celplast
metallized products

Inline Coating and Metallizing as a Way to Improve Barrier and Reduce Carbon Footprint

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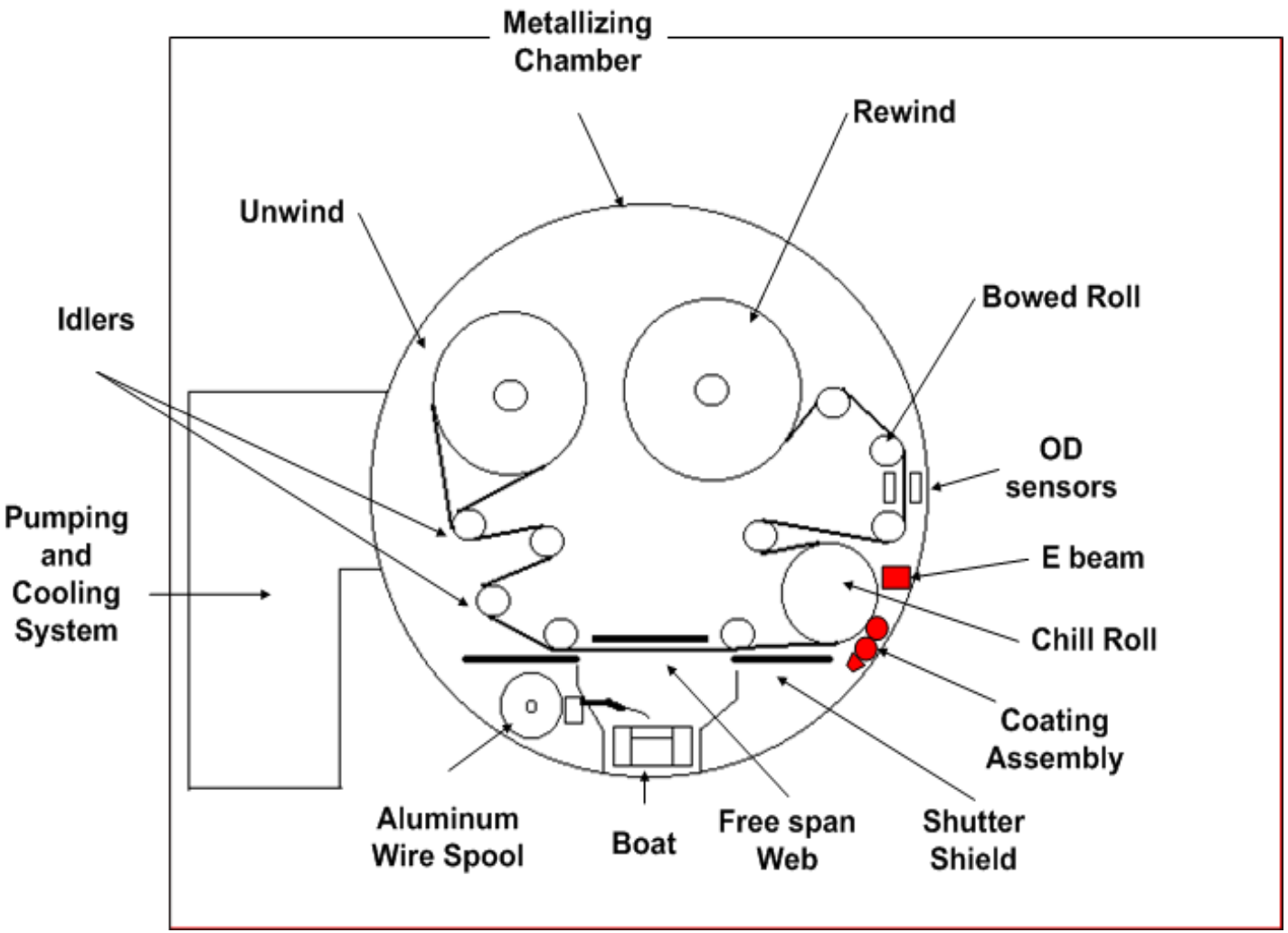
OUTLINE

