



OVER 100,000 NITS MINI-/U-LED DRIVEN BY ORGANIC TFTS BACKPLANE  
WITH MAXIMUM 80°C PROCESS TEMPERATURE

# Cautionary Note Regarding Forward Looking Statements

**This presentation contains certain forward-looking statements within the meaning of Section 27A of the Securities Act of 1933 and Section 21E of the Securities Exchange Act of 1934 and Private Securities Litigation Reform Act, as amended, including those relating to the Company’s product development, market opportunity, competitive position, possible or assumed future results of operations, business strategies, potential growth opportunities and other statements that are predictive in nature. These forward-looking statements are based on current expectations, estimates, forecasts and projections about the industry and markets in which we operate and management’s current beliefs and assumptions.**

These statements may be identified by the use of forward-looking expressions, including, but not limited to, “expect,” “anticipate,” “believe,” “estimate,” “potential,” “predict,” “project,” “should,” “would,” and similar expressions and the negatives of those terms. These statements relate to future events or our financial performance and involve known and unknown risks, uncertainties, and other factors which may cause actual results, performance or achievements to be materially different from any future results, performance or achievements expressed or implied by the forward-looking statements. Such factors include those set forth in the Company’s filings with the Securities and Exchange Commission. Prospective investors are cautioned not to place undue reliance on such forward-looking statements, which speak only as of the date of this presentation. The Company undertakes no obligation to publicly update any forward-looking statement, whether as a result of new information, future events or otherwise.



# OUTLINE OF SPEECH

## **Company Profile**

- Our focus on the display market

## What we are offering to the market

- The details



Date : 28 April, 2022

From: Steven Tsai

# SmartKem Summary

## Reshaping the World of Electronics

### Market Leading Disruptive Technology

#### Recognized as the world-leading electronic material for **organic transistors**

- Headquartered in Manchester, UK (8,000ft<sup>2</sup> R&D facility)
- Foundry service for prototyping at UK's Centre for Process Innovation (CPI)
- Went public in March 2021 raising \$24.6m
- TRUFLEX<sup>®</sup> is a full transistor stack design and process platform
  - Owns Chemistry, Process and Stack design rules, proven to produce logic circuits at only 80°C with performance significantly beyond amorphous Silicon (a-Si)
  - Validated SPICE model and Process Design Kit (PDK)
- Flexible and can be produced on low cost plastic and glass
- Compatible with existing manufacturing lines or the printing processes that the industry plans to replace them
- Private and institutional investors including, AIGH, Octopus Ventures, Entrepreneurs Fund LP, BASF Ventures.

#### World Class Technology Team

- 42 (11 PhDs) FTEs with 200+ combined years industrial and R&D pedigree at ICI, Merck, Philips, Kodak, CDT, Motorola, Global Foundries
- Having developed the chemistry, the process, and the design rules, SmartKem is a fab-less company and has outsourced its chemistry scale-up.

#### Extensive, Broad and Defendable IP Portfolio

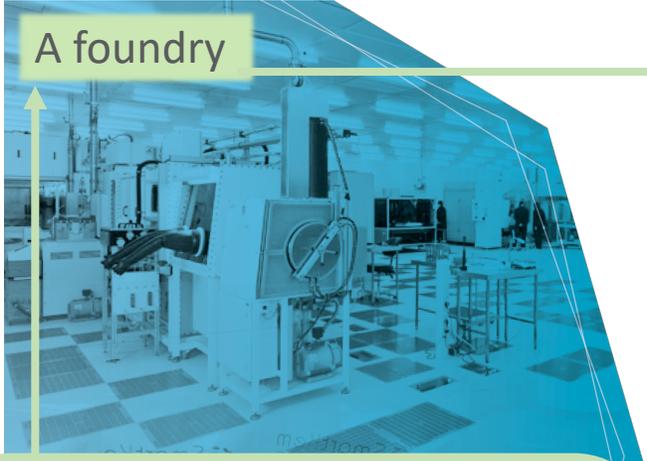
- >133 patents across 16 patent families – 122 granted and >16 pending
- >37 codified trade secrets

#### SmartKem Has Traction

- Traction at multiple technology companies producing OTFT based circuits including Mini-LED Backlights & sensors
- Launched first demonstrator at SID 2020

