

ADDING VALUE TO VACUUM COATED PRODUCTS BY IMPROVING METALLIZED FILMS PROPERTIES AND FUNCTIONALITIES

by

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OUTLINE

Introduction - Motivation

Technologies and Processes overview

New Solutions and trials results

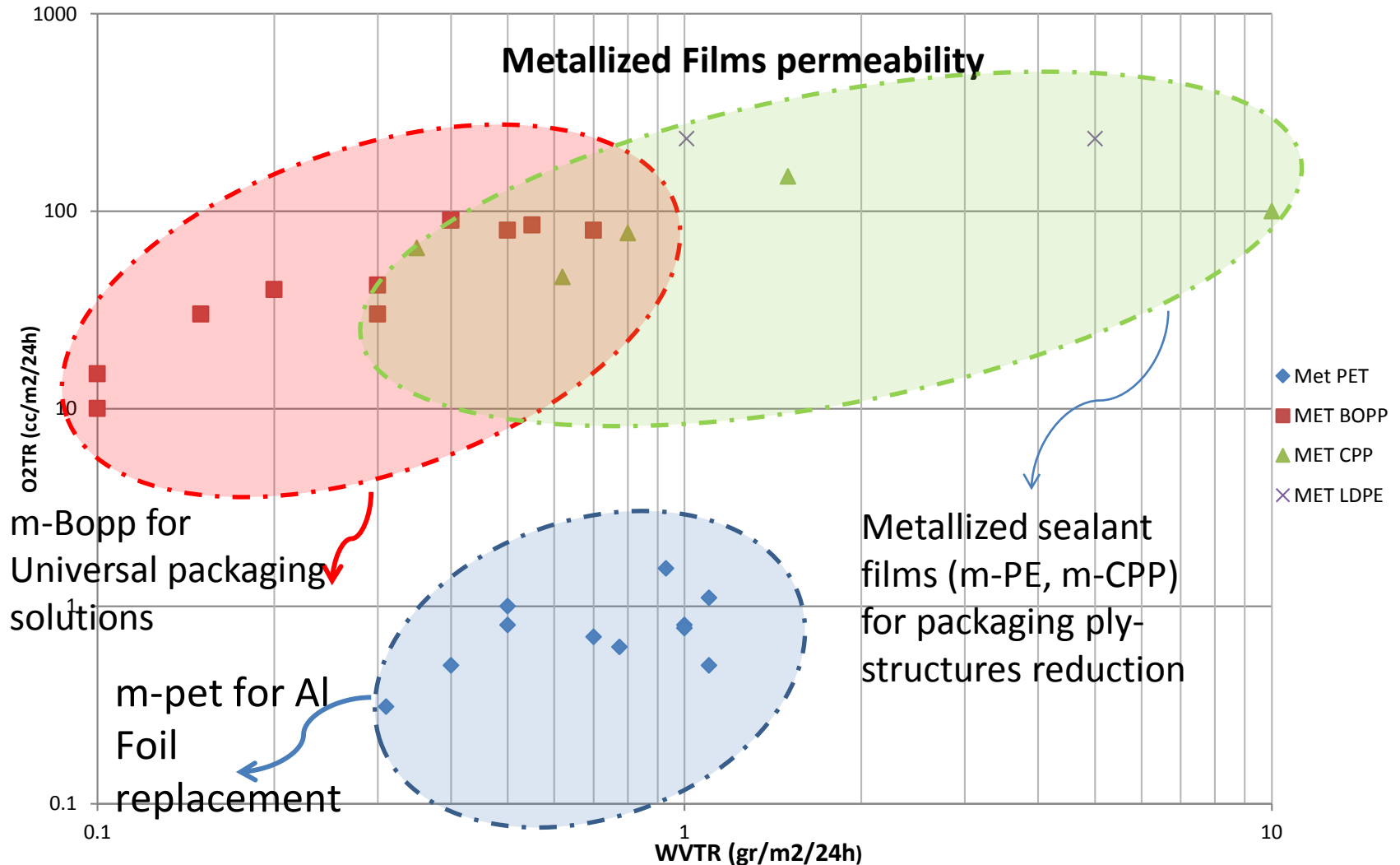
- High Gas barrier Bopp

- Clear barrier Pet film

Summary & Conclusions

ADDING VALUE TO METALLIZED FILMS

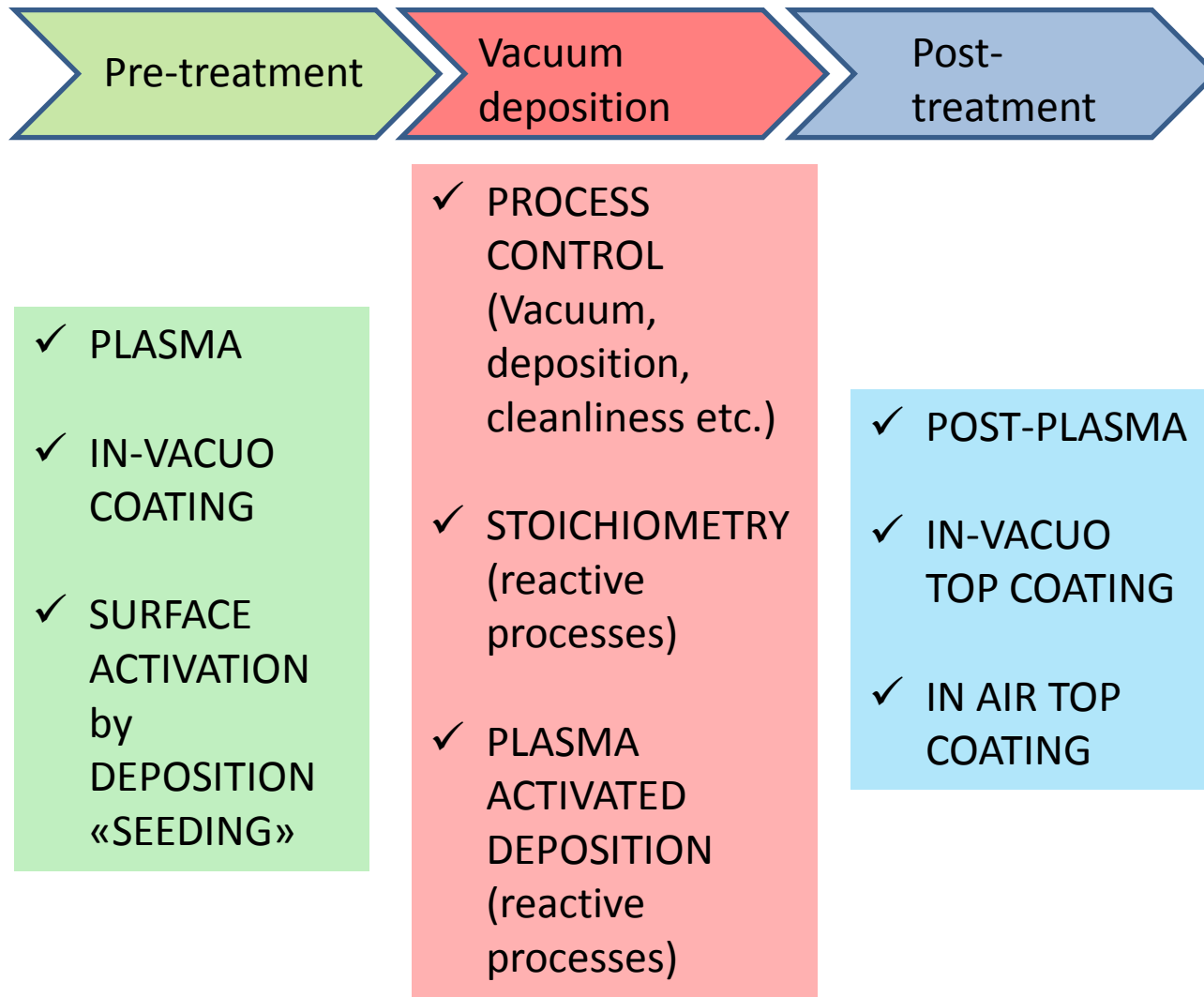
Motivations: Material saving, cost reduction, environmental friendler solution



