Extrusion Lamination of Poly-woven Bags

An over-view of primers and resins

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IOPP Technical Bag Committee Meeting

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The Science of Adhesion

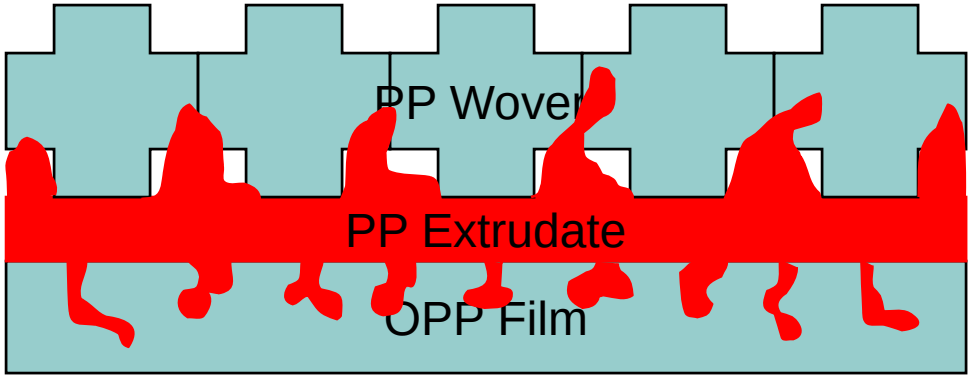
Two Types of Bonding

Chemical

&

Mechanical

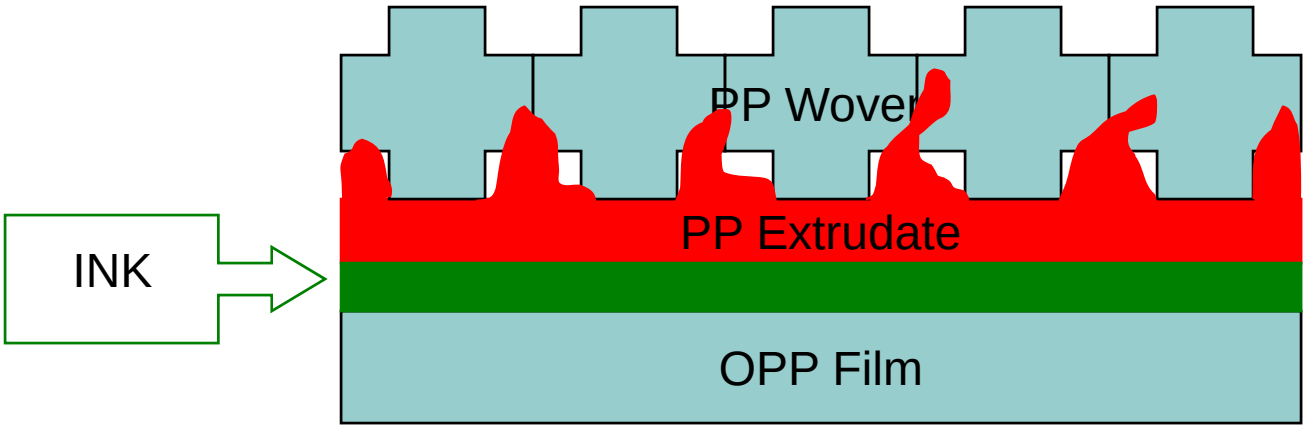
Polypropylene Woven: Basic Lamination – "Mechanical" Adhesion



What is a Bag With-out printing?

