# PRINTING TECHNOLOGY & INNOVATION DAYS FOR FLEXIBLE PACKAGING

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**PRINTING TECHNOLOGY & INNOVATION DAYS**

**FOR FLEXIBLE PACKAGING**

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PRINTING TECHNOLOGY & INNOVATION DAYS FOR FLEXIBLE PACKAGING

# ADDING VALUE TO VACUUM COATED PRODUCTS

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# OUTLINE

**INTRODUCTION**

**PRETREATMENT TO IMPROVE METALLIZED FILM PERFORMANCE – Case A : An update**

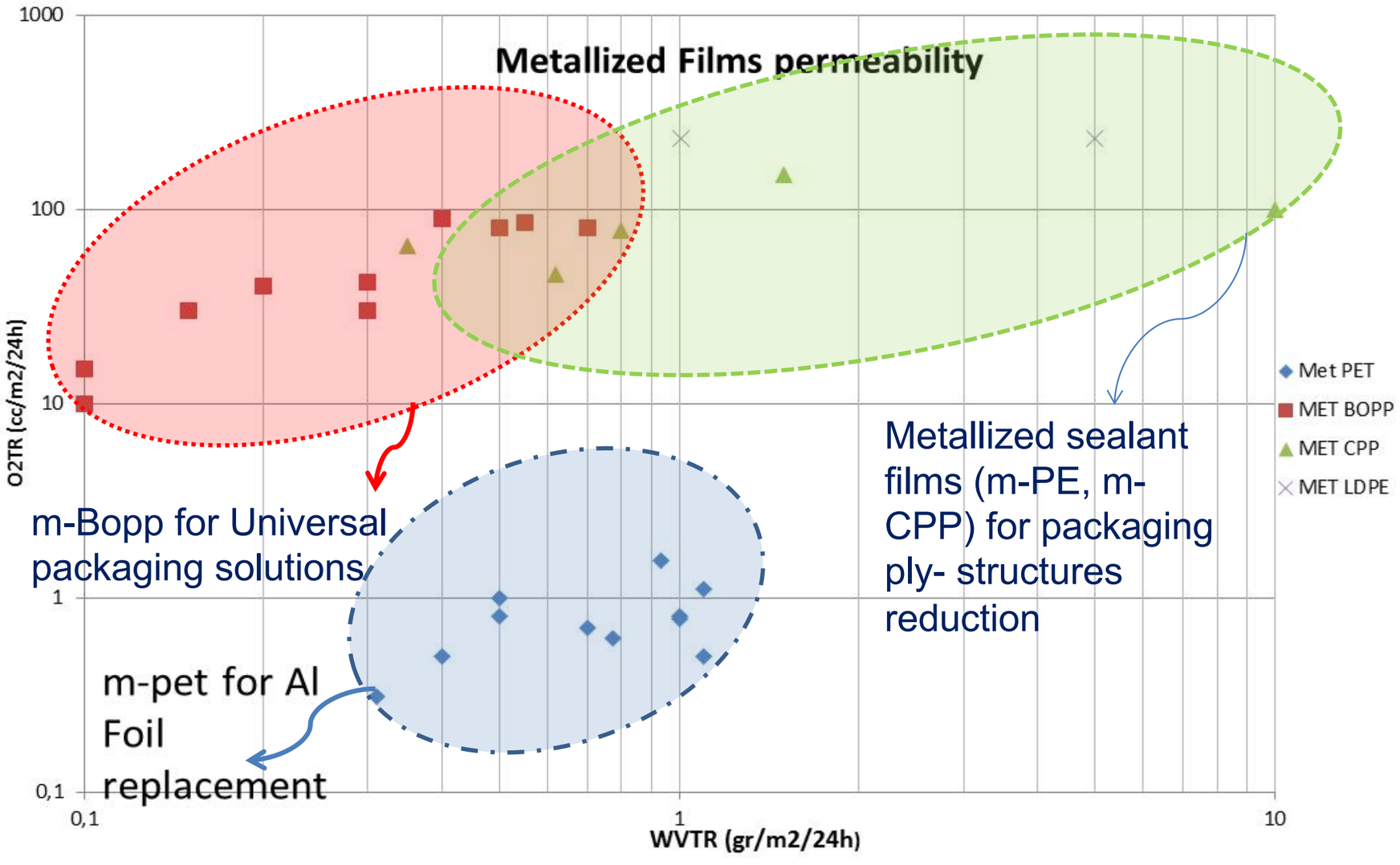
**CLEAR BARRIER (AlOX coated films) PROTECTION AND CONVERTING - CASE B : An update**

**SELECTIVE METALLIZATION - CASE C REGISTER CONTROL**

**CONCLUSIONS**

# IMPROVING METALLIZED FILM BARRIER PROPERTIES

Motivations: Material saving, cost reduction, environmental friendlier solution



# CASE A : Pre-treatment for met-BOPP upgrading

Pre-treatment → Vacuum deposition → Post-treatment

Latest solution for met-bopp properties upgrading

**Pre-treatment**

- ✓ PLASMA
- ✓ IN-VACUO COATING
- ✓ SURFACE ACTIVATION by DEPOSITION «SEEDING»

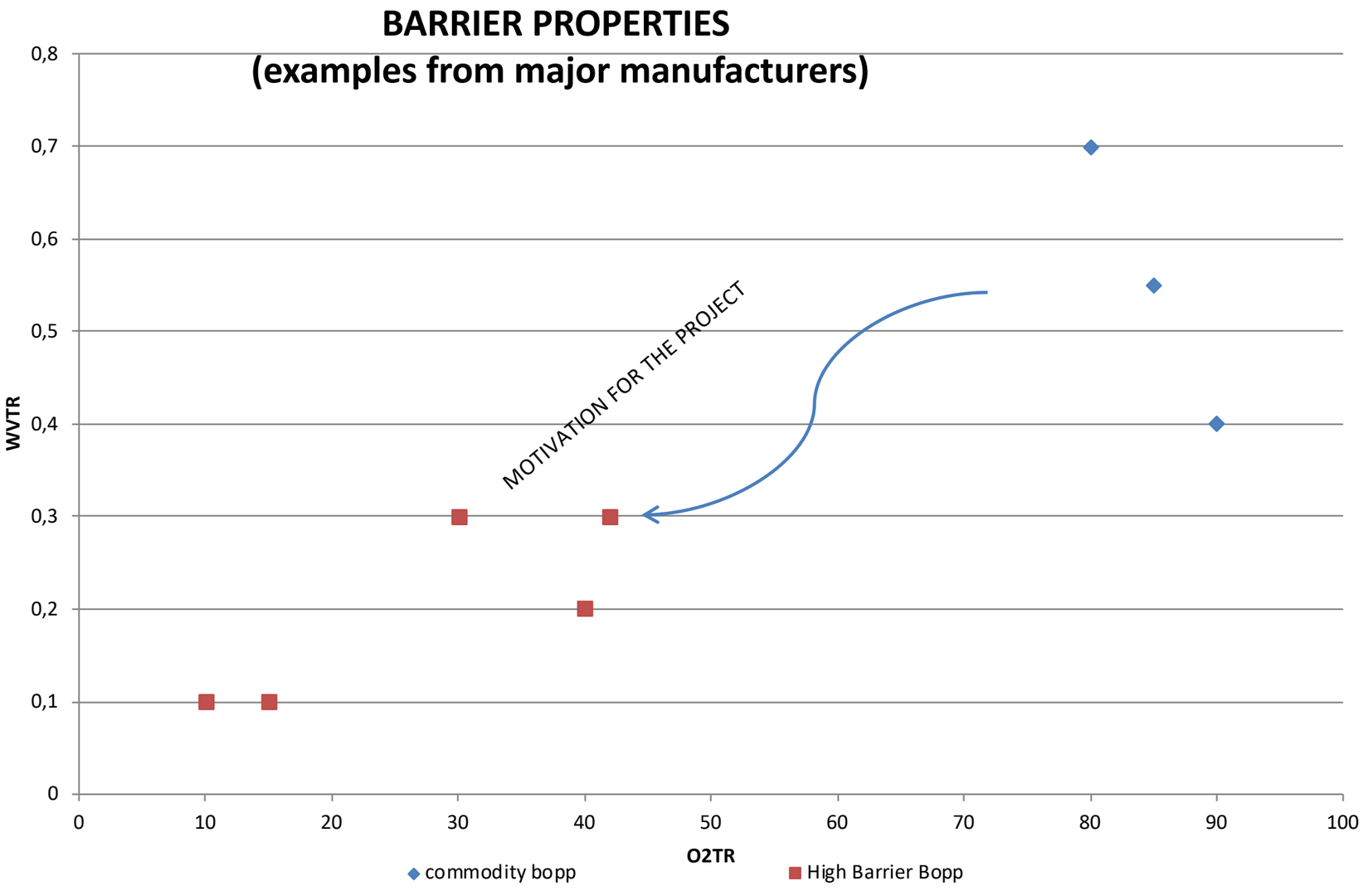
**Vacuum deposition**

- ✓ PROCESS CONTROL (Vacuum, deposition, cleanliness etc.)
- ✓ STOICHIOMETRY (reactive processes)
- ✓ PLASMA ACTIVATED DEPOSITION (reactive processes)

**Post-treatment**

- ✓ POST-PLASMA
- ✓ IN-VACUO TOP COATING
- ✓ IN AIR TOP COATING

# CASE A : Pre-treatment for met-BOPP upgrading



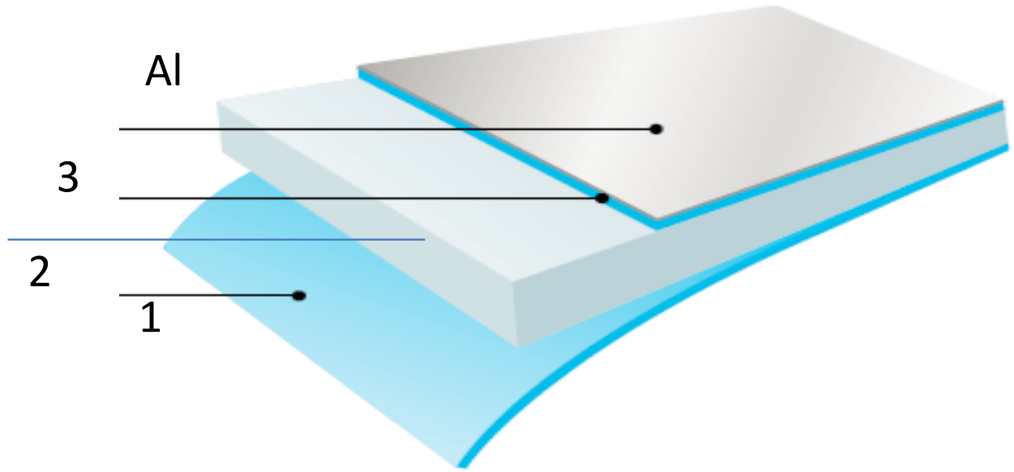

- ✓ Bi-Oriented PolyPropylene is the most used polymer film for Flexible packaging : approx 60% of all plastic films (source AWA 2012)
- ✓ Bi-Oriented PolyPropylene is produced in multiple composition and functionality.

