P-INK DISPLAYS

FLEXIBLE, LOW POWER, REFLECTIVE COLOR

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The Ever-Changing Display

• The display market is constantly changing and evolving

• Displays have grown well beyond traditional TV market
• Displays “everywhere” now a real possibility
  • Driven by innovation in materials and processes
• Widely varying performance requirements
  • Ever-increasing demand for new display technologies
P-Ink Display Material

- Brightly reflective (60%+ Reflectivity) coating
- Adjusted to any rainbow color with low voltage (<1.5V), with bistable color states
- Rigid/flexible substrates & form factors
- Graphics, icons, pixel segments & arrays, ...
Photonic Color – Naturally Inspiring

Pigments & Dyes

Structure

Change the Structure  →  Change the Color
The Opalux Color Engine

Change the Structure  →  Change the Color

Air Voids
Structural Color

Polymer Matrix
Response to Stimuli
Photonic Color Technology

- Compression
- Temperature
- Voltage
- Chemicals
- Others

Change the Structure  ➔  Change the Color
Photonic Color – Market Applications

Opalux’s Photonic Color

- Compressively Active Security Film
- Photonic Color Chemical Sensors
- Digitally Printed Photonic Color
Photonic Color by Opalux:

P-Ink Technology
How P-Ink Works

- 1.5 Volts or less
- microAmps
- Electrically bistable
P-Ink – One Material, All Colors

Preliminary Durability
- 300,000+ switching cycles
- Storage from -20 to +65 C
P-Ink – Unparalleled Flexibility

- 2\textsuperscript{nd} Generation P-Ink materials:
  - Formulated for coating on flexible substrates such as ITO-PET
- Applicable to various rigid substrates
- Form factors:
  - Can be scribed, laser-cut, die punched
  - Through-holes possible

P-Ink coated ITO-PET

Electrode Lamination
Printing P-Ink Graphics

P-Ink films readily patterned using printing

P-Ink Coating → Print Resist → opalux → Develop

(opalux images and patterns)
Printing P-Ink Graphics

Single pixel, Maple leaf “latent” image
Printing P-Ink Graphics

- RFID-enabled P-Ink devices:
  - Low power device draws power from RFID antenna
  - Vivid color change when exposed to RF source
Segmented & Pixelated P-Ink

Electrode segments
- Segments on Glass
- Segments on Plastic

P-Ink coated electrodes

P-Ink Coating
Segmented & Pixelated P-Ink

- **Segmented P-Ink**: Ready for integration into display devices
- **Pixelated P-Ink**: Potential for active/passive matrix displays, Ready for device testing
Active P-Ink Graphics

- Individually addressable 8-segment flexible P-ink device
- Polka-dot pattern, Blue-to-Red color range
# P-Ink Display Metrics

<table>
<thead>
<tr>
<th>Display Attributes</th>
<th>Opalux P-Ink</th>
<th>Established / Emerging Technologies</th>
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</thead>
<tbody>
<tr>
<td>Color strength</td>
<td>60%+ reflectivity</td>
<td></td>
</tr>
<tr>
<td>Large areas / scalable</td>
<td>Roll-to-roll production</td>
<td></td>
</tr>
<tr>
<td>Cost competitiveness</td>
<td>++</td>
<td></td>
</tr>
<tr>
<td>Customization – Performance, Appearance</td>
<td>Segments; Pixels; Graphics; Color ranges</td>
<td></td>
</tr>
<tr>
<td>Substrate type</td>
<td>Rigid &amp; flexible</td>
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<tr>
<td>Switching speed</td>
<td>0.2 seconds for full spectrum</td>
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<tr>
<td>Durability</td>
<td>Good - preliminary</td>
<td></td>
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<tr>
<td>Environmentally friendly</td>
<td>Non-toxic materials</td>
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</tbody>
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Market Outlook

Color-changing surfaces

Heat Management

Color E-Paper

Voltage Indicators

Interactive Packaging

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Booth #767

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