60.4 Rollable Displays: A Technology Development Enabling Breakthrough Mobile Devices

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CTO Polymer Vision
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About Polymer Vision

- 201X **Ubiquitous** rollable displays
- 2008 **Commercial product**: Readius®
- 2007 **Production line** and product
- 2006 **Spin-out** of Polymer Vision
- 2005 **Concept device** development
- 2000 **Development** of rollable display
- 1991 **Research** on organic electronics
## Why displays on flexible carriers

<table>
<thead>
<tr>
<th>Proposition</th>
<th>Target market</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rollable</td>
<td>Mobile phones, E-readers, UMPCs, ...</td>
</tr>
<tr>
<td>Flexible</td>
<td>Smartcards, advertisement, point of sale, wearable, ...</td>
</tr>
<tr>
<td>Robust and lightweight</td>
<td>E-readers, point of sale, advertisement, ...</td>
</tr>
</tbody>
</table>
The need for rollable displays

*Device size no longer coupled to display size*

Display larger than the device itself.
Matrix displays on flexible carriers
*No products out yet*

Some of the demo’s of last years...
## Main technology choices

<table>
<thead>
<tr>
<th>Technology block</th>
<th>Technologies currently under development</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Substrate</strong></td>
<td>Plastic, Steel</td>
</tr>
<tr>
<td><strong>Substrate handling</strong></td>
<td>Bond-debond, Free standing, Transfer</td>
</tr>
<tr>
<td><strong>Matrix stack</strong></td>
<td>Organic, A-Si, Poly-Si, Passive</td>
</tr>
<tr>
<td><strong>Patterning methods</strong></td>
<td>Lithography, Printing, Other</td>
</tr>
<tr>
<td><strong>Frontplane</strong></td>
<td>Electrophoretic, C-LC, OLED, LCD, Liquid Powder</td>
</tr>
</tbody>
</table>
Polymer Vision’s process flow

1. Laminate foil on carrier

2. 6-mask AM process

3. Laminate front plane

4. Delaminate display from carrier
Rollable display cross section
Organic electronics performance

Source: Hagen Klauk, Max Planck Institute for Solid State Research
Solution processed Pentacene

Spin-coating → Lithography → Conversion

- ID (A)

- Mobility vs VG

- Gate voltage (V)

- Conversion

- R&D performance
- Base line gen 1 performance
Polymer Vision’s rollable display

- Truly Rollable
- Paper-like
- Viewable in bright sunlight
- Low power
- Enables large displays in highly mobile devices.
- Cost competitive
- Compatible with AMLCD equipment

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Display type</td>
<td>AM Electrophoretic</td>
</tr>
<tr>
<td>Bending radius</td>
<td>7.5mm</td>
</tr>
<tr>
<td>Display thickness</td>
<td>100um</td>
</tr>
<tr>
<td>Module weight</td>
<td>5.5 grams</td>
</tr>
<tr>
<td>Display size</td>
<td>4.7 inch</td>
</tr>
<tr>
<td>Pixel count</td>
<td>76800 (QVGA)</td>
</tr>
<tr>
<td>Grey levels</td>
<td>16</td>
</tr>
<tr>
<td>Reflectance</td>
<td>40%</td>
</tr>
<tr>
<td>Viewing angle</td>
<td>Paper like</td>
</tr>
<tr>
<td>Aperture</td>
<td>97%</td>
</tr>
<tr>
<td>Driving method</td>
<td>Pulse width @ 50Hz</td>
</tr>
<tr>
<td>Update speed</td>
<td>0.6s (bi-stable)</td>
</tr>
</tbody>
</table>
Introducing READIUS

eReading comfort in a mobile phone

Small:
Pocket sized and Lightweight

Large:
5” display

Bright:
Sunlight readable

Intuitive:
Simple to use

Fast:
3.5G high speed worldwide connectivity

Usable:
30 hours of continuous reading between charges
End-to-end content solution

Content updates
Anytime, Anywhere

Readius® content selection
Configuration; personalization

…..Your personal content. Always available. When and where you need it.
Innovations projected within the coming 5 years

2008   Launch of commercial product: Readius

- Higher resolution
- Smaller roll radius
- Color
- Larger size
- Touch screen
- Increased update speed

201X   Ubiquitous rollable displays
Highest resolution e-paper prototype

- The World’s highest resolution: 254ppi!
- The world’s smallest roll radius: 6mm!
- Feature size: 5 micron
- Display thickness: 100 micron
- 40% overall white state
Highest resolution e-paper prototype

Paper print resolutions are achievable!
First ever rollable color e-paper prototype

- The world’s highest resolution: 127 ppi!
- The world’s smallest roll radius: 6mm!
- Integrated color filter (CF): 65k colors
- Display thickness: 100 micron
- CF close to reflecting layer
- 25% overall white state
Summary

- Rollable displays:
  - The breakthrough for mobile devices

- Readius:
  - First rollable display enabled e-reading device
  - Available this year

- New innovations:
  - The World’s highest resolution prototype display
  - The World’s first rollable color prototype displays
  - Smallest roll radius ever achieved

Rollable displays will become mainstream in the coming 5 years
Thank you for your attention
Higher update speed prototype platform

Fast updates enable interactivity