# CASE A : Pre-treatment for met-BOPP upgrading

## Basic met-Bopp features:

- ✓ **Low-Polarity Polymer**
  - ➢ Low water transmission rate (Wvtr : 0.3 – 0.8 gr/m2 24h)
  - ➢ «High» gas transmission rate (O2TR : 10 -80 cc/m2/24h)
  - ➢ Different levels and methods of surface treatment

- ✓ **Presence of additives (slipping/antiblocking) and loosely bound polymer chains**
  - ➢ «Blooming» : additives migration
    - ❑ Affecting the metal adhesion
    - ❑ Affecting long term treatment retention («Dyne retention»)
  - ➢ Surface roughing and porosity
    - ❑ Affecting barrier properties




1: Heat sealable inner layer

2: Inner PP core

3: Metallizable outer layer (corona treated)

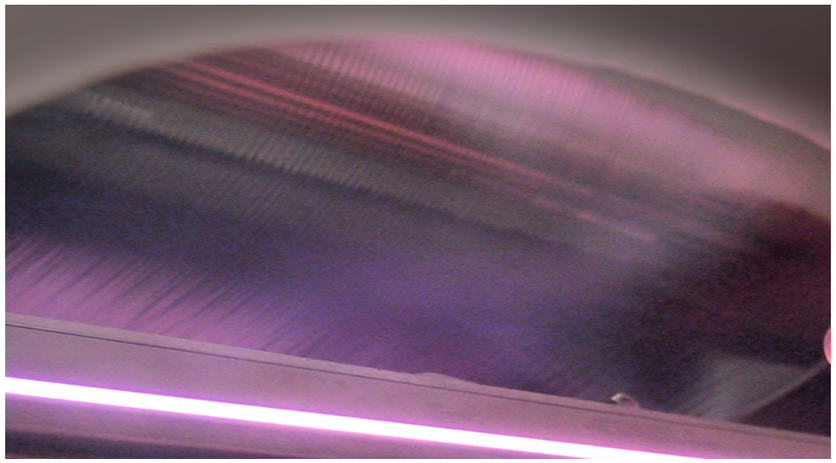
- ✓ Plasma
- ✓ Tie-layer

# CASE A : Pre-treatment for met-BOPP upgrading

## 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
(in order of treatment efficiency)

*DC magnetron based plasma treaters*

*AC type dual electrode plasma sources*

*AC hollow cathode*

«Plasma-Plus» KEY FEATURES

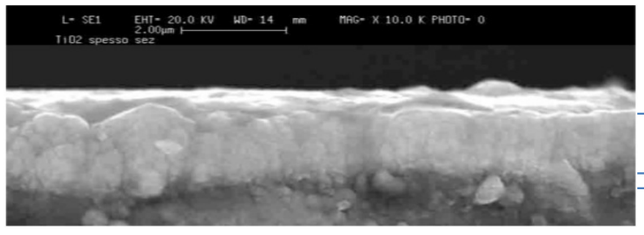
Construction : Dual Hollow cathodes, magnetically enhanced

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

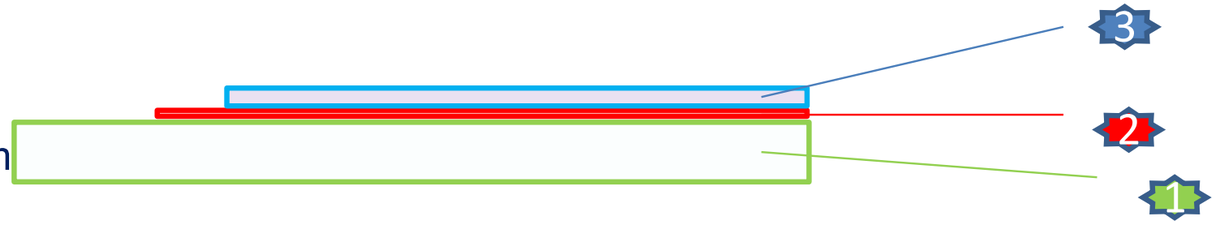
Energy dose : up to 0.8 - 1 Kjoule/m2

# *CASE A : Pre-treatment for met-BOPP upgrading*

BOPP SURFACE «SEEDING» AND «TIE LAYER» («BARRIER_MET»)




Aluminium 20-30 nm
Tie-Layer oxide : 2-3 nm
Polymer

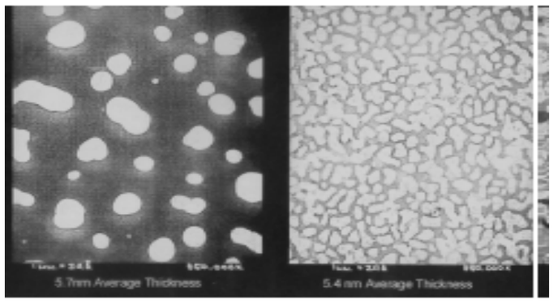



1 - Film (Bopp) — Substrate, mechanical strength

2 – «Tie» Layer
- ✓ High bond with polymer surface (adhesion promotion)
- ✓ Polymer surface modification (Planarization,seeding etc.)

3 – Aluminium layer — ✓ Functional : barrier, gloss etc.

