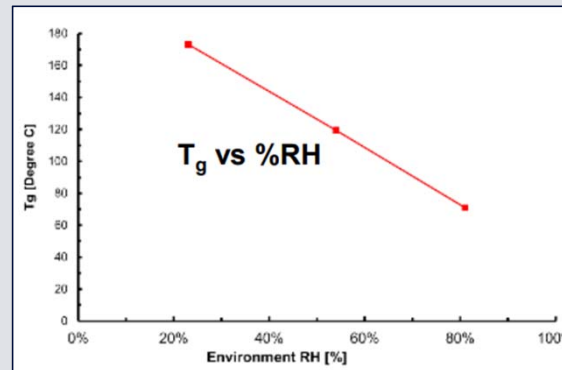
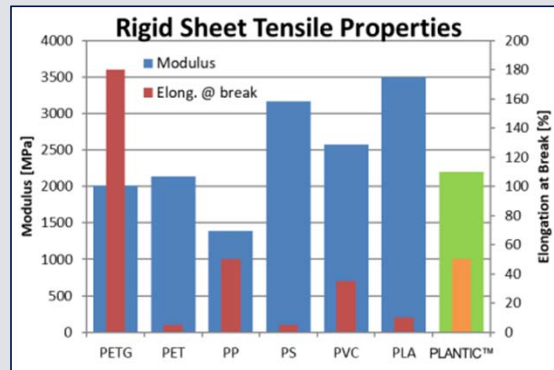
Where they come from ...

- 2022 US corn yield of 13.7 billion bushels
- Replacing the world's (1) trillion kgs of barrier packaging with our this TPS based packaging represents 0.14% of US corn production
- Non-GMO "True Trace" grain program
- 2023 corn plantings 6% higher than 2022
- Price setting "window" for growers
- Price stability of barrier film



PROPERTY SPACE

Thermofforming Material Properties



- This Natural Polymer is an amorphous thermoplastic starch with similar mechanical properties to PET
- The glass transition temperature can be changed with environmental conditions, though is typically ~ 120°C at 50% RH
- As a sheet it can be thermoformed on traditional thermofforming equipment at temperatures between 120°C – 130°C

Bio-Responsible Packaging

- The presented barrier resins are true functional polymers
- Barrier performance comparable that of conventional barrier resins
- Our Natural Polymer OTR performance supports shelf-life extension preserving organoleptics and reducing food waste
- Plant-based barrier with ability to dissociate layers in the recovery stream
- Puncture performance rivals PA allowing PA replacement

Functional Performance

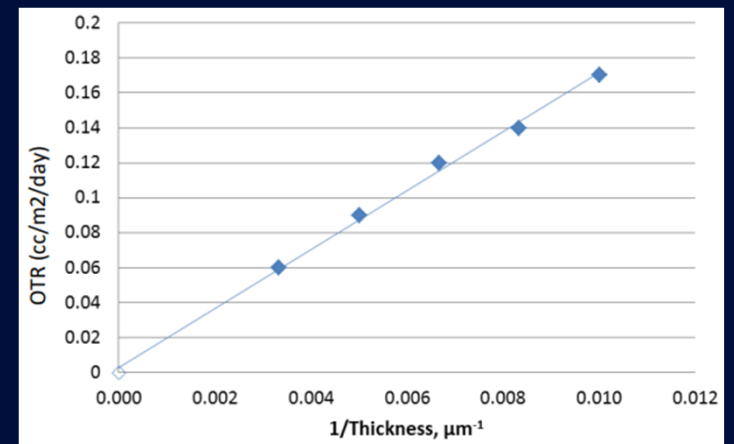
Material	OTR	WVTR
LDPE	6500	18
HDPE	2300	6
PP	2300	11
PLA	600	300
PVC	200	46
PET	90	20
Nylon 6	32	160
MXD6	2.0	80
PVDC	2.0	3
EVOH 44%	1.0	20
EVOH 32%	0.2	60
Natural Polymer	0.5	150
	cc/m ² /day	g/m ² /day
	25 µm, 23 °C, 50% RH	25 µm, 38 °C, 90% RH

Bio-Responsible Packaging



Gauge	OTR
100	0.17
120	0.14
150	0.12
200	0.09
300	0.06

Functional Performance



$$1 / P = \sum (i=1 \text{ to } n) t_i / P_i$$

cm³/m²/24hr.atm : 10°C, 90/50% RH (Mocon test data)