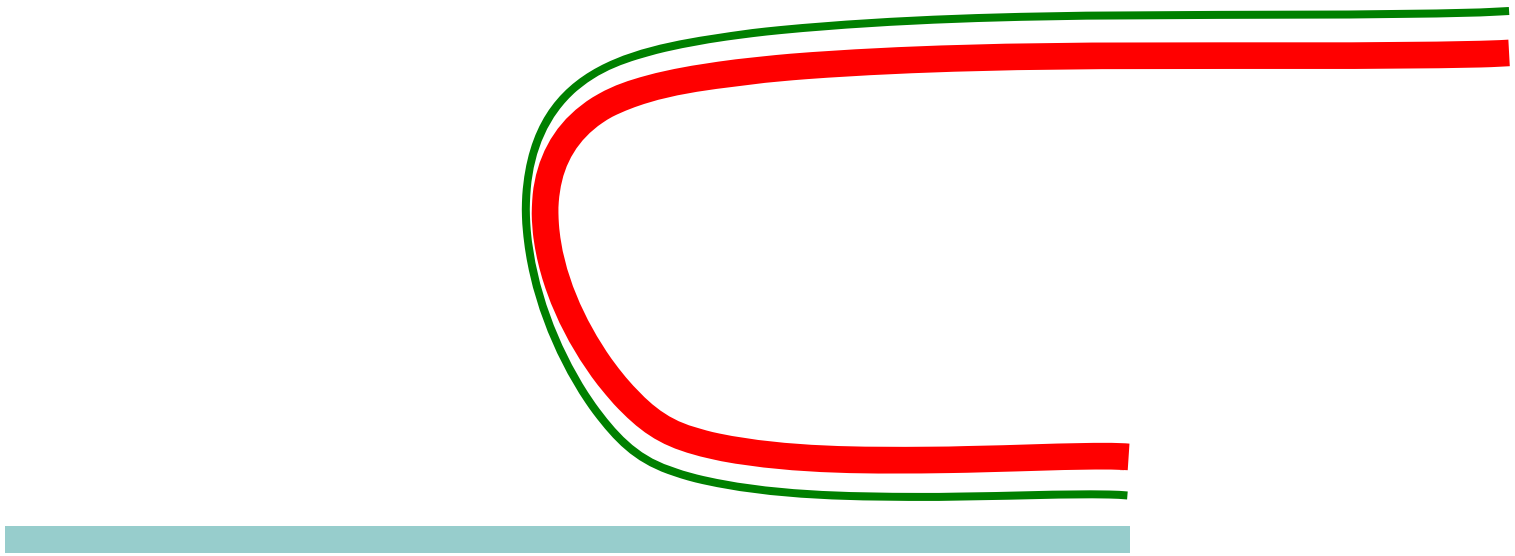
- Surface Printing does not interfere with extrudate adhesion
- Benefits of reverse printing:
  - Gloss
  - Clarity
  - Scuff Resistance
  - Moisture Resistance

