Introduction to Printed Electronics

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What is ‘Printed Electronics’?

Printed electronics (In mainland Europe usually called *Organic* Electronics)

Nothing to do with organic food or alternative lifestyles!

“Organic” and printed electronics broadly refer to electronics based on *carbon* chemistry, instead of conventional silicon.

Conventional Electronics

Printed Electronics

Different to conventional electronics!

Traditional Electronics

- Made in batches on wafers in cleanroom
- Devices run fast
- Layers added in furnace, vacuum or crystal growth
- High resolution
- Expensive processing
- Rigid silicon wafers or glass
- Devices are small
- Not transparent
- Established
- A cohesive industry

Printed Electronics

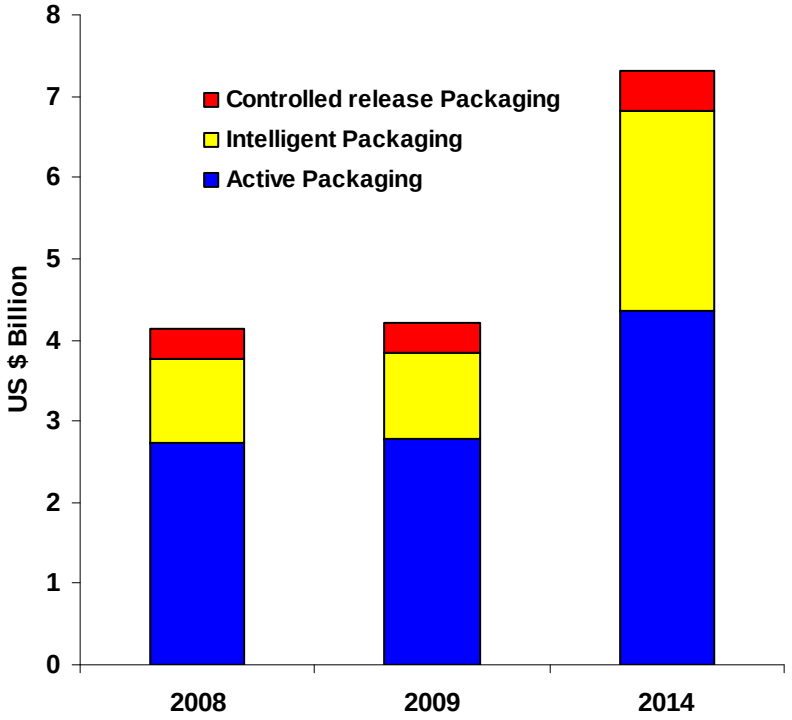
- Can be printed on a roll (or batch processed) non-cleanroom
- Devices run slowly (no plastic Pentium)
- Layers added by printing (or vacuum)
- Lower resolution
- Cheap processing
- Flexible films – paper plastic, or rigid (glass)
- Devices small or large
- Can be transparent
- Early Stage Technology
- Diverse industry

Printing Processes in PE

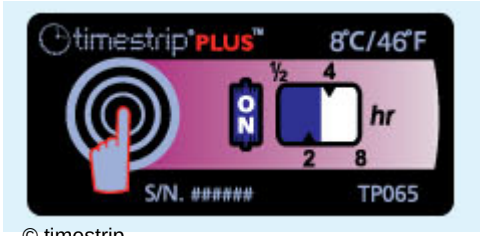
- Cleanroom
  - Spincoating, Inkjet, Photolith, vacuum
  - Applications (TVs, E-readers)
- Non-cleanroom
  - Gravure, flexo, offset litho, rotary & flat bed screen (Smart packaging….)

Why the big deal?

Printed Intelligent Packaging is expected to result in a huge industry. And still early enough for new, small players to join in. Future millionaires are out there…



©iRAP Inc (Market data for Food and Beverages)



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It will grow because of the number of applications…

Display Screens

© Dupont

Packaging

© Raflatac

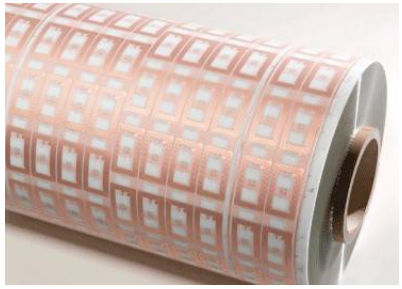
Brand Awareness

MotionDisplay

© CBS

Smart Textiles

© PolyPhotonix



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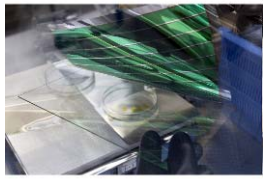
Solar Cells