# ORGANIC TRANSISTORS - THE FLOW

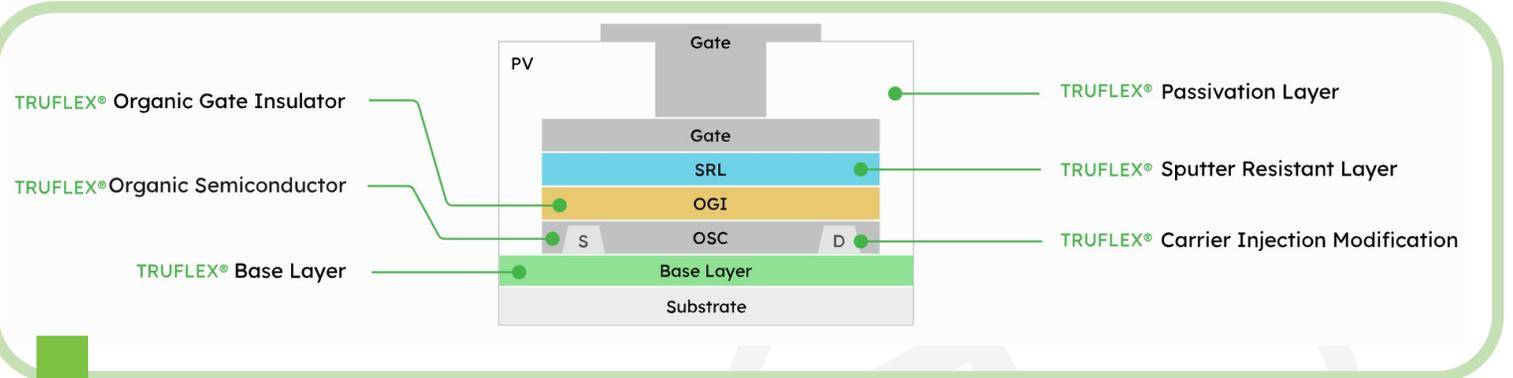
A foundry



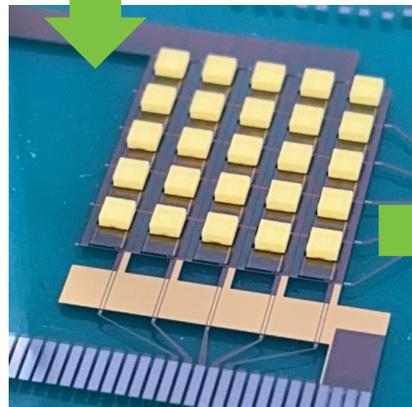
SmartKem Proprietary Materials



SmartKem's OTFTs device structure



LED integration



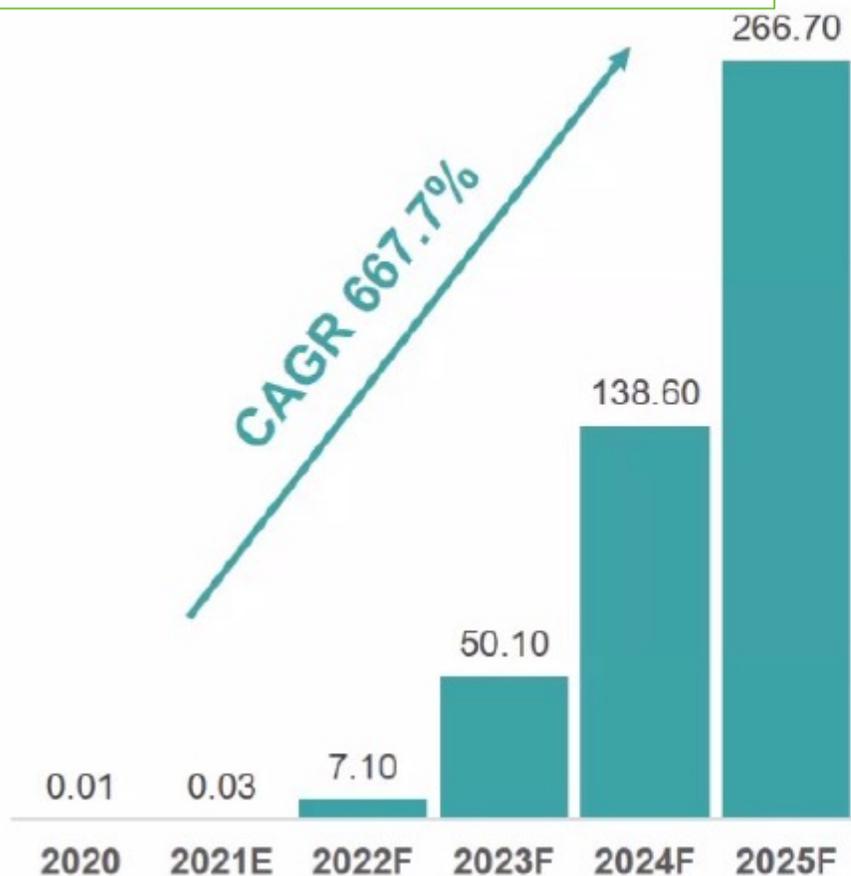
IC / System integration



# MARKET SIZE: MICRO-LED AS ULTIMATE TARGET

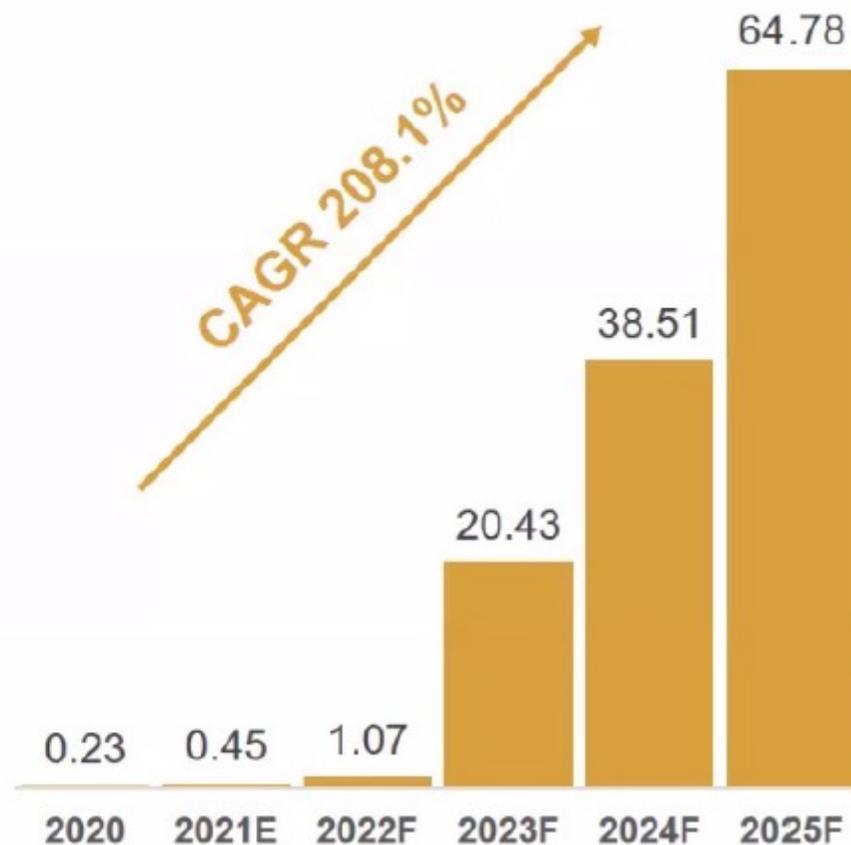
## ■ Micro LED出貨量(萬台)

Micro LED shipments ( unit : 10k sets)



## ■ Micro LED市場規模(億美元)

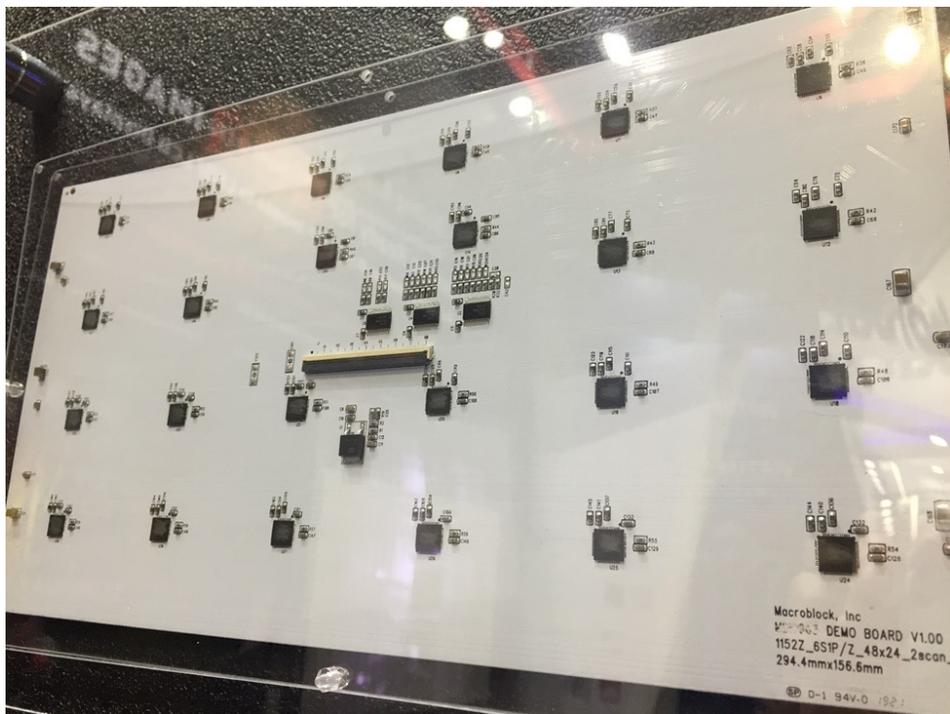
Micro LED market size ( unit : \$0.1billion)



