HP Indigo Division Technical Note

Subject: Toray MET-BOPP PRF feasibility test report

1. **Background:**

   Toray is a potential Pack Ready Film (PRF) supplier. As part of the film supplier validation process a sample of the feasibility trial tested.

2. **Objective:**

   The purpose of this trial is to test the quality and functionality of two MET-BOPP PRFs one with Lotryl 28MA07 and one with an undisclosed TAP

3. **Production summary:**

TAP Roll #	Internal #	Composition	TAP composition	Pre corona	Post corona	Thickness
XR589	PRF1015	TAP/MET-BOPP	Lotryl 28MA07	N/A	N/A	12/20
XR588	PRF1016	TAP/ MET-BOPP	Coex. unknown TAP + Lotryl28MA07	N/A	N/A	12/20

4. **Procedure:**

4.1 Each of the produced roll underwent an incoming inspection test consisting of:

- 4.1.1 Visual inspection (Coating quality, visual defects)
- 4.1.2 Curling
- 4.1.3 Thickness
- 4.1.4 COF (TAP/TAP, Seal/Seal, Print/Print)

4.2 Each produced roll underwent a feasibility matrix testing different lamination conditions in order to find the optimal working window per composition. Each of the rolls was laminated using the Maabarot laminator under the following conditions

Nip temperature [C]	Lamination speed [m/min]	Corona on TAP [W]	Corona on print [W]	Wrapping angle on print	Wrapping angle on laminate
110	15	1500	1500	Min (0 deg.)	Min (0 deg.)
140	15	1500	1500	Min (0 deg.)	Min (0 deg.)

- The lamination bond strength (LBS) was tested immediately after the lamination, using the standard T-peel testing procedure, according to ASTM D1876.

4.3 Laminates part of the trial were sealed under the following conditions:

Upper jaw type	Lower jaw type	Upper jaw temp [C]	Lower jaw temp [C]	Force [N]	Dwell time [sec]
Flat 1" + Teflon	1" Silicon + Teflon	120-160	RT	450	0.5

4.4 The dynamic coefficient of friction (COF) was measured both in-to-in and out-to-out of the PRFs and the each laminate prepared under the identified working parameters, using an INSTRON standard COF test procedure, according to ASTM D-1894.

5. Results:

5.1 Incoming QC

Roll #	Composition	TAP	TAP Thickness [um]*	Curling		TAP coating	Visual defects	COF	
				TD	MD			BOPP/BOPP	TAP/TAP
PRF1015	TAP/MET-BOPP	Lotryl28MA07	27±1					0.48	2.4
PRF1016	TAP/MET-BOPP	Coex. unknown TAP + Lotryl28MA07	26±1			**	**	0.45	N/A

* Total film thickness

** See appendix for images

Color code reflects property rating:

Red = Bad

Yellow = Moderate

Green = Good

5.2 LBS measurements

Based on the feasibility matrix results, a working point was identified for each PRF, which exhibits high LBS (>3.5) and a high quality laminate (visually).

Roll #	Composition	TAP	LBS [N/in]*	Failure mode	Working parameters		
					Temperature	Speed	Wrapping angle
PRF1015	BOPP/INK//TAP/MET-BOPP	Lotryl28MA07	1.0	TTT + Metallized failure	140	15	Min (0 deg.)
PRF1016	BOPP/INK//TAP/MET-BOPP	Coex. unknown TAP + Lotryl28MA07	5.0	TTT + Metallized failure**	140	15	Min (0 deg.)

* LBS values represent the highest achieved LBS without severe visual issues as found from the feasibility matrix
** See appendix for images

The abbreviations of the failure modes stand for the following:

NT – No Transfer of ink from the printed substrate
TT – Total Transfer
PT – Partial Transfer of ink from the printed substrate (Percentage of ink remaining on the substrate)
PTT – Partial TAP transfer from the Pack Ready film
TTT – Total TAP Transfer from the Pack Ready film to the printed substrate

Roll #	Composition	TAP	TAP/substrate adhesion [N/in]*
PRF1015	TAP/MET-BOPP	N/A	1.1
PRF1016	TAP/MET-BOPP	N/A	N/A

5.3 Seal test

Roll #	Composition	Dwell time \ Temp	120C	130C	140C	150C	160C
XR589	BOPP/INK//TAP/MET-BOPP	0.5sec	<0.5 N/in	<0.5 N/in	1 N/in	2.85 N/in	5.2 N/in
XR588	BOPP/INK//TAP/MET-BOPP	0.5sec	2.0 N/in	3.7 N/in	3.9 N/in	N/A	N/A