© Heliatek

Brand protection

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Smart Cards

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Medical

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From innovation to commercialisation

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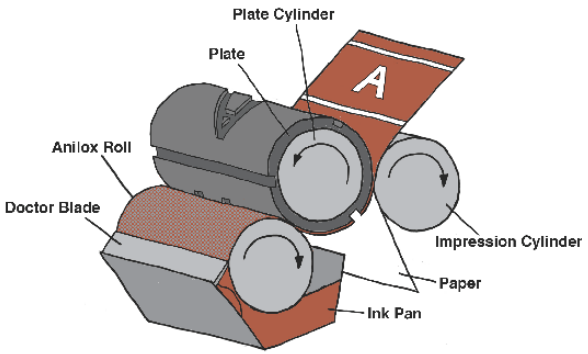
The Importance of Integration

With printable electronics not able to make everything, we look to “Integrated Smart Systems” - functional items produced by the integration of electronic components with circuits prepared by traditional printing processes



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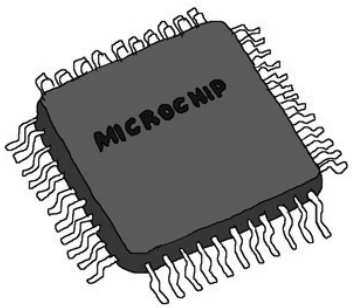


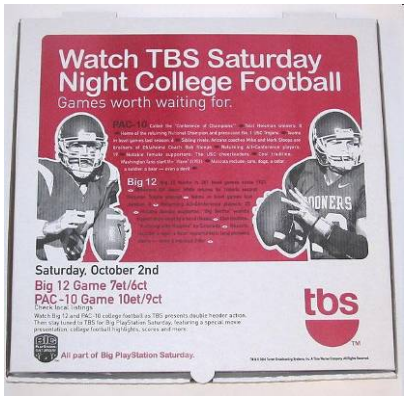
Focus on Integrated Systems

© Flexmedia

Interactive t-shirt

Talking pill bottle

© Packaging World



Pizza box with voice chip built in

© OE-A

Timers

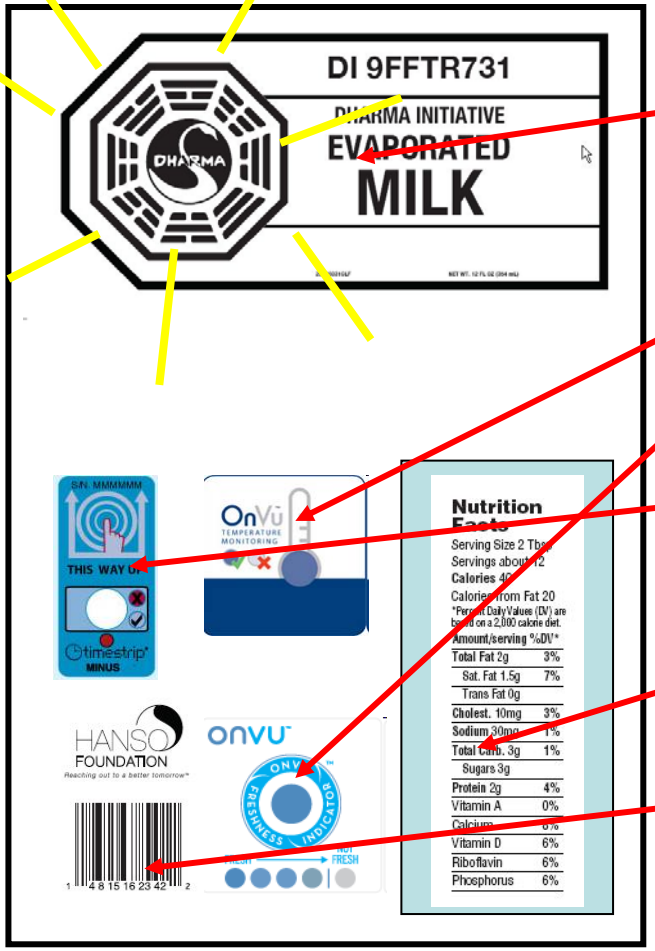
Self heating can

© Packaging World

Printers' view:

