Flexible Electrophoretic Displays Go Big!

Michael McCreary  CTO, E Ink Corporation
Flexible displays
- Ink coated on flexible substrates kilometers long
- Thin, light and rugged
- Easy lamination to flexible backplanes
- Large area format demonstrated

Low Power Reflective Technology
- Sunlight and room light readable
- 180° viewing angle (no back reflector)
- Zero power to maintain image

Manufacturability Proven
- Millions of displays shipped each year
- Fundamentally stable technology
Categories of Flexible Displays

- Glass Substrate
- Plastic Substrate
  - Flat
  - Conformal
  - Bendable
  - Foldable
  - Rollable

Especially Important for Smaller Formats!
Small EPD Flex: 1.7-20 cm Diagonal

- **Sony FES Watch U**
  - Crowd funding on First-Flight of SONY succeeded.
  - 6.05” Active Matrix TFT EPD with circular & rectangular display areas
  - Custom images through apps
  - 3 weeks operation on a single charge
  - [https://first-flight.sony.com/pj/feswatch-u](https://first-flight.sony.com/pj/feswatch-u)

- **Smart Card Inlay**
  - 1.4 x 3.3mm active area
  - 128 x 296 pixels, 224 ppi
  - 400 μm thick
  - 25 μm polyimide substrate

- **Withings Go**

- **Sony SmartBand**

- **LookSee Labs**

- **LEXAR Echo USB**
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Larger Formats: Thinner, Lightweight, Robust to Bending
Large EPD Flex: 1-3 m Diagonal

- 32 inch flexible TFT display
- 100mm radius of curvature
- Full color with CFA
- Lightweight 150g

1.1m Diagonal (2 tiles), 0.39m x 1m, 950 segments
Gigantic: WW1 Project, Codename Dazzle
Gigantic EPD Flex: 490 m Diagonal

- Designed by Ueberall International
- 2,100 Autonomous, solar powered displays
- About 0.1 acre area
- Wirelessly linked pixels
- Central control enables many artistic effects
San Diego Airport Parking Garage
### Autonomous, Self-Powered, Plastic Flexible Pixels

#### Type
- Plastic Segmented EPD

<table>
<thead>
<tr>
<th>Property</th>
<th>Specification</th>
</tr>
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<tbody>
<tr>
<td>Size (image area)</td>
<td>12 x 26.3 in. (30.4 x 66.9 cm)</td>
</tr>
<tr>
<td>Thickness (image area)</td>
<td>1.2 mm</td>
</tr>
<tr>
<td>Reflectivity</td>
<td>15:1 CR, 44% WS (180 deg viewing)</td>
</tr>
<tr>
<td>Switching Speed</td>
<td>500 ms @ ±15 V, 120 ms bursts</td>
</tr>
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Integrated, Weatherproof Support Electronics: No Batteries

2 Flexible aSi PV films by PowerFilm® Solar
- 25 μm thin
- 4.1 V, 65mA
- 5-8% Efficiency
- Better low light than monocrystalline PV
- R2R flex manufacturing: 13 in x 2400 ft.

Communication circuits, display drivers, charge pump, and supercap (waterproofed with cover)

2 PV power strips take up only 4% of total tile area!
Installation Status: June 2, 2017
Status June 19, 2017: 1,549 of 2,100 Tiles Installed
Many Technical Challenges: All Met

- Authority acceptability: Electronic paint yes / Video LCD no
- No wires, autonomous
- No batteries, small PV area (bistable display, static image at night, power efficient communication)
- Electronics wireless synchronization of very large network (2,100 units over 10k sq. ft)
- Adhesion (no creep at 10x weight of tile)
- Extreme ink part sizes (1ft x 2ft) (high yield, no-curl etc.)
- Light durability (UV and Visible)
- Moisture durability (humidity, water immersion)
- Chemical durability (salt, other)
- Mechanical durability (wind, grit, 3500 psi power washing)
- Long lifetime (>10 million switches)
• 7 standard colors plus custom color option for high volumes
• Color → white or Color → black
• Initially indoor applications
• Flexible, bendable
• Tiles or large sizes
• Bistable, low power
• 180 degree lambertian reflectivity
• Less than 1 sec response or slow smooth transition option
Adding Interest: Color Changing Flex

- Dynamic color decorative walls
- Transition patterns programmable
- 25-50+ segments (12x12 in. each)

Wovin Wall by 3form®

- Plastic, flexible films
- B&W or color
- Arbitrary, laser cut shapes, may be bent
- May have printed backplanes for various effects

Dai Nippon Printing
- Retail Tech, March 7-10 2017
- Big Sight Convention Center
- Tokyo, Japan
E Ink ACeP: How it Works

- YMC transparent particles
- W reflective particle

Only the particles on the viewing side of the W particles determine the color.
Full Color Achieved Without CFA

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<tbody>
<tr>
<td>B/W CR</td>
<td>17:1</td>
</tr>
<tr>
<td>WS</td>
<td>44%</td>
</tr>
<tr>
<td>DS</td>
<td>2.6%</td>
</tr>
<tr>
<td># Colors</td>
<td>thousands</td>
</tr>
<tr>
<td>Pixel Size</td>
<td>169 μm (150 ppi)</td>
</tr>
<tr>
<td>Drive</td>
<td>~10 sec. @ ± 24V</td>
</tr>
<tr>
<td>Backplane</td>
<td>150 ppi TFT (single)</td>
</tr>
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Ubiquitus ePaper Applicability
Summary

- Autonomous, self powered plastic electrophoretic displays are being produced and installed in “gigantic” architectural applications.

- Color electrophoretic display technology has been demonstrated for a variety of colors and including full color, particle-only (no CFA) EP, driven by a single backplane.

- Paper-like (“paint-like”) true Lambertian 180 degree reflectivity and full bistability (zero power to maintain color) are essential for these new architectural applications.

- Further decreases in the size and thickness of support electronics will benefit both small and large applications of electrophoretic reflective displays (including for use with advances in FHE (flexible and hybrid electronics) initiatives.)
E Ink Flexible Electrophoretic Displays are Enhancing the World Around Us.

Thank you

www.eink.com