



The Leader in Photonic Color

P-INK DISPLAYS

FLEXIBLE, LOW POWER, REFLECTIVE COLOR

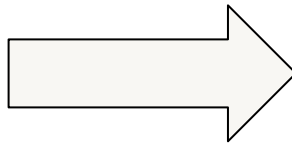
Dr. Andre Arsenault, CTO

SID Display Week 2012

Boston, MA

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

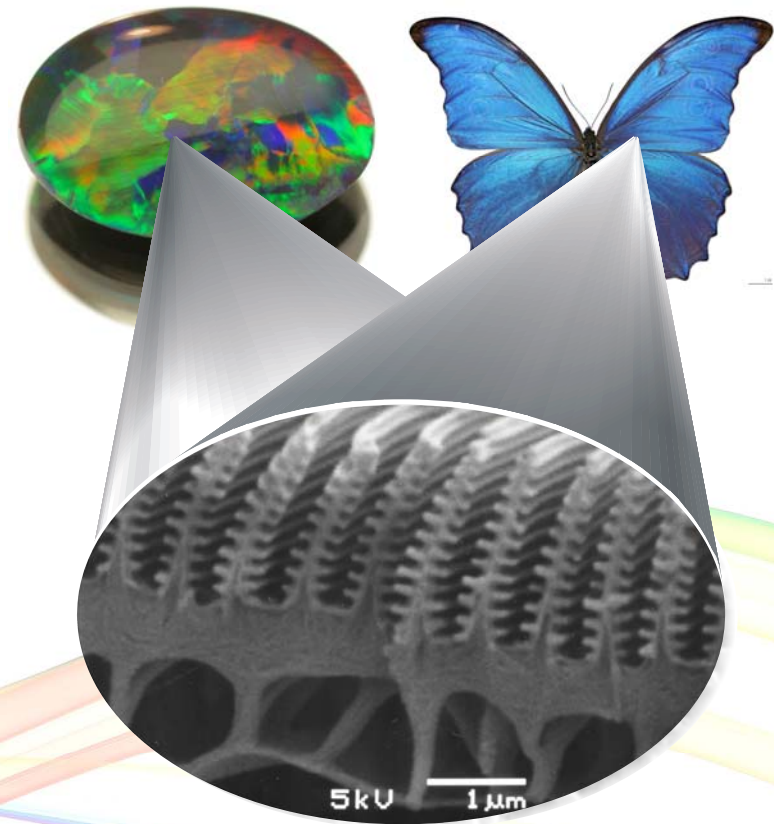
- Brightly reflective (60%+ Reflectivity) coating
- Adjusted to any rainbow color with low voltage (<1.5V), with bistable color states
- Rigid/flexible substrates & form factors
- Graphics, icons, pixel segments & arrays, ...