- Low resolution coating and printing
- Less demanding process control
- Bringing production cost low enough to make viable is the big challenge

Anatomy of the ultimate Smart Label



Illuminated branding

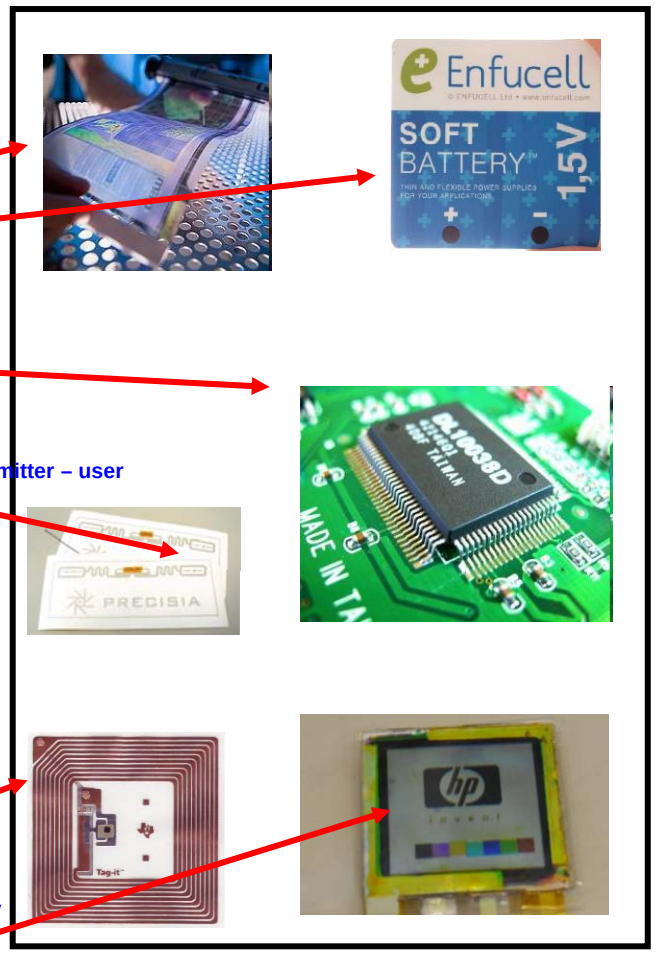
Temperature history

Freshness indicator

Tilt indicator

B&W Information Active Display

Shipper Coded Information



Printed LED

Printed Battery

Driver chip

Antenna-transmitter – user content

RFID tag

Reflective display

Even some Science Fiction is not far away…

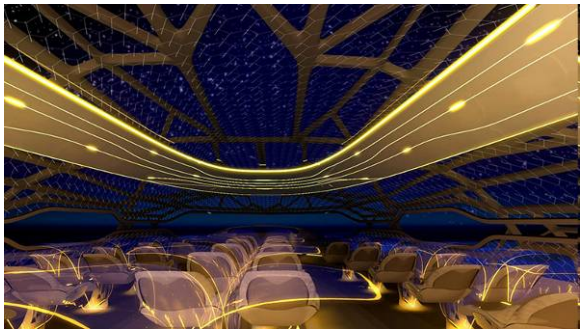
Predator (©20th Century Fox)

Colour changing panels for vehicles are imminent.

Image processing is the biggest challenge for textiles

Minority Report (©20th Century Fox)

Fully transparent touch screens could be made within the decade.



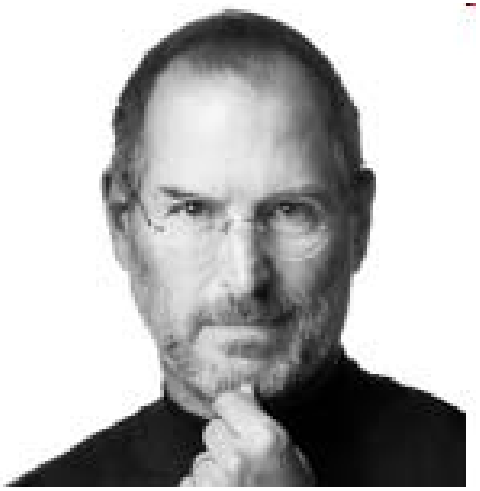
Airbus 2050 vision

Most of the technology already there, challenge is integrating it with the aircraft

Minority Report (©20th Century Fox)

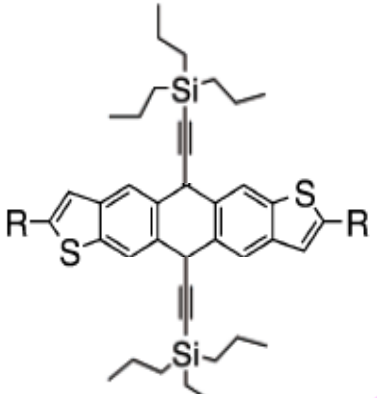
Electronic newspapers are here. Flexible printing within the decade.