- Inline Coating and Metallizing Process
  - One step vs. two step process
- Barrier Properties of Top-coated Metallized Films
  - WVTR and OTR
- Reducing Carbon Footprint
  - Opportunities for Layer Elimination
- Summary
- Conclusions

Inline Coating and Metallizing Process



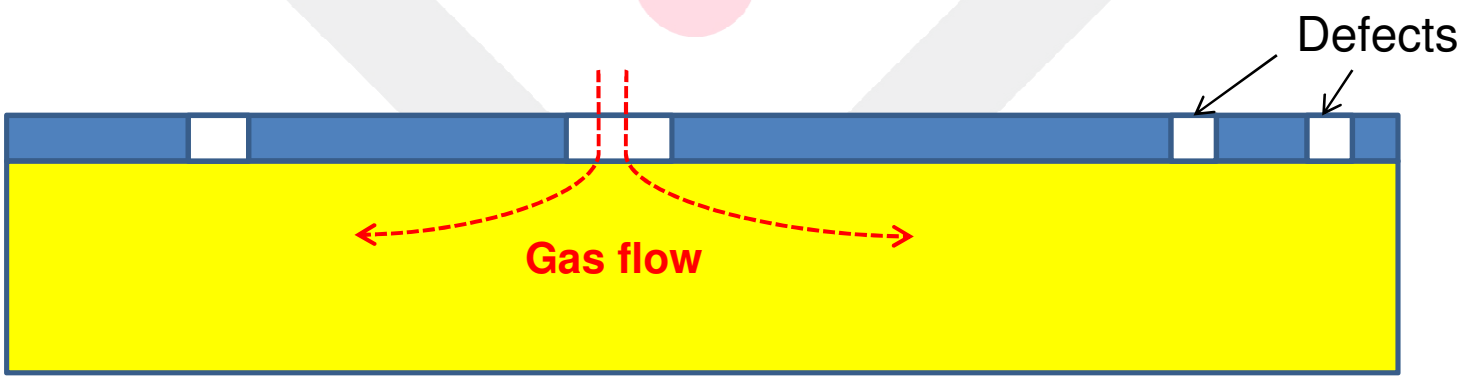
One Step vs. Two Steps

	Two Step Coating and Metallizing	One Step Coating and Metallizing
Capital Investment	• Two units and two production areas • Higher fixed costs	• One unit and one production area • Lower fixed costs
Operating costs	• Requires two sets of operators • Yield losses > 10% • Higher operating costs	• Requires one set of operators • Yield losses ~ 5%, • Lower operating costs
Film Properties	• Pinholes and scratches • Good barrier properties	• Few pinholes and scratches • Excellent barrier properties