Photonic Color – Naturally Inspiring

Pigments & Dyes

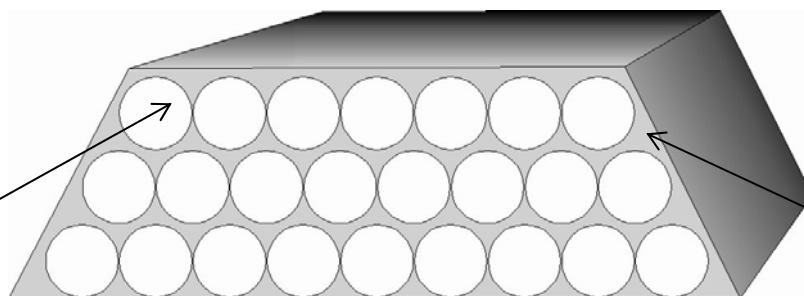


Structure



Change the Structure → Change the Color

The Opalux Color Engine

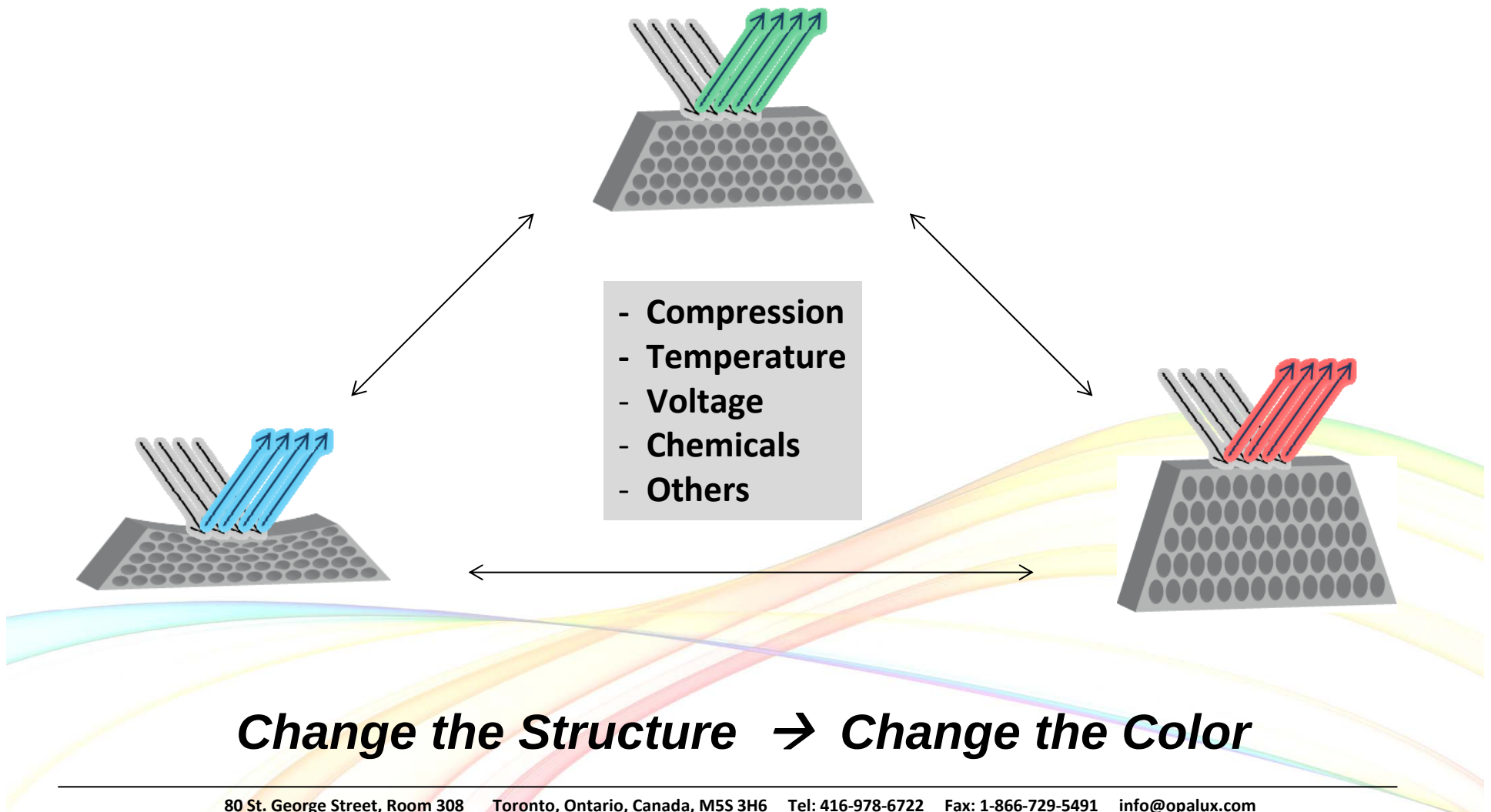


Air Voids