Source : Major producers
published data

ADDING VALUE TO METALLIZED FILMS

Technologies and Processes overview



ADDING VALUE TO METALLIZED FILMS

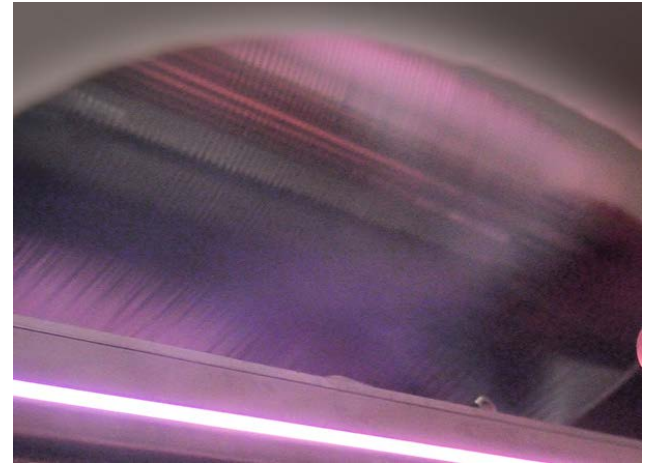
Technologies and Processes overview

Pre-treatment

PLASMA

Plasma action on polymer surface

- Cleaning and removal of organic contamination
- Oligomers Vaporization
- microetching, scission, crosslinking , grafting and functionalization
- Increasing wettability



Most Popular treaters categories

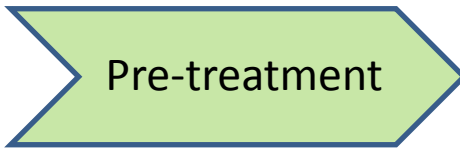
DC magnetron based plasma treaters

AC type dual electrode plasma sources

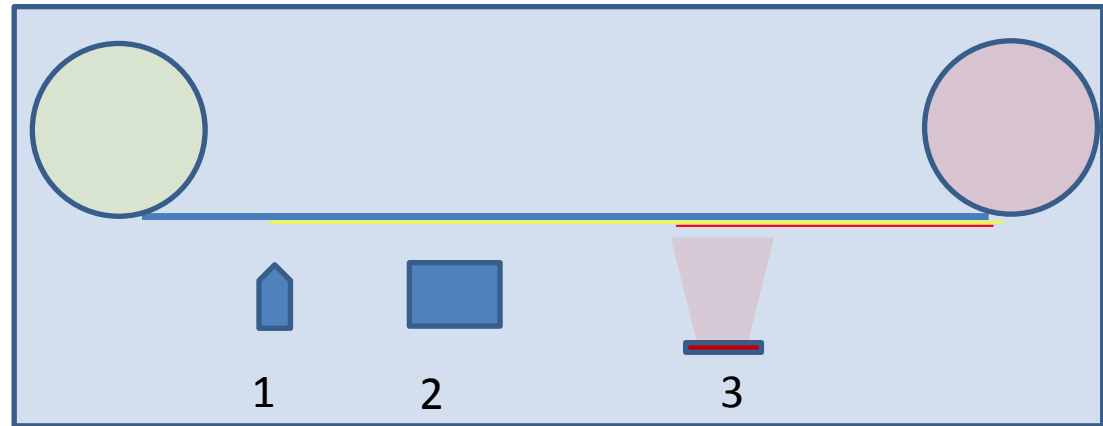
AC hollow cathode

ADDING VALUE TO METALLIZED FILMS

Technologies and Processes overview



IN-VACUO COATING



Pre-metallization coating functions :

- Polymer surface planarization
- Stabilization from loose species «blooming», dust etc.
- Can improve metal adhesion and barrier

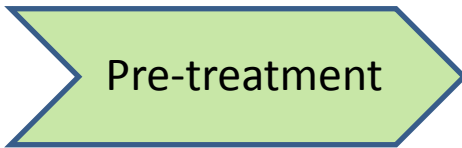
1 – Monomer dosing and application

2 - Energy curing (plasma, electron beam)

3 – Metal Deposition

ADDING VALUE TO METALLIZED FILMS

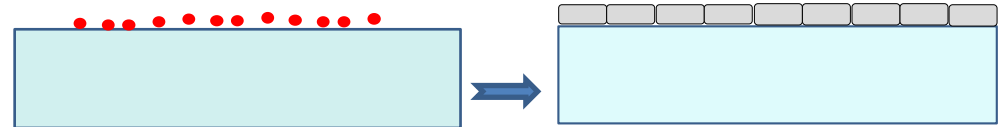
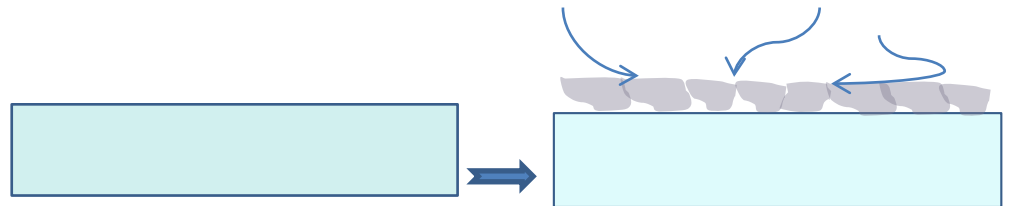
Technologies and Processes overview



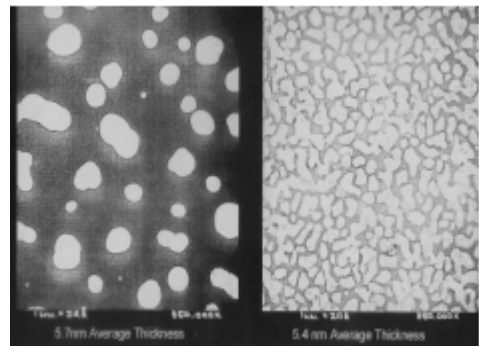
Seeding /Tie layer formation

Functions :

- Forming a more suitable base for deposited film growth
- A few nanometer layer can improve metal adhesion and barrier



The “nucleation” concept : from low-density to more densely packed thin Film



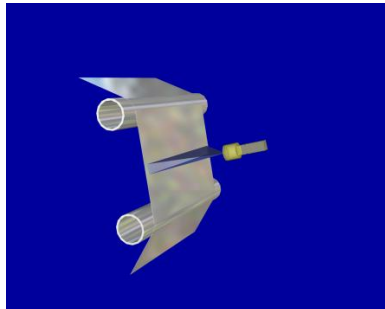
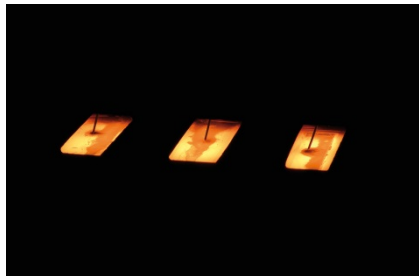
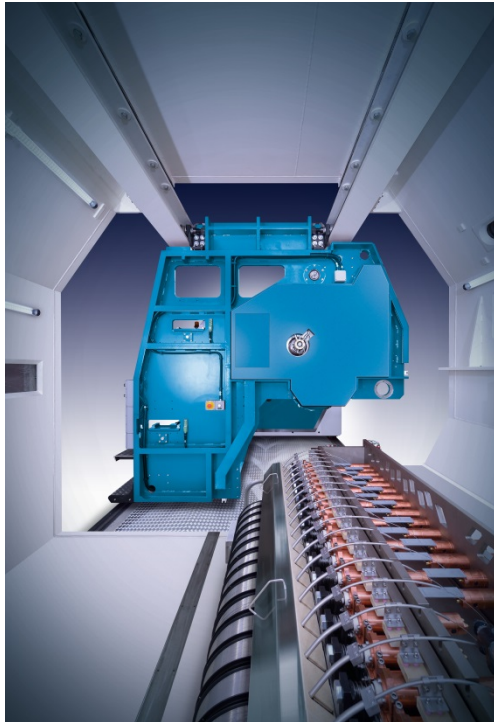
Silver nucleation