6. Conclusions:

6.1. Visual inspection of both films revealed defects in the metallized layer (see appendix).
6.2. Visual inspection of the TAP coating in film XR588 revealed non uniform coating (see appendix).
6.3. Film XR588 exhibited blocking due to extremely high tackiness of the film.
6.4. Films do no exhibit any curling issues.
6.5. The lamination of XR588 to a digital print on BOPP yielded high LBS results.
6.6. The lamination of XR589 to a digital print on BOPP yielded low LBS results, below the desired spec. this was identified to be due to poor adhesion of the TAP to the underlying substrate.
6.7. Both films exhibit partial failure of the metallized layer upon delamination (see appendix).
6.8. The sealing of the films yielded satisfactory seal strengths with no imminent issues.

7. Summary:

The TAP coated MET-BOPP produced by Toray underwent a series of tests as part of the feasibility trial of the construction as a Pack Ready Film.

- The Thickness of the film should be 30um (based on the spec of the TAP being 10um), the measured thickness suggests a TAP thickness below the desired spec.
- Holes and cracks in the metallized layer may reflect damage to barrier layer in terms of OTR/WVTR.
- The tackiness of film XR588 makes it extremely hard to handle and not usable.

Yorai Amit
Labels & Packaging team
Materials R&D
HP Indigo devision
Cell phone: +972-52-8306677

HP Indigo

Appendix:

Figure 1. MET-BOPP (XR589) visual inspection showing wrinkles in film

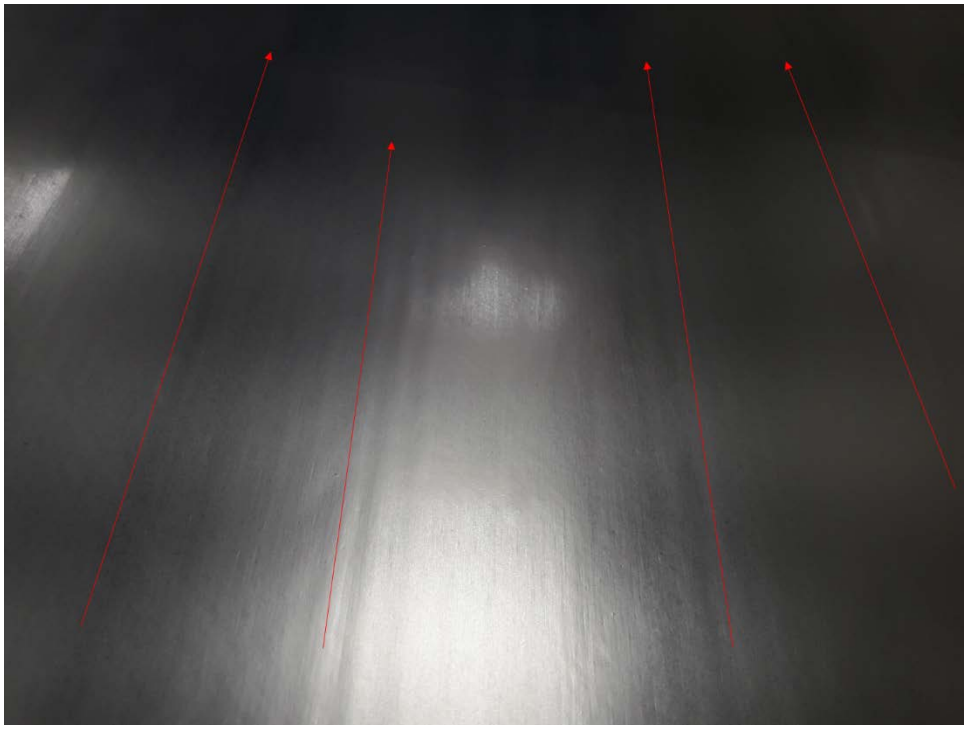

Figure 2. MET-BOPP (XR588) visual inspection showing non-uniform TAP coating

Figure 3. MET-BOPP (XR589) visual inspection of metallized layer (using back-light) showing holes and scratches in metalized layer