Structural Color

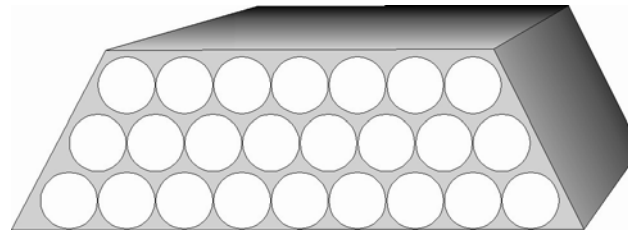
Polymer Matrix
Response to Stimuli

Change the Structure → Change the Color

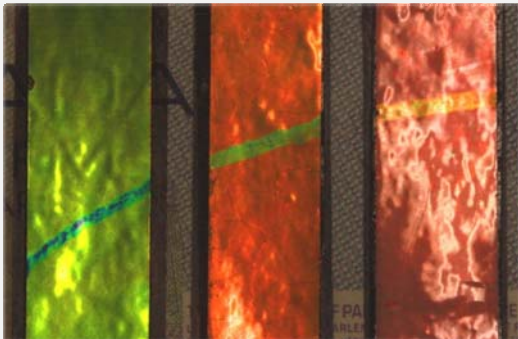
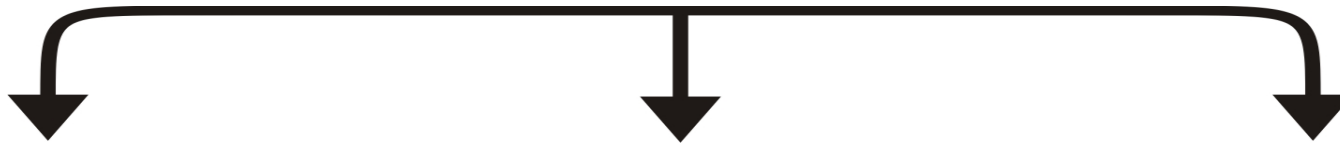
Photonic Color Technology