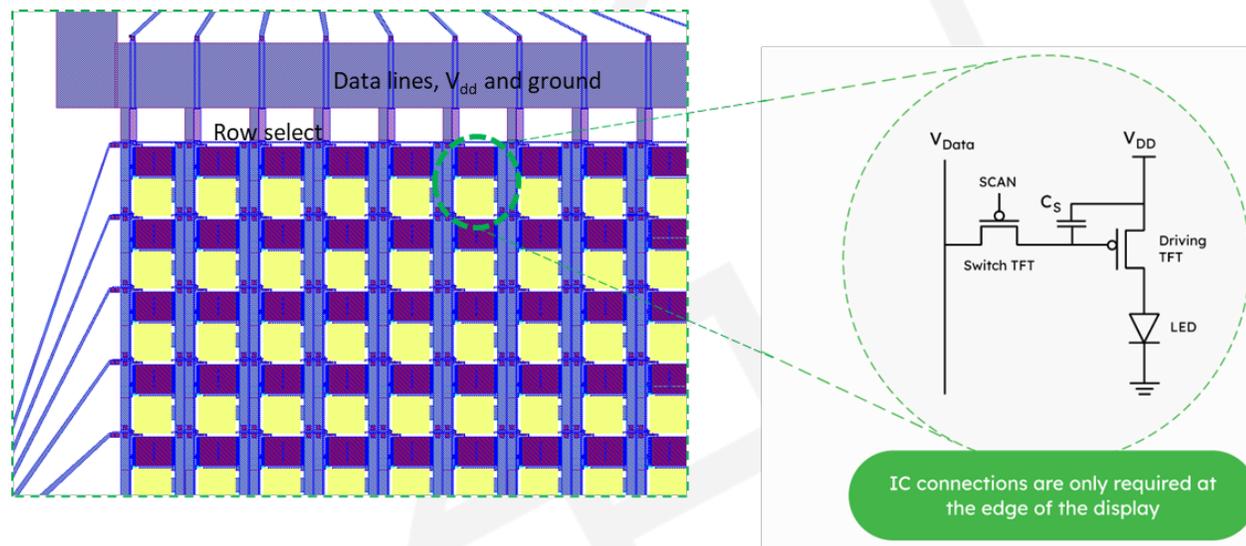
# PASSIVE MATRIX (被動式) VS. ACTIVE MATRIX (主動式)

SmartKem Backplane active matrix driving scheme

Direct wiring



PCB based - 1152 LEDs (each of the 24 ICs is wired to 48 LEDs) - for several 000's of zones this becomes too costly



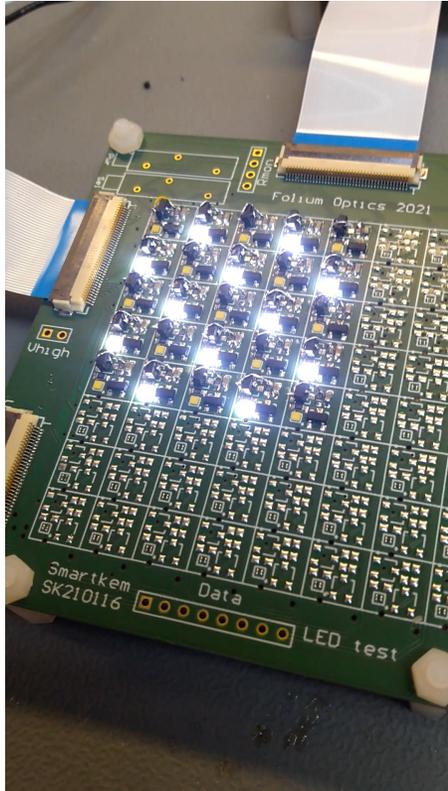
IC connections are only required at the edge of the display

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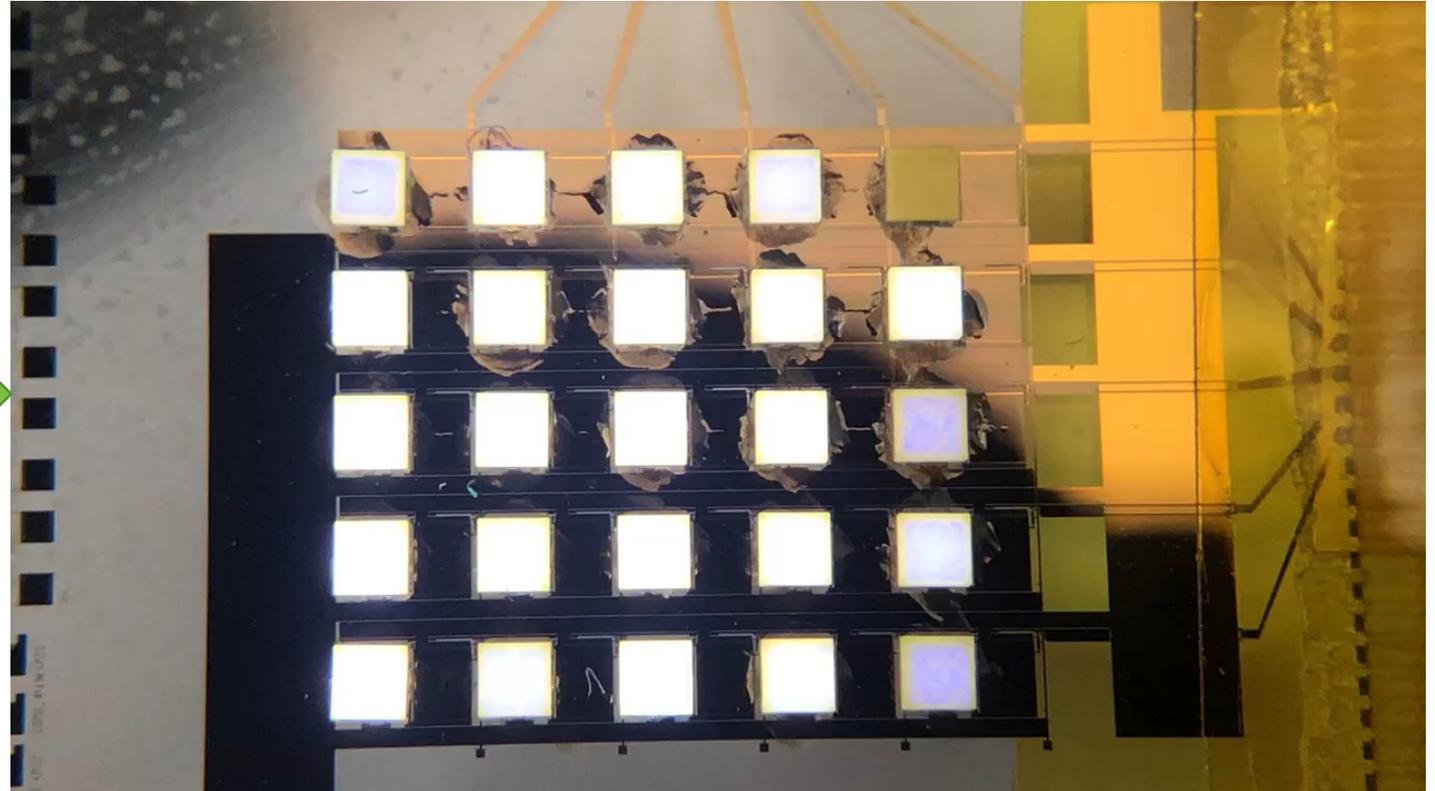
- Low T Process - flatter and less prone to substrate distortion
- Heat from LEDs can be conducted away from back of the substrate (no ICs in the way). On very thin plastic substrates so the thermal conduction is very efficient
- Backplane approach can be modified to microLED in future

# A TRANSITION FROM CONVENTIONAL PCB TECHNOLOGY

All from SmartKem (此系列展示皆為SmartKem自主展品&技術) – From SmartLight Project funded by Innovate UK



