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

The first efforts on inline or in chamber coatings of metallized film were done by General Electric who developed vapour deposition of Acrylates for the manufacture of their capacitors. This technology was subsequently further developed by Catalina Coatings and Sigma Technologies.

More recently inline coating is generating a greater interest with the development of new technologies. One reason is the economic benefits of a single machine rather than two machines from less capital, smaller footprint, less waste, and fewer operators providing lower capital and operating costs.

A second is the better barrier properties achieved from such a film.

WVTR Values

Material	Uncoated	Coated	OD	% Improvement
18µm OPP	0.09	0.03	3.50	70.0
20µm PLA	4.37	1.66	1.40	62.1
20µm PLA	3.72	1.33	2.05	64.2
20µm PLA	1.75	0.50	2.60	71.7
38µm PE	0.48	0.29	2.30	38.7
9µm PET	1.26	0.42	2.40	66.7
12µm PET	1.09	0.11	1.25	90.0
12µm PET	0.93	0.11	1.80	88.3
12µm PET	0.78	0.14	2.10	82.0
12µm PET	0.62	0.09	2.20	85.0
12µm PET	0.62	0.08	2.30	87.5
12µm PET	0.17	0.05	3.20	72.7

Values in $g/m^2/24h$ at 37.8°C and 90%RH
ASTM E-398

OTR Values

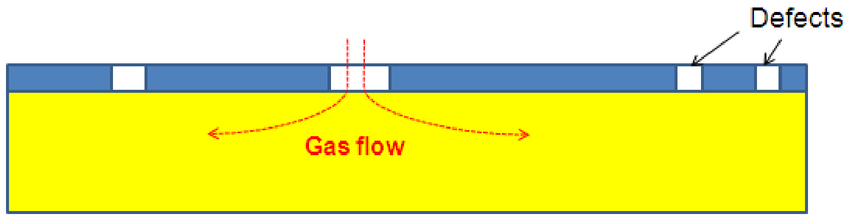
Material	Uncoated	Coated	OD	% Improvement
18µm OPP	31.62	4.81	3.50	84.8
20µm PLA	7.91	2.99	1.60	62.2
20µm PLA	3.55	0.57	2.60	83.8
38µm PE	149.50	11.55	2.30	92.3
9µm PET*	0.71	0.25	2.40	65.2
12µm PET	0.93	0.16	2.00	83.3
12µm PET	1.09	0.17	2.10	84.4
12µm PET	0.93	0.14	2.20	85.0
12µm PET	0.93	0.16	2.30	83.3
12µm PET	0.78	0.14	2.50	82.0

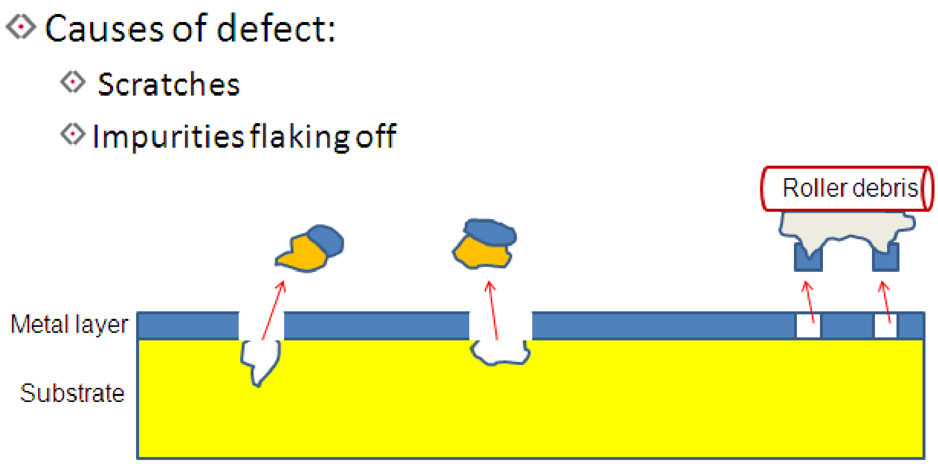
Values in cc/m²/24h at 23°C and 50%RH
*Value measured at 0% RH
ASTM D-3985