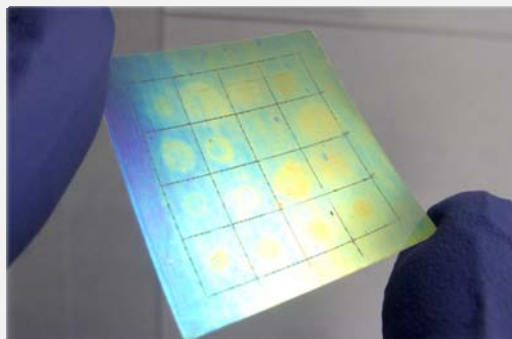
Photonic Color – Market Applications



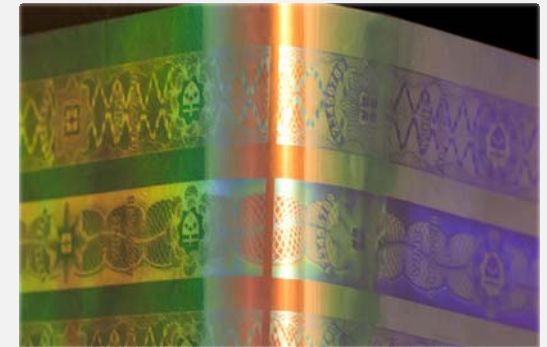
Opalux's Photonic Color



Compressively Active Security
Film



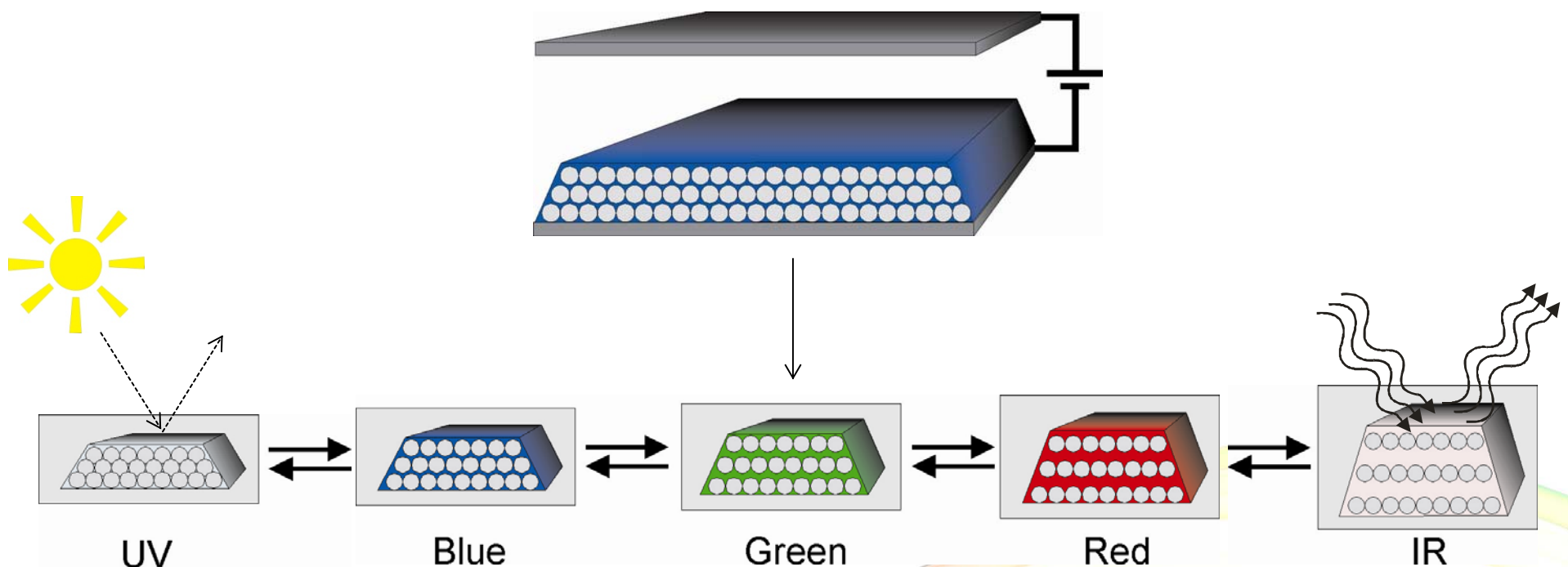
Photonic Color
Chemical Sensors



Digitally Printed
Photonic Color

