

Shaping the Next Industrial Revolution

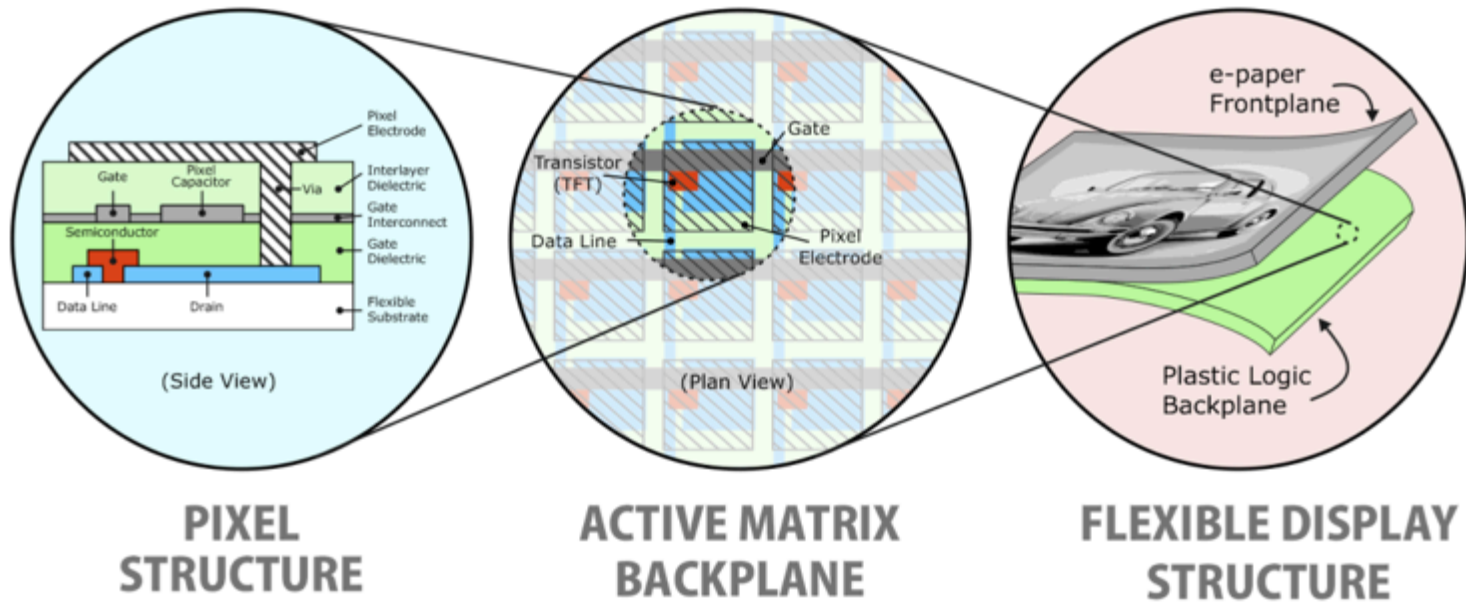
HVM Graphene 2013 Conference
5 November 2013 Cambridge
www.hvm-uk.com