Reverse Printed Lamination



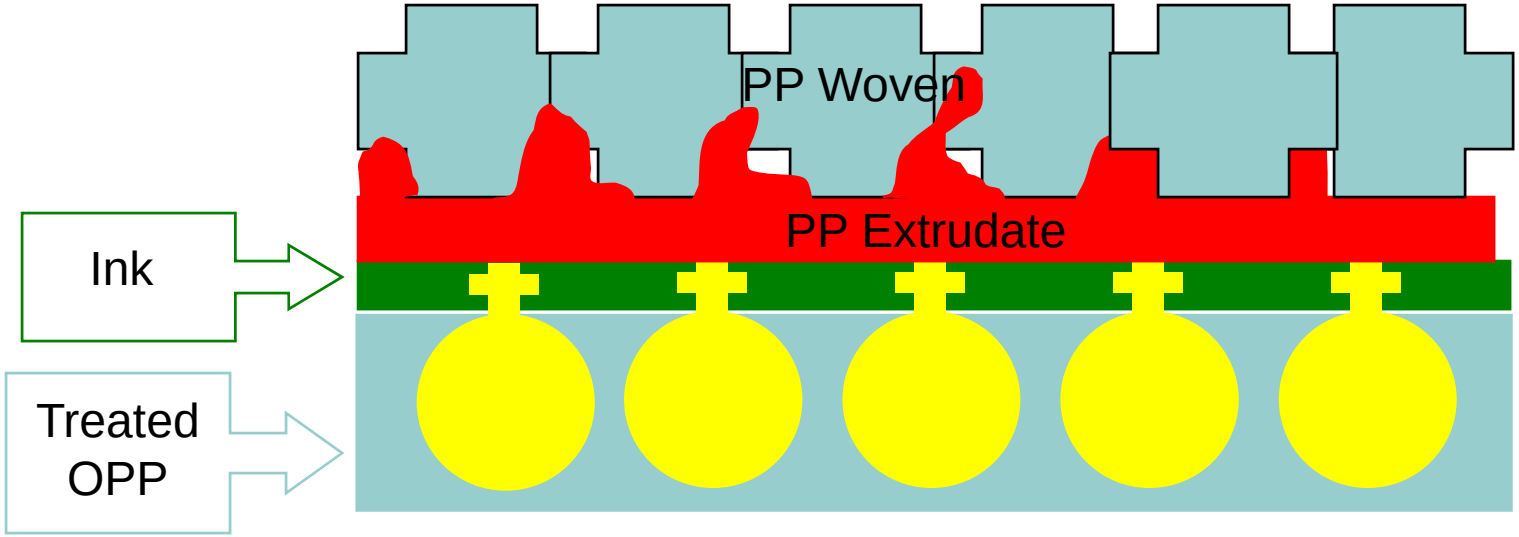
What happens next?

Ink does not stick to OPP film OR extrudate:
Failure will be at weakest interface



Ink Needs “Chemical” Adhesion

- Corona not only provides wet-out of ink – but chemical “anchors” for ink



Corona Treatment

Watt-Density = Power /(area x time)

US Units: W/(ft^2/minute)

[KW setting x 1000] / [Line Speed (ft/min) x width (ft)]

Example:

Treater output = 3.0kW; line speed = 450 fpm; Treater width = 5 ft

The watt-density is: (3.0 x1000)/(450 x 5) = 1.7 W/(ft^2/min)

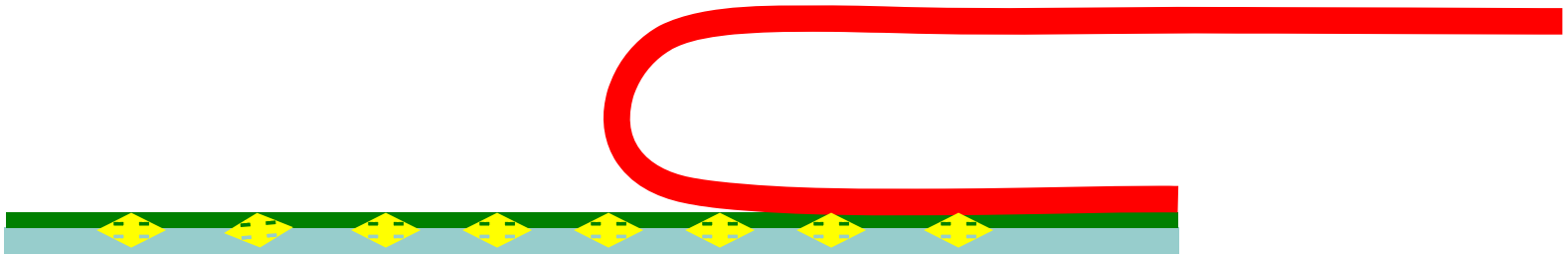
Important: You must determine optimum watt-density for each film and for each set of running conditions.

Some starting suggestions:

BOPP films: 3.0 – 4.0 WD
OPET films: 1.5 – 2.0 WD
BON films: 0.5 – 1.5 WD
(metric units are factor of 10 higher)

What Happens next?

Ink now sticks great to OPP:
Makes ink/extrudate interface appear even weaker



Two part Solution:

Part 1: Primers

What is a Primer?

