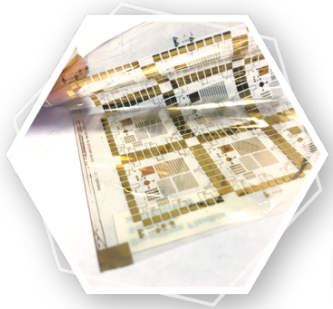
SmartKem
Display • Performance • Chemistry

Towards A Flexible Future

Dr Beverley Brown
Chief Scientist

Forward Looking Statements



This presentation contains forward-looking statements about SmartKem Ltd. based on management's current expectations which are subject to known and unknown uncertainties and risks.

Words such as "anticipated," "initiate," "expect," "intend," "plan," "believe," "seek," "estimate," "may," and variations of these words or similar expressions are intended to identify forward-looking statements. Our actual results could differ materially from those discussed due to a number of factors, including, but not limited to, our ability to raise additional equity and debt financing on favorable terms, the success of our products under development and other risk factors.

We are providing this information as of the date of this presentation and do not undertake any obligation to update any forward-looking statements contained in this presentation as a result of new information, future events or otherwise. Unless the context requires otherwise, references to "SmartKem," "Company," "we," "us" and "our" refer to SmartKem Ltd.

Company **Overview**

Enabling today's flexible electronics

- Employees: 38 FTEs
- Funding to date: $60M+
- 150+ PhD years in the development of organic semiconductors
- 8,000ft^2 R&D facility in Manchester, UK
- Foundry service for prototyping at UK's Centre for Process Innovation (CPI)
- Extensive IP portfolio comprising 16 patent families
  (~120 issued patents; 15 pending & > 30 codified company trade secrets)

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Significant Market Opportunities

$186 Bn Global Display Market 8% CAGR
Driven by demand for consumer electronics

Smartphones

Automotive

Colour e-reader tablets

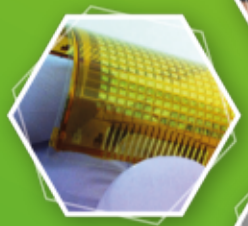
E-Paper Displays

Flat Panel Displays (Mini-LED backlights)

- Flexible
- Bendable
- Wearable
- Lightweight

$151 Bn Sensor Market 6% CAGR
Driven by IoT and wearables

Wearables



E-Skin Technology Developments

Printed Biosensors

Fingerprint Sensors

* Global Display Market 2019 – 2023 – In depth analysis of the growth drivers, market trends and challenges – Business Wire, A Berkshire Hathaway Company

*https://www.marketresearchfuture.com/reports/sensor-market-4392

Setting Up For Successful **Mass Deployment**

1
TRUFLEX® Organic INKS

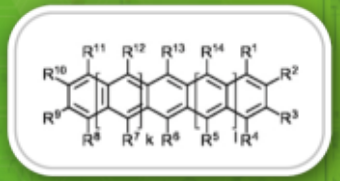
2
TRUFLEX® Design Tools

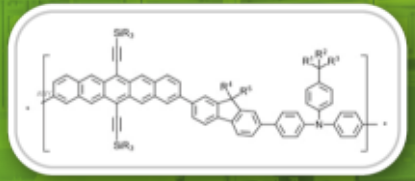
3
TRUFLEX® Foundry Services

Mass Deployment

1. TRUFLEX® Inks – Available at Scale

Components of TRUFLEX® Inks





High Mobility, Small Molecule

- Intrinsic mobility ≥ 10 cm^2/Vs

Semiconducting Polymer 'Controls'

- Morphology of OSC layer
- Phase segregation & uniformity of SM
- Viscosity of ink

Solvents

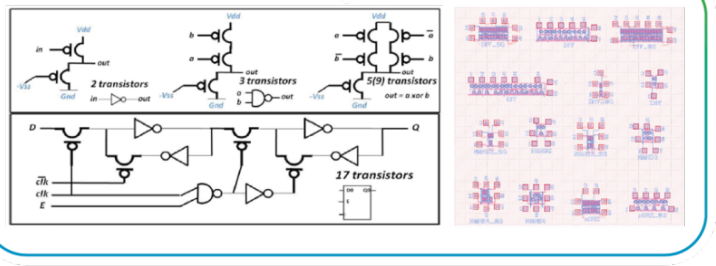
- Solubilise SM & Binder
- Modify surface tension
- Influence ink viscosity
- Customise for range of printing methods