Photonic Color by Opalux: P-Ink Technology

How P-Ink Works



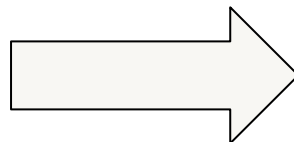
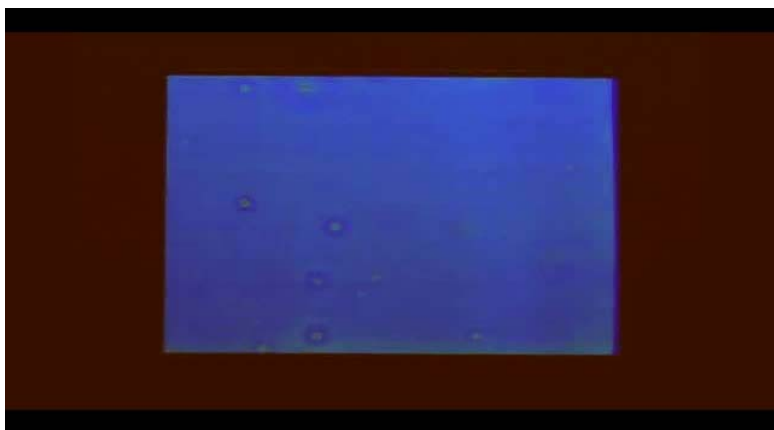
Electrical Activation

- 1.5 Volts or less

- microAmps

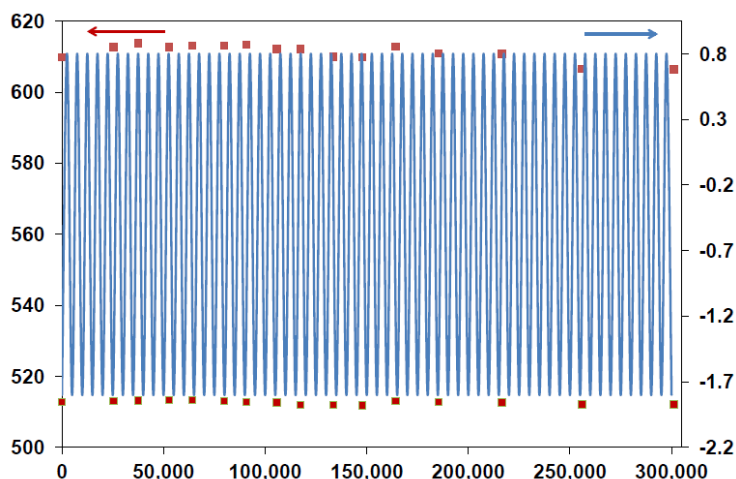
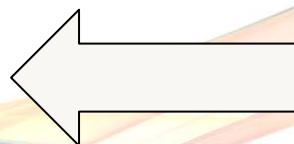
- Electrically bistable