BARRIER PROPERTIES OF TOP-COATED METALLIZED FILMS

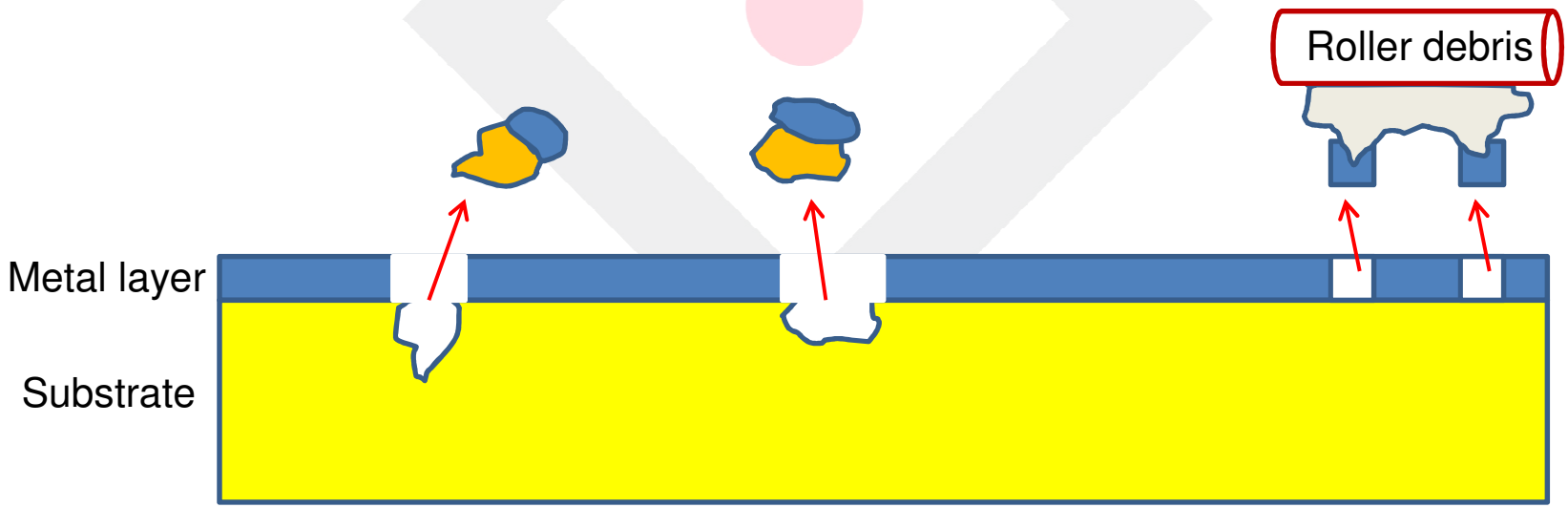
Pinhole Theory

- Gas transmission rate through a metallized film is controlled by the number of defects in the metal layer



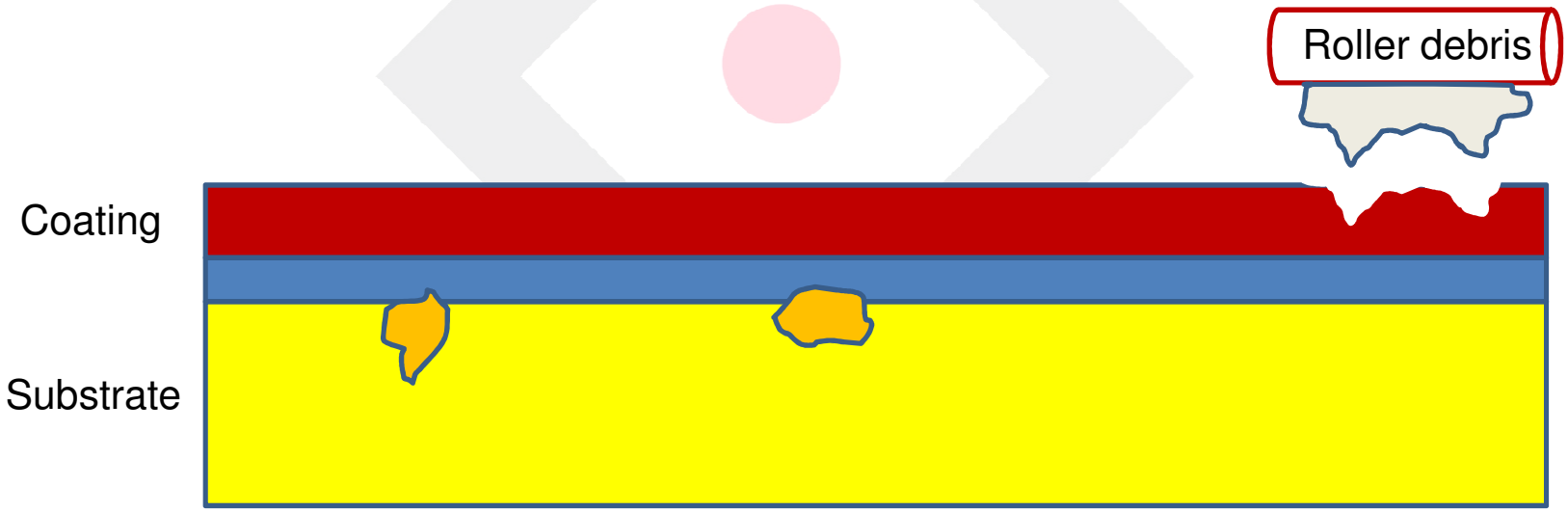
Pinhole Theory

- Causes of defect:
  - Scratches
  - Impurities flaking off



Pinhole Theory

- The coating protects the metal layer
  - Impurities are trapped



Barrier Properties

- Water Vapour Transmission Rate (WVTR)
  - 37.8°C and 90% RH (ASTM E-398)
- Oxygen Transmission Rate (OTR)
  - 23°C and 50% RH (ASTM D-3985)