SUSTAINABILITY

General Business

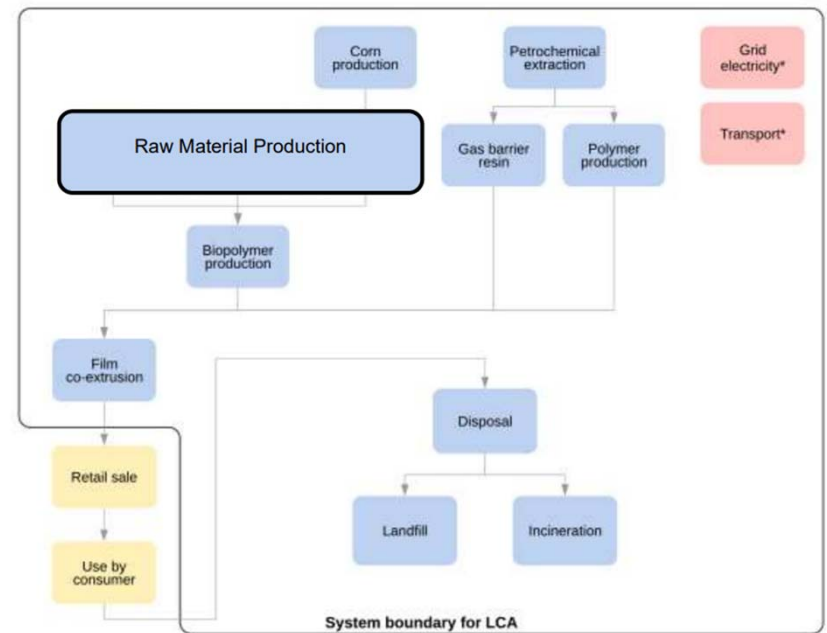
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Sustainable

Benefits



- Lowest in class carbon footprint
- Energy use approximately half that of a comparable barrier PP, barrier PET or PLA tray



Greenhouse Gas Equivalents

Metrics directly linked to corporate sustainability report(s) to support sustainability pledge(s) and drive change

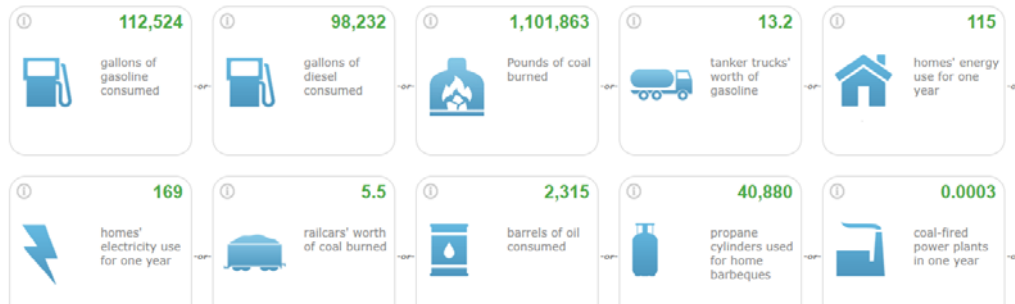
The sum of the greenhouse gas emissions you entered above is of Carbon Dioxide Equivalent. This is equivalent to:

1,000 Metric Tons

Greenhouse gas emissions from



CO₂ emissions from



- EPA has published equivalencies for CO₂ savings (<https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>)
- This can be used to translate Carbon Footprint into meaningful comparisons for consumers
- Data below is based on replacing 1,000 MT of Conventional barrier products with our Natural Polymer (TPS type) equivalents

	"EF type"	"R type"	"RB type"	"PF type"
Acres of forest	2,899	3,029	1,703	2,594
Trees planted	36,795	38,445	21,615	32,918
Homes powered	379	396	223	339
Passenger Cars	491	513	288	439
Driven Miles	5,530,400	5,778,400	3,248,800	4,947,600
Driven Kilometers	8,848,640	9,245,440	5,198,080	7,916,160