Source : AIMCAL
Reference Manual

ADDING VALUE TO METALLIZED FILMS

Technologies and Processes overview

Vacuum
deposition



LATEST GENERATION
METALLIZERS DESIGNED
AND BUILT FOR HIGH
PRODUCTIVITY **AND** FILM
PROPERTY CONTROL

MAJOR ITEMS :

- Vacuum Level
 - Cooling
 - Cleaning Convenience
 - Deposition Control
 - Careful film winding
 - Defect monitoring
 - User's friendly Automation
 - Latest Information
- Technologies serving the
production quality and
efficiency control

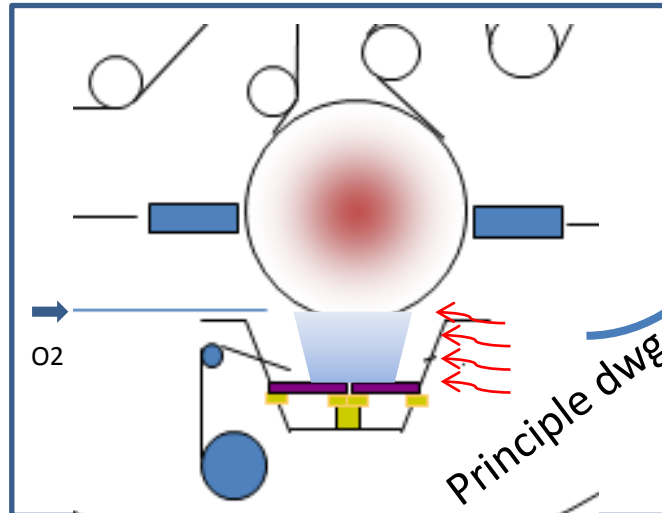


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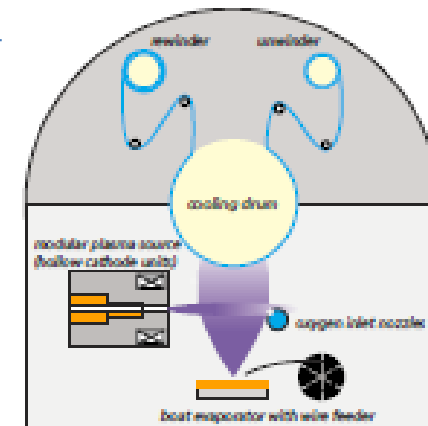
Technologies and Processes overview

Vacuum
deposition

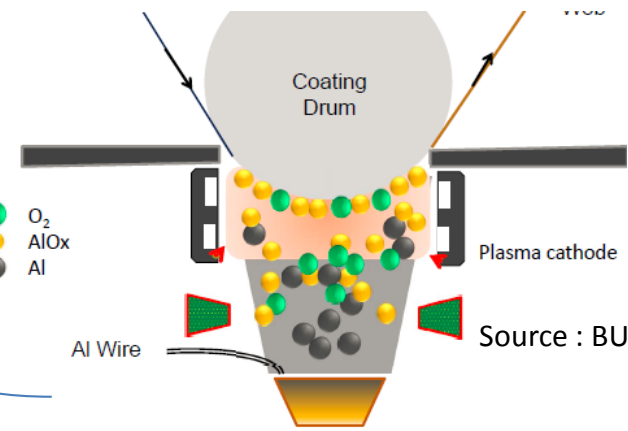
PLASMA-ACTIVATED DEPOSITION
For «Reactive evaporation «AlOx»



Examples



Source: FEP

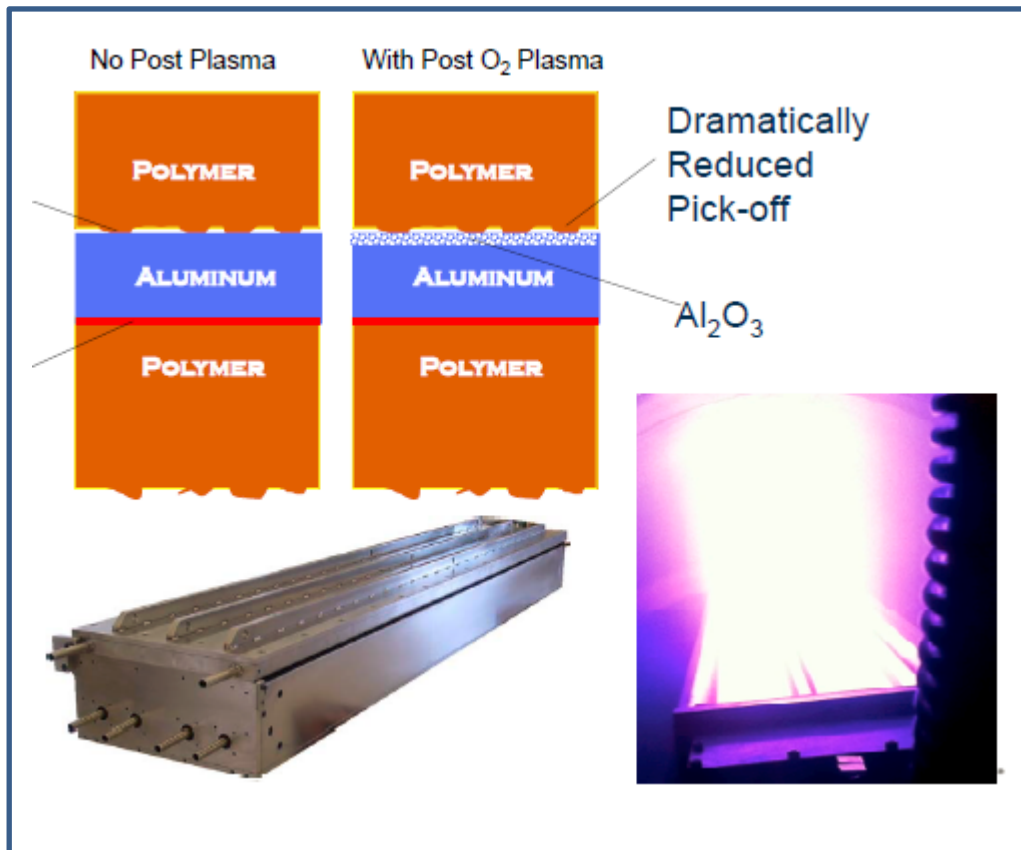


ADDING VALUE TO METALLIZED FILMS

Technologies and Processes overview

Post-
treatment

PLASMA POST-METALLIZATION TREATMENT



- Al layer passivation to keep a stable metal surface energy for the subsequent converting
- Reported Barrier increase and consistency
- Post deposition oxidation - AlO_x (3-5% T% increase)

ADDING VALUE TO METALLIZED FILMS

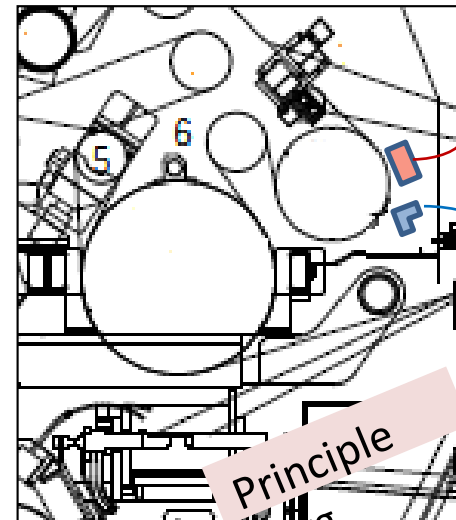
Technologies and Processes overview

Post-
treatment

IN-VACUO TOP - COATING

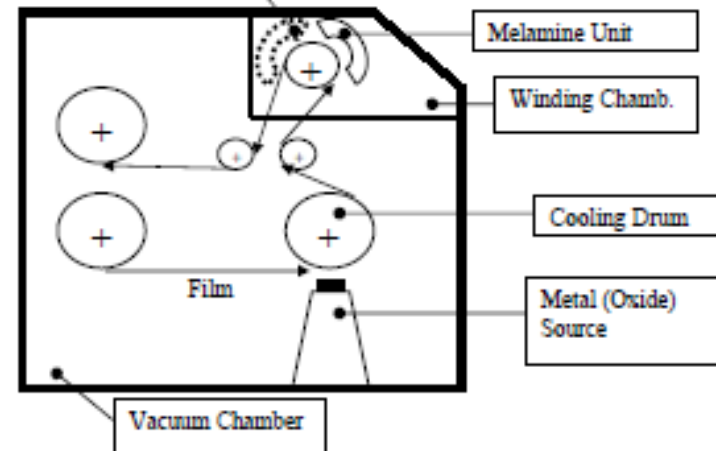
- Same concepts as illustrated for pre-metallization coating
- In top-coating the main focus is on deposited films protection (mechanical and chemical damage)
- Reported significant barrier increase
- For AlOx : a protection against brittleness caused damages