WVTR Values

Material	Uncoated	Coated	OD	% Improvement
70G OPP	0.09	0.03	3.50	70.0
80G PLA	4.37	1.66	1.40	62.1
80G PLA	3.72	1.33	2.05	64.2
80G PLA	1.75	0.50	2.60	71.7
150G PE	0.48	0.29	2.30	38.7
36G PET	1.26	0.42	2.40	66.7
48G PET	1.09	0.11	1.25	90.0
48G PET	0.93	0.11	1.80	88.3
48G PET	0.78	0.14	2.10	82.0
48G PET	0.62	0.09	2.20	85.0
48G PET	0.62	0.08	2.30	87.5
48G PET	0.17	0.05	3.20	72.7

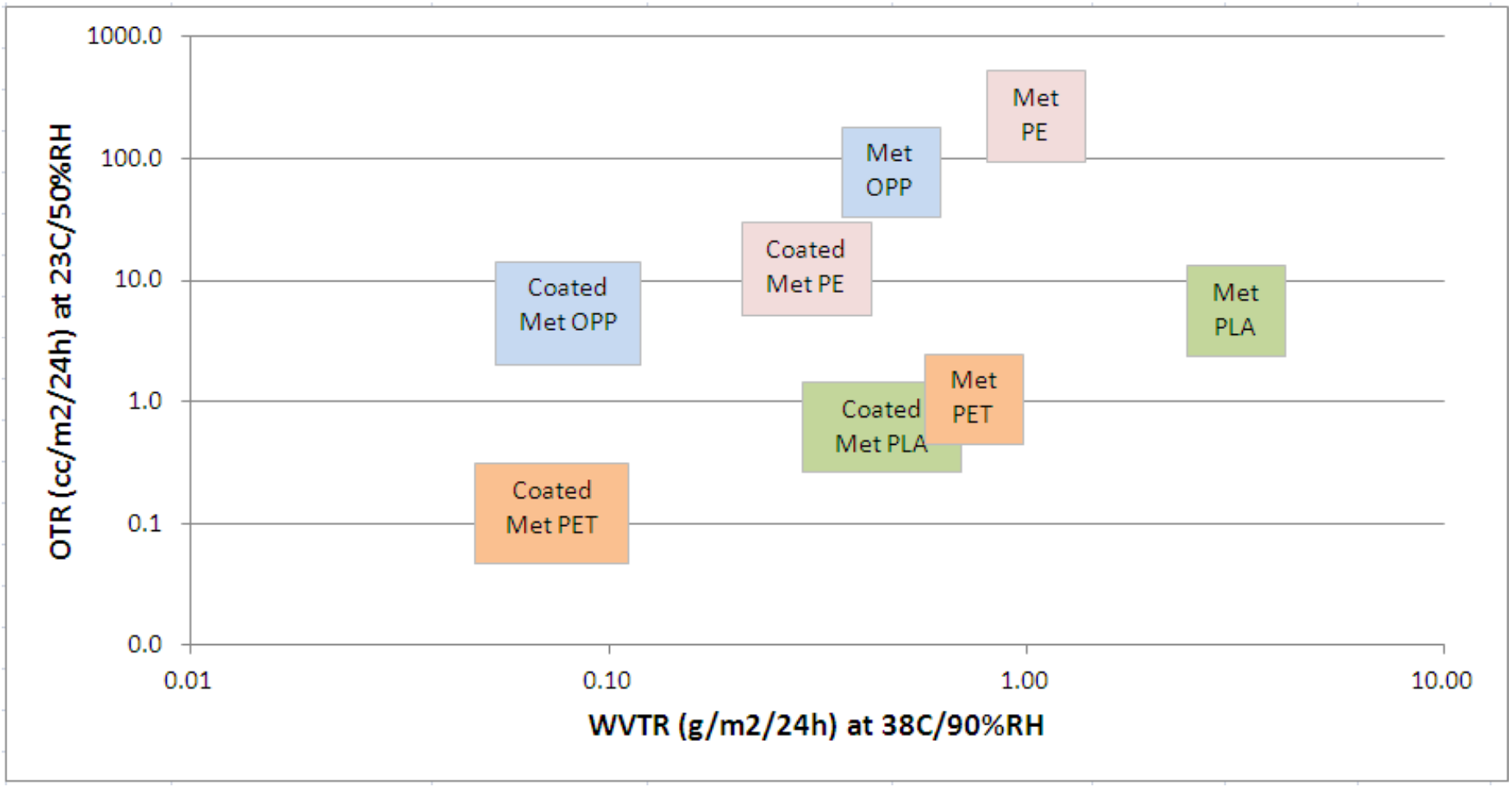
Values in $g/m^2/24h$ at 37.8°C and 90%RH