- **Technical team has excellent understanding of formulations**
- **In-depth knowledge of how to combine small molecule/semiconducting polymer to maximise the performance of OSC layer and resulting oTFT**
- **More than 50 years expertise relating to OSC formulation**
- **Best in class performance**
- **Compatible with existing a-Si process lines**
- **Scaled up manufacture**

2. TRUFLEX® Electronic Design Automation Tools – In development

EDA Components to Libraries

Device	PCell name	Design parameters	Symbol	Layout
Resistor	rlin_lw rlin_rw	w strip width l strip length / r resistance		
	rsnake_lwz rsnake_rwz	w strip width z meanders number l vertical bars length / r resistance		
Capacitor	cap_lw cap_cw	w upper plate width l upper platelength / c capacitance		
Inductor	indsq_srwnt	s turns spacing r interior turn radius w turns width nt number turns		
	indoct_srwnt	s turns spacing r interior turn radius w turns width nt number turns		
Diode	diode_lw	l upper contact length w upper contact width		
Transistor	potft_wl	l channel length w channel width		



- EDA tools establishment
- PDK (Process Design Kit) establishment (at PE foundries)
  - Standard cells – parameterizable cells (p-cells)
  - Libraries of circuits and other PE devices (force sensor, OLED, OPD, biosensor etc)
  -

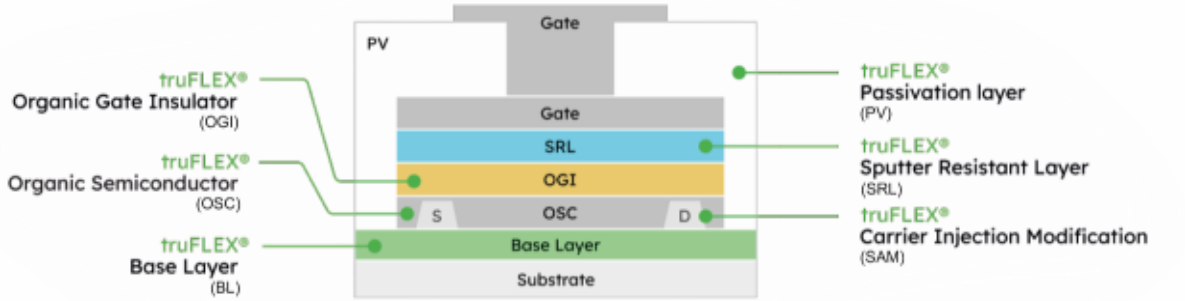
3. TRUFLEX® Foundry Services

CPI Prototyping facility for materials qualification, process development & fabrication

Adding digital lithography for full-custom circuits - sheet to sheet initially and then **roll-to-roll** in the future

SmartKem **Technology Advantage**

Leader in the **design, development,** scale up and manufacture of **solution-deposited organic semiconductors** for transistor backplanes



Ease of Technology Transfer

Own chemistry, process and stack IP

Ideal for today,s flexible displays

Fabricated on low-cost glass & plastic

Drop in technology for a-Si lines

(and ready for next gen)