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

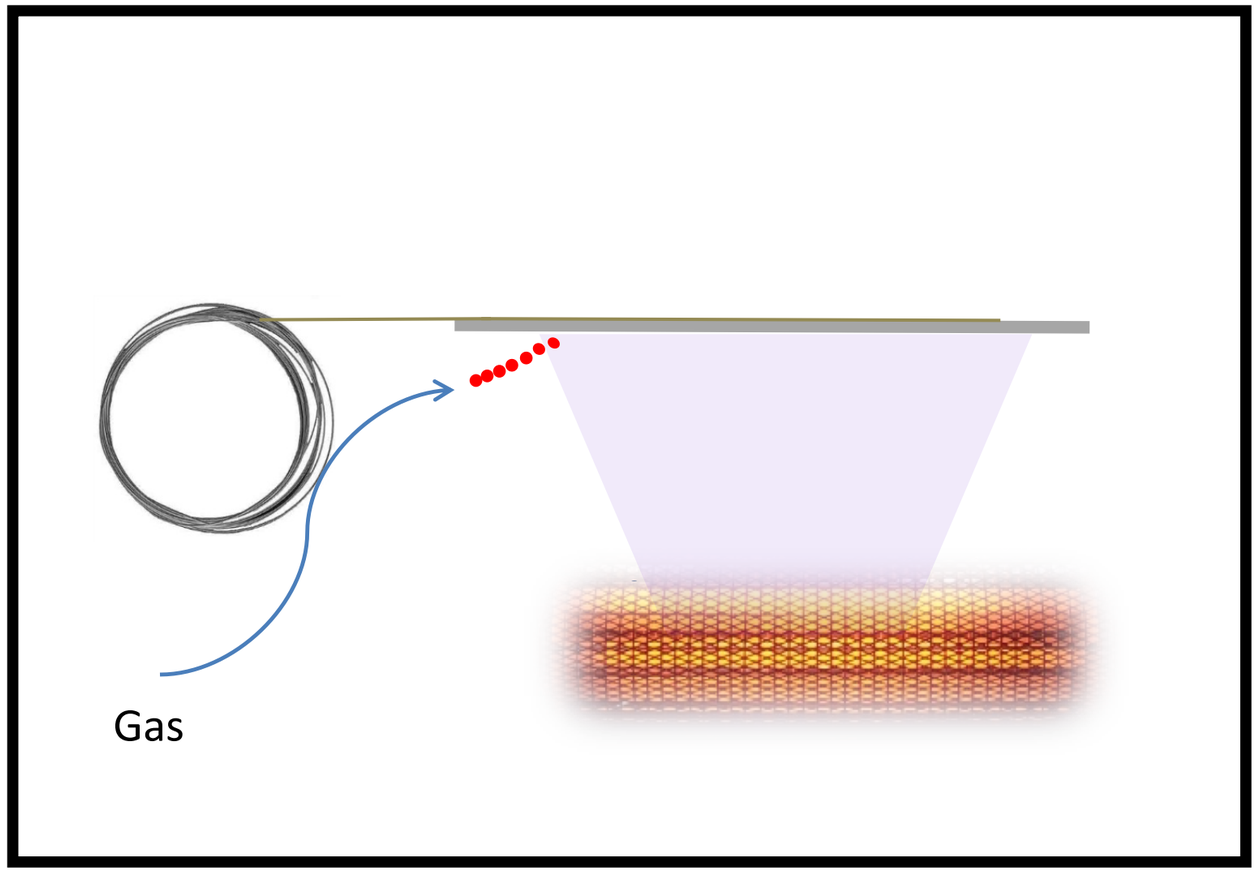



Silver nucleation

Source : AIMCAL Reference Manual

# *CASE A : Pre-treatment for met-BOPP upgrading*

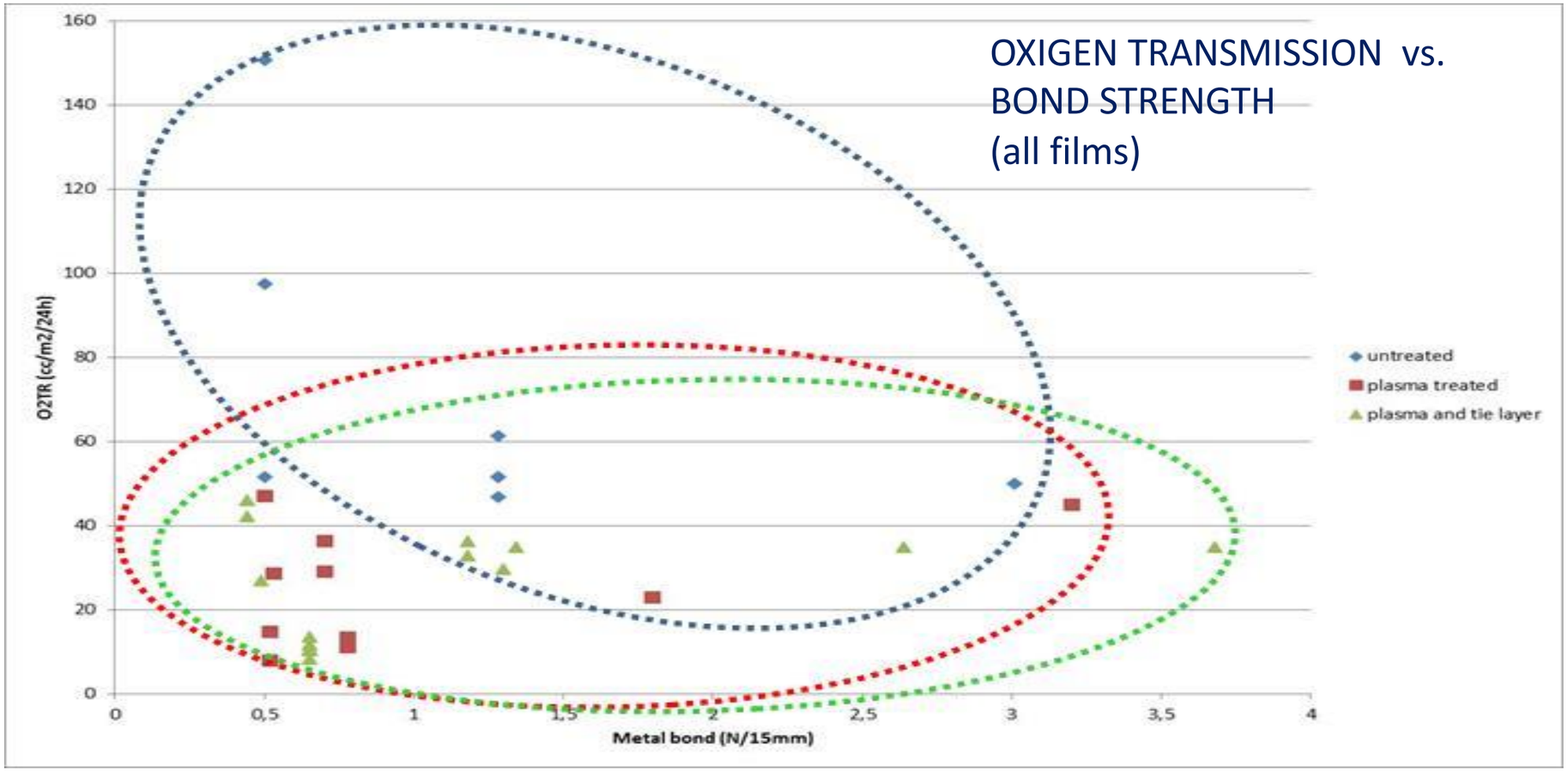
BOPP SURFACE «SEEDING» AND «TIE LAYER» («BARRIER_MET»)




- ✓ 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

# *CASE A : Pre-treatment for met-BOPP upgrading*

## PROJECT 2017 : Scouting a plurality of BOPP films with plasma + “Barrier-met”




- 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

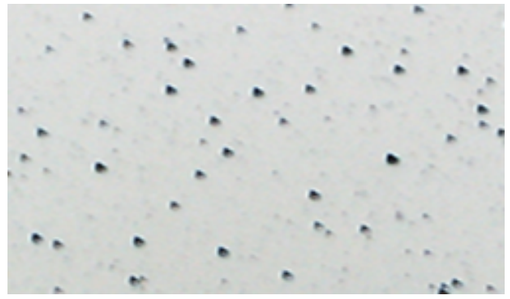
# *CASE A : Pre-treatment for met-BOPP upgrading*

PROJECT 2018 : OPTIMIZING met-BOPP barrier and metal bond

Factors for Barrier improvement :

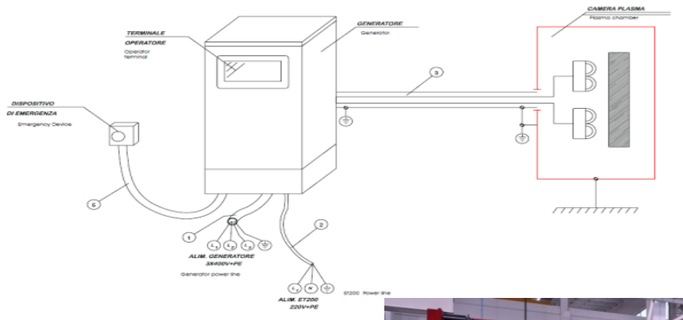
- ✓ **Base Polymer Film**
  - ✓ A standard Commercial grade
  - ✓ A moderate corona treatment
  - ✓ A minimum and properly distributed anti-block additives
- ✓ **Plasma (in vacuum) pre-treatment**
  - ✓ Moderate power and efficient energy distribution
- ✓ **Barrier-met**
  - ✓ Designed for uniform and «separate» tie-layer generation
- ✓ **Machine design and Process Parameters**

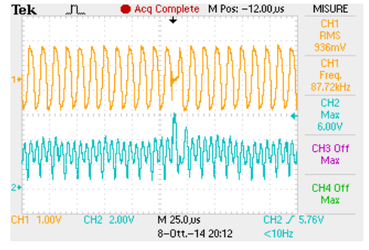
Standard(negative image)



Low additives (negative image)

The lower density of surface protruding particles translates into 30% better O2TR






# *CASE A : Pre-treatment for met-BOPP upgrading*

PROJECT 2018 : OPTIMIZING met-BOPP barrier and metal bond

The Case Study Example:

Starting point : Using Bopp 18 micron, commercial, already used on High Barrier application with very high metal thickness > 3 OD

Motivation and target : Improving the oxygen barrier and the quality consistency at more moderate OD.

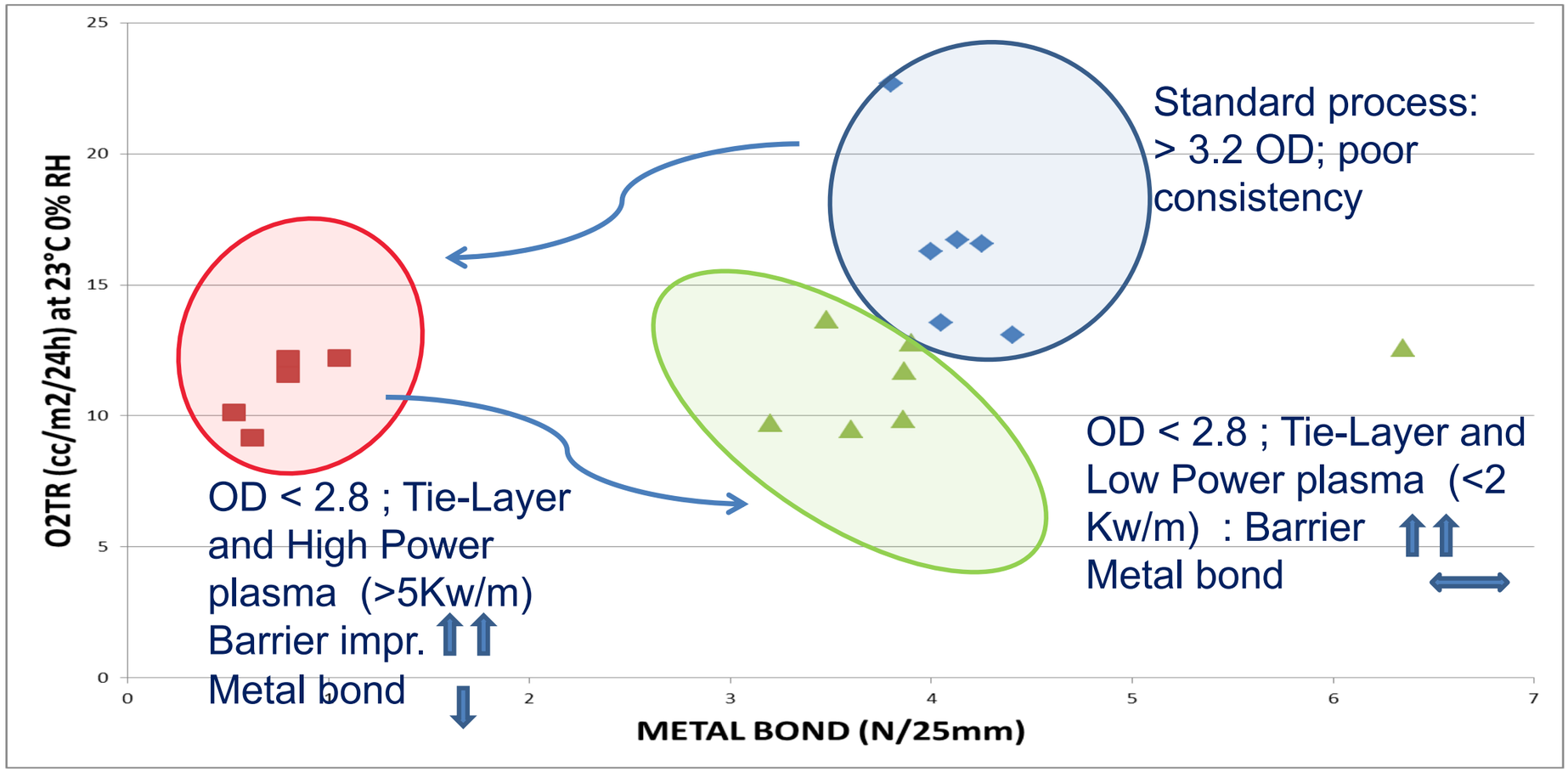
Project leading factors :

- ✓ Use of plasma pre-treatment
- ✓ Use of Tie-Layer
- ✓ Optimizing raw material properties and process control.