P-Ink – One Material, All Colors



Wavelength λ / nm

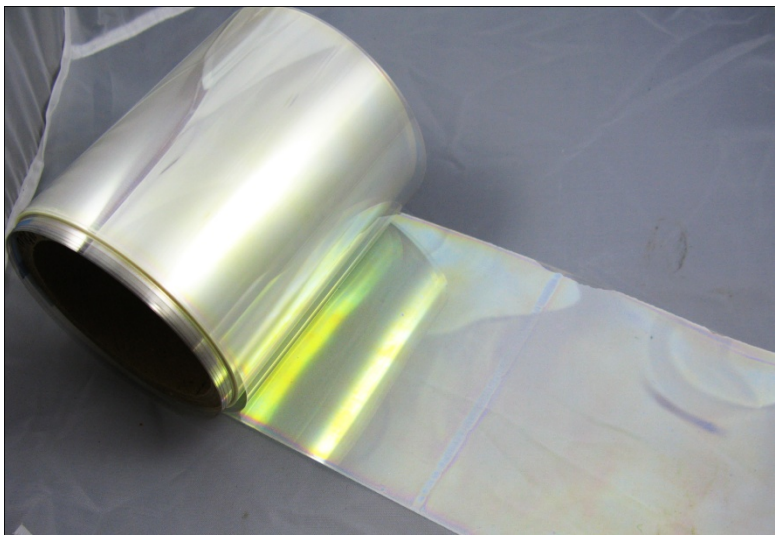
0V Applied Voltage 1.5V



Preliminary Durability

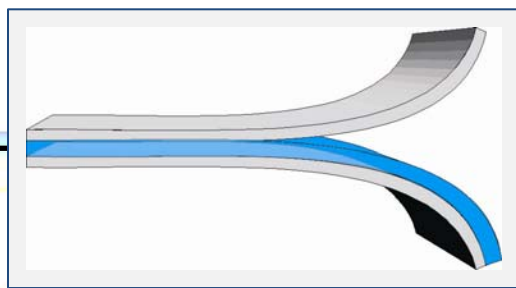
- 300,000+ switching cycles
- Storage from -20 to +65 C

P-Ink – Unparalleled Flexibility



P-Ink coated ITO-PET

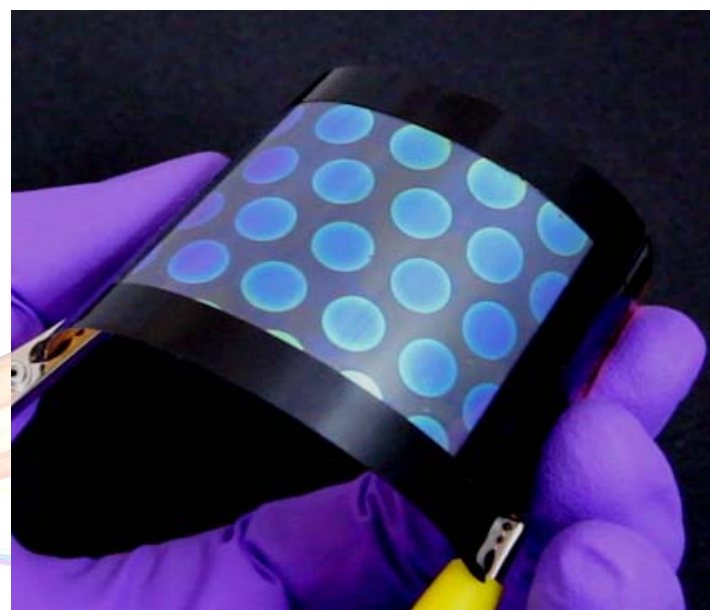
- 2nd Generation P-Ink materials:
 - Formulated for coating on flexible substrates such as ITO-PET
- Applicable to various rigid substrates
- Form factors:
 - Can be scribed, laser-cut, die punched
 - Through-holes possible



