Introduction to Synthetic Label Materials

Basic Application Engineering Series

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Principal Consultant

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Performance Criteria for Label Face-stock

- **Printing**
  - Good Printability

- **Converting & Dispensing**
  - Good Die-cut & Stripping ability
  - Good high speed Dispensability

- **End-use Application**
  - Good Conformance
  - Withstand Service Conditions
Typical Synthetic Label Construction

- Surface Treatment
- Synthetic Face-stock
- PS Adhesive
- Release Coating
- Release Liner
3 Areas of Considerations in Assessing Synthetic Face-stock Performance

- **Mechanical Properties**
  - Determined by Polymer Orientation Structure
  - Which in turn determined by its Manufacturing Process

- **Chemical & Physical Properties**
  - Determined by its Polymer Structure

- **Surface Treatment for Printing**
  - Determined by the Surface Treatment method
Orientation of Plastic Film

• Why orientate plastic film?
  ➔ Reduce Elongation
  ➔ Higher Machine Direction Stiffness

Types of Orientation

- Non-Oriented
- Mono-axial Orientation
- Bi-axial Orientation
Cast Film Process

This produce Non-Oriented Film

E.G. PVC Films for outdoor
Calendered Film Process

Formation of film and sheeting by calendering. Ingredients are resins, stabilizers, plasticizers, fillers, and pigments.

This produce Mono-axially Oriented Film
E.G. PVC Film for Indoor & PE Film
Blown Film Process

This produce slight Mono-axially Oriented Film
E.G. PE Film
Biaxially Orientated Film

This produce Bi-axially Oriented Film
E.G. PP & PET Film
Conformabilities/Flexibilities

- Cast Coated Paper
- Acetate
- PS
- PET
- BOPP
- Flexible PVC
- Cast PP & PE

Flexibility Index

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Surface Energy of Materials

High Surface Energy Substrate
- Copper (Cu)
- Aluminum (Al)
- Stainless Steel (SS)
- Glass

Medium Surface Energy Substrate
- Polyester (PET)
- Polyvinylchloride (PVC)
- Polycarbonate (PC)
- Acrylic

Low Surface Energy Substrate
- Polypropylene (PP)
- Polyethylene (PE)
- Polystyrene (PS)
- Teflon
Surface Energy & Principle of Wetting on Substrate

Poor wetting

Surface Energy of Liquid > Surface Energy of Substrate

Good wetting

Surface Energy of Liquid ≤ Surface Energy of Substrate
Measure of Surface Energy

• Surface Tension is force per length;
  – in SI-units is **N / m**
  – **1 mN / m = 1 dyne / cm**

General good wetting rule:
The Dyne level of the substrate has to be at least **10 dynes** higher than the liquid being applied.
Natural Surface Energy of Solids

- Teflon: 18 dynes/cm
- Silicone: 21 dynes/cm
- Parafin Wax: 23 dynes/cm
- Polypropylene (PP): 29 dynes/cm
- Polyethylene (PE): 31 dynes/cm
- Flexible PVC: 35 dynes/cm
- Polystyrene (PS): 36 dynes/cm
- Rigic PVC: 38 dynes/cm
- Acrylic glass: 42 dynes/cm
- Polyester (PET): 42 dynes/cm
- Epoxy: 42 dynes/cm
- Polycarbonate (PC): 43 dynes/cm
- Nylon: 46 dynes/cm
- Glass, Ceramics, Metals: 100 dynes/cm
Natural Surface Energy of Liquid

- n-Hexane: 18 Dynes/cm
- Ethyl Alcohol: 22.3 Dynes/cm
- Acetone: 23.7 Dynes/cm
- Xylenes: 29 Dynes/cm
- Toluene: 28.4 Dynes/cm
- Benzene: 29 Dynes/cm
- Solvent Ink: 29 Dynes/cm
- UV Ink: 29 Dynes/cm
- Water-Based Ink: 35 Dynes/cm
- Water: 72 Dynes/cm
# Synthetic Face-stock Treatments