Energy-
cured
Polymer



Energy curing
ebg
uv
plasma
Monomer application

Melamine
deposition



ADDING VALUE TO METALLIZED FILMS

NEW SOLUTIONS & RESULTS

TWO PROJECTS FOR THE MOST POPULAR POLYMER FILMS



1 – INCREASING GAS BARRIER OF
METALLIZED BOPP

2 – PRODUCING A CONSISTENT AND
ENDURING CLEAR BARRIER WITH
ALOX - PET



Pre-treatment :

- ✓ Plasma
- ✓ Tie-layer

- ✓ Vacuum Deposition
- ✓ Atmospheric Top Coating

ALL PROJECTS TRIALS RUNNING ON INDUSTRIAL MACHINE AT SHOP-FLOOR CONDITIONS

ADDING VALUE TO METALLIZED FILMS

NEW SOLUTIONS & RESULTS

BOPP FILM PLASMA PRE - TREATMENT

PLASMA KEY FEATURES

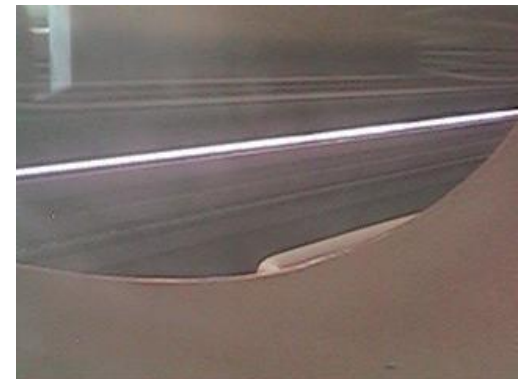
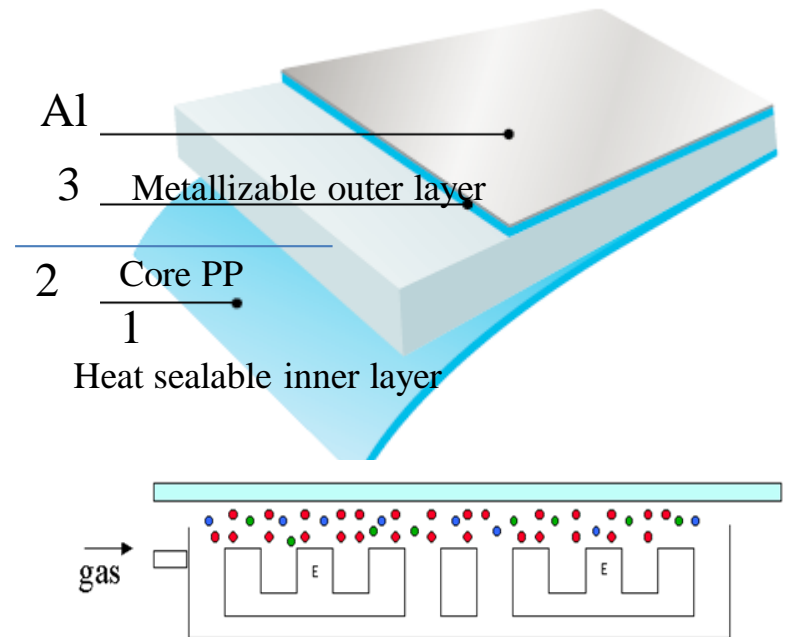
Construction : Dual Hollow cathodes,
magnetically enhanced

Power : AC 80 KHz , quick arc
detection and suppression system

Energy dose : up to 0.8 - 1 Kjoule/m²

ADVANTAGES

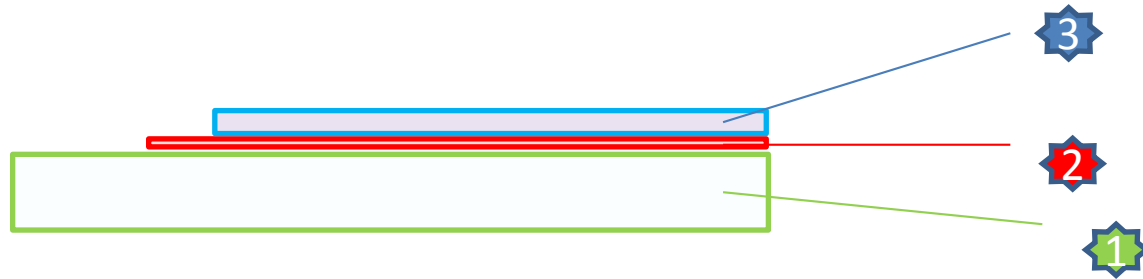
- High energy for receptive substrates
- Treatment continuity
- No back treatment
- Uniform power distribution



ADDING VALUE TO METALLIZED FILMS

NEW SOLUTIONS & RESULTS

BOPP SURFACE «SEEDING» AND «TIE LAYER»



1 - Film (Bopp)

Substrate, mechanical strength

2 – «Tie» Layer

- ✓ High bond with polymer surface (adhesion promotion)
- ✓ Polymer surface modification (Planarization, seeding etc.)

3 – Aluminium layer

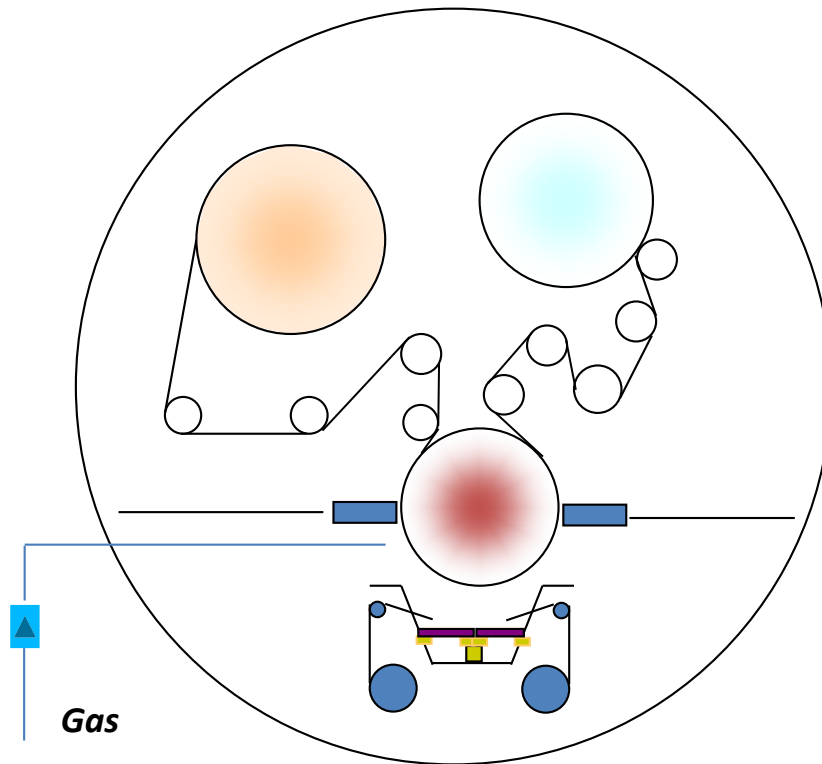
Functional : barrier, gloss etc.