- Surface modifier
  - ✓ increases energy
  - ✓ cleans, removes contaminants
  - ✓ adds reactive sites
- Facilitates “wet-out” of secondary coating
- Provides adhesion between substrate and coating/extrudate
- Enhances chemical resistance

Mica Water-Based Primers for Film When Using Polyolefin Extrudate

- Cross-linked (!) Polyethylene Imine (PEI)
- Mica A-131-X – 5% solids, standard of the industry, pH 10.5, easy to use and clean-up, components are FDA CFR 175.105
- Mica H-760-A – 12% solids, less shipping, more attention to dilution, easy clean-up and components are FDA CFR 175.105

How do you apply a Primer?

- Smooth Roll Applicator
- Gravure or Anilox Applicators
- Mayer Rod (Wire Wound) Applicator

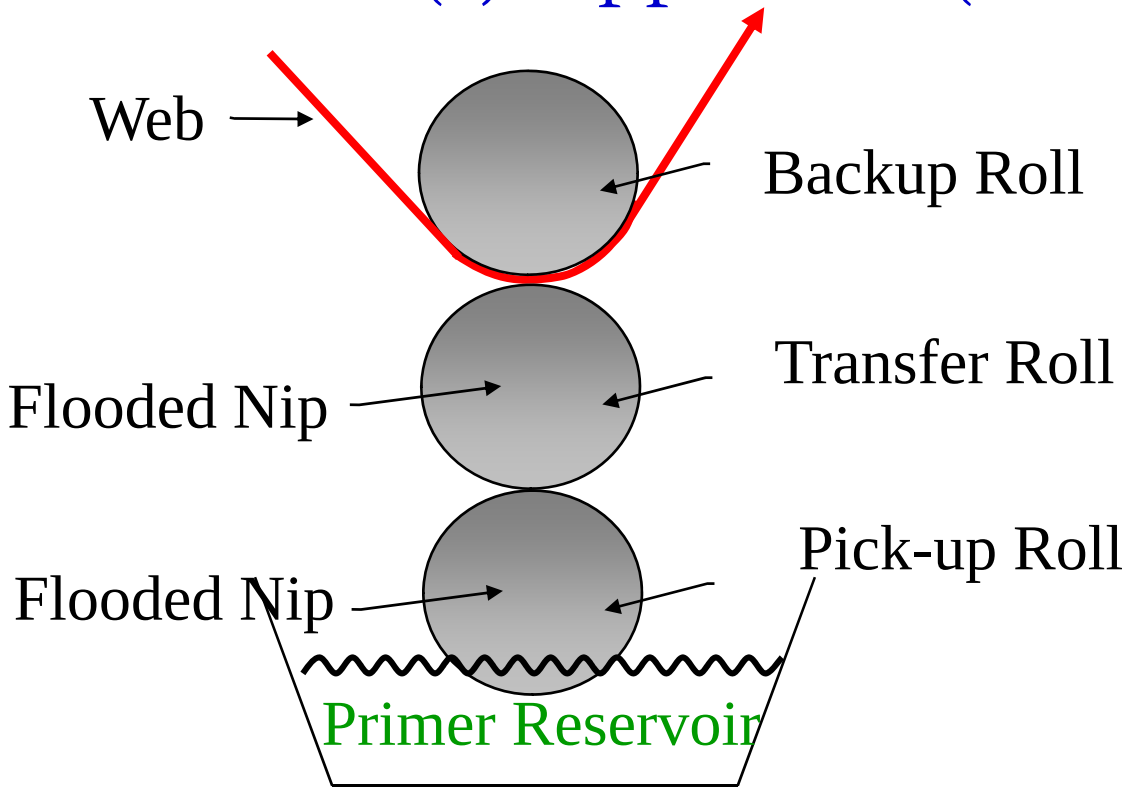
How do you apply a Primer?

