

UK Displays
& Lighting

Knowledge Transfer Network

The UK home of
Plastic Electronics,
Flat Panel Displays
and Lighting

Knowledge Transfer Networks

Accelerating Business Innovation

A Technology Strategy Board programme

PLASTIC ELECTRONICS

- the disruptive technology



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UK Displays & Lighting
Knowledge Transfer Network

Action packed agenda...

1. *Introduction*
2. *Where are we today?*
3. *Where will we be tomorrow?*
4. *How are we going to get there?*

KEY DIFFERENTIATORS for **PLASTIC ELECTRONICS**

1

PLASTIC ELECTRONICS is a “catch all” phrase to separate this emerging industry from the older Semiconductor and Consumer Electronics Manufacturing Industries.

PLASTIC ELECTRONICS can be imported as an “added value” technology into “other” market areas such as: Food packaging, General packaging, Graphics printing, Printable lighting (electronic wallpaper), Medical sensors and other Healthcare products

Highlights of key activities - Universities

...and clusters in **SCOTLAND**
Edinburgh, St Andrews, Dundee
Strathclyde

...and clusters in **MANCHESTER**
Manchester, Liverpool

...and clusters in the **MIDLANDS**
Birmingham, Warwick, Aston

...and clusters in **WALLES**
Swansea, Cardiff, Bangor

1. Multidisciplinary
2. Engaged strongly with Industry
3. World-class IP portfolios
4. Operating in a Sector that has Government focus for substantial support

...and clusters in **SOUTH EAST OF ENGLAND**
Bristol, Newcastle, London

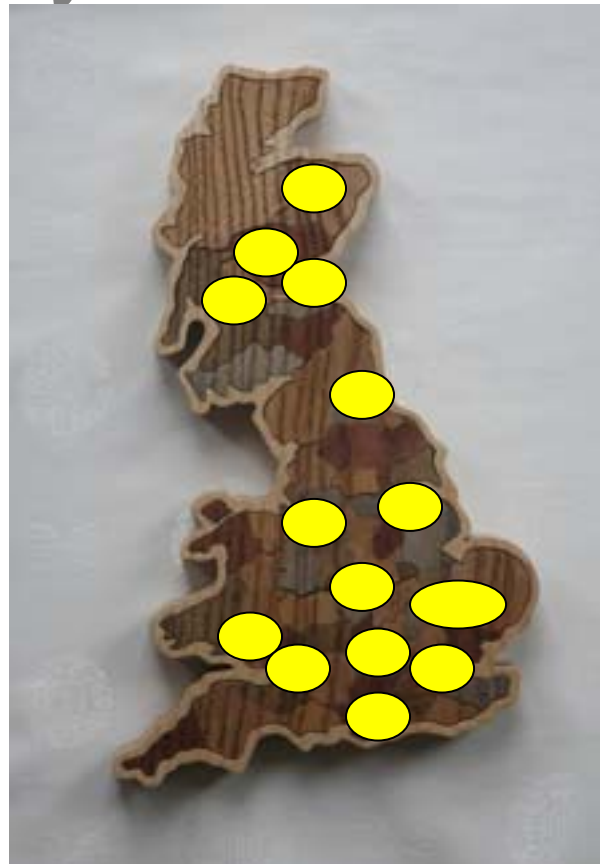
...and clusters in **CAMBRIDGE**
cluster activity at
CAMBRIDGE
Organic Materials
Organic Materials
Process development
LED architecture
LED production

...and clusters in **LONDON**
Imperial, QM, South Bank
Brunel

Highlights of key activities - Companies

Many common interests in **next generation** products

- materials, low-temp processes, device architecture



Diverse activities around the UK

- Many located near to Universities

- Many Start-up's and SMEs

- Few OEMs and Multi-national Co's

Highlights of key activities

Solution processable Organic and Inorganic materials

- Polymer OLED and Small Molecule OLED materials for printing
- ITO replacement materials for printing

Low temperature deposition of materials

- Room temperature sputtering of Amorphous silicon, metals, metal oxides, hafnium etc.