# *CASE A : Pre-treatment for met-BOPP upgrading*

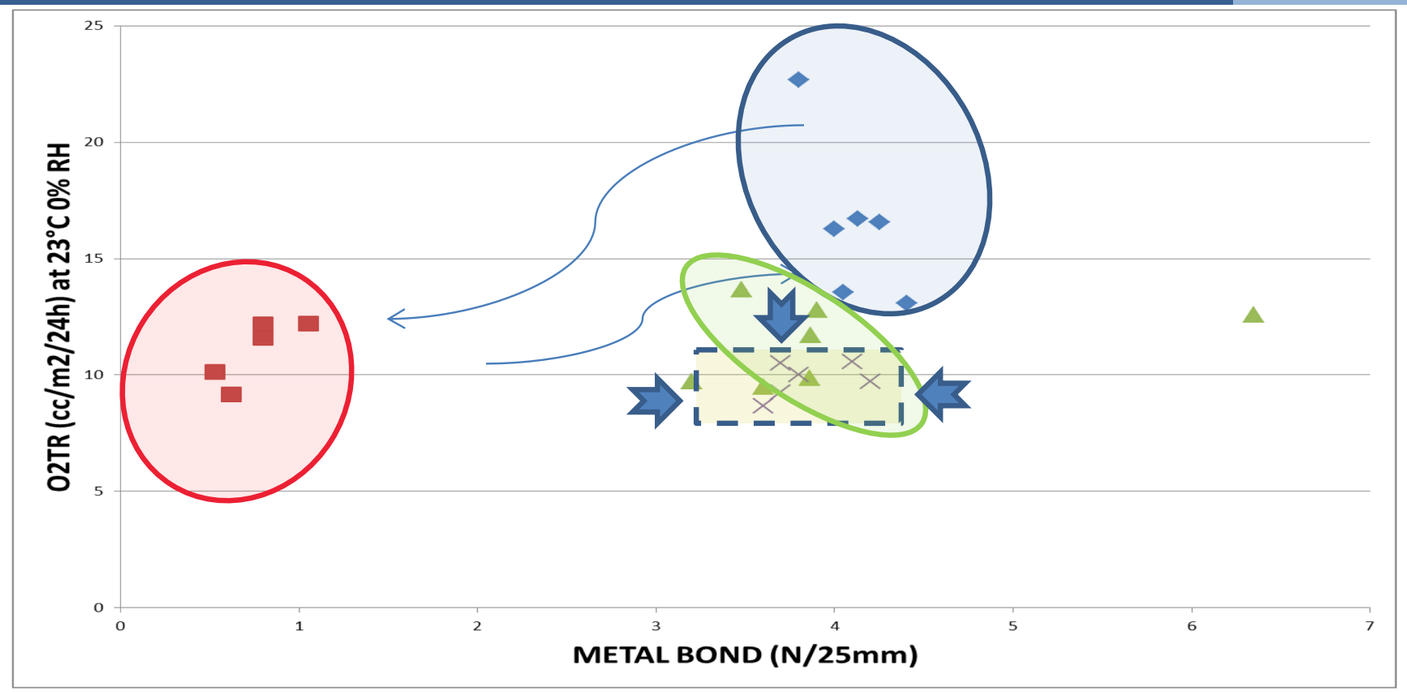
PROJECT 2018 : OPTIMIZING met-BOPP barrier and metal bond

Plasma System and Tie-Layer («Barrier met»)



# *CASE A : Pre-treatment for met-BOPP upgrading*

## PROJECT 2018 : final stage – Achieving and stabilizing superior product




Path to stabilize materials and processes :

a) A controlled film quality (e.g. : additives contents and distribution)
b) Solutions designed to :
    I. Uniform layer formation (gas distribution, gas nozzles position, protection for cleanliness)
    II. Stable plasma energy delivery at different power requirement
    III. Tension and web control, minimizing possible material damages

# *CASE A : Pre-treatment for met-Polyolefine upgrading*

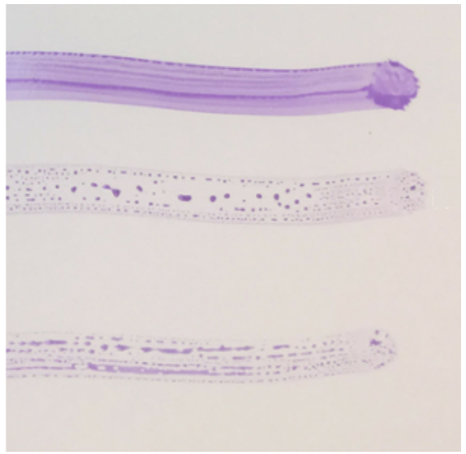
## PROJECT 2017- 2018 : examples of multiple substrates

| FILM TYPE | ORIGIN | PROCESSES | O2TR | BOND STRENGTH |
|---|---|---|---|---|
| | | BM = Barriermet<br>PL = Plasma | Cc/m2/24h | N/25mm |
| Bopp 18 | Italy | Bm : on, pl off | 33.5 | 2 |
| Bopp 18 | India | Bm:on, pl off | 15,5 | 3.5 |
| Bopp 18 | India | BM on, pl on | 8.5 | 4 |
| Bopp 18 | Pakistan | BM on, pl on | 13.5 | 4.2 |
| Bopp 17 | M.East | BM on, pl off | 15.5 | 3.5 |
| CPP 25 | Indonesia | BM on, pl on | 28 | 1.5 |
| CPP 25 | Pakistan | BM on, pl on | 35 | 2 |
| LLDPE 25 | Italy | BM on, pl on | 75 | 3 |
| LLDPE 25 | Italy (2) | BM on, pl on | 70 - 80 | >5 |

# *CASE A : Pre-treatment for met-BOPP upgrading*

## PROJECT 2018 : “BARRIER-MET” FOR “DYNE RETENTION”

- ✓ Metallized Films have the tendency to lose the pristine surface tension within weeks or months from metallization
- ✓ The dyne loss depends on the nature of the film and the storage conditions
- ✓ The most likely cause : additives slowly moving to the film metal interface , contaminating the metal surface.




There is  evidencevidence that the metal/polymer tie-layer stabilizes the surface tension , preventing or limiting the dyne level degradation

# *CASE A : Pre-treatment for met-BOPP upgrading*

## PROJECT 2018 : “BARRIER-MET” FOR “DYNE RETENTION”

Examples of  diversified Polyolefine film

| Material | Origin | Time from metallization | Surface tension (dyne/cm) |
|---|---|---|---|
| Bopp 18mic | Asia | 18 months | > 40 |
| CPP 25 mic | Asia | 5 months | >40 |
| CPP 25 mic | Asia | 6 months | >38 |
| LDPE 25 mic | Europe | 7 months | >42 |

Note :

- The «dyne protection» effect is material dependant and needs to be checked on the specific film of interest
- The data collection is in progress

# *CASE B: Clear barrier films (AlOx) Protection & Converting An Update*

**<u>AlOx by «Reactive Evaporation»</u>:**

**- Aluminium «conventional» metallizer**

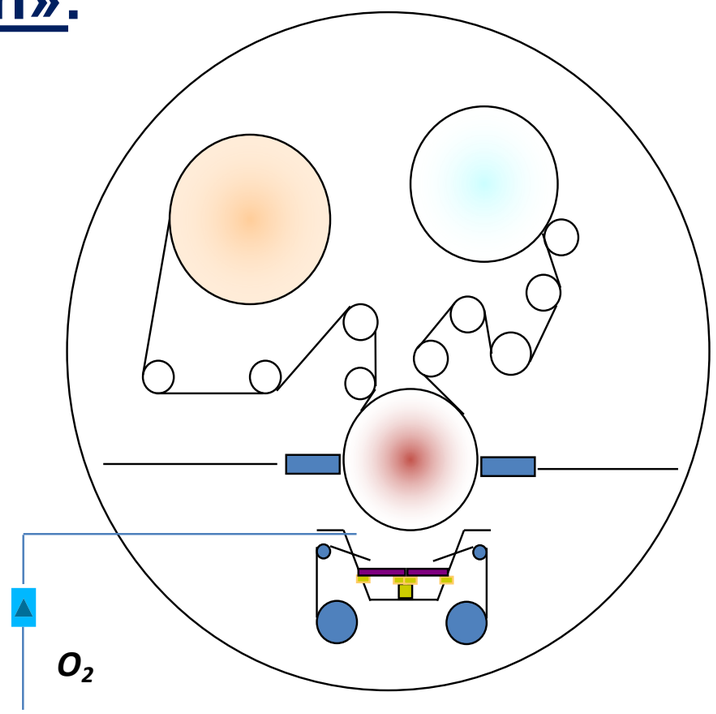
**-A Specially Designed Gas Diffuser/Distributor**

