



HP Indigo Division Technical Report

Subject: KDX TAP/METT-BOPP 28µm (EVA) compatible Pack Ready Film feasibility test report

December 25, 2018

1. Background:

Compatible Pack Ready Films are commercially available films with a thermal adhesive polymer that can be used as laminates over the LEP print in flexible packaging production.

Lamination is performed using the Karlville Pack Ready laminator for Pack Ready Film testing.

2. Objective:

The purpose of this trial is to test the adhesion of the compatible films BOPP-METT/TAP 28 µm (EVA) to reverse digital printed BOPP 20micron.

3. Procedure:

3.1 Each roll underwent a feasibility matrix testing different lamination conditions in order to find the optimal working window per composition. The roll was examined for:

- Appearance:
 - General appearance as haziness, turbidity etc.
 - Curling in MD (machine direction), TD (transversal direction)
 - Wrinkles
 - Pinching
- Lamination bond strength performance between the laminate and the LEP Indigo digital ink

The lamination was performed under the following conditions:

3.2.1 Thermal film: BOPP-METT/TAP 28 µm

Lamination method: TAP on 2nd

Unwinder 1	Unwinder 2	Temperature [°C]	Speed [m/min]	Nip pressure (bar)	Wrapping angel [deg.]	Pre-heat [°C]
Reverse printed BOPP 20 micron	EVA/MET-BOPP	70	20	3	0	80
		70	20-40	3	0	90
		100	20-40	2-4	0	90



4. Results:

4.1 BOPP-METT/TAP 28 µm

Laminated film appearance under the lamination conditions:

Unwinder 1	Unwinder 2	Temperature [°C]	Speed [m/min]	Nip pressure (bar)	Wrapping angel [deg.]	Pre-heat [°C]	Overall appearance
Reverse printed BOPP 20 mic.	EVA/MET-BOPP	70	30	3	0	80	Wrinkles Low LBS
		70	20	3	0	90	GOOD
		85	20-40	2	0	90	Strips, wrinkles
		100	20-40	2-4	0	90, By pass	Pincing, wrinkles

4.2 LBS results of the laminates resulted in best appearance, taken immediately after lamination process. LBS was retested again within 24 hours after lamination process.

4.3.1 BOPP-METT/TAP 28 µm

Laminated film appearance under the lamination conditions:

Unwinder 1	Unwinder 2	Temperature [°C]	Pre-Heat [°C]	Wrapping angle [deg.]	Speed [m/min]	LBS at t=0hrs [N/in]			LBS at t=24hrs [N/in]		
						Patch #22	Patch #16	Patch #11	Patch #22	Patch #16	Patch #11
Reverse printed BOPP 20 mic.	EVA/MET-BOPP	70	90	90	20	4.8	4.0	NA	3.7, 3.8	3.5, 3.8	5.6, 4.2

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

**4.3 Sealed area Sealing Bond Strength (SBS)
METT-BOPP to METT-BOPP**

Top ply	Second ply	Jaws type	Dwell time [s]	Upper jaw temperature (°C) protected with Teflon Lower jaw at RT protected with silicon and Teflon					
				Up to 140	150	160	170	180	190
EVA/METT-BOPP	Ink/BOPP	Flat 1"	1.0	0	20	26.6	26.0	24.4	30.0

METT-BOPP to BOPP

Top ply	Second ply	Jaws type	Dwell time [s]	Upper jaw temperature (°C) protected with Teflon Lower jaw at RT protected with silicon and Teflon					
				Up to 140	150	160	170	180	190
EVA/METT-BOPP	Ink/BOPP	Flat 1"	1.0	0	8	10.8	10.5	10.2	9.0



All seal area resulted in good and acceptable appearance at seal conditions: using 1" flat jaws Teflon protected, up to 190°C, with pressure of 450N for 1 sec. No substrate shrinkage, tunneling or any other imperfection were observed.

The METT-BOPP to METT-BOPP laminate sealing bond strength resulted in 20N/inch at 150°C and higher as temperature is elevated. Below 140°C there was no sealing. The METT-BOPP to the printed clear BOPP sealing bond strength resulted in 8N/inch at 150°C and ~10N/inch as temperature is elevated. Below 140°C there was no sealing.

5. **Conclusions:**

Laminated film with BOPP-METT/EVA resulted in good appearance at low hot drum temperature of 70°C with pre-heat mode of the laminator at 90°C. At higher nip temperatures, laminate appearance was not acceptable. Wrinkles and pinching were present on the film, at various nip pressures and different film speed.

At the nip temperature of 70°C after softening the TAP layer (via pre-heat), the lamination bond strength resulted in acceptable values >3.5N/inch. Retesting the LBS 24hours after lamination resulted also in acceptable values of 4.0 ± 0.4 N/inch that higher than the threshold of 3.5N/inch.

The METT-BOPP to METT-BOPP laminate sealing bond strength resulted in 20N/inch at 150°C and higher as temperature is elevated. Below 140°C there was no sealing. The METT-BOPP laminate to the printed clear BOPP sealing bond strength resulted in 8N/inch at 150°C and ~10N/inch as temperature is elevated. Below 140°C there was no sealing.

All seal area resulted in good and acceptable appearance.

6. **Summary:**

A Metalized BOPP with a thermal adhesive polymer (EVA) from KDX was used and laminated over the LEP reverse printed BOPP in flexible packaging production.

Appearance and LBS values of laminated film was good and reached the acceptance criteria, at the lamination conditions used.

The sealing bond strength values for METT-BOPP to METT-BOPP laminate and METT-BOPP laminate to the printed clear BOPP measured were 20 and 10N/inch, respectively. All seal area resulted in good and acceptable appearance at tests conditions.

Overall, the BOPP-METT with EVA TAP resin compatible films **pass** the feasibility trial for resulting in acceptable LBS and SBS values and good appearance, at the test condition described above.

Liora Braun
R&D Researcher
Labels & Flexible Packaging Materials Team
HP - Indigo Division