World leading electronic performance

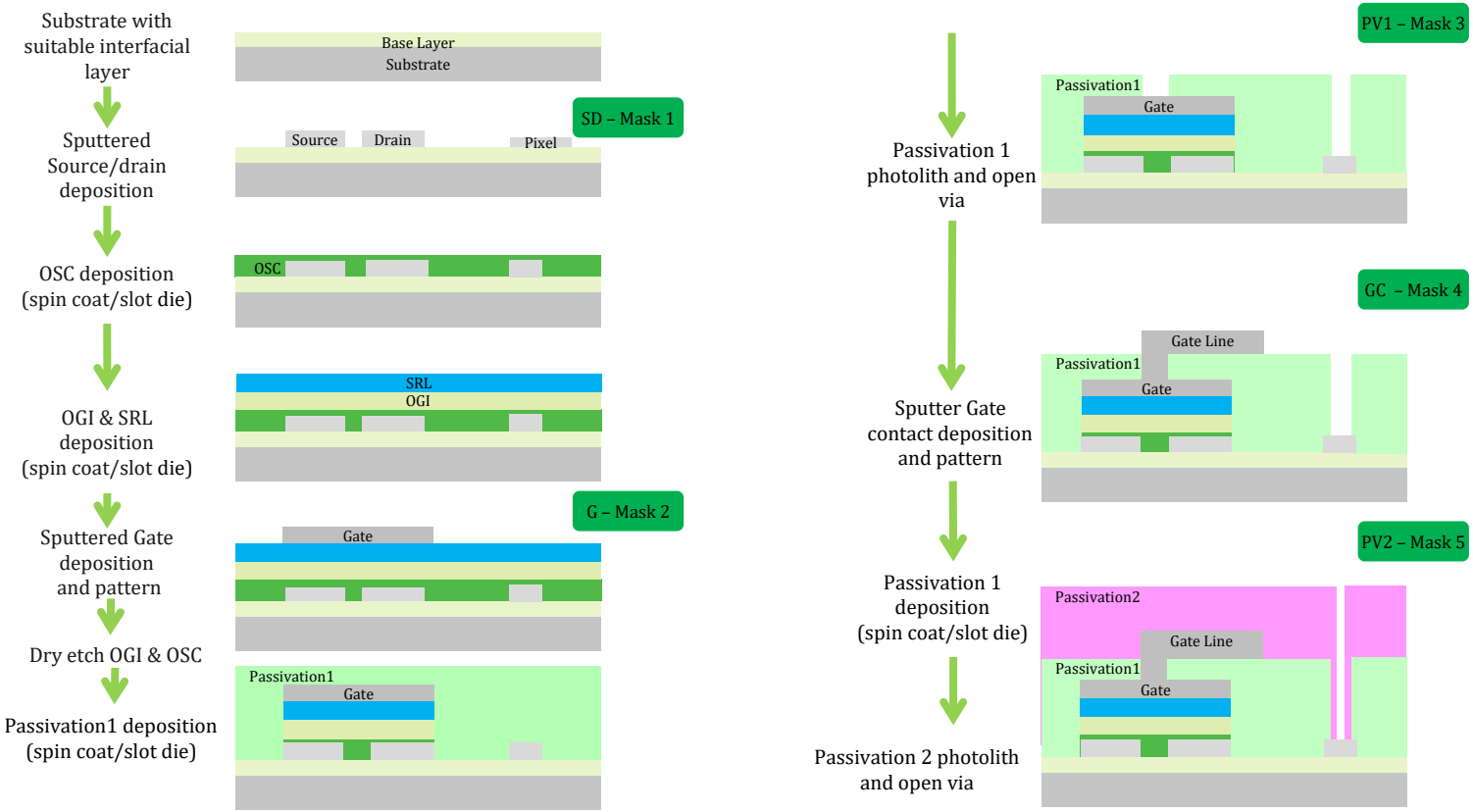
Meets industry test specifications

On specific parameters, outperforms competitive materials (a-Si, IGZO & LTPS)

SmartKem OTFT – Towards a Flexible Future

Parameter	SmartKem OTFT	a-Si	IGZO	LTPS
Current Usage	In development (demonstrated in e-paper, LCD and OLED)	LCD and rigid e-paper	OLED TV and some tablet LCD	Mobile phone (OLED and some LCD)
Typical Charge Mobility in Display Pixel	3 cm^2/Vs	0.5 cm^2/Vs	10 cm^2/Vs	50+ cm^2/Vs
Process Temperature	80˚C	300 ˚C	320 ˚C	350 ˚C
Substrate Compatibility	Wide range of plastics and glass	Glass	PI/glass	PI/glass
Current Driving Stability	Very Good	Average	Very Good	Excellent
Off Current	Excellent	Average	Excellent	Average
Impact Resistance	Excellent	Poor	Poor	Poor
Bend Radius	0.5mm	4mm	2mm	4mm
Manufacturing Maturity	Prototype	Excellent	Fair	Good
Process Cost	Low	Low	Medium/High	Medium/High

truFLEX® OTFT – **Fabrication Process**

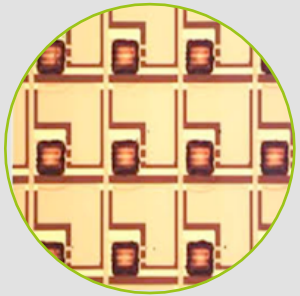


OTFT
Applications

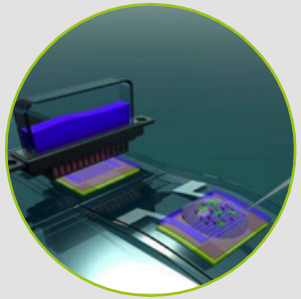
Information Displays

PoS Displays

Touch sensor



Printed biosensors



Displays

- Many potential applications exist for solution processed OTFT arrays
- Today's presentation will focus on mini-LED backlights (also referred to as Full Array Local Dimming Backlights).