**- Metered and Controlled Gas Injection**

**- Accurate Optical Sensors**

**-Oxygen Safe Pumping**

**- Design for Safe Operation**




**<u>Basic AlOx Requirements</u> :**

**Base Film : Pet**

**Clarity : Transparency > 90%**

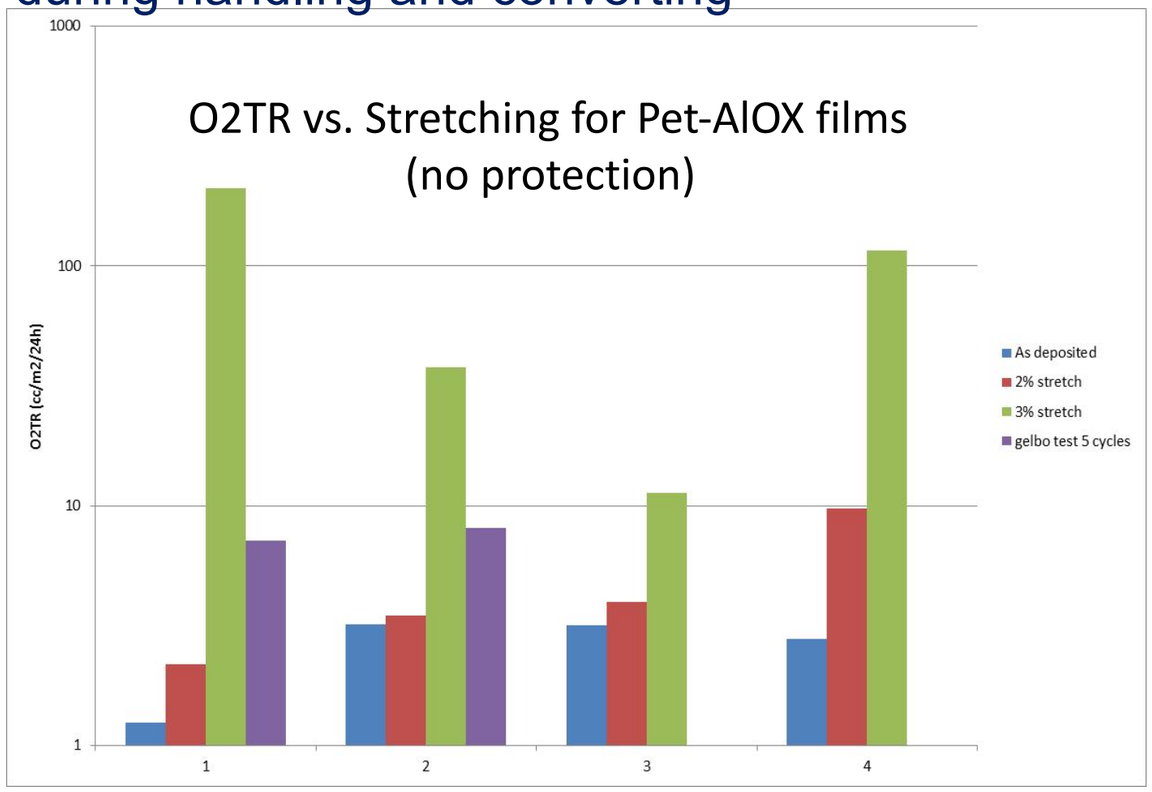
**Barrier Properties : OTR 1-5 cc/m2/day (Film Dependant)**

**WVTR : 1-5 gr/m2/day (Film Dependant)**

# CASE B: Clear barrier films (AlOx) Protection & Converting
## AlOx brittleness

### Conventional Wisdom

Oxide coatings are more brittle than metallic ones possibly leading to barrier loss during handling and converting

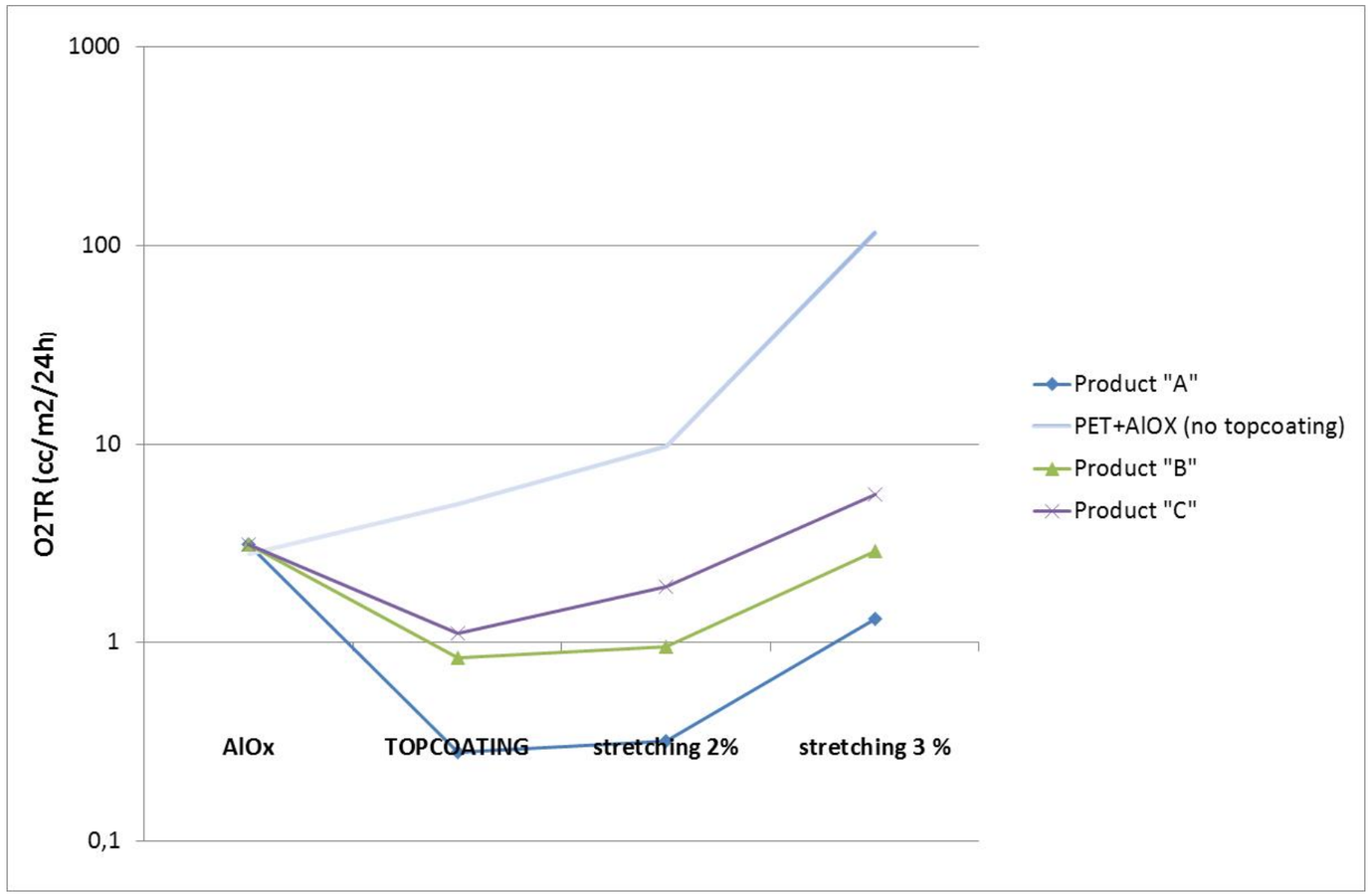



- ✓ By deposition process control : untill 2% stretching  no significant barrier loss occurs
- ✓ For a more secure durability

TOP COATING AND/OR LAMINATION

# CASE B: Clear barrier films (AlOx) Protection & Converting

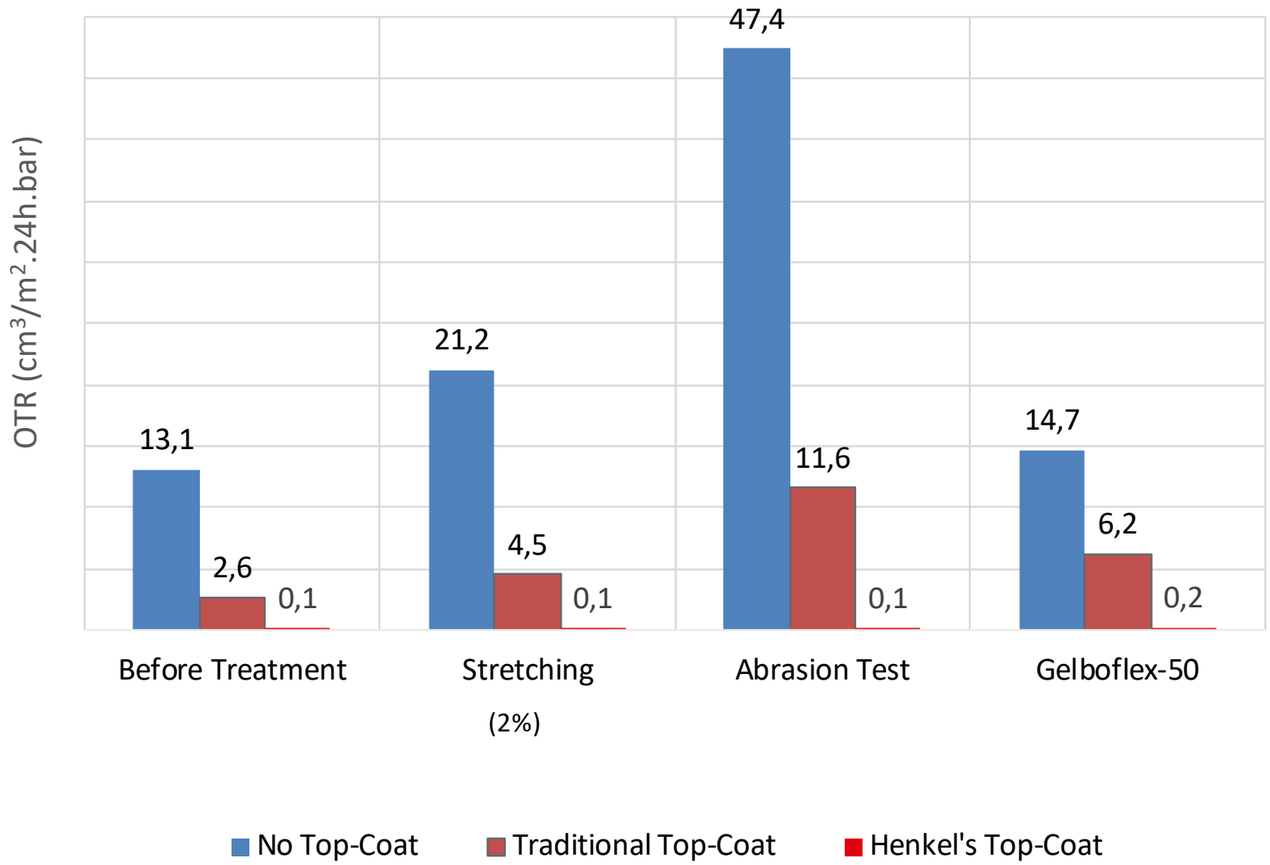
## PROJECT 2017 : SCOUTING DIFFERENT TOP COATING