Smooth Roll Applicator

- Hard rubber impression roll
  - 90 durometer
  - Does not have to be undercut
- Low compression
  - Approximately ¼ inch (6 mm)
- Vary application weight by;
  - Applicator roll speed
  - Primer dilution recipe

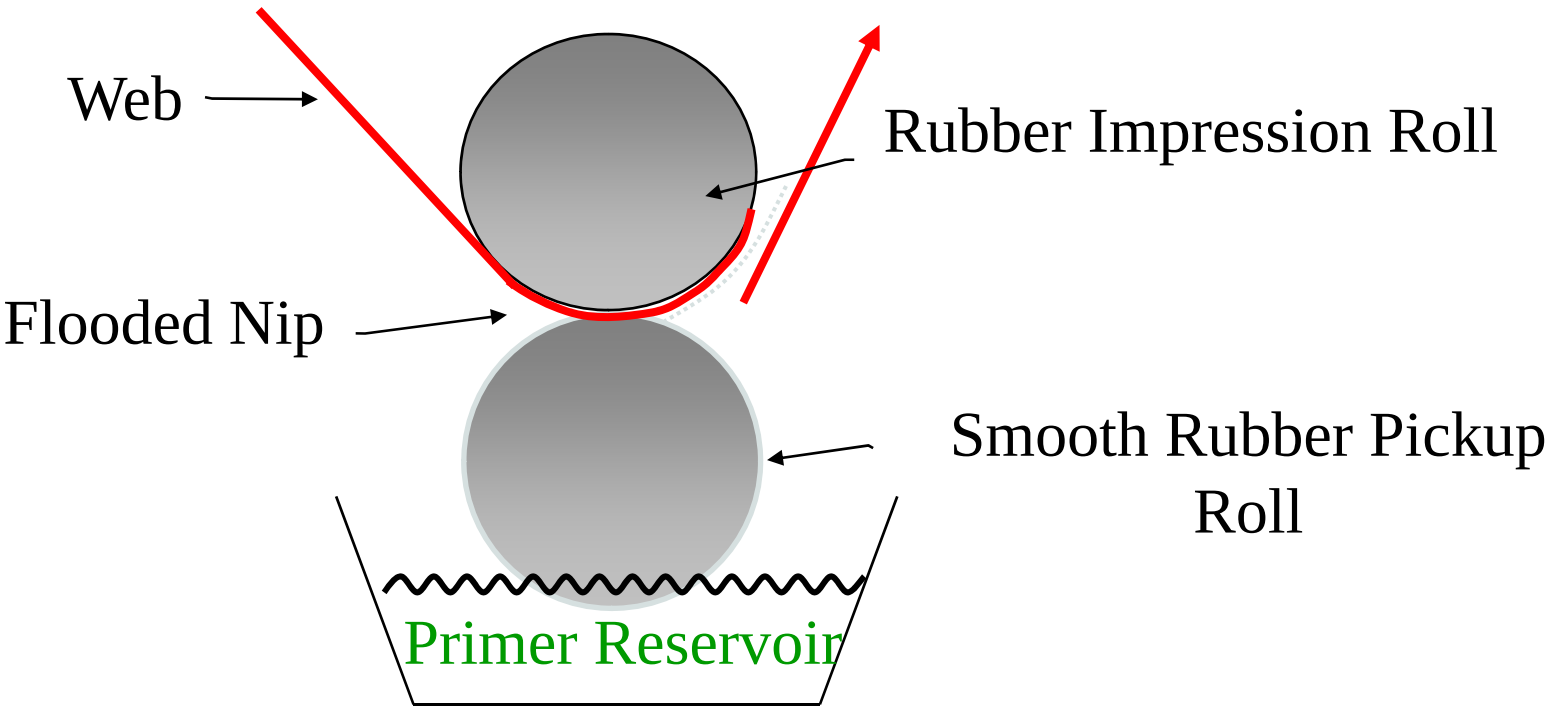
How do you apply a Primer?