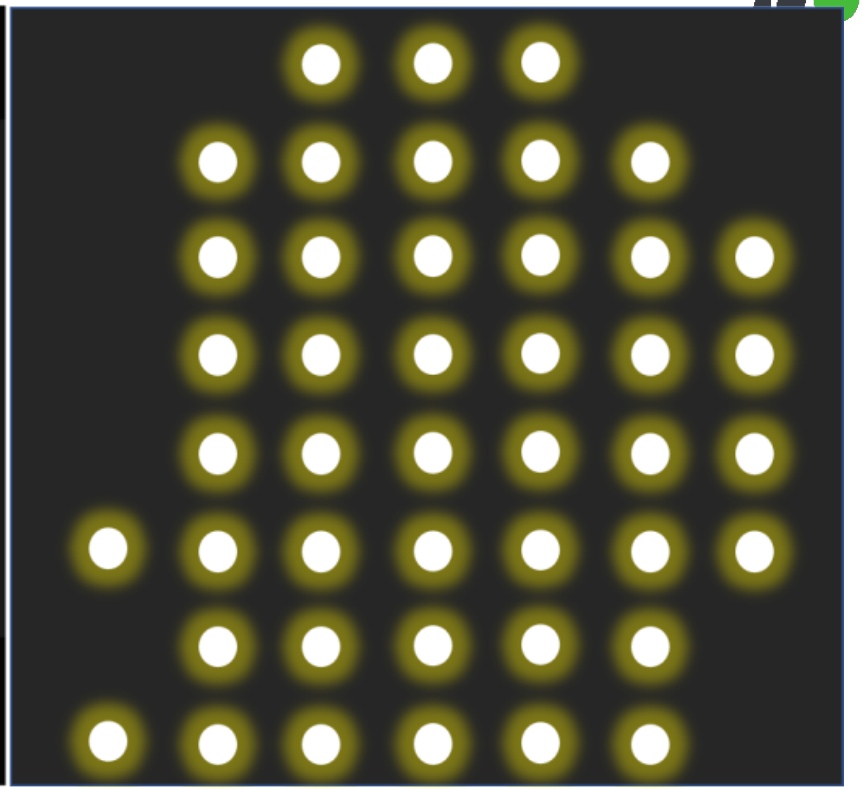
Mini-LED (Full Array Local Area Dimming) Backlights: **Background**