- 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

# CASE B: Clear barrier films (AlOx) Protection & Converting

## PROJECT 2018 : TOP COATING AND CONVERTING INDUSTRIAL TESTS




**From: Caimmi, Kolbach: New Design-Enabling Technologies Flexible Packaging – AIMCAL –EU 2018**

**A purpose-formulated coating :**

✓ **Significant barrier improvement**

**and**

✓ **Superior Protection and Robustness**

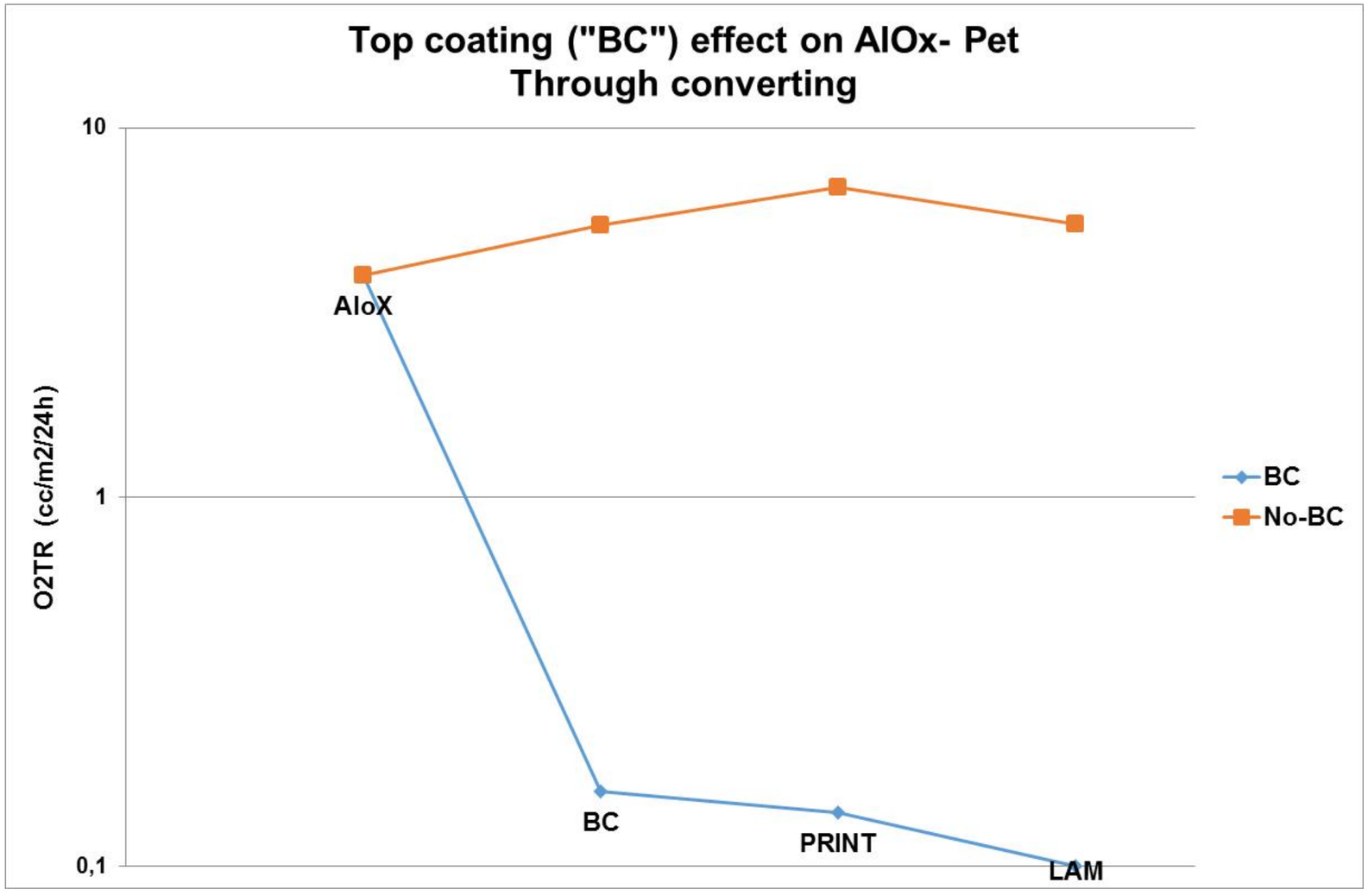
**High-performance Top-coating Technology**

**AlOx-layer**

**Substrate (e.g. PET, OPP)**

# CASE B: Clear barrier films (AlOx) Protection & Converting

## PROJECT 2018 : TOP COATING AND CONVERTING INDUSTRIAL TESTS




AlOX
600 m/min

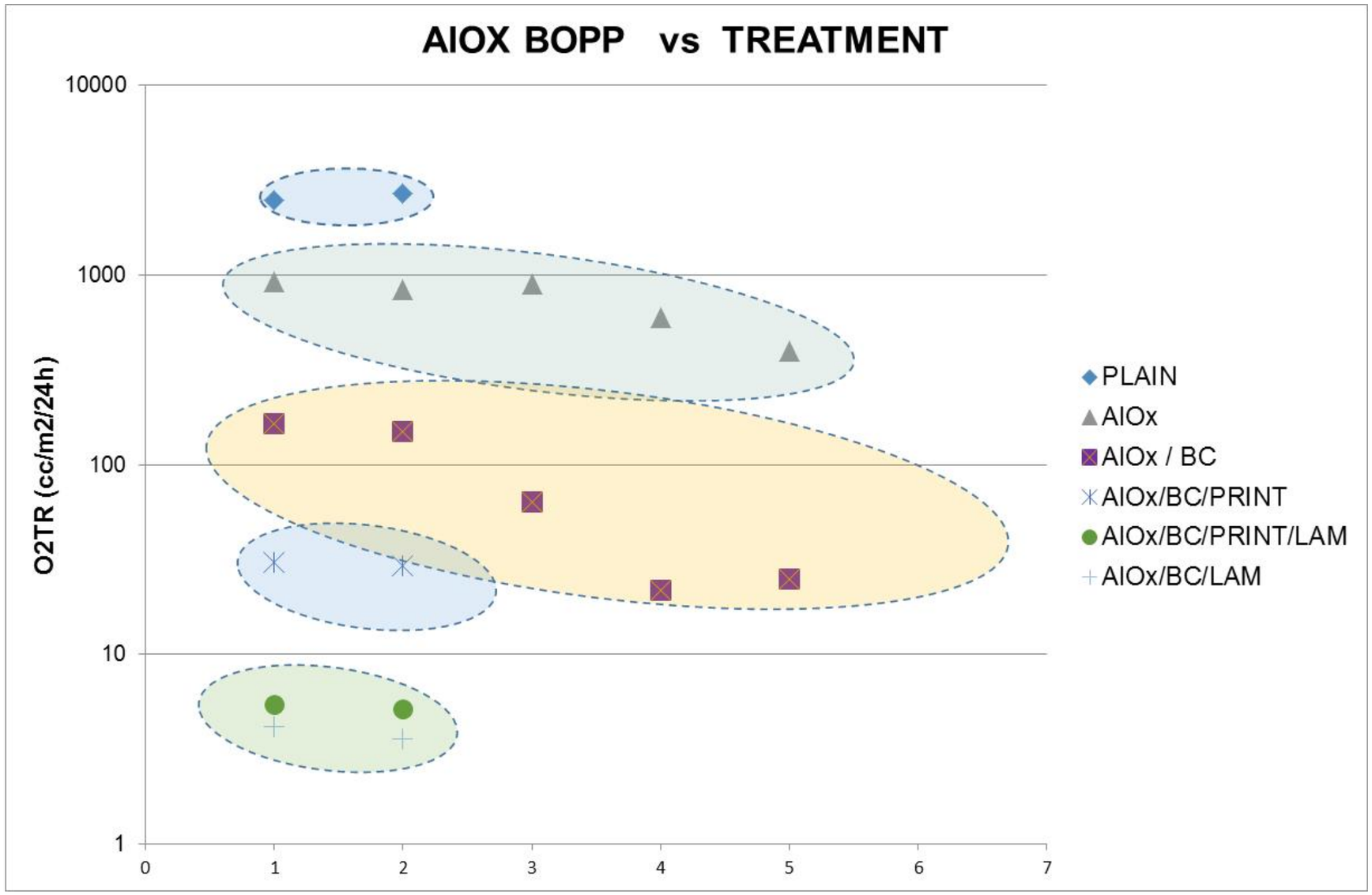
BC top coat
150 -200 m/min
0.5-0.7 gr/m2