Smooth Roll (3) Applicator (Indirect)



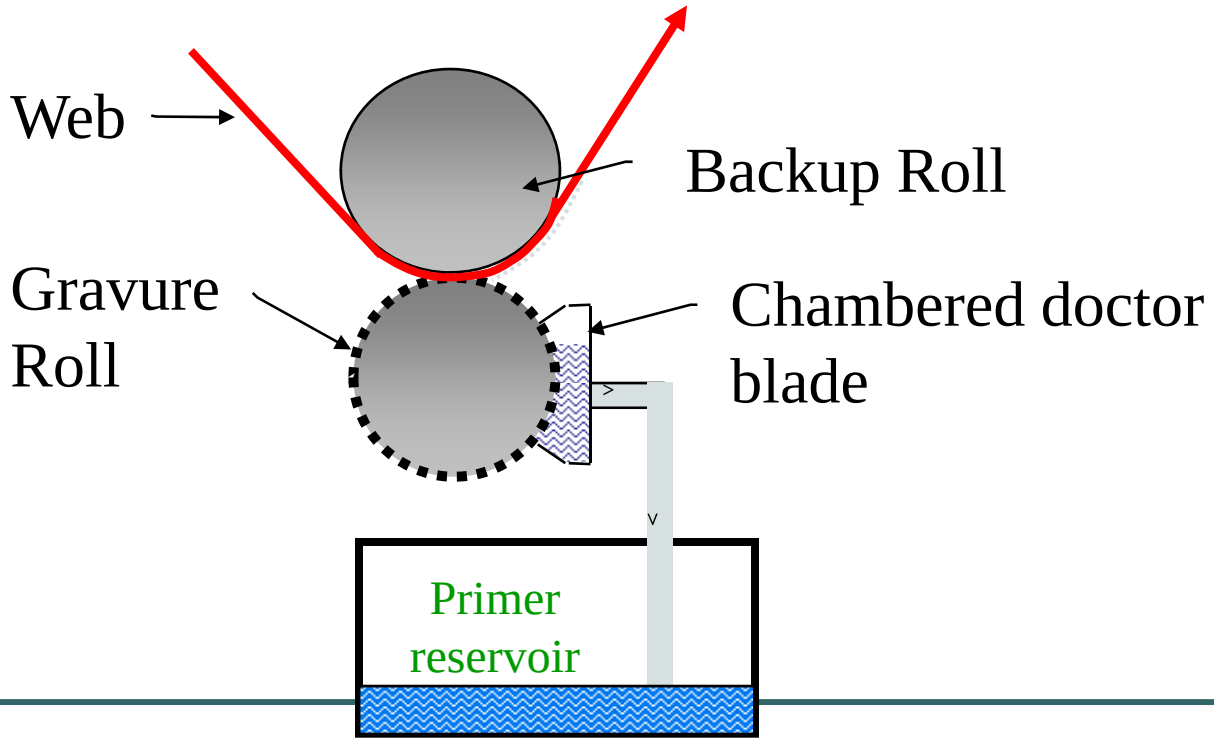
How do you apply a Primer?

Smooth Roll Applicator (Direct)



How do you apply a Primer?

Direct Gravure Applicator



How do you apply a Primer?

Gravure Applicator – Specifications

To deliver target wet/dry weight;

Specify a cell volume - not a line count.

Example: PEI type primer for film substrate

Dilute primer 1:1

Apply 0.02 dry lbs/ream

Many possible configurations:

Direct forward gravure, 180 pyramid, 3.2 bcm

Direct forward gravure, 360 pyramid, 3.7 bcm

How do you apply a Primer?