ADDING VALUE TO METALLIZED FILMS

NEW SOLUTIONS & RESULTS

BOPP SURFACE «SEEDING» AND «TIE LAYER»

- ✓ A «primer» layer generation within a conventional aluminium metallization process
- ✓ An accurately controlled gas distribution for tie-layer uniformity and thickness
- ✓ Complemented by plasma treatment

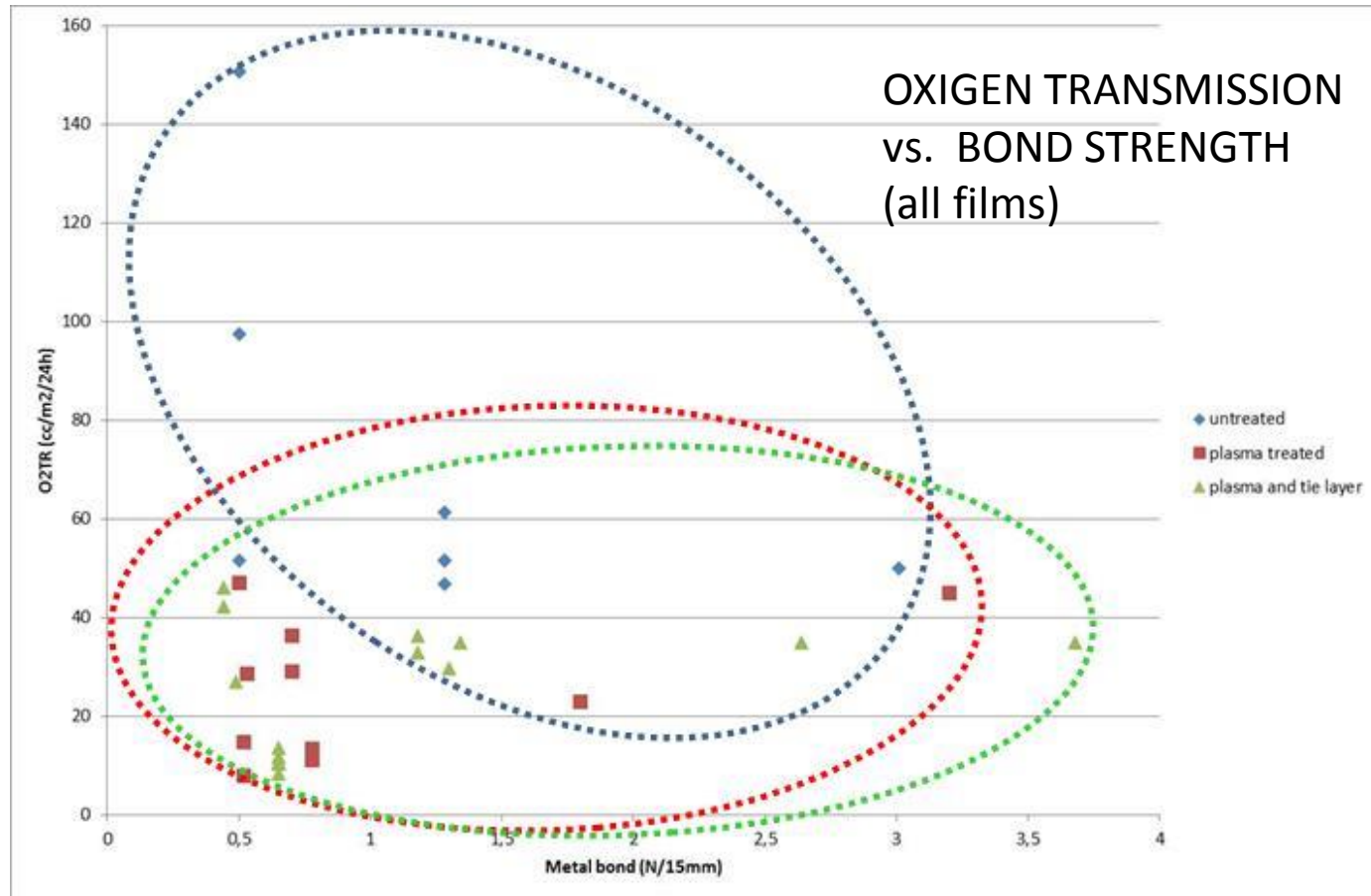


Conceptual dwg

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NEW SOLUTIONS & RESULTS

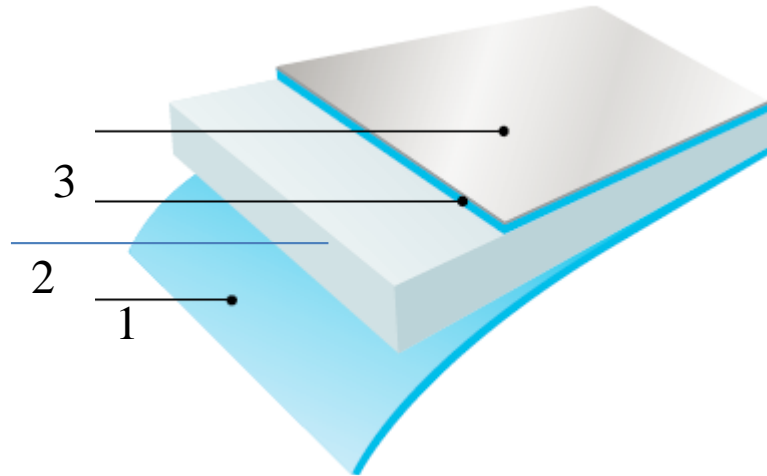
BOPP PRE-TREATMENT



- Plenty of film types from diversified sources(points representing average values)
- A clear indication of pretreatment positive effect in decreasing gas permeability but the plurality of film properties would prevent a more specific analysis

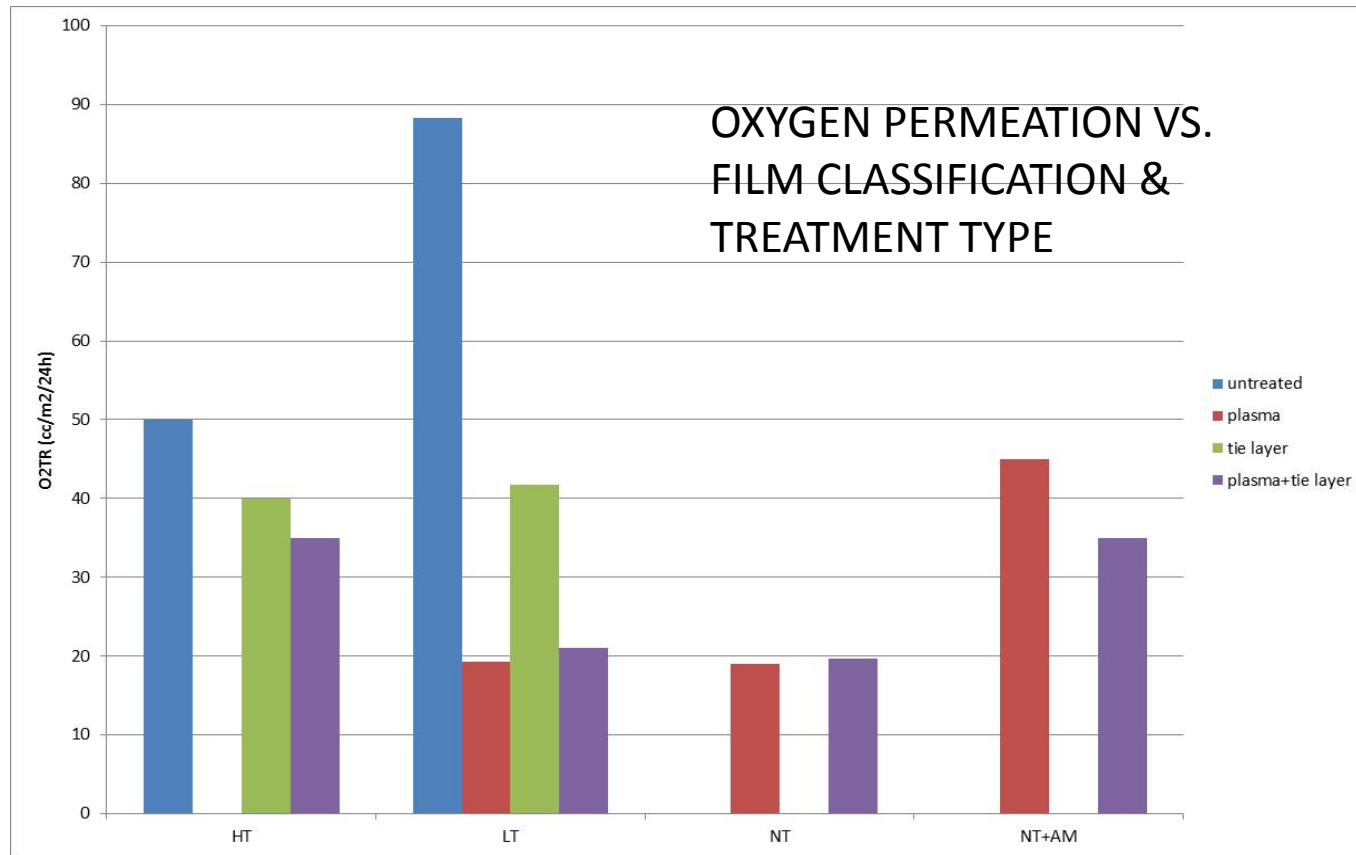
ADDING VALUE TO METALLIZED FILMS
NEW SOLUTIONS & RESULTS
BOPP PRE-TREATMENT

TEST FILMS CLASSIFICATION :