Electrode Lamination

Printing P-Ink Graphics

P-Ink films readily patterned using printing



Printing P-Ink Graphics

Single pixel, Maple leaf “latent” image

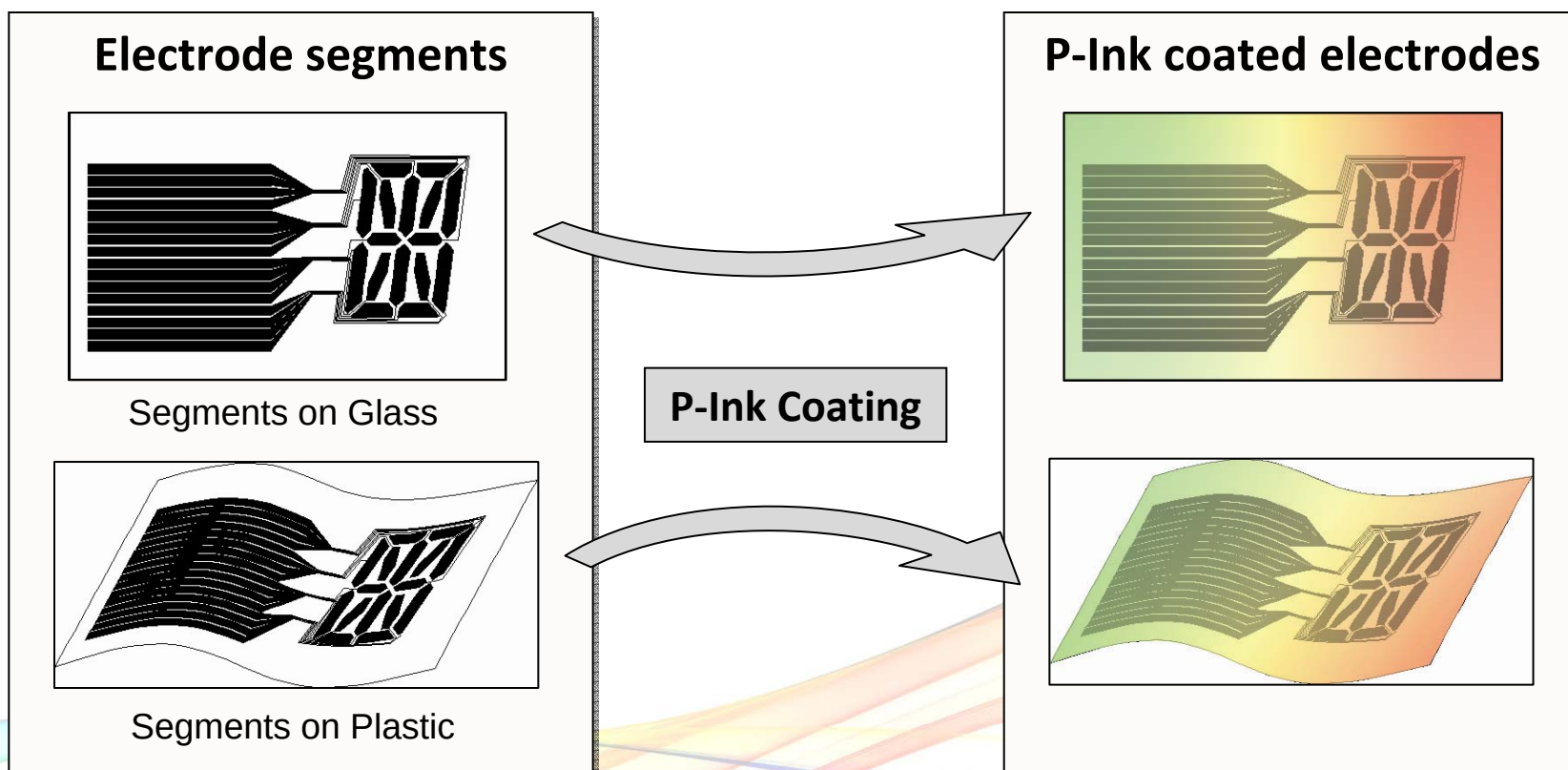


Printing P-Ink Graphics

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

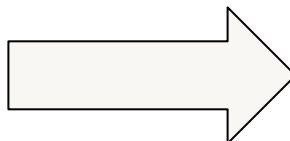
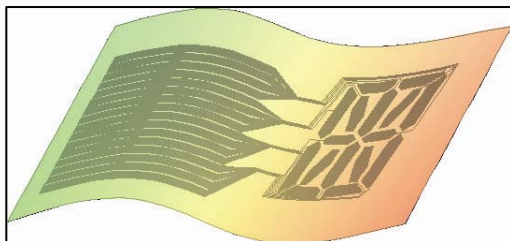
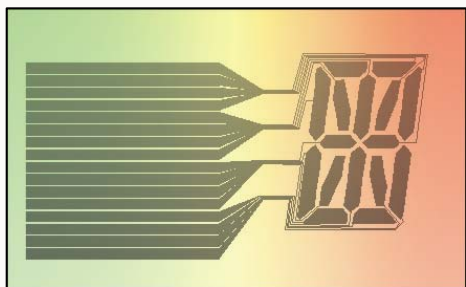