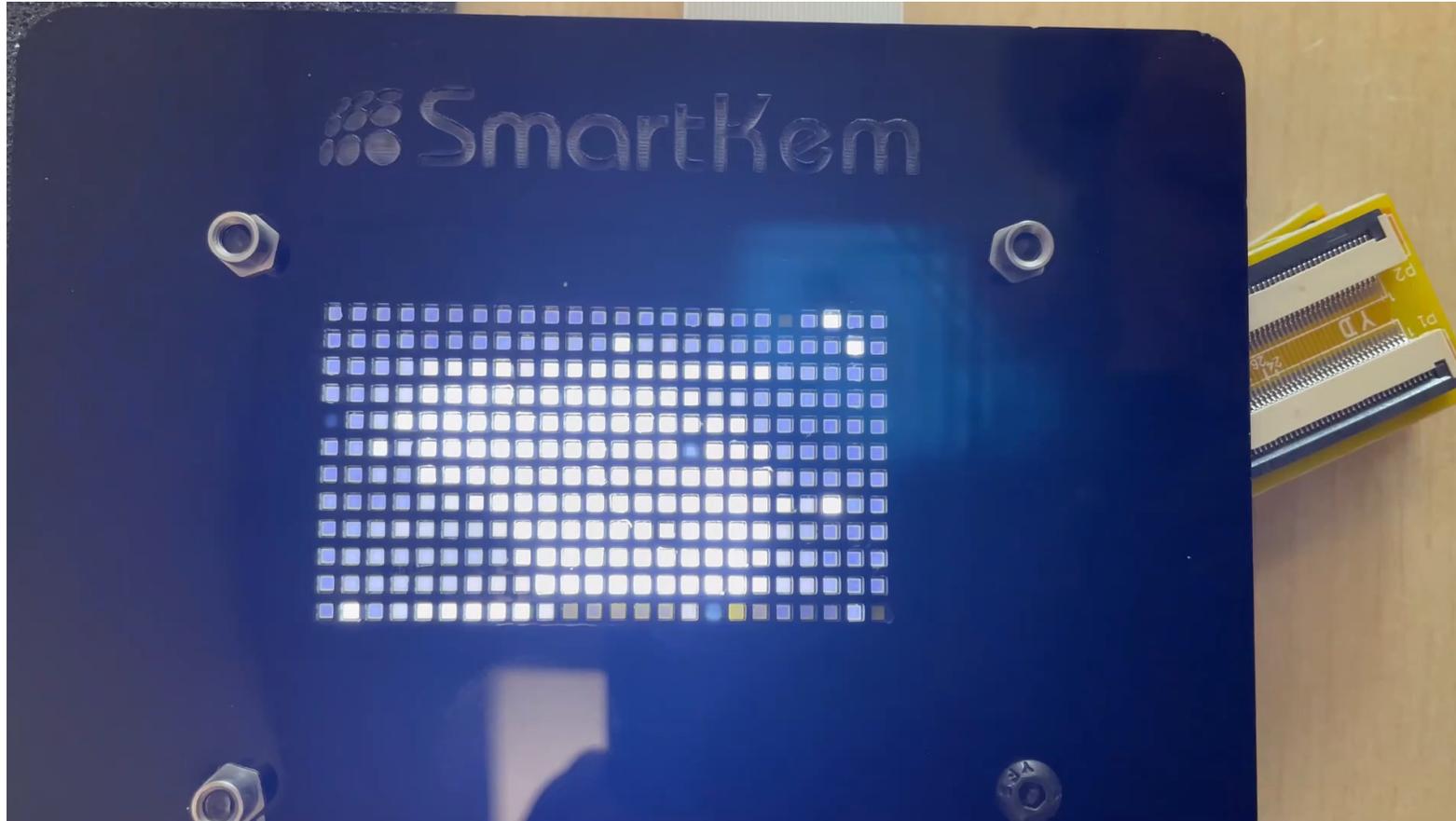
5x5 Si-MOSFET + surface mount capacitor circuit generated on a PCB for driver electronics evaluation



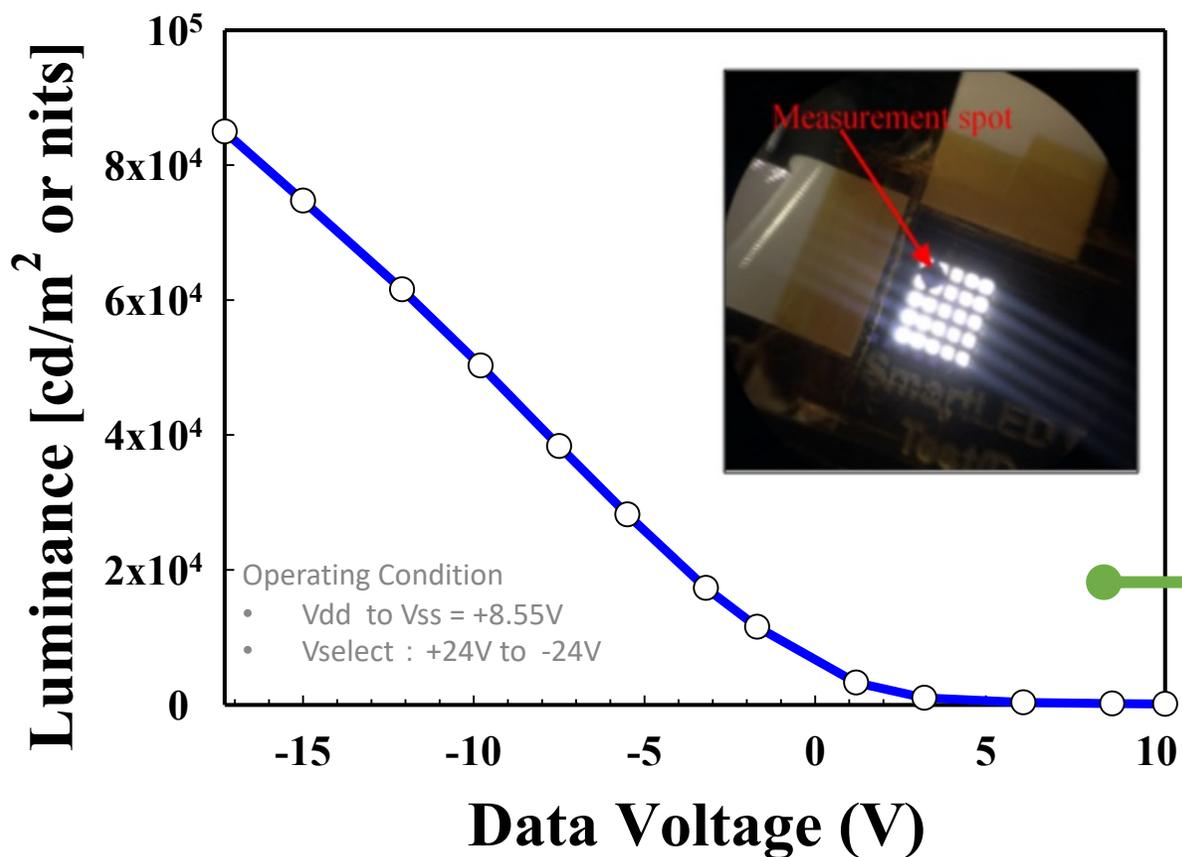
Upgrade to Active Matrix driving (driven by SmartKem OTFTs)