Gravure print
150 -200 m/min
Standard inks

Lamination
150 -200 m/min
Solventless glue
50mic LDPE

# CASE B: Clear barrier films (AlOx) Protection & Converting

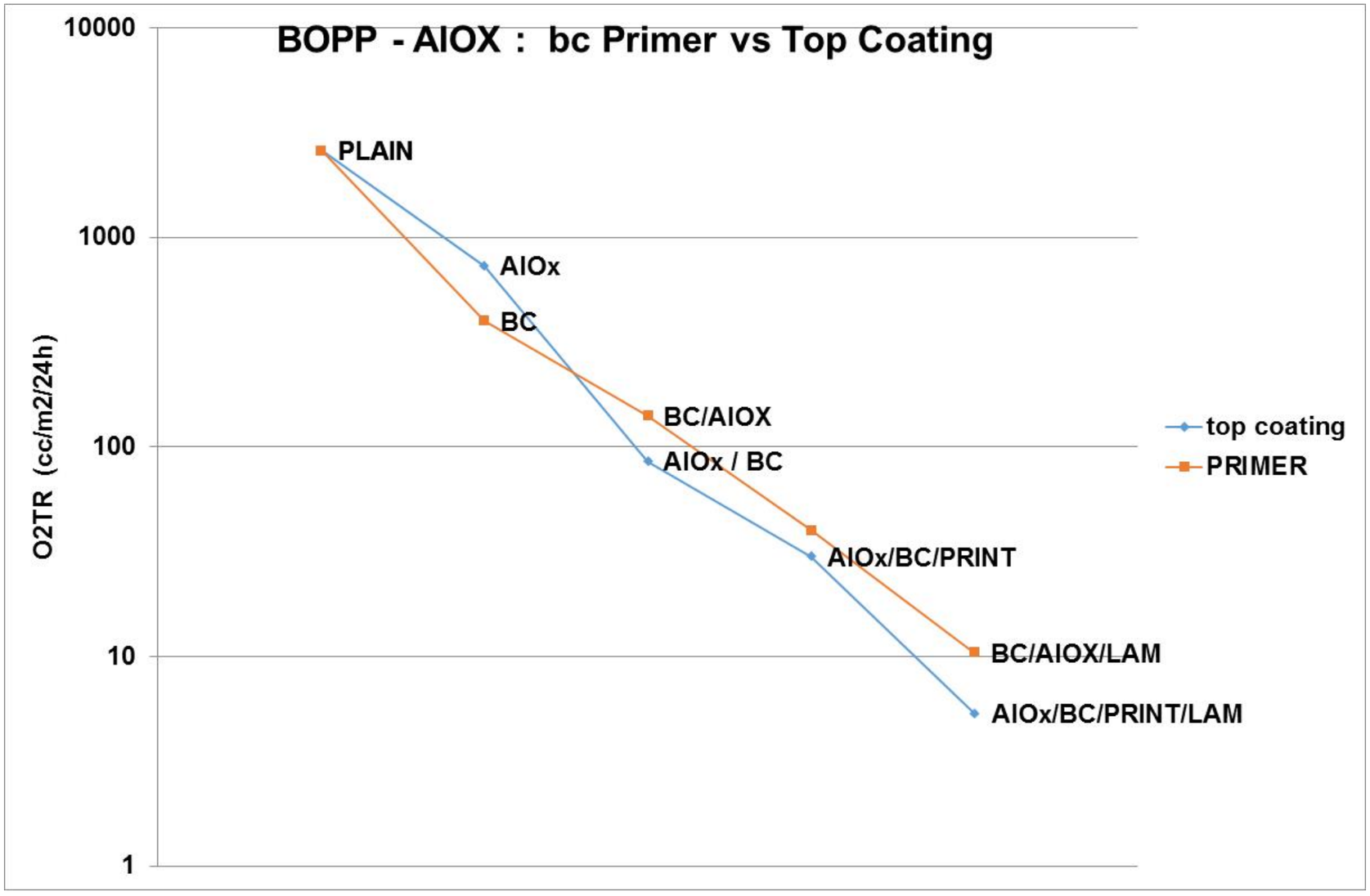
*PROJECT 2018 : AlOx on BOPP – Work in Progress*




- ✓ BOPP COMMODITY
- ✓ MIXED (medium/poor) BARRIER IMPROVEMENT RESULTS WITH PURE AlOX
- ✓ BARRIER TOP COATING (BC) EFFECTIVE IN REDUCING OXYGEN PERMEABILITY - still mixed results
- ✓ MARGINAL PRINT EFFECT ON IMPROVING BARRIER
- ✓ LAMINATION (bopp-AlOX//bopp) very effective in reducing gas permeation

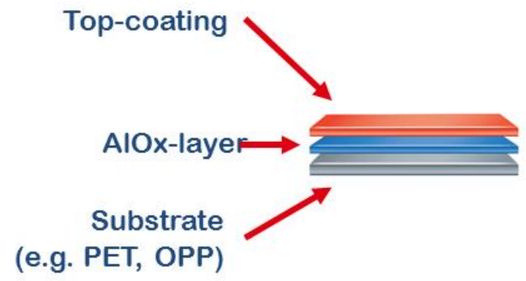
# CASE B: Clear barrier films (AlOx) Protection & Converting

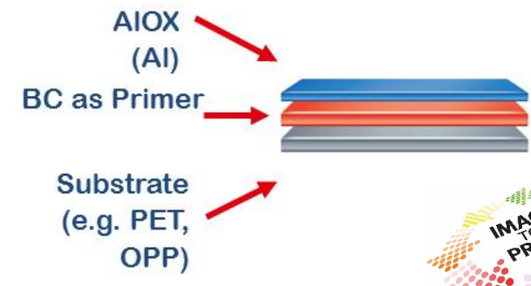
*PROJECT 2018 : AlOx on BOPP – Work in Progress*




Solutions for consistent AlOx on Bopp :

- ✓ Use of a «special» skin PP
- ✓ Combining primer and top coating



# *CASE C: SELECTIVE METALLIZATION «IN-REGISTER»*

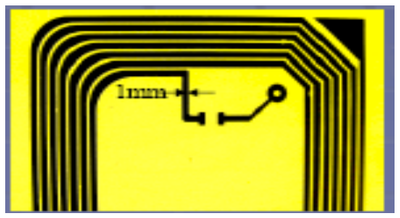
*Vast Variety of potential Applications*