Bio-Responsible Packaging



COFFILM
eco-friendly coffee packaging solution

High barrier and biodegradable packaging for coffee and food

Biodegradable Zipper

Biodegradable Aroma

CERTIFICATION
PLANTIC™ HP : EN13432 by AB Vincotte



BIO PBS : TUV HOME S0534, TUV SOIL S0534



Environmental Solutions



Recyclable



Repulable



Compostable



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Possible starts here



Multilayer Solutions

General Business

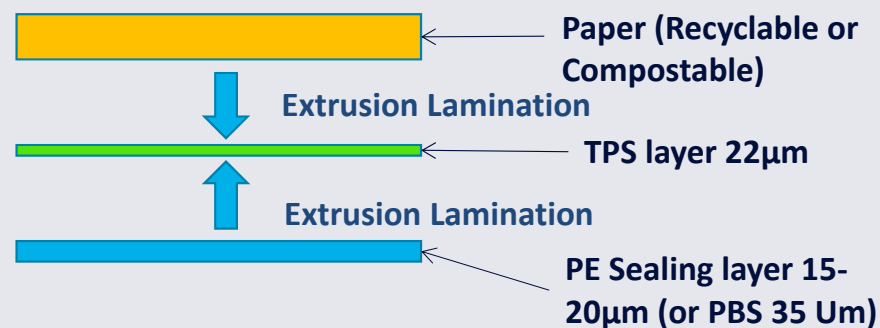
Extending the Natural Polymer barrier to paper



Korea Environmental Packaging Institution (Kepi) / The 8th Green Packaging Awards 2018 Grand prize (Compostable)

Recyclable and Repulpable multi-material barrier paper packaging with compostable sealant option

- Recyclable coffee bag with degassing valve
kraft paper // extruded TPS layer // PE film
- Compostable coffee bag with degassing valve
kraft paper // extruded TPS layer // bioPBS



OTR
23°C 50% RH
0.61 cc/m ² day atm

Fiber recovery > 97% from repulping of
thin cast TPS //paper laminate

Western Michigan University repulpability assessment

Reject screen residue appears to be from the laminating adhesive



75 μ m kraft paper
laminated to a 50 μ m
(2 mils) TPS film



97.5% and 99.2%
fiber yield from
two samples

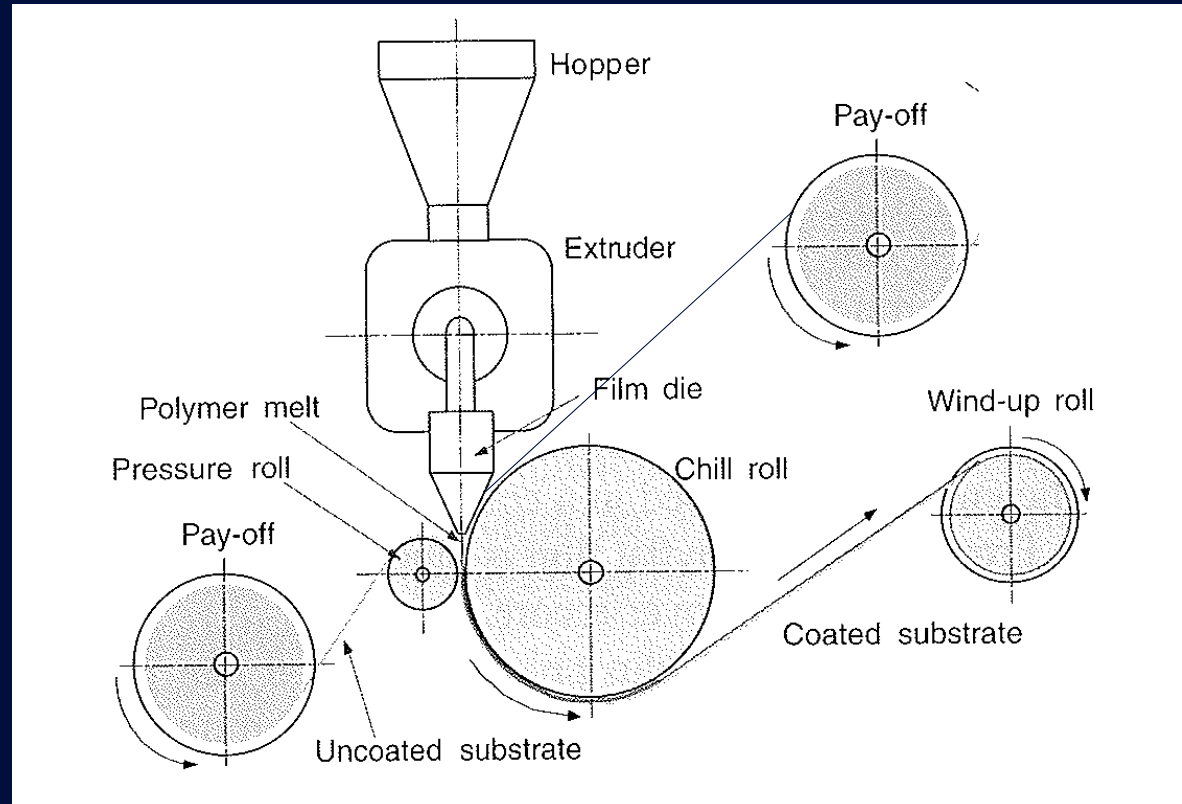
To pass, Yield of sample (% accepts)
must be no less than 85%
for non-bleached paper