# OTFTS-MINILED BLU DEMONSTRATOR: OTFTS PER LED

- 1 OTFTs driving 1 LED (1個OTFT驅動1個LED) , 12x24 in total



# BACKLIGHT LUMINANCE PERFORMANCE



## Panel Brightness

- 85,000 nit brightness was measured
- Contrast ratio if 1,000,000 : 1

## Working temperature

- LED temp ~30°C While Panel is working

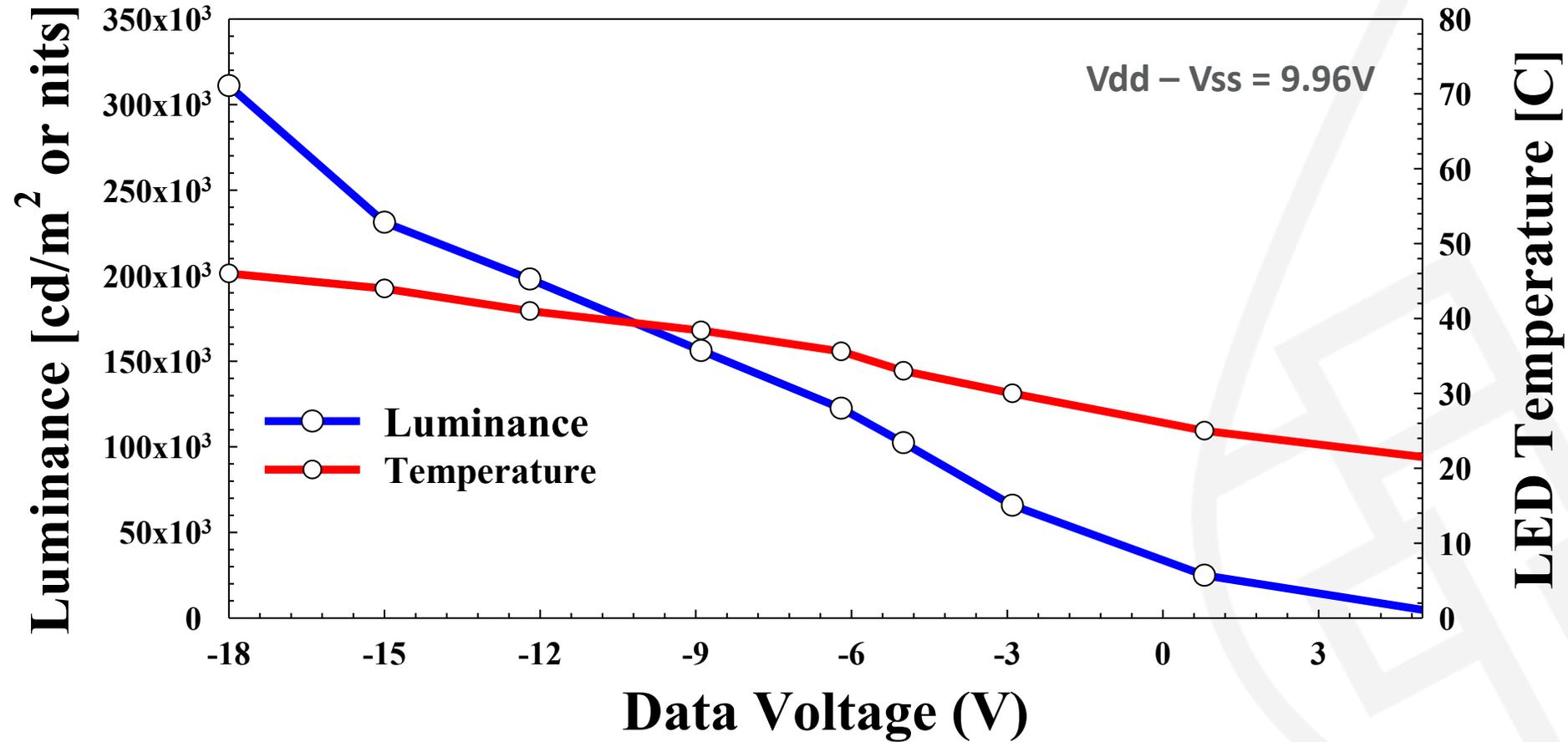
## LCD integration as backlight component

- Equates to 4,250 nits front of the screen with a 5% LCD %T
- LCD native contrast ratio of 2000 : 1)



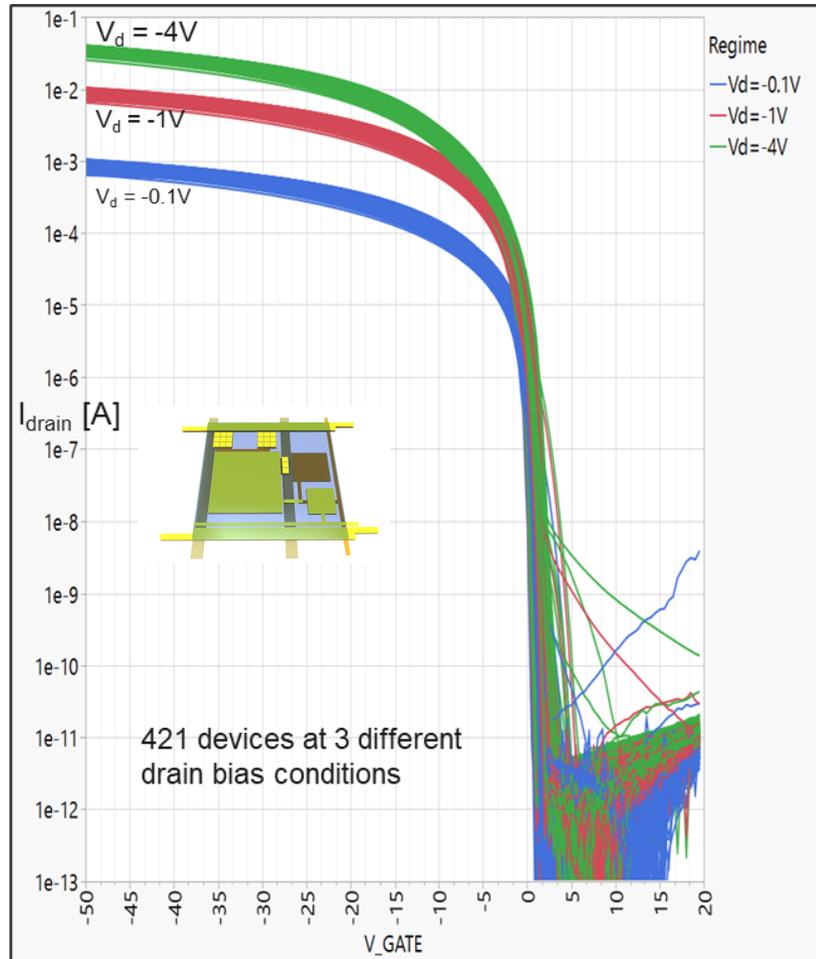
# BACKLIGHT LUMINANCE PERFORMANCE

Luminance > 300k Nits is proven through Vdata applied -18V on OTFTs



# DEMONSTRATORS : MINILED BACKLIGHTS

## OTFTs device performance for Mini-LED Backlight demonstrators



- Median on current at  $V_d = -4V$   $V_g = -50V$  is 40mA
- Off current is a few pA
- On/off ratio is  $\sim 10^{10}$

According to different LED current requirements, SmartKem has the ability to **optimize the TFT design**

$$I_D = \frac{W}{L} \mu C_{\text{ox}} (V_g - V_{\text{th}}) V_d$$

# OUR CAPABILITY



- Substrate from 4inch to Gen2.5 (370\*470mm<sup>2</sup>)
- Capability for a wide region of plastic substrates
- Full device testing & study could proceed in UK/Taiwan
- We could provide a **“SmartKem laboratory”** service to make your idea realized through lab-scale, implementing our proprietary materials (inks) to scale up through your preferred supply chain!