<table>
<thead>
<tr>
<th>Base Polymer</th>
<th>Corona Treatment</th>
<th>Top Coating</th>
<th>Other Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>PET</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>PS</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>PE</td>
<td>Yes</td>
<td>Yes</td>
<td>FS Print Skin</td>
</tr>
<tr>
<td>PP</td>
<td>Yes</td>
<td>Yes</td>
<td>FS Print Skin</td>
</tr>
</tbody>
</table>

**Corona Treatment** – Altering the surface characteristic by exposing the surface to a high voltage corona discharge resulting in an increase in surface energy.

**Filler Surface** - Consists of natural minerals (fillers) bonded with the plastic compound to provide a paper-like surface properties.
## Top Coating Requirements

- Printability
- Ink Wet out
- Film Formation (No Voids)
- Ink Anchorage
- Smudge Resistance
- Chemical Resistance
- Thermal Stability
- Absorbency (Ink jet printing)
Topcoat Chemistry

• **Polymer Types**
  – Acrylic Copolymers
  – PET Copolymers

• **Process Types**
  – Solvent
  – Emulsion
  – UV / EB Cured
UV Aging Durability of Synthetic Materials

The diagram compares the durability of various synthetic materials under outdoor exposure. The horizontal axis represents the number of outdoor years, ranging from 0 to 6. The materials are listed on the vertical axis: PET, PVC, PP, PE, PS, Acetate, Latex Paper, Metal Foil, and Varnish Paper. The length of each bar corresponds to the durability of the material, with PET showing the longest durability, followed by PVC, PP, PE, PS, Acetate, Latex Paper, Metal Foil, and Varnish Paper in that order. The diagram indicates that PET is the most durable material among those listed.
Serviceable & Heat Distortion Temperature of Common Face-stock

- Paper
- PC
- PET
- PP
- PE
- PVC
- PS

Temperature in degree C

- Service Temperature
- Softening Temperature

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# Synthetic Facestock Physical Properties

<table>
<thead>
<tr>
<th>Base Polymer</th>
<th>BOPP</th>
<th>PET</th>
<th>Flex PVC</th>
<th>PS</th>
<th>LDPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haze (%)</td>
<td>3.3</td>
<td>2.0</td>
<td>2.0</td>
<td>3.0</td>
<td>15.0</td>
</tr>
<tr>
<td>Tear Resistant</td>
<td>Good</td>
<td>Excellent</td>
<td>Good</td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td>Shrink Resistance</td>
<td>Good</td>
<td>Good</td>
<td>Poor</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Heat Resistant</td>
<td>90°C</td>
<td>150°C</td>
<td>70°C</td>
<td>60°C</td>
<td>80°C</td>
</tr>
<tr>
<td>Solvent Resistant</td>
<td>Good</td>
<td>Excellent</td>
<td>Fair</td>
<td>Poor</td>
<td>Good</td>
</tr>
</tbody>
</table>
# Film Label Materials Application Domains

<table>
<thead>
<tr>
<th>Destructible / Tamper evidence</th>
<th>Indoor Primary Label</th>
<th>Outdoor Signage &amp; Graphic</th>
<th>Name Plate</th>
<th>High Temperature (&gt; 150°C)</th>
<th>Special Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetate</td>
<td>PP</td>
<td>PVC</td>
<td>PET</td>
<td>Polyimide (Kapton)</td>
<td>Digital / Laser print PET CPP</td>
</tr>
<tr>
<td></td>
<td>Filled PP</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PS</td>
<td>PE</td>
<td>CPP</td>
<td>PC (Lexan)</td>
<td>Fluoropolymer (Teflon)</td>
<td>Tear resist Tyvek / Valeron</td>
</tr>
<tr>
<td></td>
<td>Polyolefin</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Filled PO</td>
<td></td>
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</tbody>
</table>