OTR Values

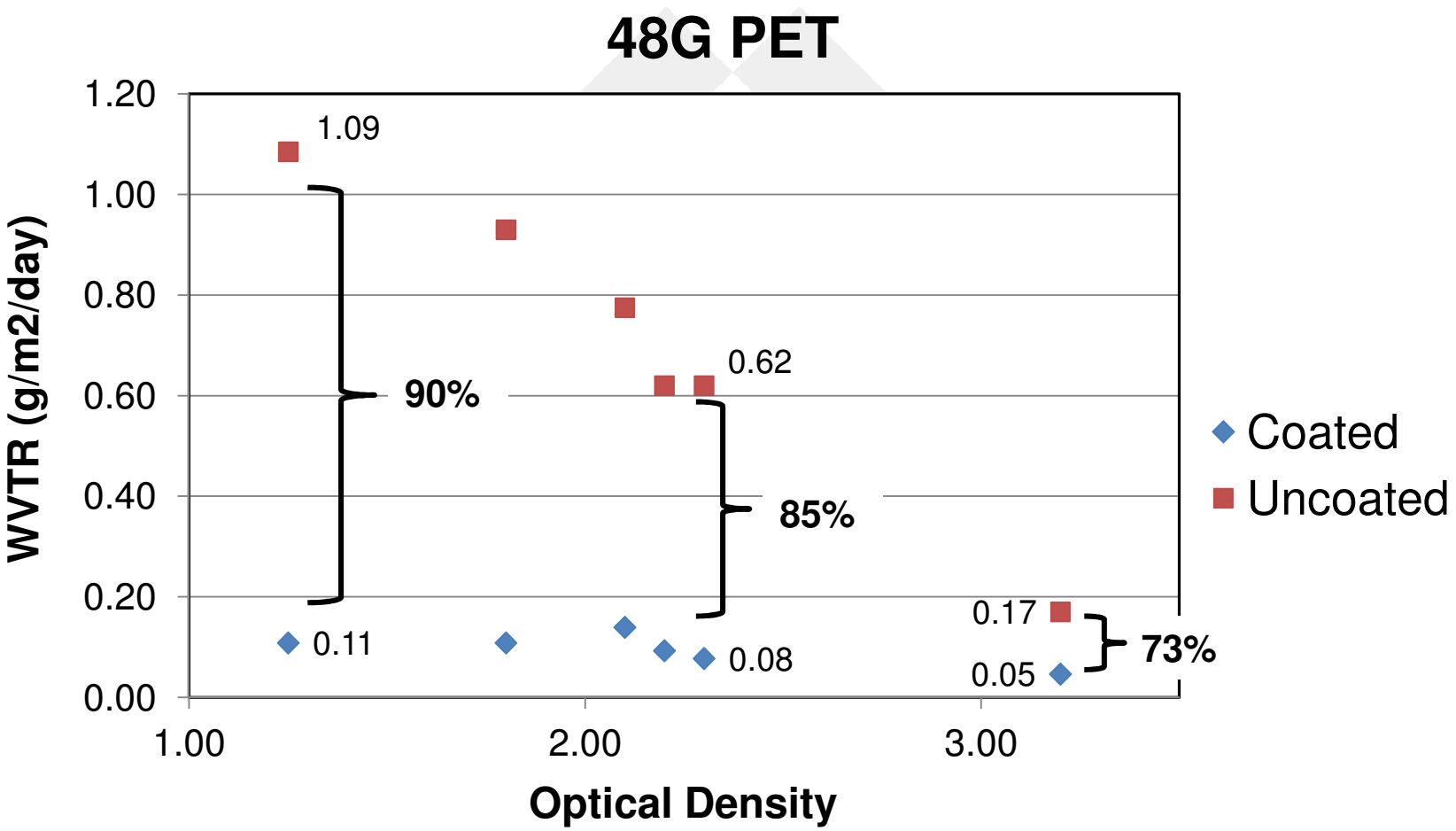
Material	Uncoated	Coated	OD	% Improvement
70G OPP	31.62	4.81	3.50	84.8
80G PLA	7.91	2.99	1.60	62.2
80G PLA	3.55	0.57	2.60	83.8
150G PE	149.50	11.55	2.30	92.3
36G PET*	0.71	0.25	2.40	65.2
48G PET	0.93	0.16	2.00	83.3
48G PET	1.09	0.17	2.10	84.4
48G PET	0.93	0.14	2.20	85.0
48G PET	0.93	0.16	2.30	83.3
48G PET	0.78	0.14	2.50	82.0