IDENTIFICATION	DESCRIPTION	CRITERIA
NT	No or minimum treatment on skin 3	$\sigma < 35$ dyne/cm
LT	Low corona treatment	$\sigma < 38$ dyne/cm
HT	Medium/high corona or flame treated	$\sigma > 40$ dyne/cm
NT+AM	Modifies skin for adhesion promotion , non treated	$\sigma < 35$ dyne/cm

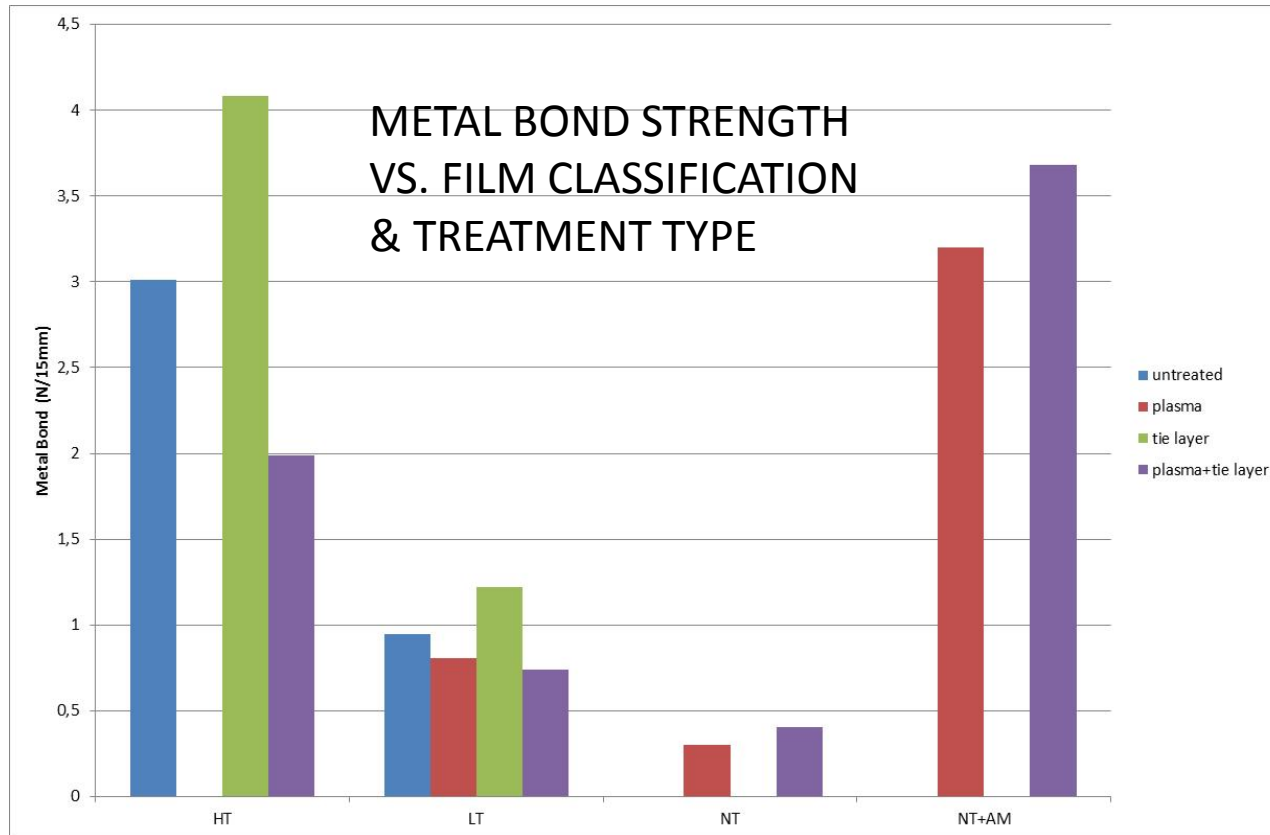
ADDING VALUE TO METALLIZED FILMS
NEW SOLUTIONS & RESULTS
BOPP PRE-TREATMENT



ADDING VALUE TO METALLIZED FILMS

NEW SOLUTIONS & RESULTS

BOPP PRE-TREATMENT



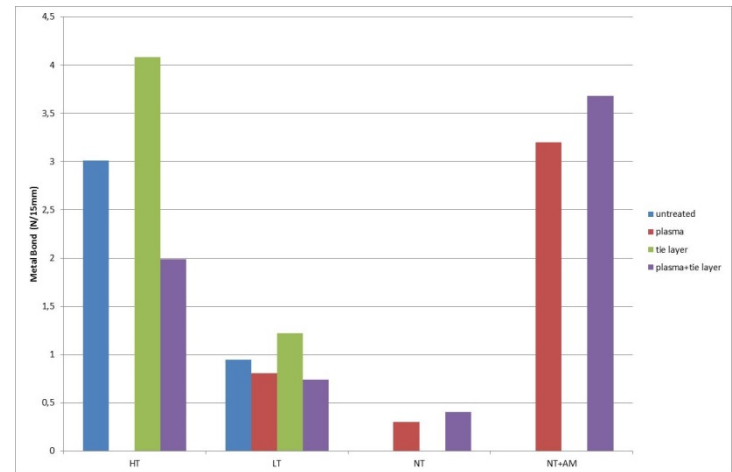
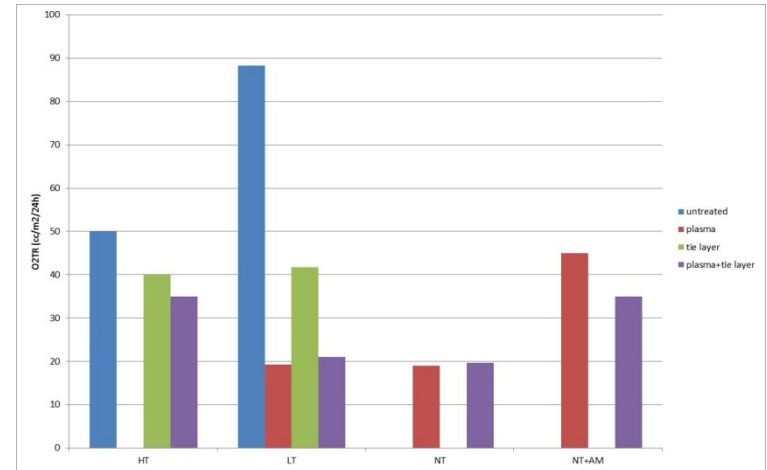
ADDING VALUE TO METALLIZED FILMS

NEW SOLUTIONS & RESULTS

BOPP PRE-TREATMENT

Conclusions :

- ❖ PLASMA IS A POWERFULL TOOL FOR HIGH GAS BARRIER ESPECIALLY WHEN THE FILM TREATMENT LEVEL IS LOW (and consequently the adhesion is at low/medium level)
- ❖ THE COMBINATION OF PLASMA AND TIE LAYER ALLOWS FOR A BETTER ADHESION AND BARRIER TRADE-OFF
- ❖ FOR HIGH ADHESION MODIFIED SKINS THE TIE LAYER+PLASMA CAN INCREASE THE INTRINSICALLY «POOR» GAS BARRIER