Edge Lit LCD Display- **No local dimming**

LCD image

Backlight illumination

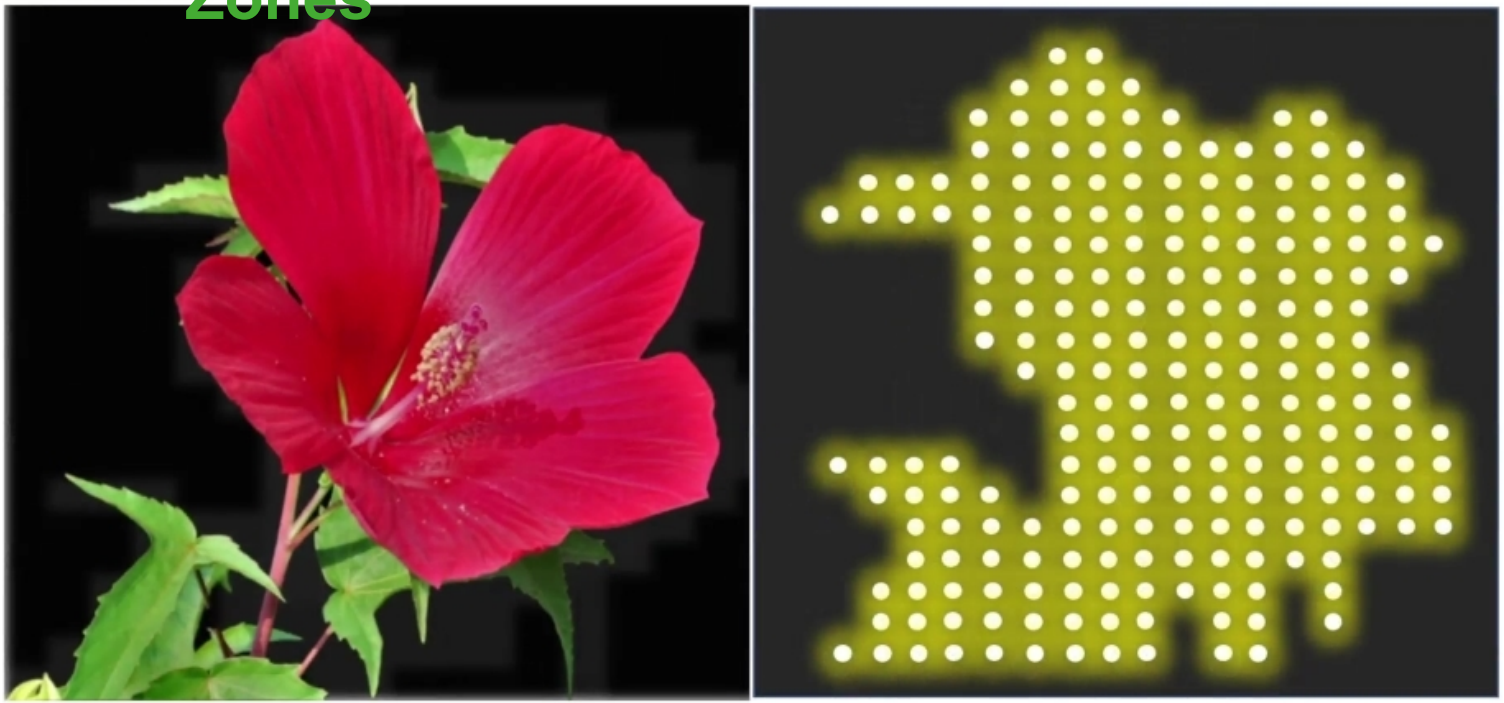
Direct Lit – **<100 Zones**



LCD Image

Backlight illumination

Mini LED backlight LCD – **1000's of Zones**



LCD image

Backlight illumination

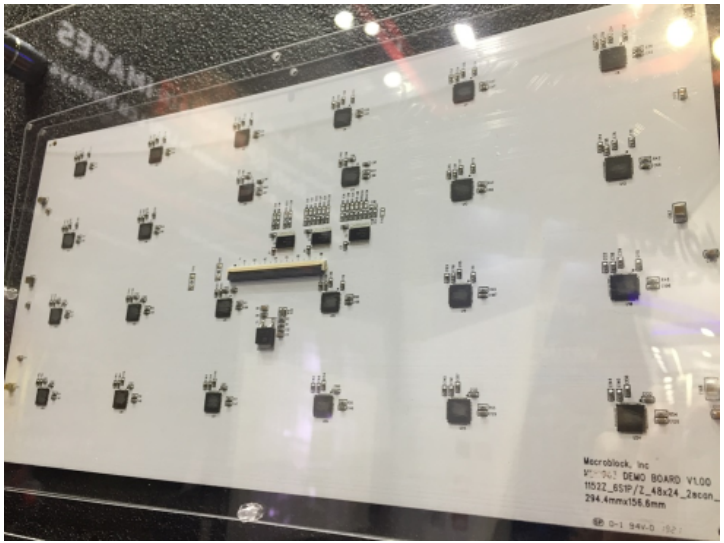
FALD – **many 1000's of Zones**

LCD Image

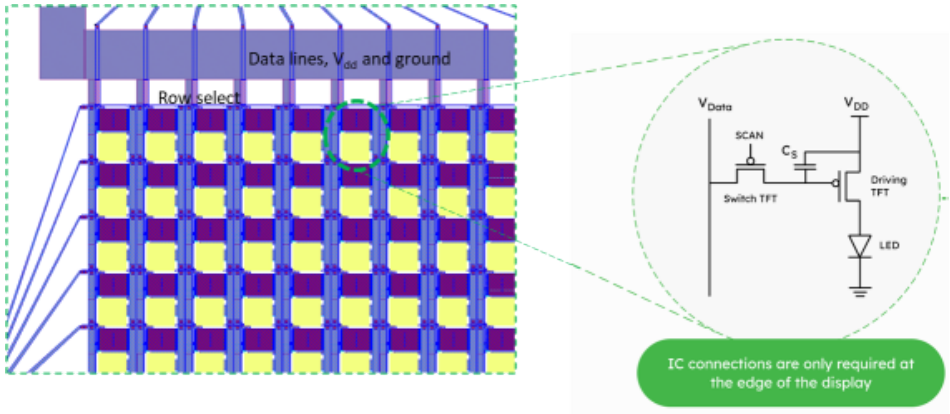
Backlight illumination

Mini LED – Direct wiring vs backplane approach

Direct wiring



Backplane matrix driving scheme