Processing Conditions

- Operates at line speeds compatible with traditional olefinic resins
- Rehydrated high amylose TPS resin
- Low shear screw – barrier mixing screw sufficient
- Low extrusion temperatures; e.g., 90°C to 105°C
- Heated casting drum ; e.g., typical temperatures between 85°C and 90°C

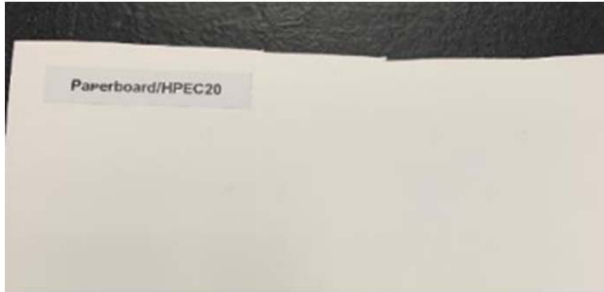
Extrusion Coating of the innovation grade TPS



100% fiber recovery from repulping of innovation grade TPS extrusion coated onto paper

Western Michigan University repulpability assessment

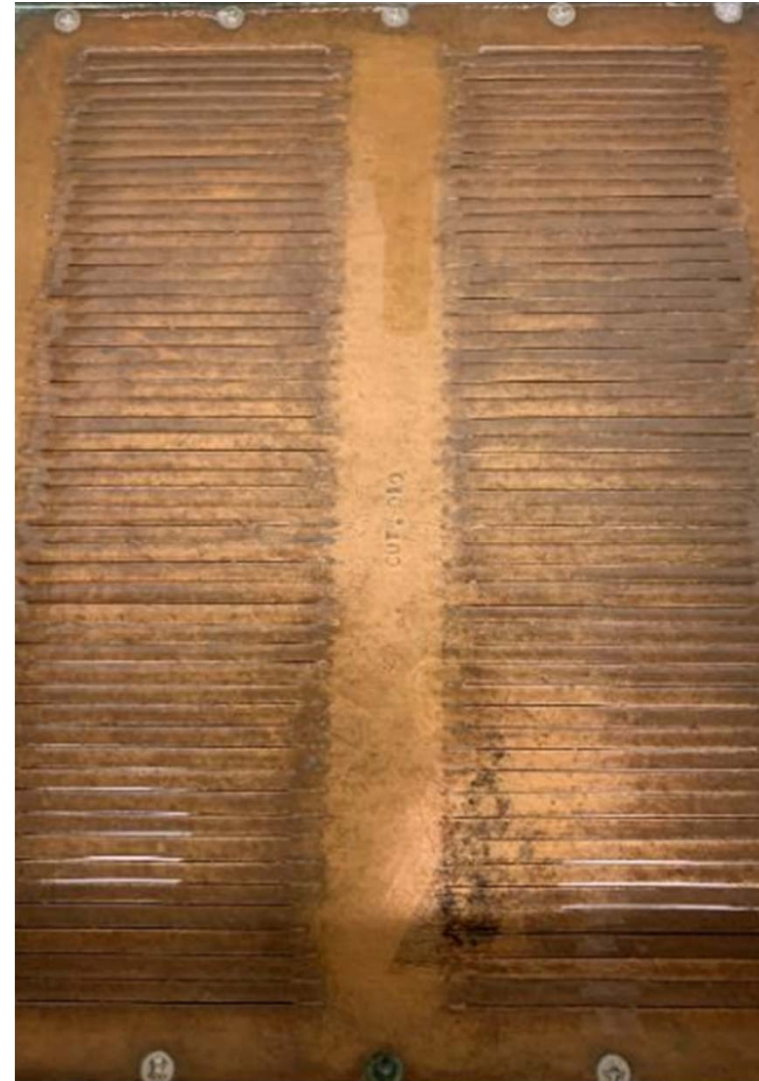
No reject screen residue



SBS cup stock
extrusion coated with
20 Um (0.8 mils) of
TPS extrusion coating



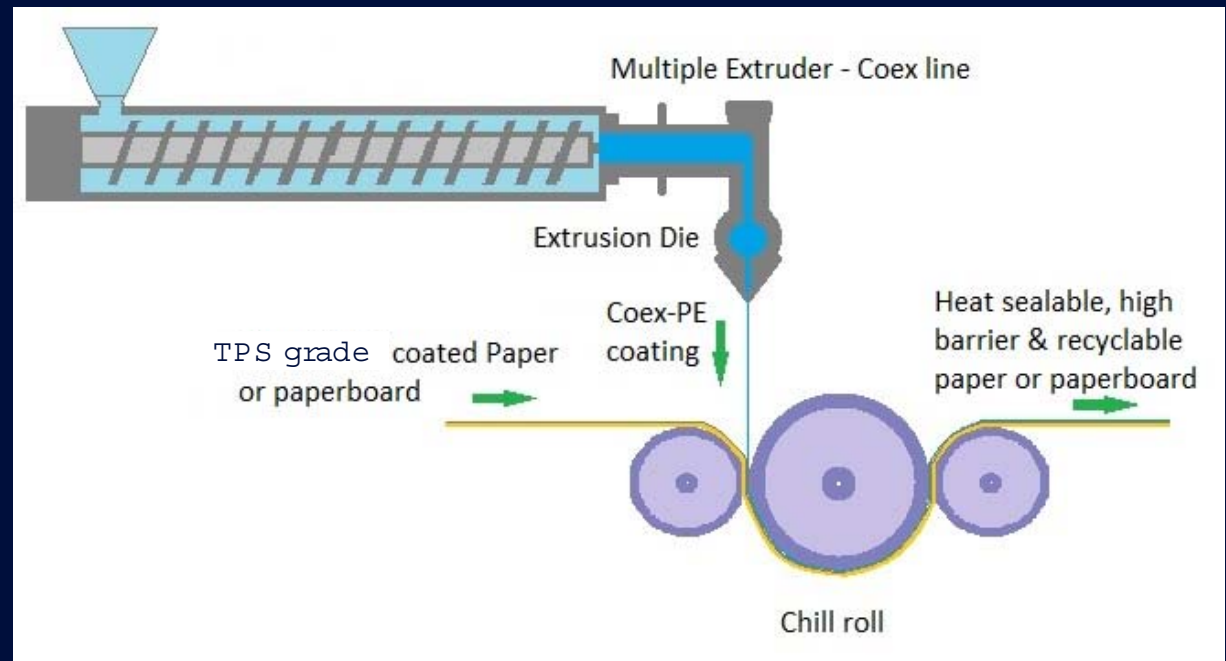
100% and 100%
fiber yield from
two samples



Important Features

- 3-layer coextrusion lines
- Flexibility to change from LDPE to HDPE based coatings
- Can run in tandem or two pass after the extrusion coating of the innovative TPS grade
- Or the co-extrusion process can be used to apply onto pre-made Paper/TPS ctg' brought from a different location
- PE co-extrudable multilayer provides the seal and WVTR required for each of the application

Coextrusion of a Multilayer PE coating



Collaboration with Westlake Chemical

- 5-layer, 3-extruders coextrusion
- Introduction of a multilayer structure based on TRUCOAT® MC2007 (HDPE) to provide lower WVTR
- Combined with a range of tie layer materials, including TYMAX® products.
- And options to run LDPE sealants, such as EC808
- Able to run at commercial speed extrusion coating/lamination of the previously TPS coated substrate