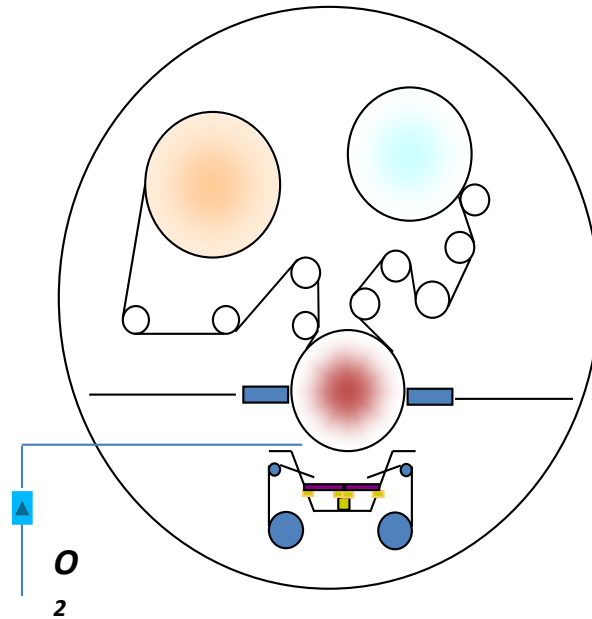
IT IS POSSIBLE TO UPGRADE BOPP TO SUPERIOR OXYGEN BARRIER (<15 – 20cc/M2/day) BY TAILORING POLYMER SKIN DESIGN TO IN-VACUO PRE-TREATMENT

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NEW SOLUTIONS & RESULTS

ALOX - PET CLEAR BARRIER : ENDURING MECHANICAL STRESS

A widespread industry Concern:
«Oxide coatings are more brittle than metallic ones possibly leading to barrier loss during converting processes : Slitting, Printing, Laminating, Bag making»



THIS PROJECT AIMS TO MITIGATE OR SOLVE
THE PROBLEM :

✓ Depositing a more
«flexible» oxide

✓ Top Coating

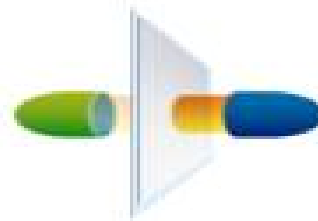
ADDING VALUE TO METALLIZED FILMS

NEW SOLUTIONS & RESULTS

ALOX - PET : A MORE «FLEXIBLE» ALOX BY PROCESS CONTROL

- ✓ A very thin – uniform AlO_x film

10 nm : < 1gr/min Al per
evaporator at 600 m/min



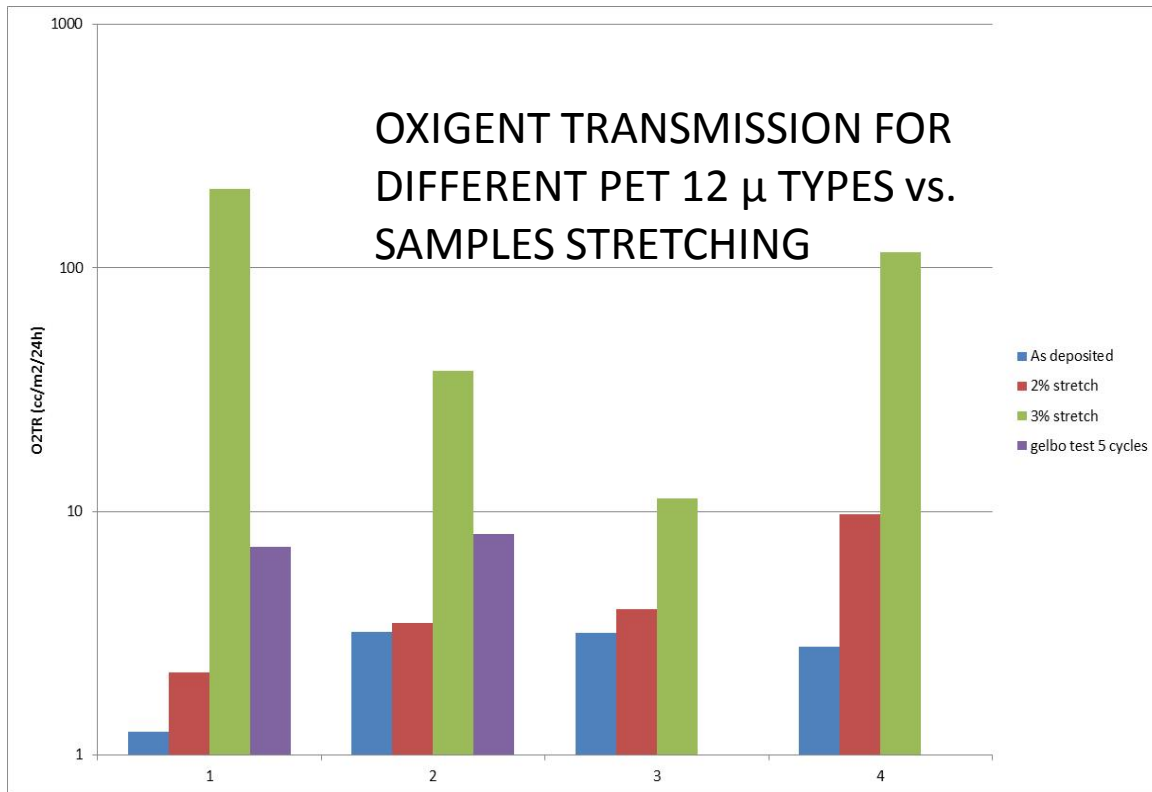
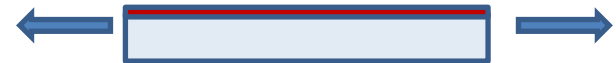
- ✓ A controlled sub stoichiometric oxidation (with subsequent atmospheric «curing» or plasma post treatment)
- ✓ Plasma pre-treatment may help depending on the pet original treatment (plain, corona or chemically treated)

	T % (*)	OD
Uncoated	93-92	0.03-0.04
AlO _x 10nm	89-91	0.05
(*) 700 nm wavelenght		

ADDING VALUE TO METALLIZED FILMS

NEW SOLUTIONS & RESULTS

ALOX - PET : A MORE «FLEXIBLE» ALOX BY PROCESS CONTROL



- Till 2% stretching , limited barrier loss occurs on all film kinds
- «Gelbo» tests (5 cycles) on two samples seem to create a limited film damage
- 2% (equivalent to a tension of 1000 N per m width) look already a rather severe simulation of machine stress

ADDING VALUE TO METALLIZED FILMS

NEW SOLUTIONS & RESULTS

ALOX - PET : TOP COATING

GENERAL PRODUCT REQUIREMENT

- Compatible with Aluminium Oxide
- Good adhesion property
- Fully transparent
- Eco friendly and food compatible-water base
- Providing protection to avoid or compensate for the ALOx cracking
- Preferably contribute to reduce gas permeability to lower values than uncoated
- Low application weight to reduce cost