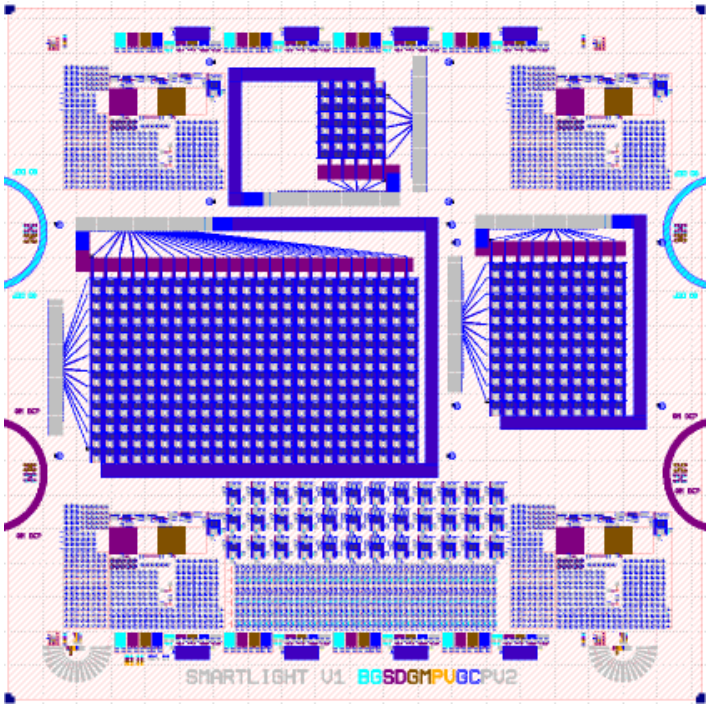


IC connections are only required at the edge of the display

- Glass substrate is flatter and less prone to distortion
- Heat from LEDs can be conducted away from back of substrate (no ICs in the way). On thin plastic substrate, thermal conduction can be very efficient
- Backplane approach can be modified to micro LED in future

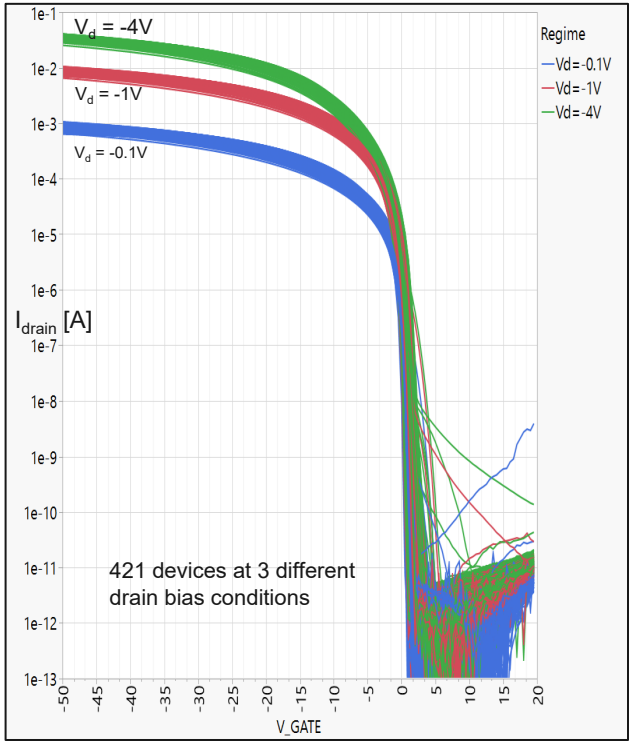
SmartKem **OTFT Mini-LED backlight:**
Recently Completed Customer Designs