Mike Banach – Research Director Plastic Logic

Myths and reality



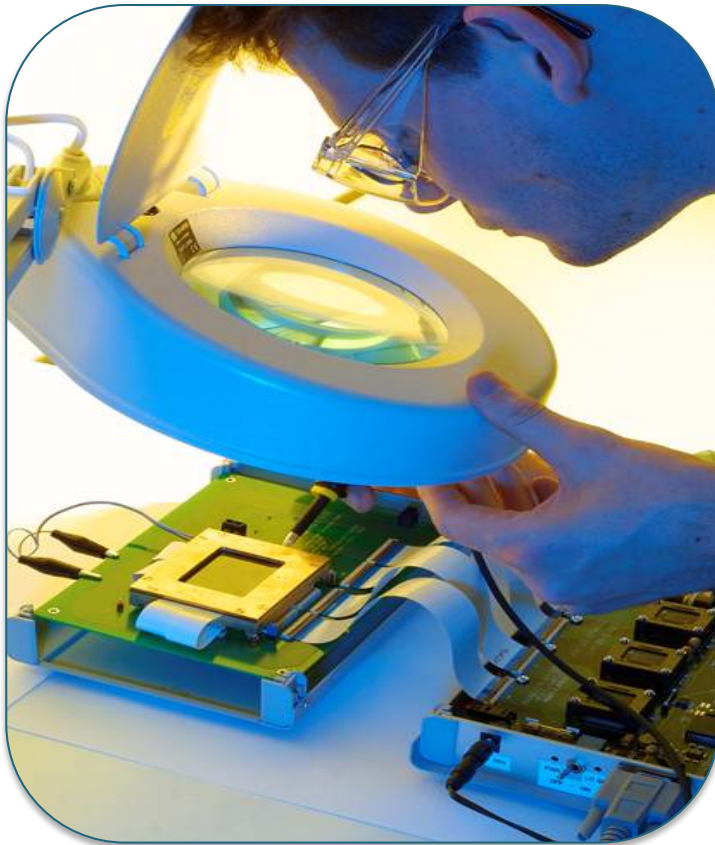
Revolutionary new transistor



The most significant new transistor technology in decades

Key Differentiator: Technology is compatible with plastic substrates

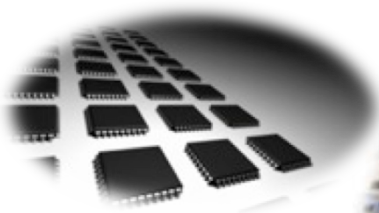
From science project to industrial reality



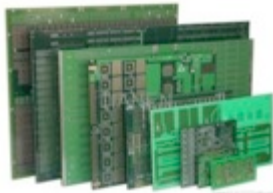
Powering the next industrial revolution

The Cambridge eco-system is key to this revolution and to Plastic Logic's value proposition going forward.