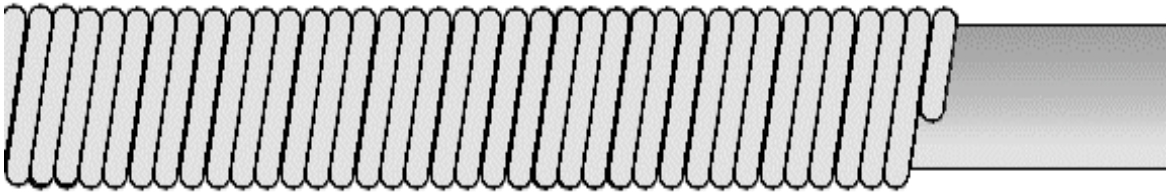
Gravure Applicator – Materials

- Ceramic
  - Long service life
  - Prone to clogging
  - Add 15 – 20% cell volume to compensate
- Chrome
  - Easier to clean
  - Shorter service life

How do you apply a Primer?

Mayer Rod Applicator

- Wire Wound Coating Rod



- Space between wire windings determine amount delivered (0.003" - 0.060" in 0.001" increments).

How do you apply a Primer?

Steps to follow;

1) Treat
   - Corona, Flame
2) Apply
   - Smooth roll, Gravure, Flexo
3) Dry
   - Hot, circulating air; infrared
   - Flame (paper only)

How do you apply a Primer?

❷ Ensure Proper Coatweight

Recommended Range is: 0.02 – 0.03 dry lbs/ream

- ✓ % Solids by refractometer or gravimetric oven test.
- ✓ Monitor coatweight by consumption of primer.
- ✓ Use Mica "Color-Chip" Stain Test
- ✓ Primer coating uniformity;
  - a) Water soluble optical brightener with a UV lamp.
  - b) Eosin stain testing and "Color-Chip"/Colorimeter.

How do you apply a Primer?

❸ Ensure Complete Drying

a) Drying MICA A-131-X is relatively easy.

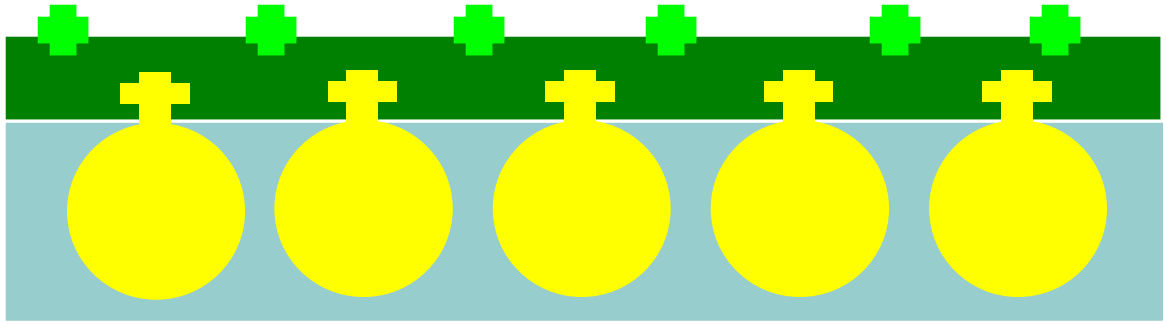
b) Oven airflow is equally important as the exit web temperature.

c) Recommended Exit Web Temperature: 140°F – 180°F

Primers and reactive sites

- Primer adds reactive sites to the ink?

= primer



- But what about the extrudate?

Part 2

The Resins

Polyethylene

- Oxidized in extrusion process
- Reactive sites form chemical bonds with primers
- Does not stick to polypropylene woven (will stick the HDPE though)
- Does not have strength, heat and grease resistance of polypropylene

Polypropylene

- “Inert” chemical nature – does not oxidize during extrusion
- No reactive sites for chemical reaction (inks OR primers)
- Does “mix” with PP poly-woven (mechanical)
- Tough, strong, excellent moisture and grease resistance

Maleic Anhdride Adhesive Resins

- Known to give adhesion as tie-layer (costly and requires co-extrusion)
- Mica has discovered that “MAH” concentrates can be blended in polypropylene
- Mica water-based primers have perfect chemistry for reaction with MAH – serves as the reactive site for the extrudate

Maleic Anhydride Concentrate Considerations

- Backbone (concentrate base resin) needs to be compatible with resin to be extruded
- Needs 1-2% maleic anhydride (or equivalent) in order to be diluted to 0.2% total anhydride content in final blend
- Blending 10 – 20% of material must not interfere with extrusion properties (melt strength, neck-in etc.)