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## **What we are offering to the market**

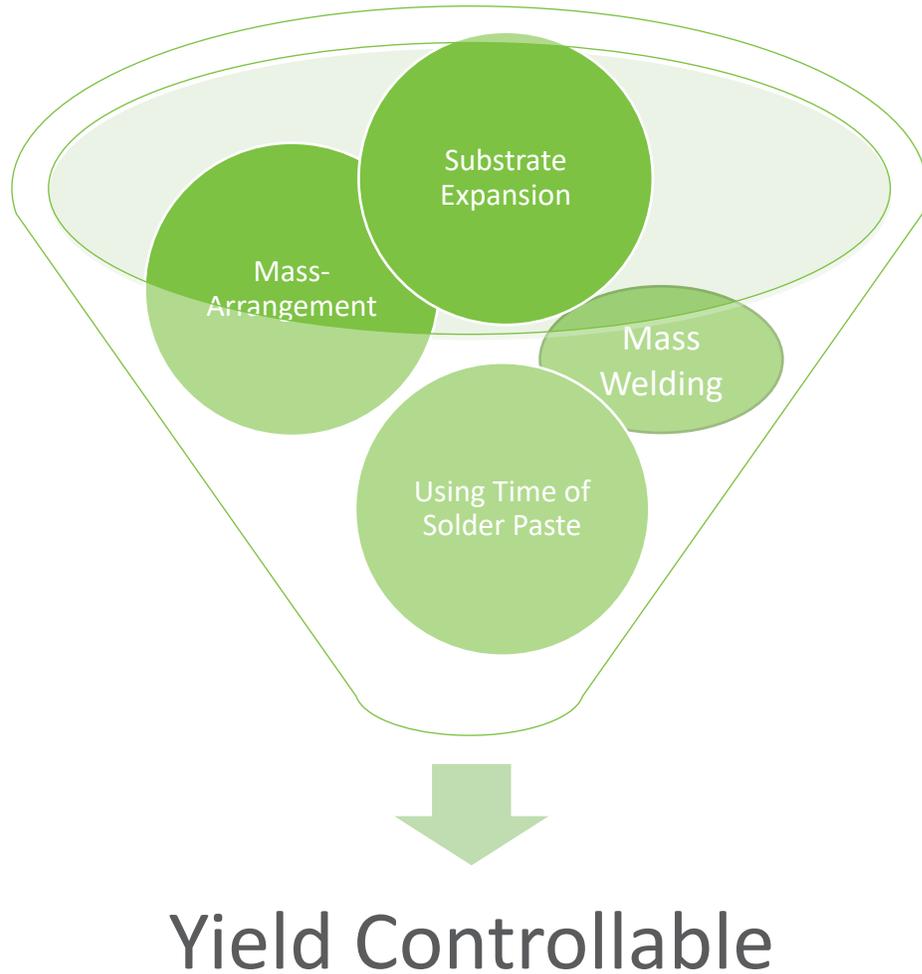
- The details



Date : 28 April, 2022

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# KEY POINT FOR U-LED MASS TRANSFER



- **Substrate Expansion (基板脹縮)**
- **Mass-Arrangement (巨量排列)**
- **Using Time of Solder Paste (錫膏使用時間)**
- **Mass Welding (巨量焊接)**

# SUBSTRATE EXPANSION

There are three different types of plastic substrates (commercialized):

Item	NPG200R	IT-140GTC	EM825
Taiwanese Supplier	Company N	Company I	Company E
Type	BT resin	No Halogen	-
Tg ( Degree C)	205 (DMA)	155 (DESC)	150 (DSC)
CTE (Z axis before Tg)	35 ~45	35	50
CTE (Z axis After Tg)	180~210	180~210	260
CTE (X,Y Axis)	1.2~1.6	1.2~1.6	1.2~1.5
Flammability (UL-94)	V0	V0	V0
Peel strength (lbf/in) 剝離強度	6~9	8	6.5

CTE  
(ppm / degree C)

# SUBSTRATE EXPANSION FOR 16INCH PANEL

- **Normal Soldering** process ~ 240 °C ( 無鉛噴錫表面處理製程,約240 °C)

When CTE(ppm/°C) : **1.2~1.6** for X,Y direction

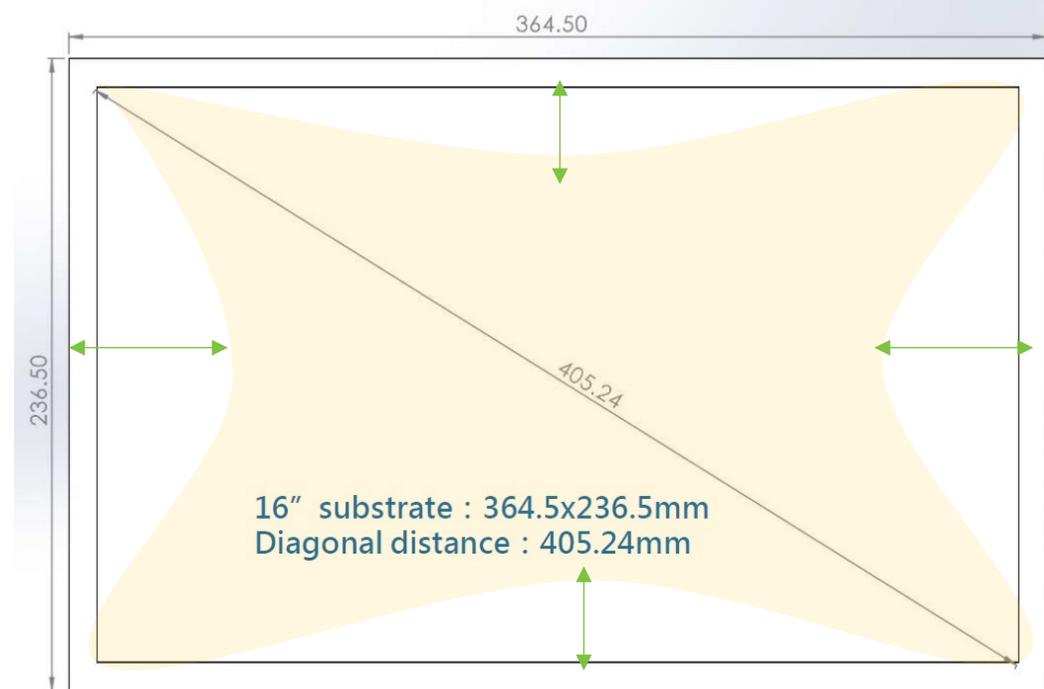
$$405.24\text{mm} \times (1.2/10^6) \times (240\text{ °C} - 25\text{ °C}) = 104.552\text{um}$$

- **By OTFTs process** + Low-temperature mounting (低溫背板製程)

When CTE(ppm/°C) : **1.2~1.6** for X,Y direction

$$405.24\text{mm} \times (1.2/10^6) \times (80\text{ °C} - 25\text{ °C}) = 26.746\text{ um}$$