Pilot Plant trials – Longview, TX



Images courtesy of Westlake Chemical

Repul & Recycle

Passes the Western Michigan University repulability and recycling standard

- Recoverable polyethylene on reject screen
- No fiber residue attached to the sealant

WESTERN MICHIGAN UNIVERSITY

REPORT RESULTS: REPULPABILITY PROCESS (PART 1)

Trial: Kuraray Date Run: 9/7/2022

Sample: 70KEP-2-1B1

	Set #1:	Set #2:	Set #3: (if required)
Is sample representative of the material as a whole? (Y/N)	Y	Y	
STARTING SAMPLE			
Moisture Content	9 %	9 %	%
Temperature Range	130 °F	130 °F	°F
Amount of Fiber in Charge	25.32 g	25.21 g	g
Temp & pH Maintained? (Y/N)	Y	Y	
Hot Slurry Charged to Flat Screen, as Instructed? (Y/N)	Y	Y	
FINISHED SAMPLE: Oven dry mass			
Amount of Fiber Rejects	2.168 g	2.139 g	g
Amount of Fiber Accepts	12.61 g	12.71 g	g
Yield of Sample (% Accepts)	85.3 %	85.6 %	%
Observe and note deposition on vessel walls, screens, moving parts, etc.			
Deposition Observed? (Y/N) If yes, detail below.	N	N	

SUMMARY Operational Impact: (Pass/Fail) Pass Pass

Yield: (Pass/Fail) Pass Pass

To pass % accepts must be no less than 80%

Note, details:

Stickies - 7, 28, 9. Average of 14.67 stickies per hand sheet.

paper

Coated TPS
PE sealant

Rejects Screen



Accepts Screen



WESTERN MICHIGAN UNIVERSITY

REPORT RESULTS: RECYCLABILITY PROCESS (PART 2)

Trial: Kuraray 70KEP-2-1B1 Date Run: 1/31/2022

Sample: C-1 T-1

	Untreated Control	Recyclability Test Sample
Is sample representative of the lot as a whole? (Y/N)	Y	Y
Moisture Content	8.7 %	8.75 %
Pulping		
At 6% Consistency? (Y/N)	Y	Y
15/85% Charged by weight? (Y/N)		Y
If greater than 15/85%, specify ratio here:		%
Temp & pH maintained, per App. B, #3? (Y/N)	Y	Y
Number of batches required?	1	1
0.0625 Screens		
2% (note if different) Consistency, Temp & pH, per App. B, #5? (Y/N)	Y	Y
10% Volumetric Reject Rate? (Y/N)	Y	Y
0.010 Basket:		
Temp, pH, & Reject Rate, per App. B, #6? (Y/N)	Y	Y
Reverse Cleaners:		
Temp & Pressure Differential, per App. B, #7? (Y/N)	Y	Y
Determine Volumetric Reject Rate	17.4 gpm	20.3 gpm
Was it necessary to stop the test to clean any apparatus at any time during this procedure? (Y/N)	N	N
Deposition observed? (Y/N) If yes, detail below.	N	N
Were the required Temp & pH maintained throughout the entire protocol? (Y/N)	Y	Y

Note, details:
C-1 is 100% control supplied by WMU. T-1 is 85% control 15% test material

PASS/FAIL SUMMARY

	Trial #1	Trial #2	Trial #3
1. For both treated and untreated were the substrate, samples, specimens appropriate? (Y/N)	Y	Y	
2. Fibre Yield ≥ 80%? (Y/N)	Y	Y	
3. Operational impact acceptable? (Y/N)	Y	Y	
4. Product performance acceptable? (Y/N)	Y	Y	
5. Product appearance/spot count acceptable? (Y/N)	Y	Y	
Overall Pass / Fail - by trial: (Pass/Fail)	Pass	Pass	

MATERIAL AS SUBMITTED "PASSES" VOLUNTARY STANDARD.

Flexible Solutions...