Materials

Resin 1: DuPont Bynel 50E803

Resin 2: Chemtura Polybond 3000

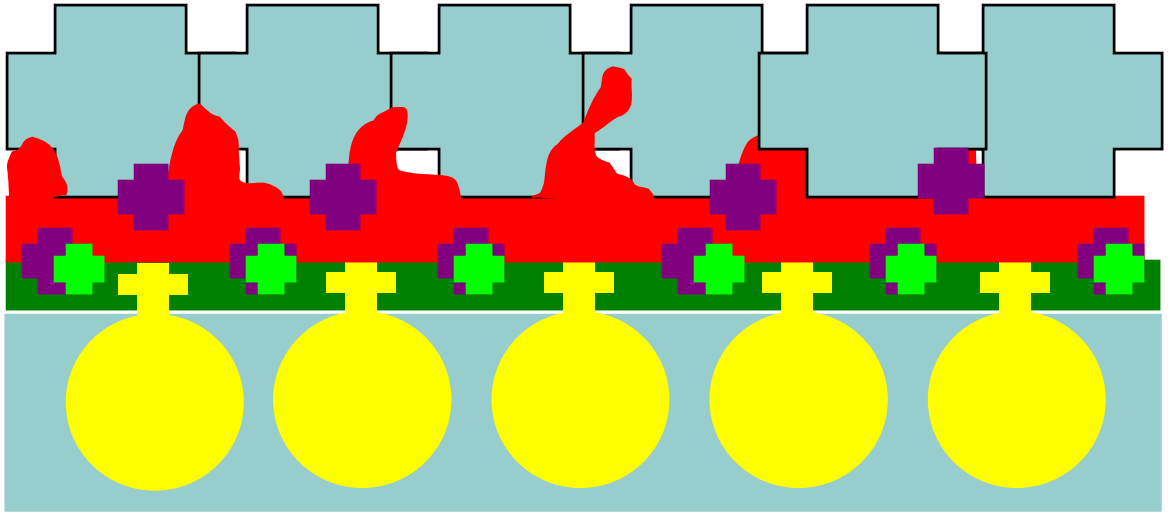
Resin 3: Arkema Orevac CA 100

- Concentrates were blended into polypropylene so that the final MAH concentration was 0.20%

Finished Structure

= primer

= MAH resin



Chemical reactions at <u>every</u> interface = destructive bonding

Steps to Making Poly-woven Lamination

1. OPP with 54 or higher dyne level
2. Print
3. Prime with 0.02 dpr cross-linked PEI
4. Dry thoroughly
5. Extrude with PP + 15-20% MAH concentrate
6. Laminate PP woven

Some Additional Considerations

- PP base resin (extrusion grade!)
  - Homo-polymer
  - Co-polymer
  - Added polyloefin for run-ability
  - Final mix should be at least 70% PP
- Slip additives in OPP film
- Cohesive strength of the ink
  - Ink chemistry
  - Coverage
  - Drying
  - In-line/out of line priming

Experimental

Primer	Resin	Bonding
Yes	PP only	zero
No	PP + resin one	zero
Yes	PP + resin one	60% ink removal
No	PP + resin two	zero
Yes	PP + resin two	80% ink removal
No	PP + resin three	zero
Yes	PP + resin three	60% ink removal

Discussion of Results

- Strength of structure will be strength of the weakest interface
- In this case – ink cohesion was weakest
- Primer can be used under the inks when this is the issue (still needs corona treatment)

OPP/”T”/primer/ink/primer/PP+MAH/woven

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THANK YOU!