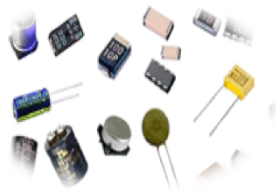
Driver chips



Printed circuit boards



Passive components



Solar



RFID tags



Displays

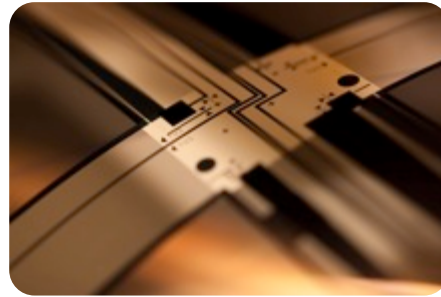


Sensors



3D printing

Value proposition for flexible displays



Display Demos

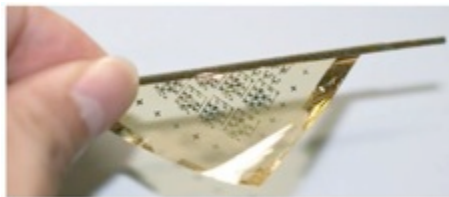
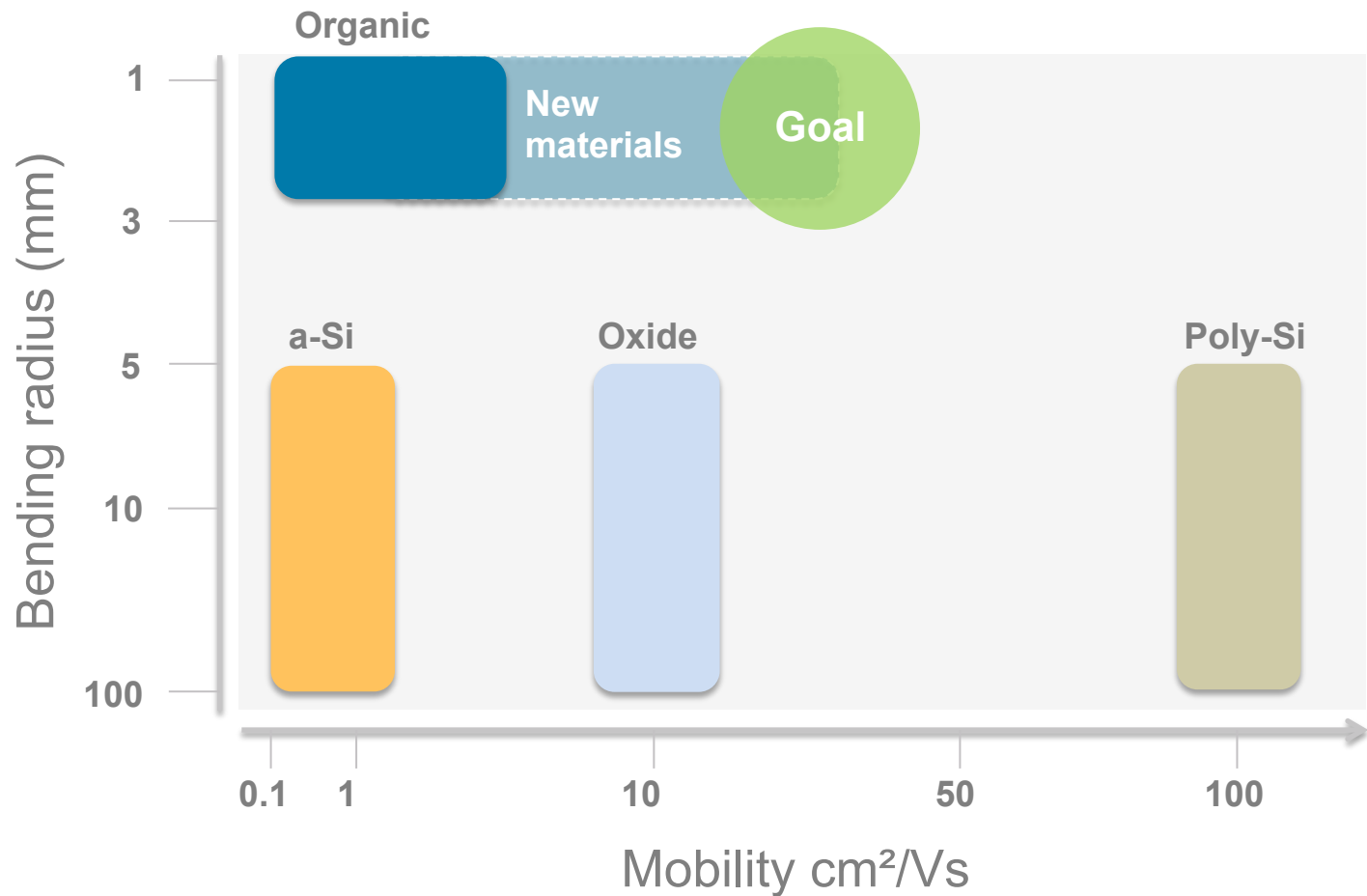


Market opportunity for Flexible OLED

- First products using “flexible displays” are slightly curved, not flexible.
- A significant technical step forward, though perhaps not enough yet to unlock consumer interest according to many commentators
- Nevertheless, the journey towards truly flexible displays is certainly underway.



Organic flexible backplane



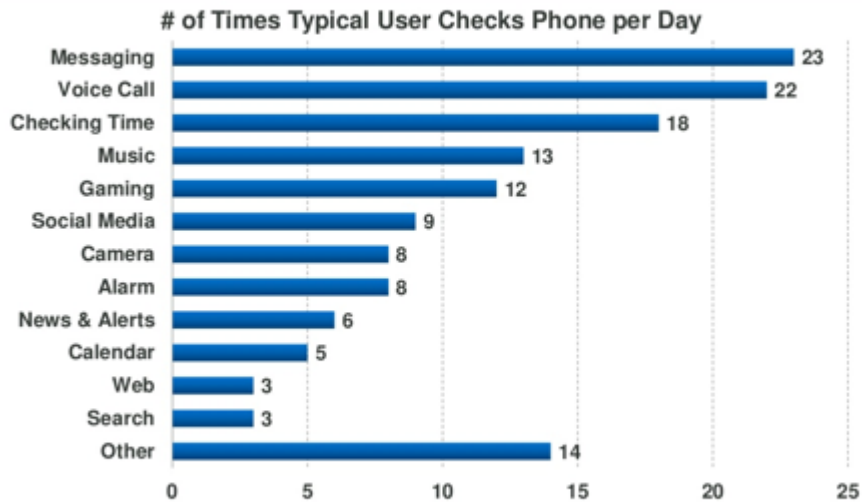
OTFTs already demonstrated to operate at radius of curvature $\sim 100\mu\text{m}$.