Mini-LED backlight panel layout

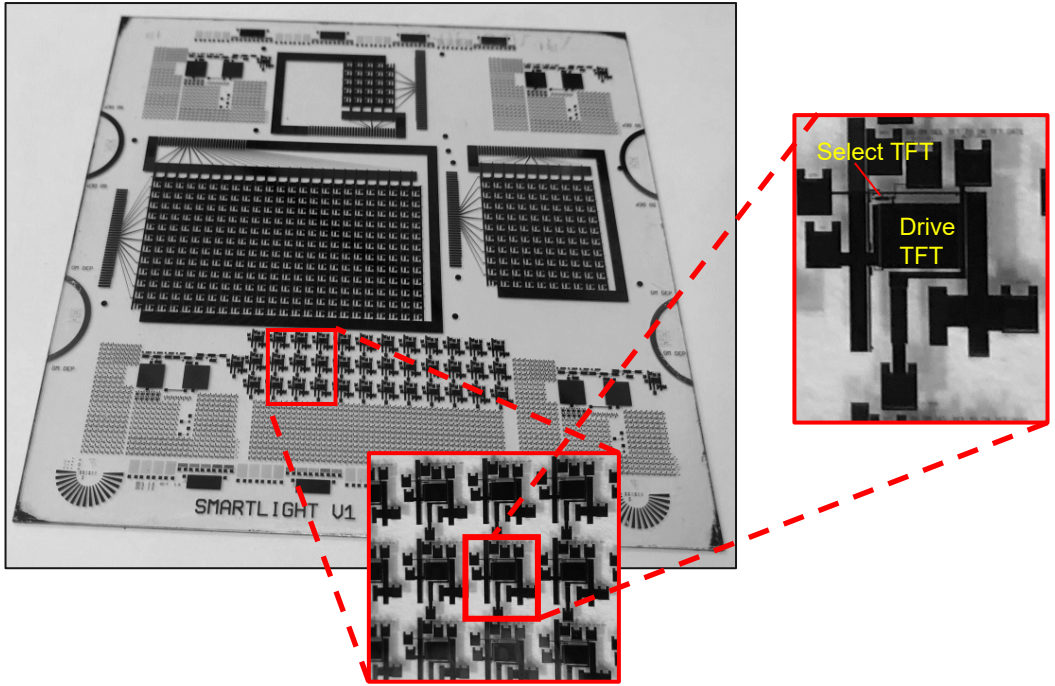


- Contains 3 designs (5 x 5, 10 x 10 and 24 x 12), same pitch (2mm x 2.25mm)
- Individual pixels capable of up to ~100mA current driving at maximum brightness.
- LEDs to be used - 9V operation.
- Process to prepare panel uses 6 masks, and tool sets compatible with a-Si line

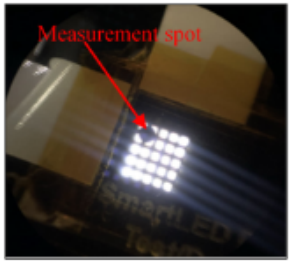
Electrical Performance of TRUFLEX™ OTFT array



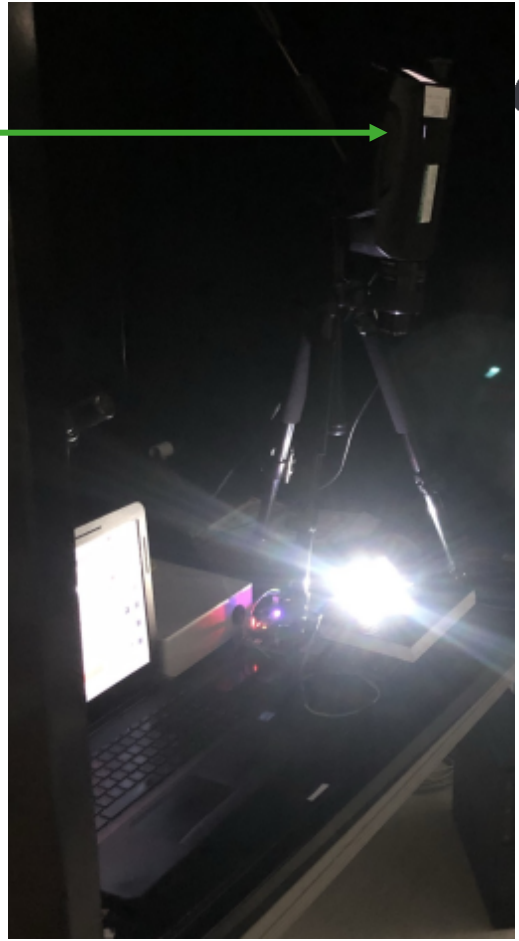
- 40mA median on current, V_d =-4V, V_g = -50V
- Off current is a few pA
- On/off ratio is ~10^{10}