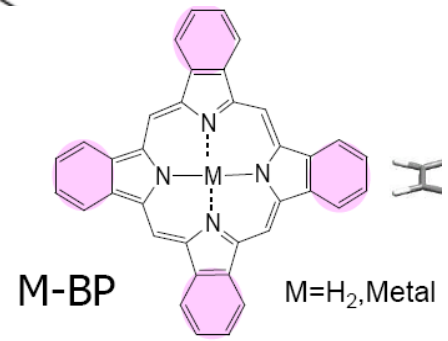
So with all this potential why aren't we millionaires yet?



Challenges: Materials Inks cost, availability for print processes, drying, test standards

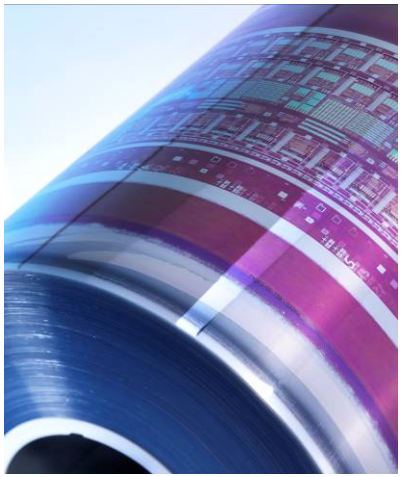
- Raw material costs
  - Economies of scale, ink cost
- Process environment
  - Moisture, air stability
- Test standards
- Drying
- Durability
  - Application
  - Barrier Development





Challenges: High Volume Production

- Flexible substrates
  - Alignment
  - Distortion
  - Brittle materials
- Still some vacuum steps!
- Batch vs. Continuous Production
  - Move to roll-to-roll (R2R) processes
- Full automation



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A word from our sponsors - How does CPI fit in this?

- Founded in 2004 as an independent company limited by guarantee as a public/private partnership
- Government investment of over £60m in assets and buildings:
  - Sustainable processing facility £30m
  - Printable electronics facility £30m
  - Thermal technologies centre £2.5m
- Founded in recognition that University based research needs to be converted into manufacturing solutions
- The UK has a wealth of excellent University based laboratory solutions but the necessary investment to bring the technology to market has long been a weakness

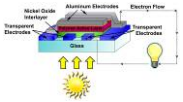
Innovation Centres like CPI bridge the development gap.

TRL9 – Application operating in final form

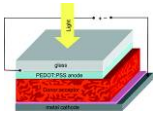
TRL8 – Technology proven to work

TRL7 – Prototype of operational system

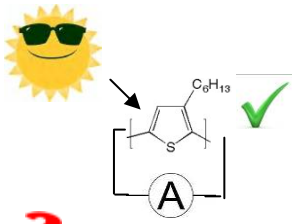
TRL6 – Test in relevant environment



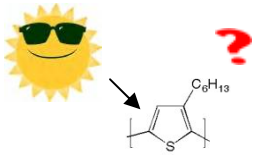
TRL5 – Improved integration, and test



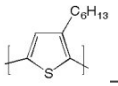
TRL4 – Basic components integrated



TRL3 – Active R&D initiated



TRL2 – Invention begins



TRL1 – Basic principles observed

Universities

Innovation Centres

Industry

From innovation to commercialisation

CPI's National Printable Electronics Centre

Collaborative projects

Industry Events

Clean room processing

Print line

Supporting Funding Access

Incubator space

From innovation to commercialisation

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Summary

- Printable electronics is an exciting new technology, with applications in a huge range of markets
- This new technology creates opportunities for traditional industries, such as printing, to enter these markets
- CPI's Printable electronics platform supports innovation and development work in this new technology
- There are still technology challenges to overcome, however there are big wins for companies who get there first.