Intermittent Coating

A comparison of Three Methods
What is Intermittent Coating?

- The coating of discrete patches on a substrate
- Wide range of industrial uses
  - Flat panel displays
  - Packaging/labeling
  - Masking for IC products
  - Battery electrodes
What are the Common Coating Processes?

- Comma bar or reverse roll
- Slot die
  - Backing roll
  - Tensioned web
- Gravure
- Others?
  - Combinations of slot with roll/gravure
  - Flexo
What is the Fundamental Coating Process?

- Metering of the coating through the fluid delivery mechanism
- Coating deposition onto or transfer to the substrate
- Interruption of transfer to form pattern
Comparison of Coating Processes

• Comma Bar
  – Metering of coating onto transfer roll
  – Reduction in coating thickness at transition pt.
  – Transfer of coating to substrate
  – Movement of nip roll at the point of MFZ

• Slot Die
  – Metering of coating onto substrate
  – Stopping or diversion of coating near the MFZ point
  – Movement of the die or substrate at the MFZ
What about multiple passes?

• Registration process for comma bar and slot die is the same

• Registration of coating passes to each other
  – Feed-forward process control
  – Feed-back process control?
  – Registration sensor types
System Design Considerations

- Product requirements
- Production output or cost considerations
- Intellectual property
Other considerations?

• What are the product requirements?
  – Coat weight or thickness tolerance
  – Dimensional tolerances
  – Registration tolerances
  – Speed of application

• Higher levels of precision and coating speed result in increased cost
Coating Design Parameters

t = coating thickness; microns

L = "mass-free" zone; mm

α = Maximum deviation for "on-coat" and off-coat" taper = 1mm

<table>
<thead>
<tr>
<th>Speed (mpm)</th>
<th>α (mm)</th>
<th>Time for &quot;α&quot; (msec)</th>
<th>Free Zone L (mm)</th>
<th>Total Cycle Time (msec)</th>
<th>Free Zone L (mm)</th>
<th>Total Cycle Time (msec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>1</td>
<td>6</td>
<td>10</td>
<td>60</td>
<td>30</td>
<td>180</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>4</td>
<td>10</td>
<td>40</td>
<td>30</td>
<td>120</td>
</tr>
<tr>
<td>20</td>
<td>1</td>
<td>3</td>
<td>10</td>
<td>30</td>
<td>30</td>
<td>90</td>
</tr>
<tr>
<td>25</td>
<td>1</td>
<td>2</td>
<td>10</td>
<td>24</td>
<td>30</td>
<td>72</td>
</tr>
<tr>
<td>30</td>
<td>1</td>
<td>2</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>35</td>
<td>1</td>
<td>2</td>
<td>10</td>
<td>17</td>
<td>30</td>
<td>51</td>
</tr>
<tr>
<td>40</td>
<td>1</td>
<td>2</td>
<td>10</td>
<td>15</td>
<td>30</td>
<td>45</td>
</tr>
<tr>
<td>45</td>
<td>1</td>
<td>1</td>
<td>10</td>
<td>13</td>
<td>30</td>
<td>40</td>
</tr>
</tbody>
</table>
Dimensional Control System

• Time-based
  – Intuitive
  – Flexible
  – Requires adjustment for line speed changes

• Position-based
  – Flexible
  – Operate over a wide range of line speeds
  – Not as intuitive as time-based systems
Significant Factors in Patch Control

• Slurry Properties
  – ZERO air entrainment
  – Consistent rheology

• Process
  – Precise, repeatable control system to manage $\Delta P$
  – Flexible controls that allow for fine-tuning of the coated profile

• QA
  – Capable measurement system to characterize the product
Sample C.B. Motion Profile

Coat

Off-coat

Comma Bar

Off-coat

Coat

Bump Roll

Length Zero (Start of Patch) End of Patch Start of Patch
Sample S.D. Motion Profile

Off-coat

On-coat

Die Movement

Open

Closed

Bypass Valve

Open

Closed

Supply Valve

Length Zero (Start of Patch) | End | Start of Patch
Coated Patch Profile

- Precise control of coating start and stop

- This is usually the desired outcome for a coated patch profile

- A well designed coating process and control system enables full control and flexibility of the product
Typical Intermittent Coating Problems

- This is a typical profile created as a result of an inadequate process and control system.
Typical Intermittent Coating Problems

- Profile caused by air entrapment in the fluid delivery system or air entrainment in the coating fluid
Comma Bar Process Diagram

Coating Supply -> Comma Pond -> Comma Bar -> Bump Roll

Web Direction -> Registration Sensor
Slot Die tensioned Web Process Diagram
Fluid Delivery System
Process Diagram

Delivery Tank

Pump

Filter

Bypass Valve

Supply Valve

Optional, fluid displacement mechanism

Fluid Delivery to Die
## Process Capabilities

<table>
<thead>
<tr>
<th></th>
<th>Comma Bar</th>
<th>B.R. Slot Die</th>
<th>T.W. Slot Die</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions</td>
<td>&lt;2</td>
<td>&gt;&gt;2</td>
<td>&gt;&gt;2</td>
</tr>
<tr>
<td>Registration</td>
<td>~2</td>
<td>&gt;&gt;2</td>
<td>&gt;&gt;2</td>
</tr>
<tr>
<td>Coat Weight</td>
<td>&lt;2</td>
<td>&gt;2</td>
<td>~2</td>
</tr>
</tbody>
</table>

- Process capability (Cpk) tolerances:
  - +/- 1 mm for dimensions
  - +/- 3% for coat weight
- Capability tends to decrease with increasing line speed
## Conclusions

<table>
<thead>
<tr>
<th></th>
<th>Comma Bar</th>
<th>B.R. Slot Die</th>
<th>T.W. Slot Die</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ease of use</strong></td>
<td>Easiest</td>
<td>Most robust</td>
<td>Most difficult</td>
</tr>
<tr>
<td><strong>System design</strong></td>
<td>Easiest</td>
<td>Complicated</td>
<td>Complicated</td>
</tr>
<tr>
<td><strong>Process precision</strong></td>
<td>Least precise</td>
<td>Most precise</td>
<td>Intermediate Precision</td>
</tr>
<tr>
<td><strong>Application speed</strong></td>
<td>Slowest</td>
<td>Intermediate speed</td>
<td>Highest speed</td>
</tr>
</tbody>
</table>
Translating Ideas into Solutions

Innovative Solutions for Advanced Materials Processing

Clean Technologies for Environment, Climate & Energy

Production Efficiency for Printing & Packaging Systems

Questions?