Trials description

Substrate : Pet 12 μ corona treated-EU

Metallized on : Nordmet 12 F

Top coated on : Combi 3000

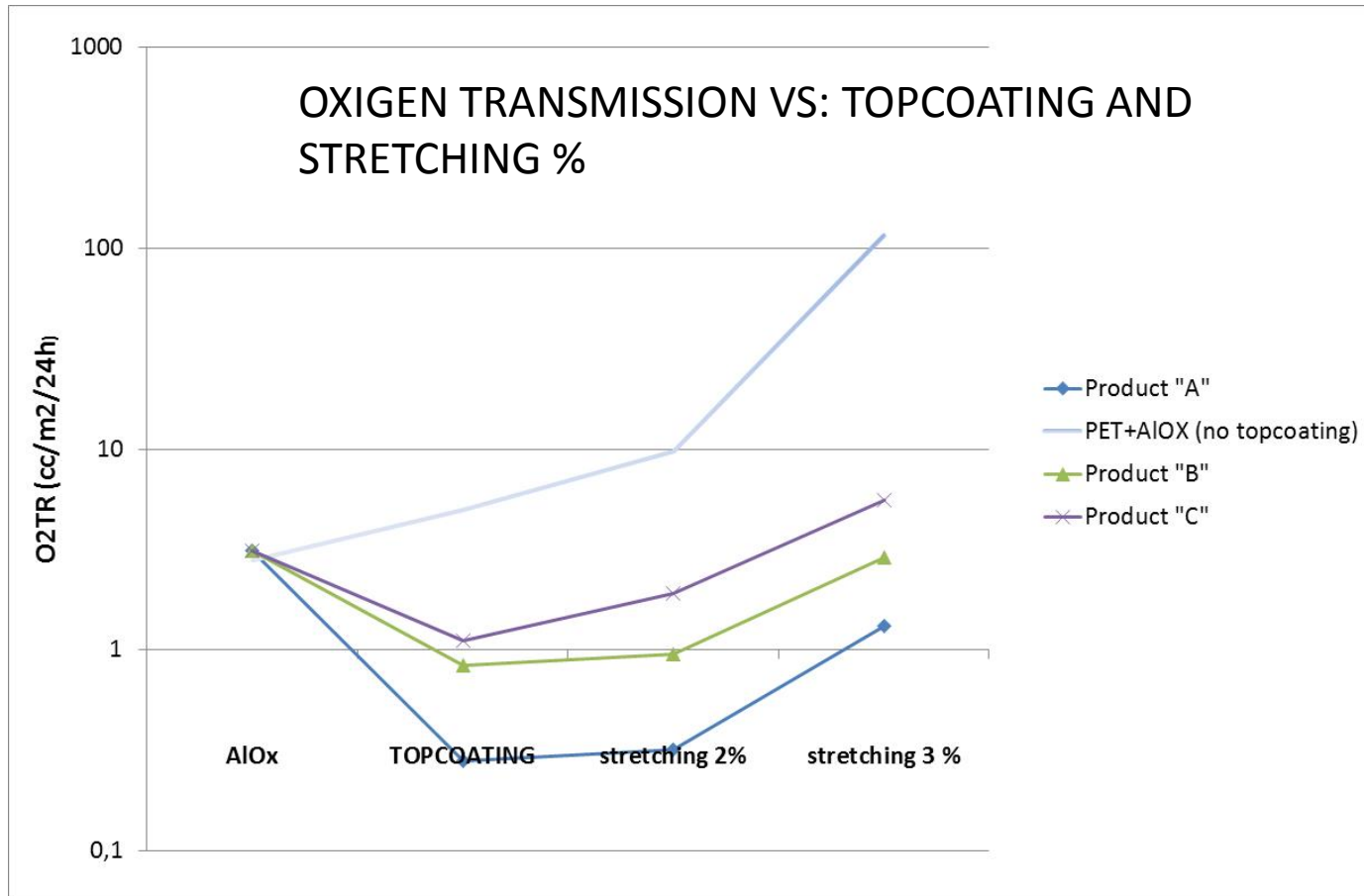
Coating speed : 150 m/min

Application weight : 1 gr/m²

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NEW SOLUTIONS & RESULTS

ALOX - PET : TOP COATING

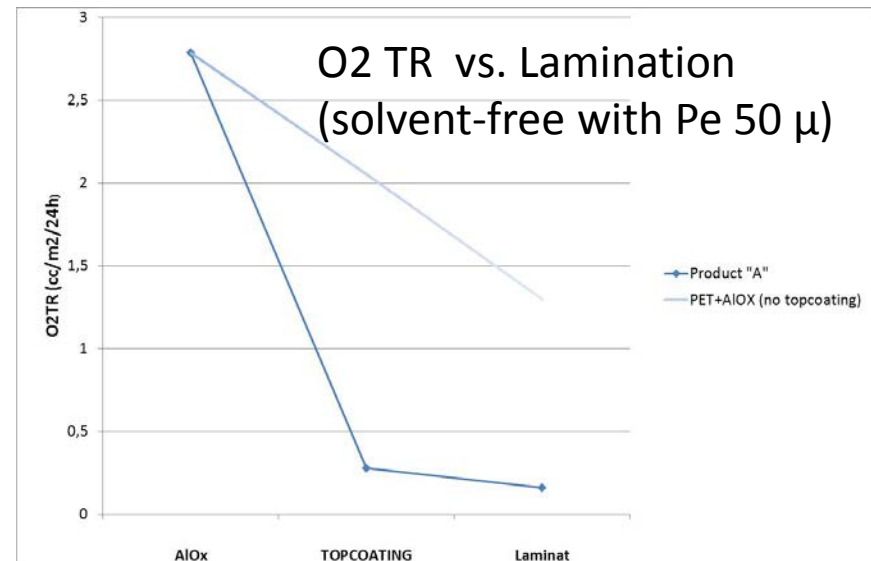
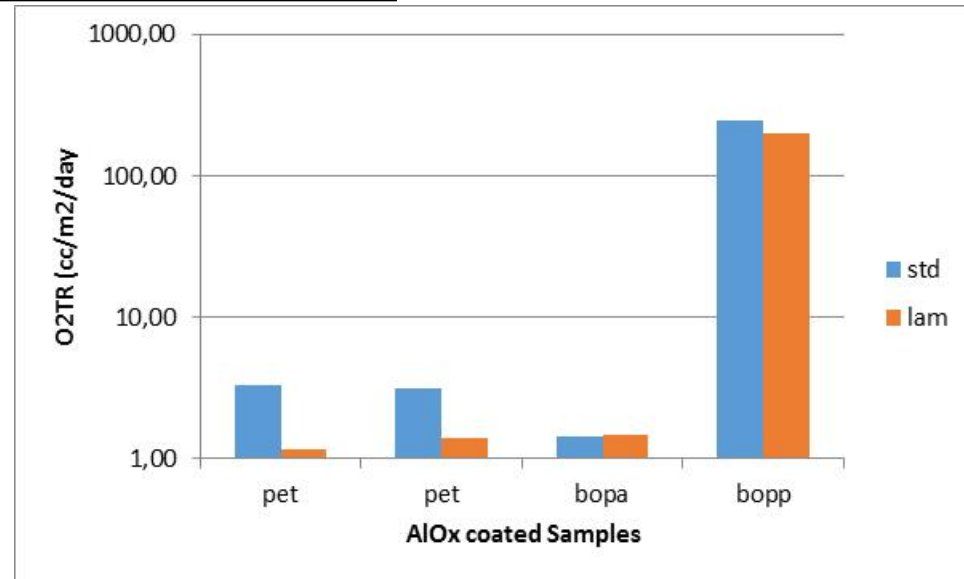


- 3 products : «A», «B», «C» , all water base from different sources
- All topcoatings increase the ALOx original barrier
- All topcoatings are resistant to mechanical stretching

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NEW SOLUTIONS & RESULTS

ALOX - PET : TOP COATING & LAMINATION

- ✓ Lamination provides a permanent protection for mechanically sensitive barrier coating
- ✓ In general, lamination increases the vacuum coated film barrier properties: no indication of barrier loss on unprotected ALOx
- ✓ Lamination contributes to gas barrier improvement even with Topcoating



SUMMARY & CONCLUSIONS

- TO RESPOND THE INDUSTRY REQUIREMENT OF IMPROVING METALLIZED FILM BARRIER PROPERTIES, THIS PAPER PRESENTED TWO CASES :
 - MET - BOPP PRETREATMENT
 - ALOX – PET & TOPCOATING
- EXTENDED TRIALS DEMONSTRATED THAT SUPERIOR GAS BARRIER CAN BE ACHIEVED BY MATCHING BOPP NATURE AND SURFACE ENERGY WITH IN - VACUO PRE-TREATMENT
- REASONABLY STRESS RESISTANT ALOX - PET CLEAR BARRIER CAN BE PRODUCED WITH ADEQUATE PROCESS CONTROL . FOR A FULL PROTECTION, TOPCOATING IS A RELABLE SOLUTION: OUR PROJECT SCOUTED A NUMBER OF FORMULATIONS AND SORTED OUT A FEW OF THEM : WORK IS IN PROGRESS TO OPTIMIZE THE PRODUCT SELECTION.