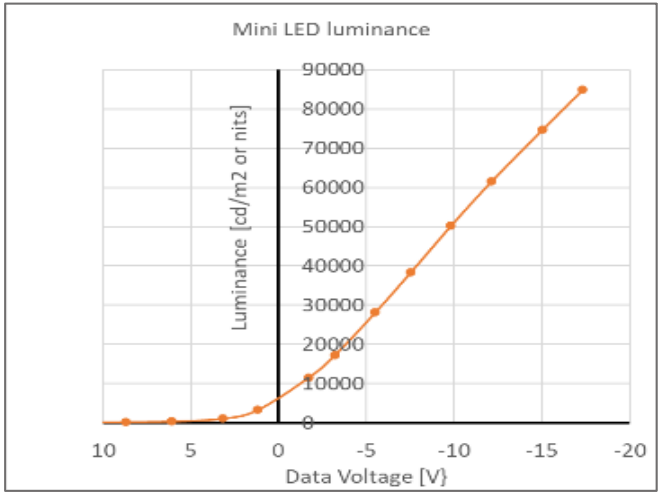
Backlight luminance testing

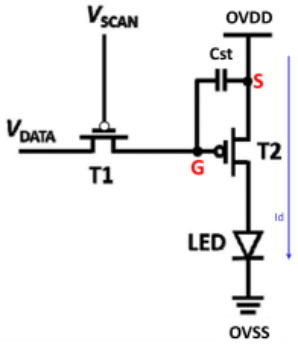


Spectrascan
PR670



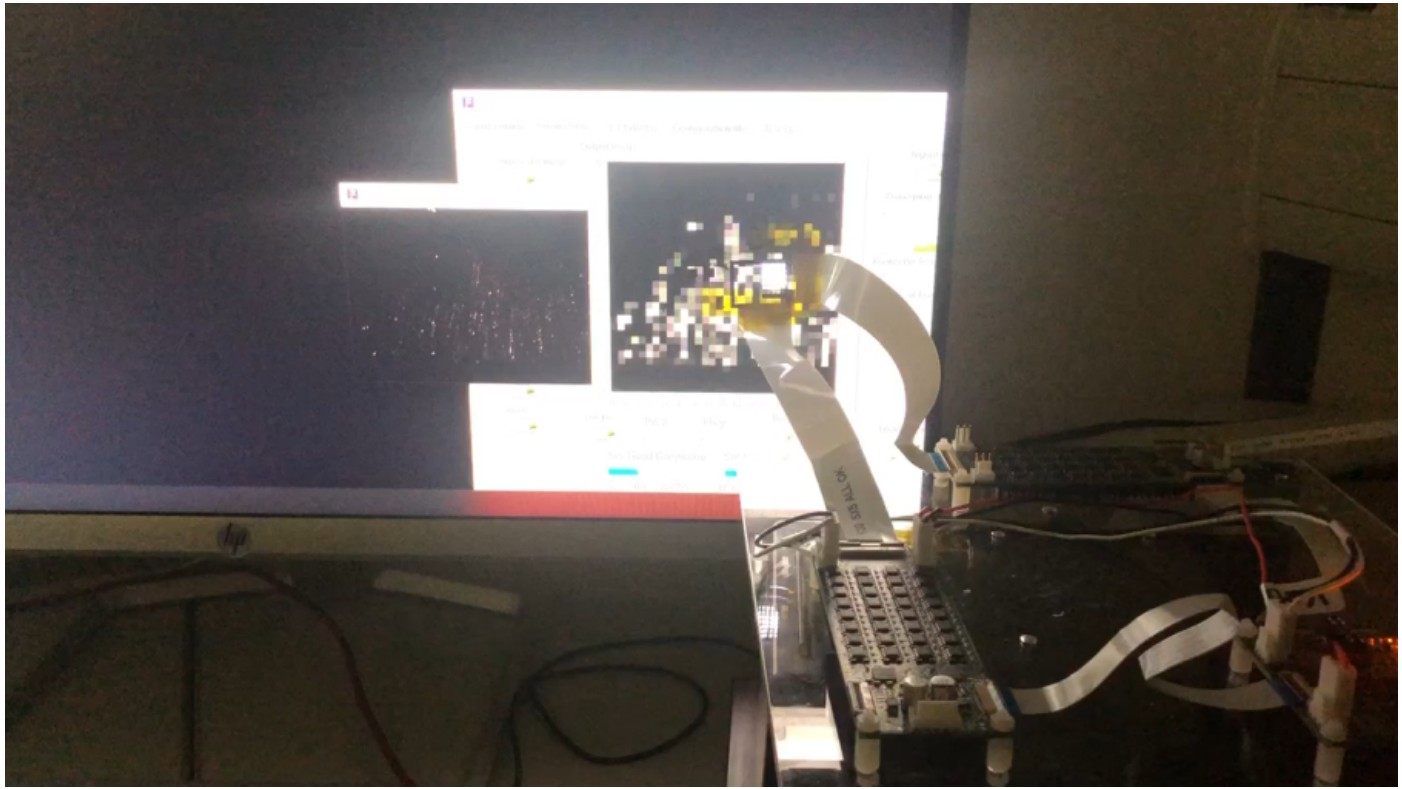
V_{dd} to V_{ss} = +8.6 V
V_{select} +24V to -24V
V_{data} vs Luminance measured





Measured 85,000 nits – equates to 4250 nits front of screen with a 5% transmission through LCD and a contrast ratio of 1,000,000:1 if the LCD has a native contrast ratio of 2000:1

OTFT Active-Matrix Backlight Testing



Scale-up OTFT backplane on existing a-Si line

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Thank You

Questions?

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