Sekitani et al., Nat. Mat. 9, 1015 (2010)

Huge potential for wearables



Mobile Users Reach to Phone ~150x a Day...
Could be Hands-Free with Wearables



Source: TomiAhonen/Altimarc 2013. 'Other' includes voicemail, charging and miscellaneous activities. We cross-checked Tomi's analysis to gain context. Our references include: 1) Motorola Mobility / Google (consumers interact with their phones more than 100x per day, mid-2012); 2) Leading 3G Carrier with Operations in Europe & Asia (smartphone users interact with mobiles ~150x per day); 3) IDC (51 blended average of social sessions per smartphone user per day in USA, 3/13...excluded services like checking time, alarm and calendar events, web browsing, gaming, using camera, listening to music, searching, using maps, charging and other activities that require checking the phone) and 4) other third parties, including app providers.

KPCB

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➤ Global smart watch forecast 200M units by 2018 (Generator). Some reservations over current form factors with glass displays:

➤ “To achieve its market potential, the smartwatch must work as a standalone device, with features that are compatible with the wristwatch form factor”

– Shane Walker, senior manager for medical devices & healthcare IT at IHS

➤ “Once you get a curved display you'll see more interesting designs, but for the moment you are basically just putting a glass screen on a wrist and I don't think that will appeal to many”

– Carolina Milanese, of Gartner

<http://www.digitimes.com/news/a20130905PR200.html>

<http://www.bbc.co.uk/news/technology-23961692>

Cambridge Technology Centre



Cambridge R&D
Prototype Line (14")

Cambridge R&D Prototype Line



- **Proof of concepts**
- Highly configurable process
- New designs in < 1 month
- 1" Chips to A4 displays
- Material development with suppliers
- R&D Engineers

Growth through partnerships



...we're ready to take the next step

Partnership for Industrialisation

PLASTIC LOGIC



- Hard-won experience, skills & assets
- Industrialising plastic electronics
- Printed electronics & flexible substrates

- World leading academics & science
- Funded graphene research program
- Network of partners



Route to industrialisation

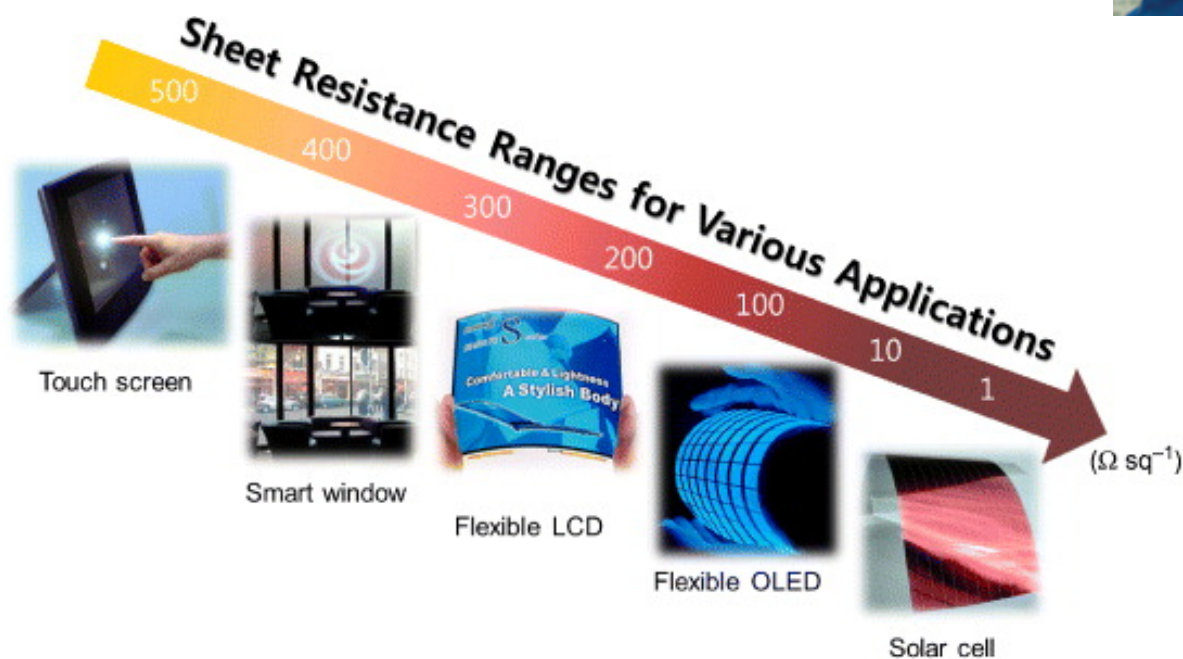
Plastic Logic / Cambridge Graphene Centre announcing partnership