High accuracy, high speed printing processes

- Sheet and roll to roll printing
- Target feature size resolution 10 / 1 / 0.1 micron

Pre- and post-deposition processing to improve performance of circuit elements

- Surface energy modification
- Laser / UV enhanced patterning of printed precursors and/or other materials

Hybrid production processes

- Integration of multiple production processes to maximise production efficiency
- Development of high volume and low volume production systems for different markets

New Device architectures to mitigate reduced performance of OSC and amorphous silicon compared to X-silicon

PLASTIC ELECTRONICS in the UK today

1. World-leading science and engineering in Universities and SMEs
2. Pioneer SMEs moving into early stage production
3. Strong engagement with initial stakeholders (TSB, EPSRC, RDAs, DAs, VCs)
4. Established complementary **Centres of Excellence** around the UK
CIKC, CPI, OMIC, PETeC, WCPC
5. Move towards DTCs and other training initiatives (undergraduate, postgraduate, technician, business), very active Conference scene

PLASTIC ELECTRONICS in the UK today

“State of the Art’ review - materials and devices

1. 1st Generation (conventional top-gate or bottom gate FET) organic semiconductor circuits in devices moving into production will have electron mobility of order **0.01 cm²/Vs**
2. Research bench results for arrays of 2nd Generation organic transistor materials show electron mobility **>1 cm²/Vs**
3. *Early research bench results for arrays of “Plasma Quest” low-temperature sputtered and patterned non-Silicon inorganic transistors show electron mobility **>5 cm²/Vs***
4. New device architecture for organic and inorganic material sets suggest **orders of magnitude** improvement in performance will be possible

Plastic Logic,
Polymer Vision

Plastic Logic,
CDT,
Cavendish etc

U o Surrey,
Nano e-Print,
Cavendish etc

PLASTIC ELECTRONICS in the UK today - first devices to market

Both device types are world-leading examples of flexible organic semiconductor active matrix backplanes with electrophoretic frontplanes

- high complexity, high-resolution, but high added value (and high risk!)

- ~ >10" SVGA monochrome Flexible E-Reader from **Plastic Logic**
- READIUS "wrap-around" monochrome flexible reader mobile phone accessory from **Polymer Vision**