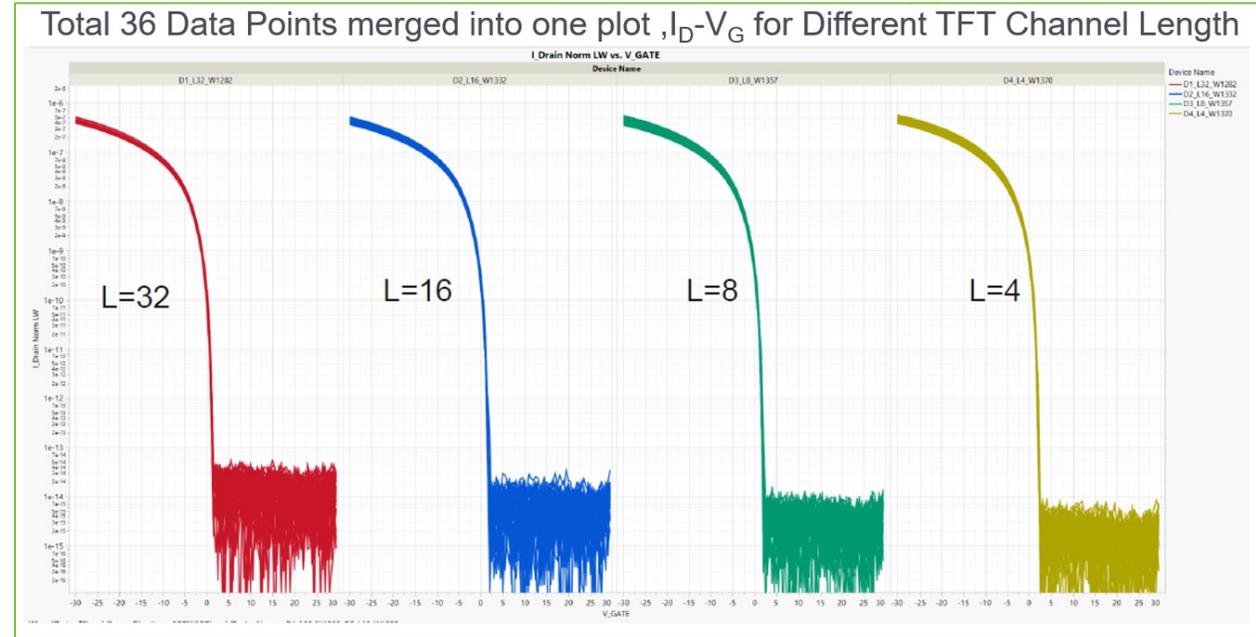
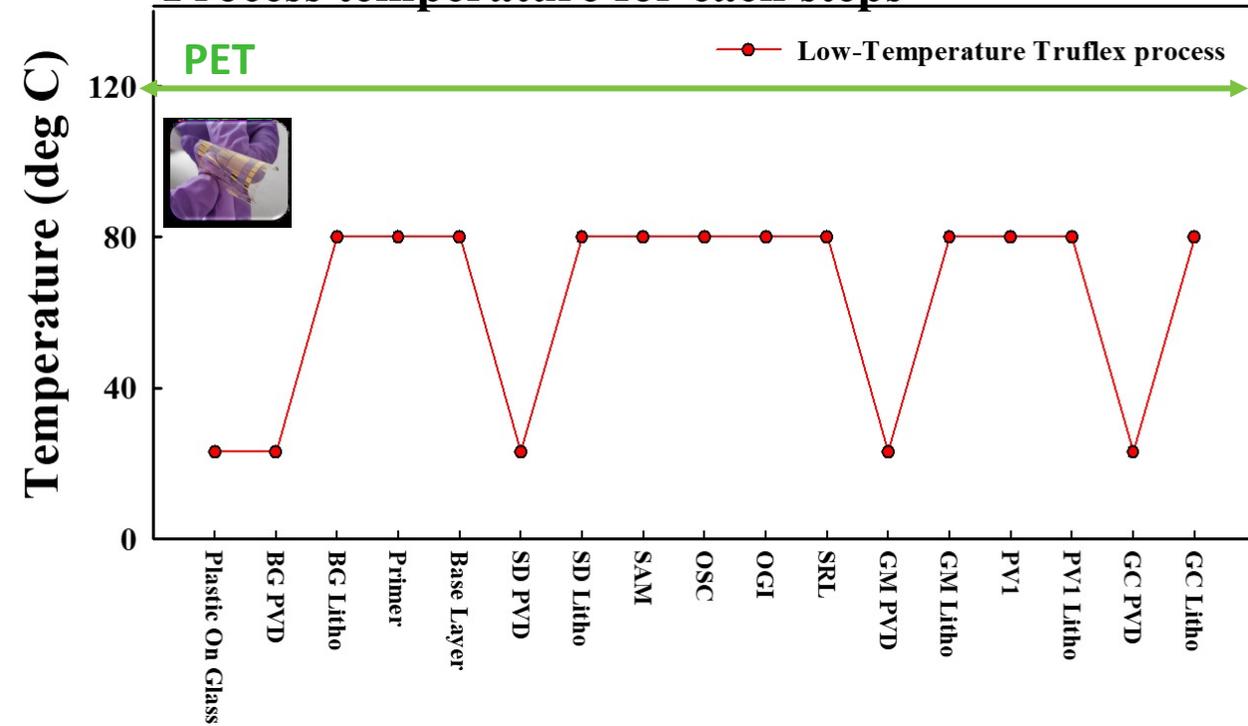
**Improvement >74.5%!**



# 80 DEGREE-C OTFTS PROCESS

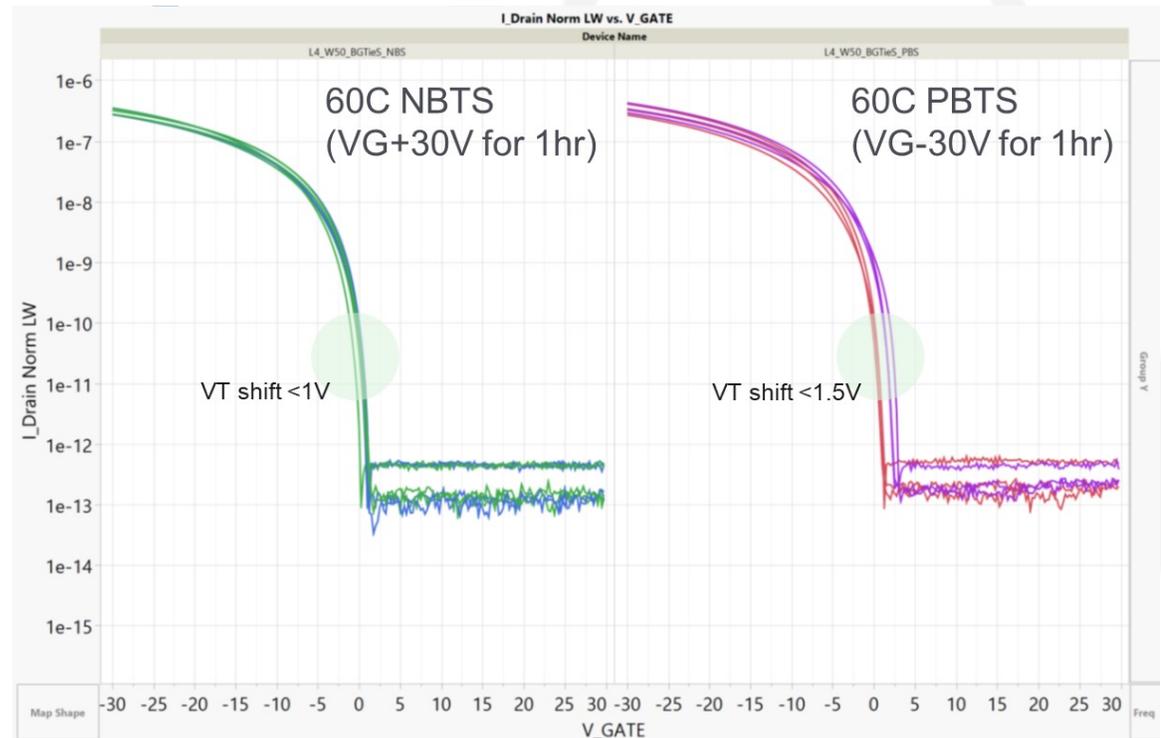
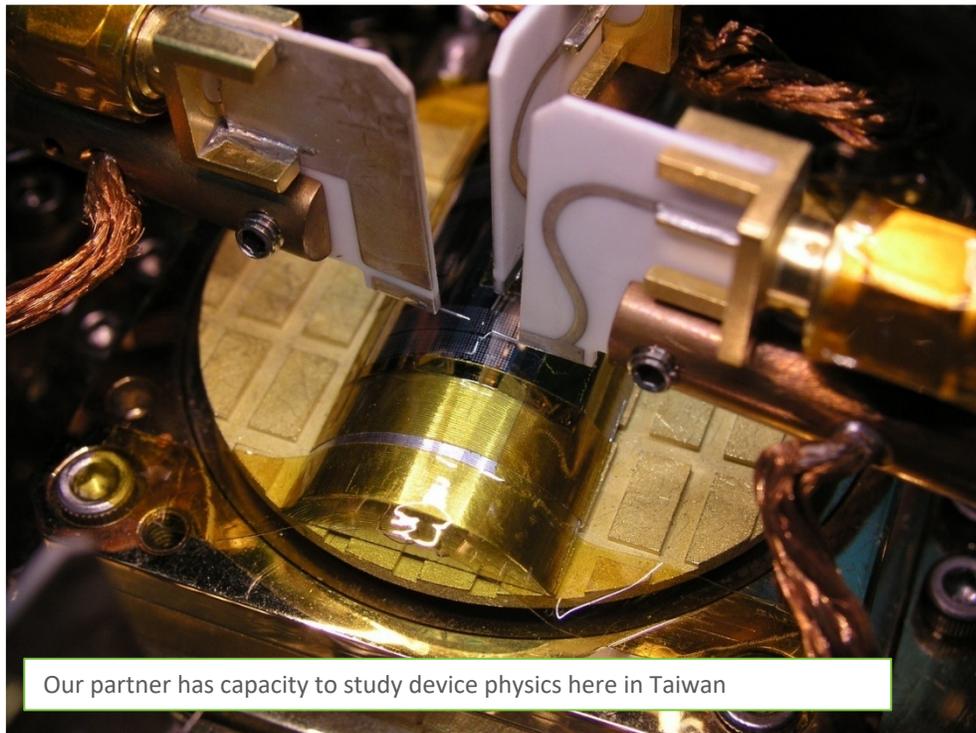
80 °C OTFTs process demonstrated consistent performance shown in ID-VG (36 data points merged )