Values in cc/m^2/24h at 23°C and 50%RH
*Value measured at 0% RH

Barrier Properties of Several Metallized and Coated Films



WVTR vs. Optical Density



It is possible to significantly improve the barrier properties of the films by metallizing and coating in a single step and without having to work at optical densities greater than 2.0-2.3

REDUCING CARBON FOOTPRINT

Converting Operations

	Processing Energy Usage (MJ/Ream)	Processing CO_2 Equivalent[1] (Kg/Ream)	Material CO_2 Equivalent[2] (Kg/Ream)
Solvent Based Print or Coat	203*	40.5	11.0
8.5lbs/ream LDPE (15um)	162*	32.3	45.5
Metallizing	27**	5.4	1.2
Metallize & top coat, one pass	43**	8.6	4.5

**Life Cycle Inventories for Flexible Packaging Lamination*, Rick DiMenna, Rohm & Haas.

**Celplast calculations based on equipment manufacturer specifications and internal M & V studies.

[1]Ontario power carbon footprint of 0.5447 kg CO2 eq./MJ, *How it Works: Electricity Generation*, OPG, 2009.

[2]*CRADLE-TO-GATE LIFE CYCLE INVENTORY OF NINE PLASTIC RESINS,* Franklin Associates, 2008. Also *Eco-profiles of the European Plastics Industry*, Plastics Europe (2005), I. Boustead, ed. Includes yield losses.

Opportunities For Layer Elimination

- Potential layer elimination for 3 different structures:
  - Fractional coffee pouch: Metallized PET
  - Dry powder pouch : Aluminum foil
  - Bag-in-box pouch: Metallized OPP
- It also allows us to look at eliminating additional plies of material, that are there primarily to protect the metallized layer

Material Reduction:

Dry Powder Or Stick Pack

3-ply laminated structure		2-ply laminated structure	
Layer Description	Material Weight (g/msi)	Layer Description	Material Weight (g/msi)
SB reverse print PET	11.7		
SB adhesive lamination	0.8	SB reverse print PET	11.7
27.5 g Al foil	12.2	SB adhesive lamination	0.8
SB adhesive lamination	0.8	Metallizing & EB coating	0.8
1.5 mil sealant web	22.8	1.5 mil sealant web	22.8
Total Material Weight (g/msi)	48	Total Material Weight (g/msi)	36

Material reduction: 25.3%

Material Reduction:

Frac Pack Coffee

2-ply laminated structure		Single ply structure	
Layer Description	Material Weight (g/msi)	Layer Description	Material Weight (g/msi)
SB surface print	0.8		
48 g metallized PET	10.9	SB surface print	0.8
SB adhesive lamination	0.8	Metallizing & EB coating	0.8
1.5 mil sealant web	22.8	1.5 mil sealant web	22.8
Total Material Weight (g/msi)	35	Total Material Weight (g/msi)	24