Segmented & Pixelated P-Ink



Segmented & Pixelated P-Ink

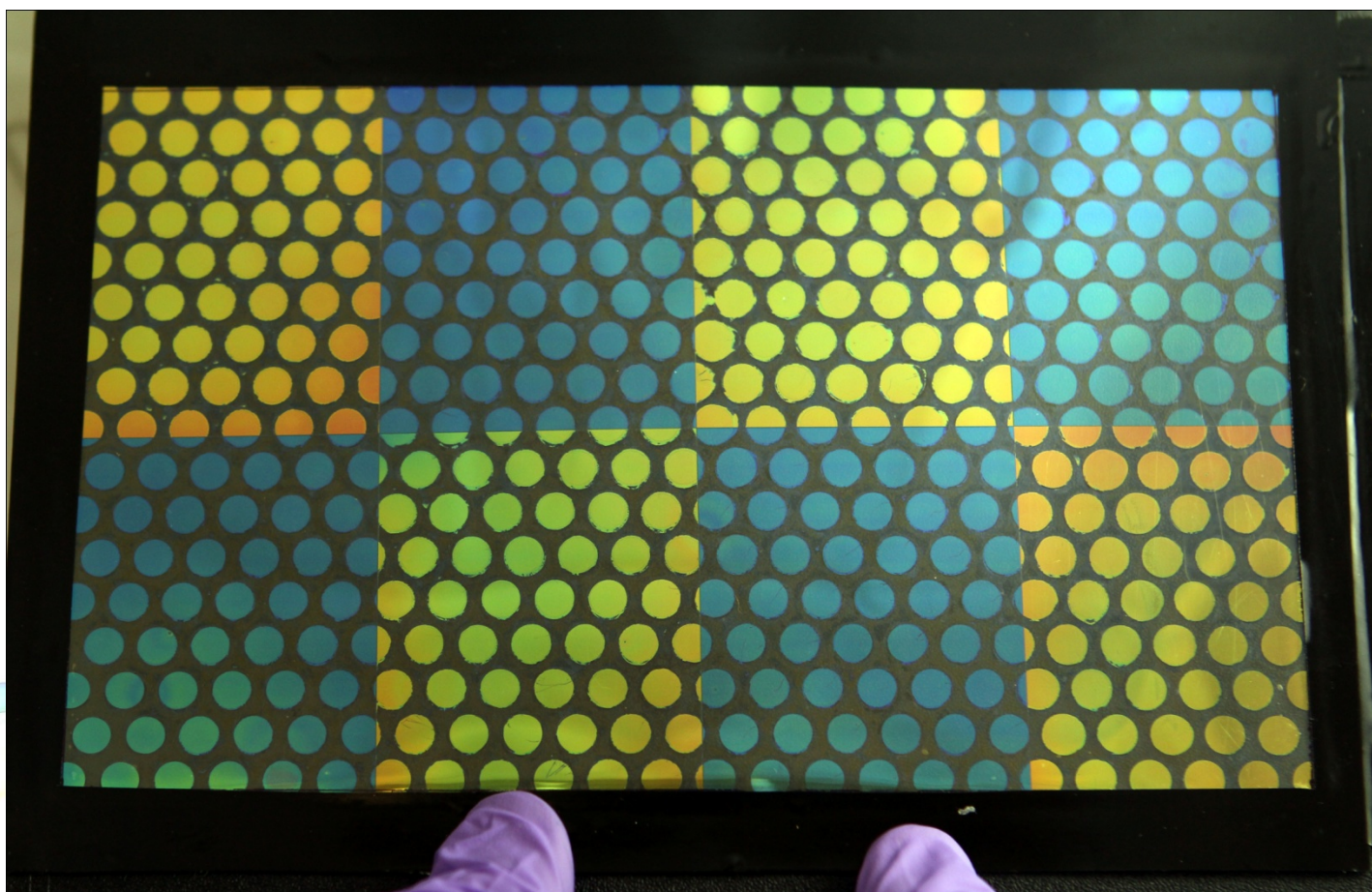
P-Ink coated electrodes



- **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



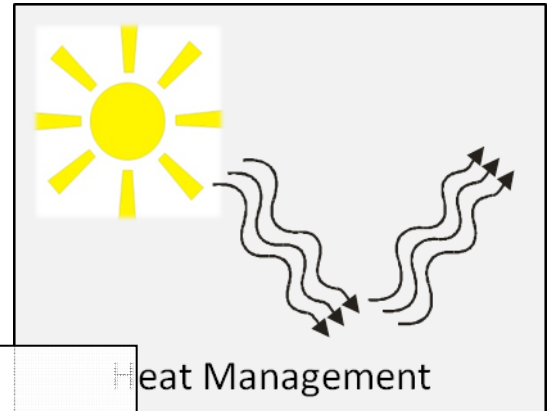
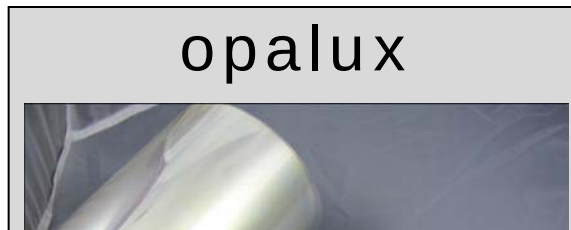
P-Ink Display Metrics

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

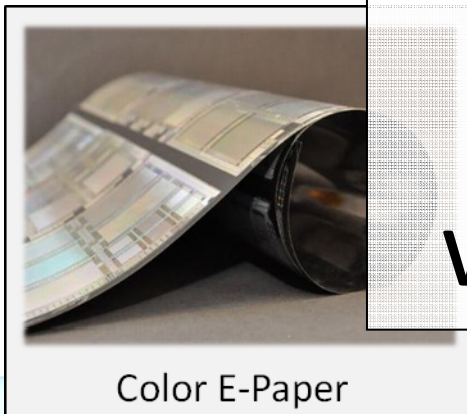
Market Outlook



Color-changing surfaces



Heat Management

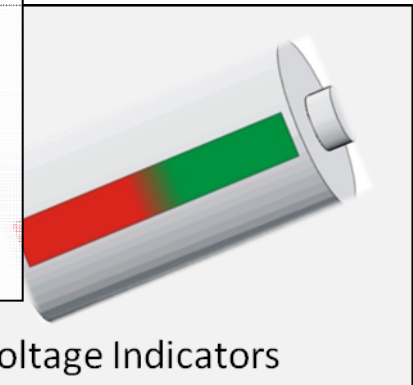


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Voltage Indicators