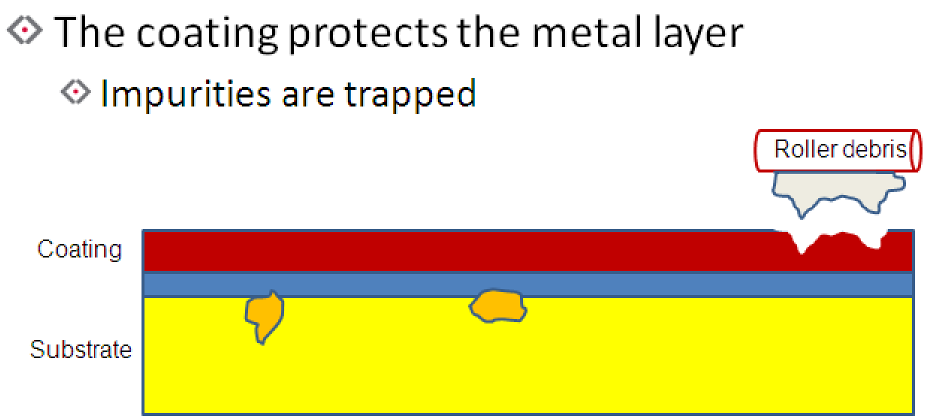
The reason for this improvement is in our opinion based on the pinhole theory

Pinhole Theory

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







This has been confirmed by looking at coated and uncoated metallized samples under a strong backlight: The uncoated samples have higher levels of pinholing than the coated ones.

The third reason for the great interest in inline coating of metallized films is that once coated the barrier properties will not be compromised by further downstream processing. This is of great value in designing products; eliminating uncertainty as one no longer has to compensate or overdesign for roller debris, poorly maintained rollers and minor nicks on the subsequent equipment the metallized surface touches before the metal is trapped. It also eliminates the need to "trap" the metal as a first step before doing any other converting.

Environmental

Because of the efforts of Walmart and others, there is a growing trend among Consumer Package Goods (CPG's) to create carbon emission reduction targets and publicly track how they are doing in meeting these targets. In many cases, this is a new spin on the old philosophies of downgauging and layer elimination to save money on their packaging spend.

Now the promise of reducing carbon footprint of their packaging is an added benefit that can be marketed to consumers.

Inline coating of metallized films offers the benefit of carbon footprint reduction as well as material reduction through layer elimination. The one-step process eliminates the need to protect the metal as a first step in converting and opens the possibilities for new laminated and unlaminated structures to be introduced into the marketplace. CPG's can reduce their carbon footprint and material usage while at the same time reducing their packaging spend.

Carbon Footprint Reduction

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.

Carbon Footprint Reduction:
Dry Powder or Stick Pack

3-ply laminated structure Solvent-Based

Layer Description	CO2 Equiv. (kg/ream)
SB rev. print PET	72.4
SB lam adhesive	51.5
27.5 g Al foil	62.6
SB lam adhesive	51.5
1.5 mil sealant web	17.5
CO2 Equiv.(kg/rm)	256

2-ply laminated structure

Layer Description	CO2 Equiv. (kg/ream)
SB rev. print PET	72.4
SB lam adhesive	51.5
Metallizing & EB ctg	13.0
1.5 mil sealant web	17.5
CO2 Equiv.(kg/rm)	154

Carbon footprint reduction: 39.6% vs. Solvent-Based

Carbon Footprint Reduction:
Dry Powder or Stick Pack

3-ply laminated structure Solvent-Less

Layer Description	CO2 Equiv. (kg/ream)
SB rev. print PET	72.4
SL lam adhesive	9.5
27.5 g Al foil	62.6
SL lam adhesive	9.5
1.5 mil sealant web	17.5
CO2 Equiv.(kg/rm)	172

2-ply laminated structure

Layer Description	CO2 Equiv. (kg/ream)
SB rev. print PET	72.4
SL lam adhesive	9.5
Metallizing & EB ctg	13.0
1.5 mil sealant web	17.5
CO2 Equiv.(kg/rm)	112

Carbon footprint reduction: 34.8% vs. Solvent-Less

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%

Layer Elimination

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:
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%

Summary: Material, Energy and Carbon Footprint Reduction

Traditional Structure	New Structure	% Reduction				
		Material Weight	Energy Usage		CO2 Footprint	
Rev. Print PET / Al Foil / LLDPE	Rev. Print PET / Top-coat met LLDPE	25.3	53.5 SB	13.4 SL	39.6 SB	34.8 SL
Clear OPP / Met OPP	Top-coat met OPP	19.5	77.2		60.9	

To summarize Inline or In Chamber Coating:

1. Has Lower Capital and Operating Costs
2. Provides excellent barrier properties
3. Provides predictable barrier properties
4. Opens the possibilities for new laminated and unlaminated structures to be introduced
5. Environmentally reduces material and energy consumption and carbon footprint