PET FOOD

Conceptual Structure:

Paper / Coated TPS / heat-sealable layer

Key Benefits / Properties:

- Fiber Yield
- Repulpable/Recyclable/Compostable
- Fat, grease & oil resistance
- Odor, gas protection
- Shelf-life preservation/extension

Manufacturing requirements:

- Extrusion Coating
- Extrusion Lamination

COFFEE

Conceptual Structure:

Paper / Coated TPS / heat-sealable layer

Key Benefits / Properties:

- Fiber Yield
- Repulpable/Recyclable/Compostable
- Fat, grease & oil resistance
- Odor, gas protection
- Shelf-life preservation/extension

Manufacturing requirements:

- Extrusion Coating
- Extrusion Lamination

SNACKS / CEREALS

Conceptual Structure:

Paper / Coated TPS / heat-sealable layer

Key Benefits / Properties:

- Fiber Yield
- Repulpable/Recyclable/Compostable
- Fat, grease & oil resistance
- Odor, gas protection
- Shelf-life preservation/extension

Manufacturing requirements:

- Extrusion Coating
- Extrusion Lamination

DRY MIX POWDERS

Conceptual Structure:

Paper / Coated TPS / heat-sealable layer

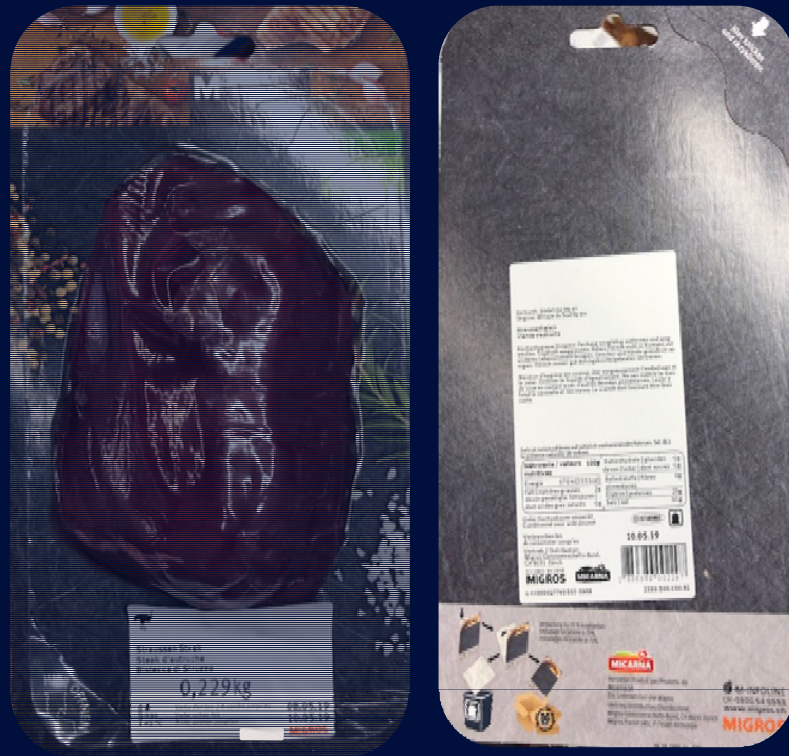
Key Benefits / Properties:

- Fiber Yield
- Repulpable/Recyclable/Compostable
- Fat, grease & oil resistance
- Odor, gas protection
- Shelf-life preservation/extension

Manufacturing requirements:

- Extrusion Lamination
- Extrusion Coating

Skin on Board applications



Sustainability Metrics – Collaboration efforts

Provides dissociation of packaging layers to support recovery and packaging economics

- Coated TPS and laminated card stock
- Customized Coating grade material (LDPE) and sealant (Peelable)
- Weight reduction
- Cube utilization
- Longer shelf life
- Less food waste
- Lower energy use & Lower carbon footprint
- Case ready
- Peg board display
- Premium branding
- Message alignment
- Consumer participation

Take A w a y s

- Natural polym er that can offer tangible sustainability benefits via LCA
- Providing a Flexible Packaging solution through Value Chain Collaboration
- W ith outstanding mechanical and barrier properties
- *A new Extrusion coating TPS grade that adheres to paper*, without any additional tie layer, prim er, or adhesive
- And allowing the recovery of 100% of the fibers back from the paper recycling
- Achieving a Recycle Ready Paper Based packaging that allows both Paper and Polyethylene layer to be recycled

2024 FlexPack PLACE Conference

April 14-17, 2024 • San Diego, CA • Wyndham San Diego Bayside



Thank You !

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Technical Service & Market Development

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