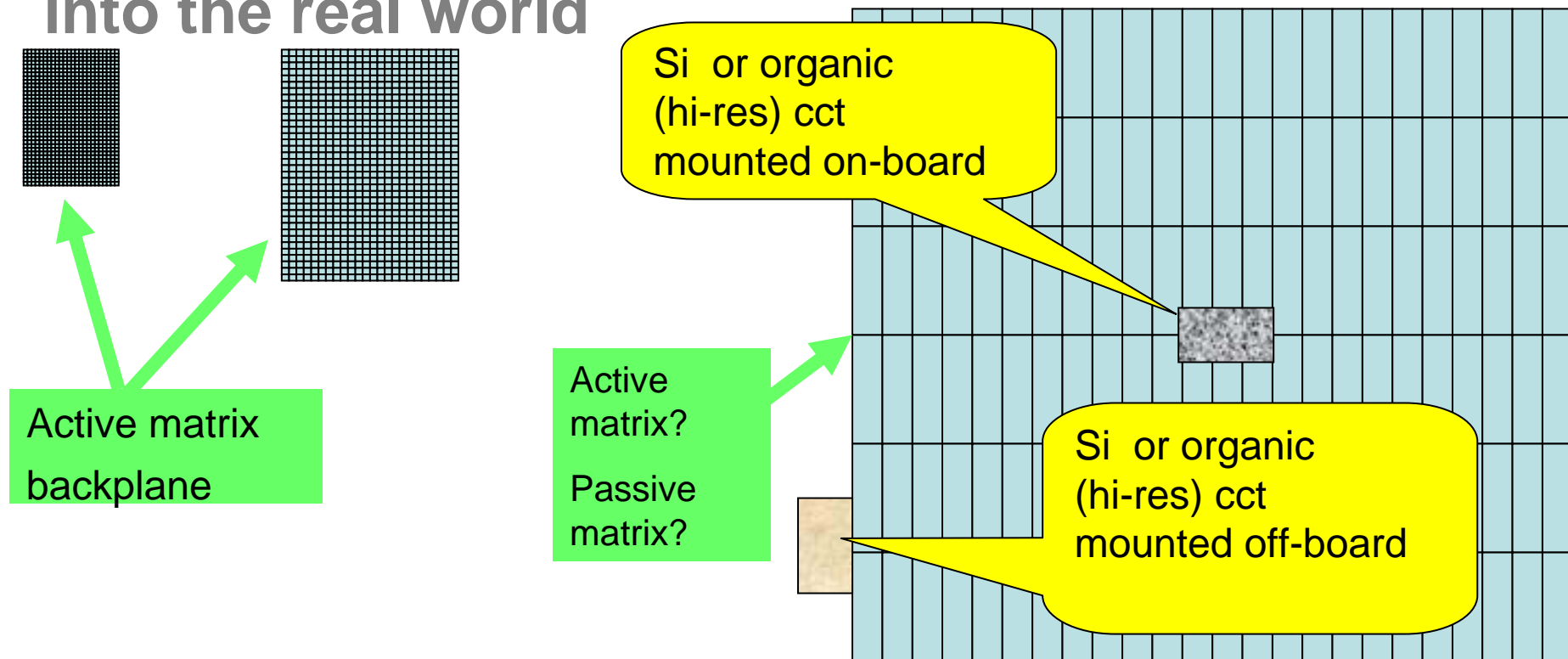
PLASTIC ELECTRONICS in the UK today

- basic processes

There are presently three different ways to manufacture organic Plastic Electronic devices:

1. Conventional semiconductor processes (Vertical structure top gate, bottom gate FETs)
 1. Deposit and pattern different solution processable material sets in sequence at lower temperatures and coarser resolutions (that with crystalline silicon wafers).
 2. Device size limited to size of semiconductor handling kit - typically 6" in the UK.
2. Hybrid manufacturing processes (Vertical structure top gate, bottom gate FETs)
 1. Print, spin coat, doctor blade coat or otherwise sequentially deposit materials for multiple layers
 2. Photolithographic patterning and subsequent chemical and/or laser etch back for each layer.
3. Novel stamping method for co-planar architecture
 1. Print semiconductor
 2. Stamp circuit design using lithographic imprint tool.

Integrating PLASTIC ELECTRONICS into the real world



PLASTIC ELECTRONICS in the UK today

- basic applications usage

The 1st Generation Plastic Electronics technologies available to UK integrators and converters have various primary functions:

- A **display** (e-reader, flexible display, hybrid graphics poster)
- An **illumination device** (electronic wallpaper, light emitting bandage for photo-dynamic therapy)
- A **sensing device** (RFID tag, electronic “nose”, smart packaging)
- A **microgeneration element** (Photovoltaic cells)

**No development (yet) of multi-functionality
on a common substrate**




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Where will we be tomorrow?

Highlights of key activities

UK already develops and manufactures materials, processes and equipments for **TODAY's** Mass Production of **Displays** in the **Far East**.

UK is developing materials, processes, equipments *and devices* for **TOMORROW's** Mass Production of **Plastic Electronic** devices which will be manufactured in the **UK and Europe** as well as licenced overseas.

**PLASTIC ELECTRONICS will lead to
Employment and Wealth creation
opportunities for UK plc.**

A vision of the future

In the H

Electronic wa

Transparent

Lighting pan

E-newspape

Smart food p

Smart medic

Self powered

Item level tagging s

In the CAR

Electr

Every

Wind

Every

contro

Seat r

passe

At WORK

External windows replaced by hi-res electronic wallpaper that can reproduce any scene as desired.

Paperwork replaced by e-paper, e-books and 3D stations

All personal clothing has multiple electronic functionality - colour change, personal environment control, medical sensors, built in audio and limited computing capability

Wristwatch mounted 3D volumetric projector allows personal replay ***of England thrashing Scotland at Rugby - again***

Our Vision

- We predict that **Plastic Electronics** will change forever how designers and manufacturers create products.
- Many *early* adopters of Plastic Electronics will **NOT** be electronics companies.
- Companies and designers will adopt Plastic Electronics to add value to their existing product portfolio - e.g. food packaging, medical sensors, illuminate clothing, wearable computing, disposable electronic games

How are we going to get there?

1. Persuade Government, its Agents and the private finance community to back **PLASTIC ELECTRONICS** with sufficient funding to make a difference.
2. Create (and help fund) consortia of Companies and Universities to deliver **DEMONSTRATORS** of multi-functionality on common substrates.
3. Bring major **End Users** on board to pull the technology through to the market.
4. Address the fundamental problem of how an **SME** company delivers novel solutions to **Tier 1 Global OEMs**.



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Getting FREE help along the way!

UK Displays & Lighting KTN (UKDL) is funded by the Technology Strategy Board to help UK Companies and Academics work together and with Overseas partners

Membership of UKDL is open to anyone working with or interested in:

PLASTIC ELECTRONICS, Flat Panel Displays & Lighting

Membership is free of charge! - please join at the website

www.ukdisplaylighting.net



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What do we do?



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Thank you for your attention!