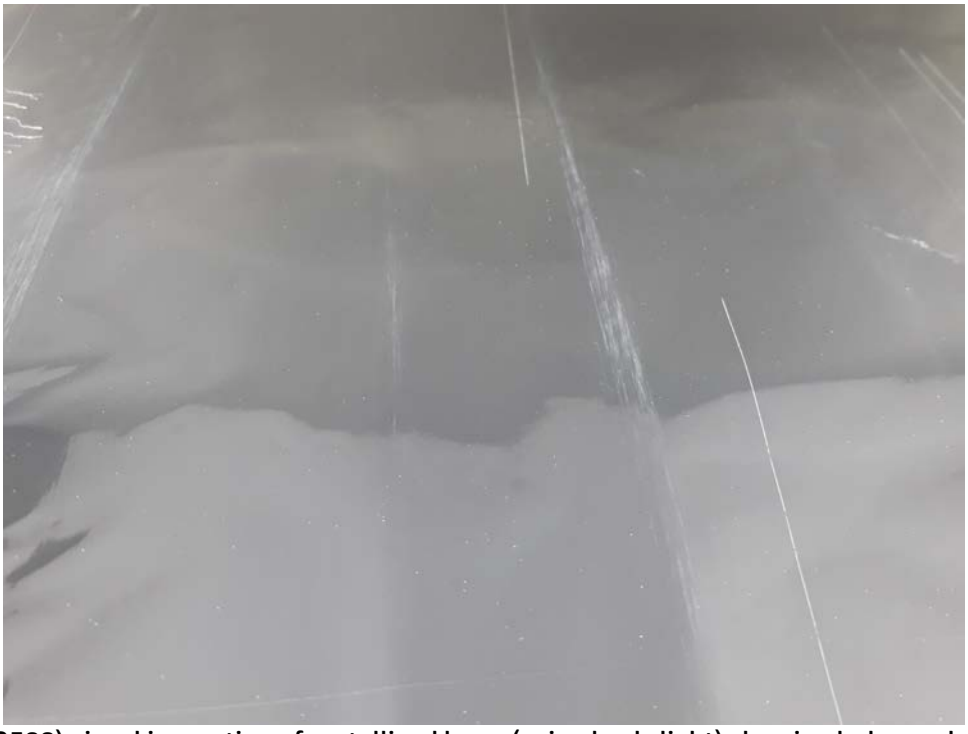

Figure 4. MET-BOPP (XR588) visual inspection of metallized layer (using back-light) showing holes and scratches in metalized layer

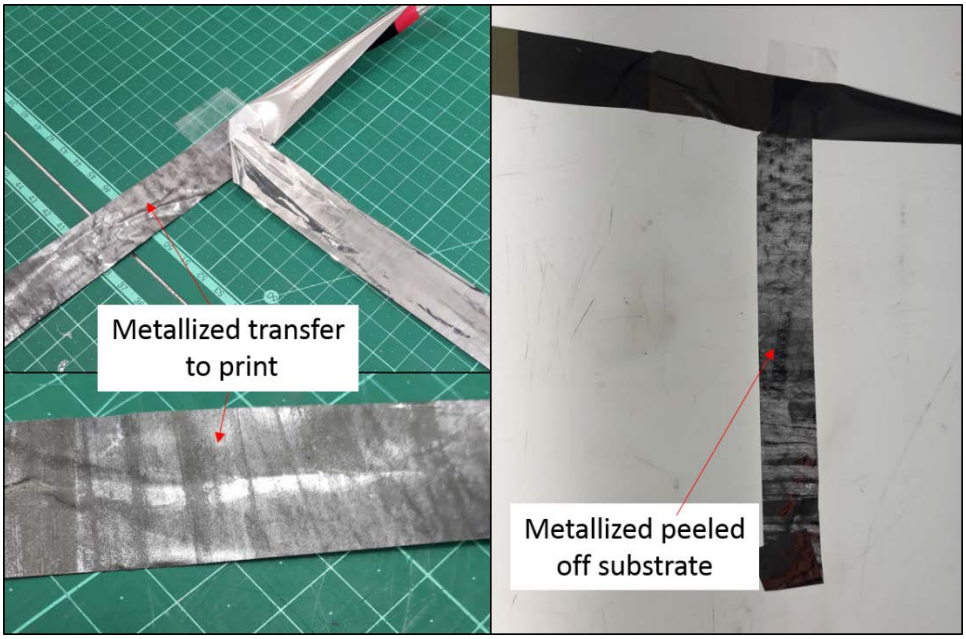

Figure 5. Visual inspection of delaminate (left) and using back-light (right) showing the metallized layer failure