Partnership to accelerate the industrialisation of graphene

Target UK supply chain as well as global, volume markets

Graphene for electrodes

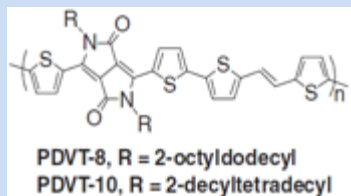
- Graphene and associated two dimensional materials offer great promises for ITO replacement
- For flexible displays large area deposition of graphene a solution processable solution is desirable
- Main applications are flexible displays



Horizon for flexible transistors

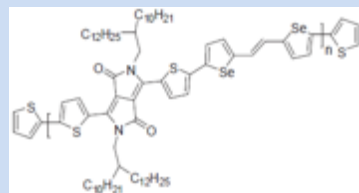
Solution-Processed Semiconducting Polymers for High-Mobility TFTs

$$\mu \geq 8 \text{ cm}^2/\text{Vs}$$



Chen, *Adv. Mater.*
[24](#) 4618 (2012)

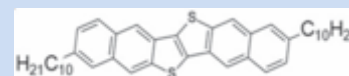
$$\mu \geq 5 \text{ cm}^2/\text{Vs}$$



Kang, *Adv. Mater.*
[25](#) 524 (2013)

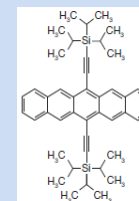
Solution-Processed Soluble Small-Molecules for High-Mobility TFTs

$$\mu \geq 10 \text{ cm}^2/\text{Vs}$$



Nakayama, *Adv. Mater.*
[23](#) 1626 (2011)

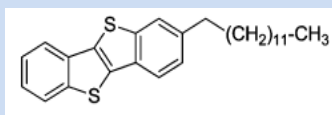
$$\mu \geq 6 \text{ cm}^2/\text{Vs}$$



Xu, *J. Appl. Phys.*
[110](#) 104513 (2011)

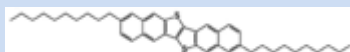
Vacuum-Deposited Small-Molecules for High-Mobility TFTs

$$\mu \geq 10 \text{ cm}^2/\text{Vs}$$



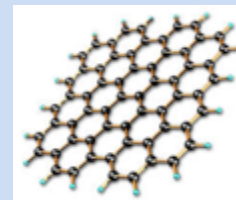
Amin, *J. Am. Chem. Soc.*
[134](#) 16548 (2012)

$$\mu \geq 8 \text{ cm}^2/\text{Vs}$$



Niimi, *Org. Lett.*
[13](#) 3430 (2011)

Graphene



- Highest current density (1,000,000 times > Cu)
- Highest intrinsic mobility (100 times > Si)
- Strongest material ever measured
- Most stretchable crystal (20% elasticity)
- Most impermeable
- Can be processed at low temperatures

Plastic Logic Display Technology

- Plastic Logic is a flexible display technology provider. We can supply displays in variety of sizes and resolutions and enable others to do so through licensing arrangements.
- Plastic Logic is a global leader in OTFT devices and have overcome many of the challenges of manufacturing on plastic.
- Plastic Logic is specifically targeting organic TFT for highly flexible for OLED displays.
- Plastic Logic is actively looking to partner with companies who can open up new markets for our technology.

PLASTIC LOGIC

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