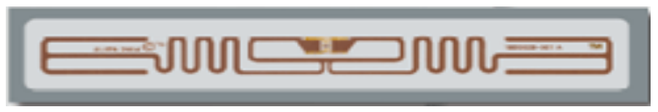
Packaging




Security

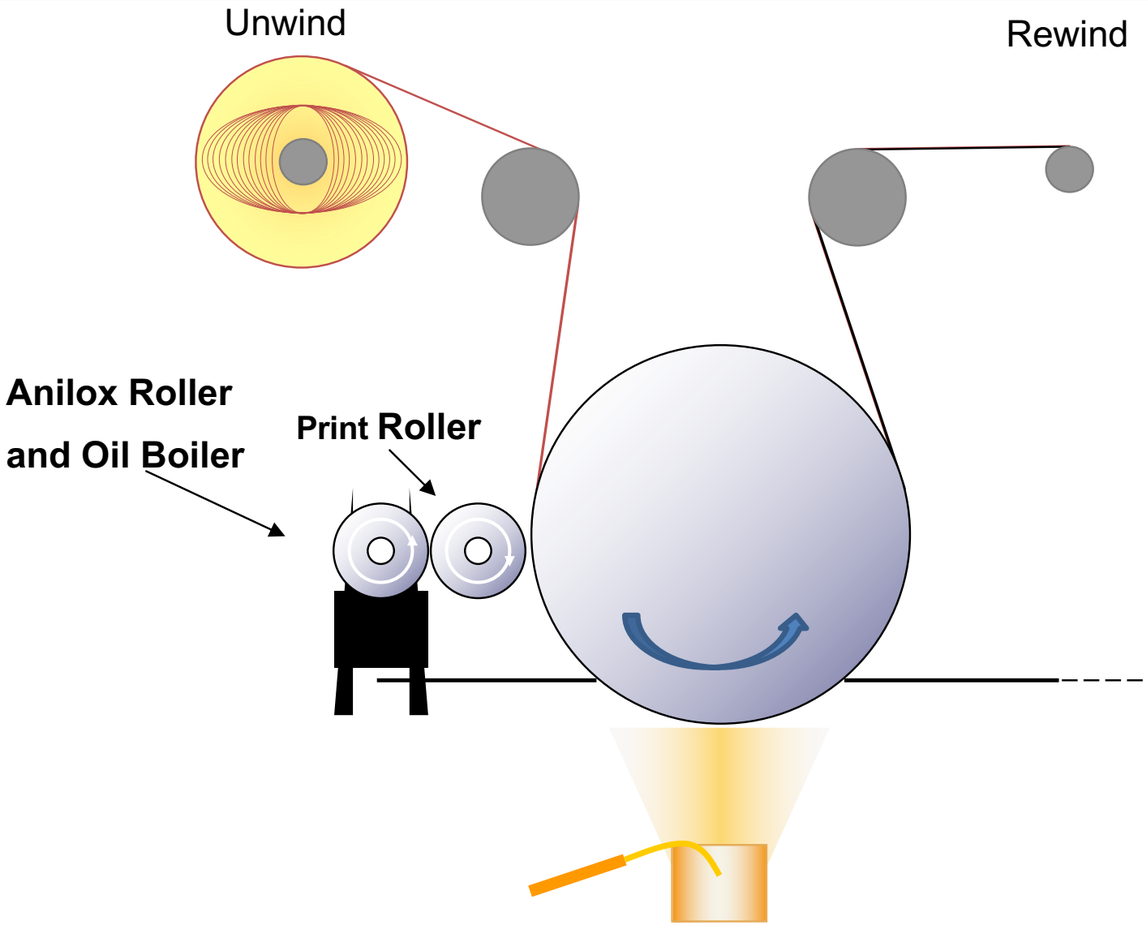

Others

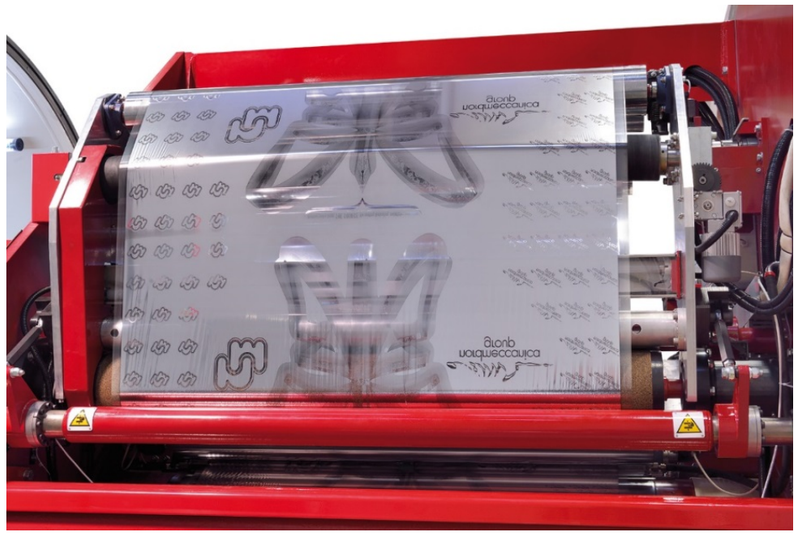


# CASE C: SELECTIVE METALLIZATION «IN-REGISTER»

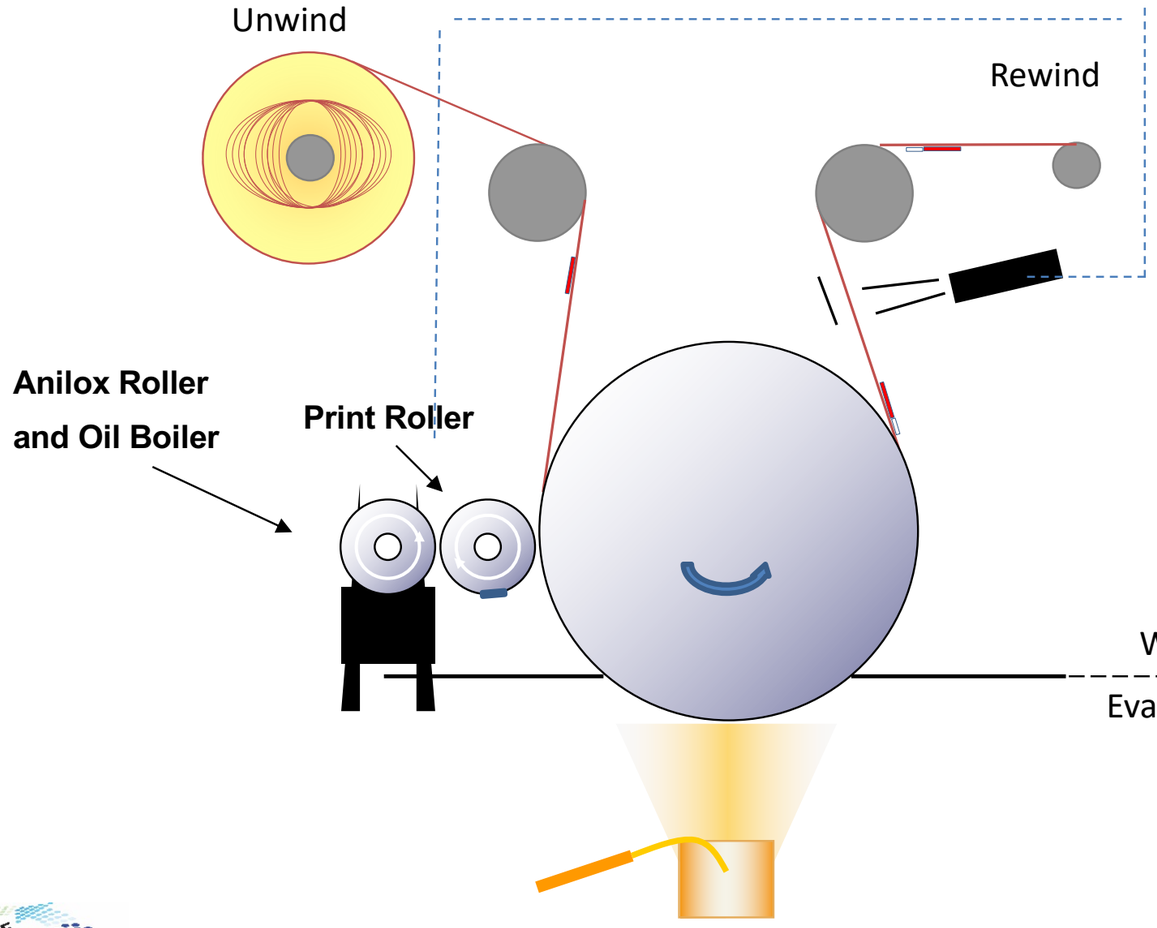
*Standard Design: Selective metallization for plain film*



# CASE C: SELECTIVE METALLIZATION «IN-REGISTER»

*Project 2018: Selective metallization for pre-printed film*




# CASE C: SELECTIVE METALLIZATION «IN-REGISTER»

*Project 2018: Selective metallization for pre-printed film*

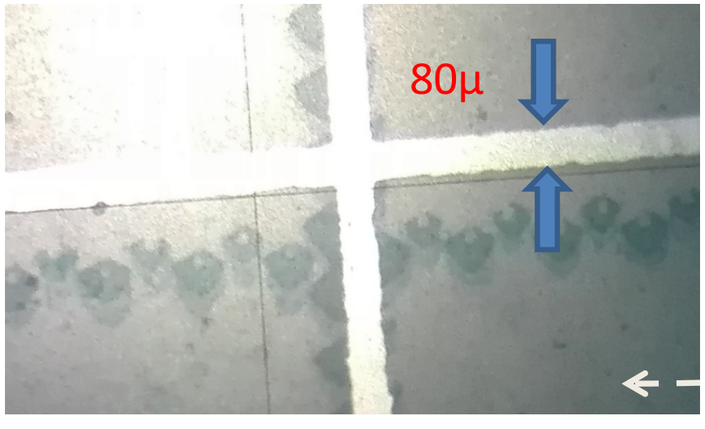
## PRINT RESOLUTION AND ACCURACY

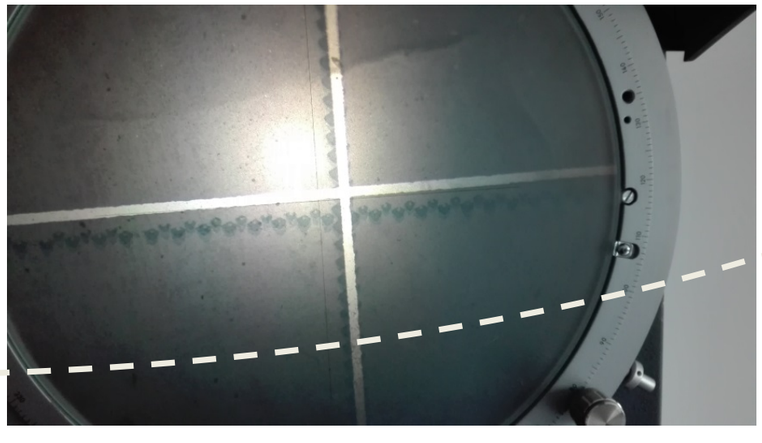
SYSTEM CAPABILITY :

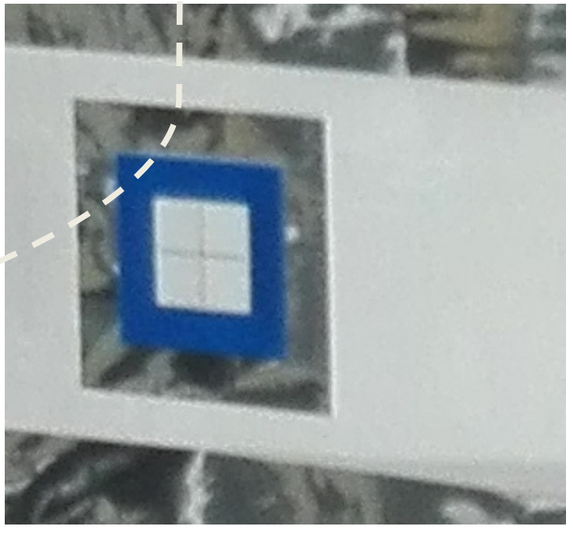
Print Resolution : 50 micron

Registration control (across/along) : avg. 0.2 mm +/0.1mm

Detection capability : Ink/ embossing mark





# CONCLUSIONS

Presented three examples of recent promising development to extend metallizing scope and applications :

✓ Vacuum pre-treatments to improve polyolephine performance

✓ Vacuum + atmospheric  coating for superior clear barrier Pet AlOx performance and stconversion .  Work-in-progress for Bopp-AlOx

✓ Selective metallization for pre-printed materials – Work-in-Progress

**MANY THANKS FOR THE ATTENTION**