Material reduction: 30.9%

Material Reduction:

Bag-in-box Snack Food

2-ply unprinted laminated structure		Single ply unlaminated structure	
Layer Description	Material Weight (g/msi)	Layer Description	Material Weight (g/msi)
Unprinted 60 g OPP	8.8		
8.5 lbs LDPE adhesive	8.9	Metallizing & EB coating	0.8
Metallized layer	0.0	Heat sealable 140 g OPP	20.5
Heat sealable 60 g OPP	8.8		
Total Material Weight (g/msi)	27	Total Material Weight (g/msi)	21

Material reduction: 19.5%

Carbon Footprint Reduction:

Dry Powder or Stick Pack

3-ply laminated structure Solvent-Based		3-ply laminated structure Solventless		2-ply laminated structure	
Layer Description	CO2 Equiv. (kg/ream)	Layer Description	CO2 Equiv. (kg/ream)	Layer Description	CO2 Equiv. (kg/ream)
SB rev. print PET	72.4	SB rev. print PET	72.4	SB rev. print PET	72.4
SB lam adhesive	51.5	SL lam adhesive	9.5	SB lam adhesive	51.5
27.5 g Al foil	62.6	27.5 g Al foil	62.6	Metallizing & EB ctg	13.0
SB lam adhesive	51.5	SL lam adhesive	9.5	1.5 mil sealant web	17.5
1.5 mil sealant web	17.5	1.5 mil sealant web	17.5		
CO2 Equiv.(kg/rm)	256	CO2 Equiv.(kg/rm)	172	CO2 Equiv.(kg/rm)	154

Carbon footprint reduction: 39.6% vs. Solvent-Based
10.0% vs. Solventless

Carbon Footprint Reduction:

Frac Pack Coffee

2-ply laminated structure Solvent-Based		2-ply laminated structure Solventless		Single ply structure	
Layer Description	CO2 Equiv. (kg/ream)	Layer Description	CO2 Equiv. (kg/ream)	Layer Description	CO2 Equiv. (kg/ream)
SB surface print	51.5	SB surface print	51.5		
48 g metallized PET	23.6	48 g metallized PET	23.6	SB surface print	51.5
SB lam adhesive	52.8	SL lam adhesive	9.5	Metallizing & EB ctg	13.0
1.5 mil sealant web	17.5	1.5 mil sealant web	17.5	1.5 mil sealant web	17.5
CO2 Equiv.(kg/rm)	145	CO2 Equiv.(kg/rm)	102	CO2 Equiv.(kg/rm)	82

Carbon footprint reduction: 43.6% vs. Solvent-Based
19.7% vs. Solventless

Carbon Footprint Reduction:

Bag-in-box Snack Food

2-ply unprinted laminated structure		Single ply unlaminated structure	
Layer Description	CO2 Equivalent (kg/ream)	Layer Description	CO2 Equivalent (kg/ream)
Unprinted 60 g OPP	12.9		
8.5 lbs LDPE adhesive	77.8	Metallizing & EB coating	13.0
Metallizing	6.6	Heat sealable 140 g OPP	30.1
Heat sealable 60 g OPP	12.9		
Total CO2 Equiv. (kg/ream)	110	Total CO2 Equiv. (kg/ream)	43

Carbon footprint reduction: 60.9%

Summary: Material, Energy and Carbon Footprint Reduction

Traditional Structure	New Structure	% Reduction		
		Material Weight	Energy Usage	CO_2 Footprint
Surface Print Met PET / LLDPE	Top-coat met LLDPE	30.9	43.2	43.6
Rev. Print PET / Al Foil / LLDPE	Rev. Print PET / Top-coat met LLDPE	25.3	26.3	39.6
Clear OPP / Met OPP	Top-coat met OPP	19.5	77.2	60.9

Conclusions

- One Step Process:
  - Provides excellent barrier properties
  - Reduces:
    - Material and energy consumption
    - Carbon footprint
- It opens the possibilities for new laminated and unlaminated structures to be introduced into the marketplace

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