## Process temperature for each steps



# 80 DEGREE-C OTFTS PROCESS – ELECTRICAL STABILITY

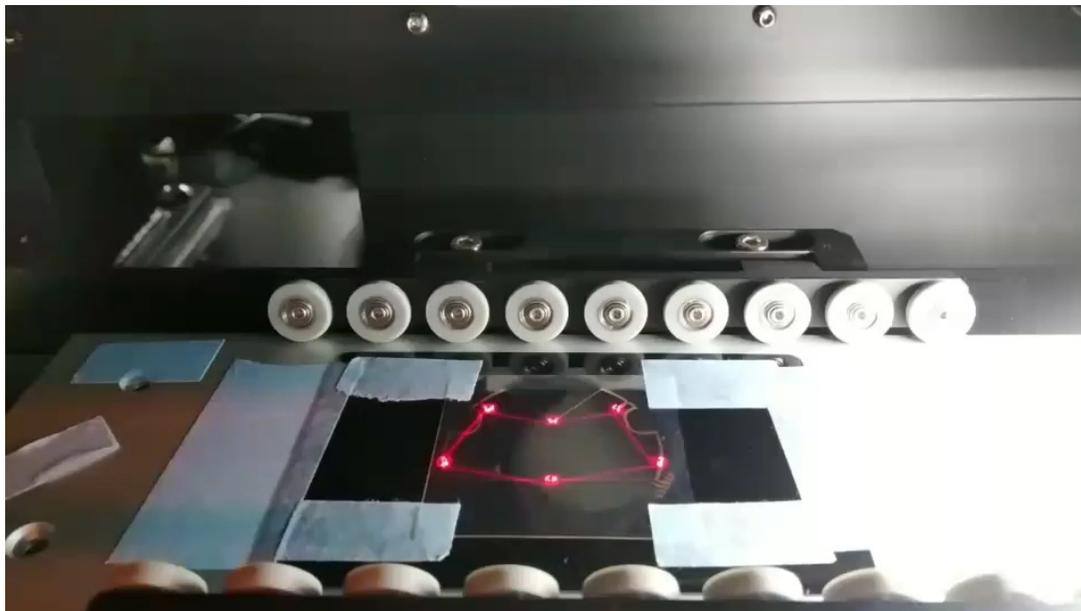
- 1) 80 °C OTFTs process demonstrated excellent electrical stability (under high-temperature DC bias stress)
- 2) OTFTs device stability measured through fixed curve mechanical stress as separate studies



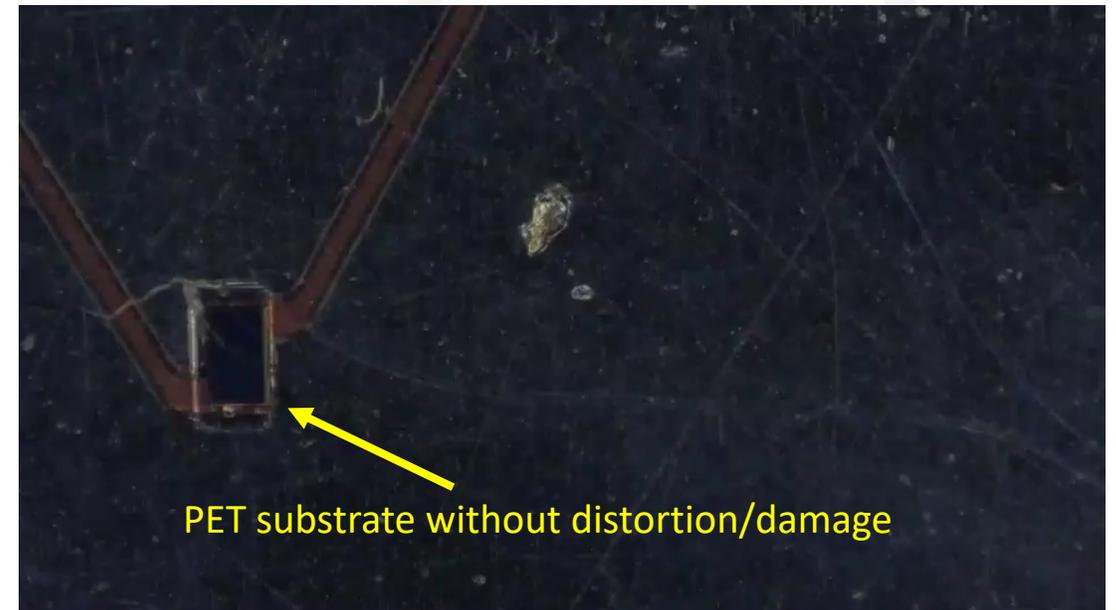
# LOW TEMPERATURE MINI-LED MOUNTING ON PET SUBSTRATE

Background: eye tracking applications (especially near eyes display) requires an IR LED on a plastic substrate driven by TFT or IC .

Video – Laser mounting IR LED on PET substrate



Video – After LED mounting, Light-on test



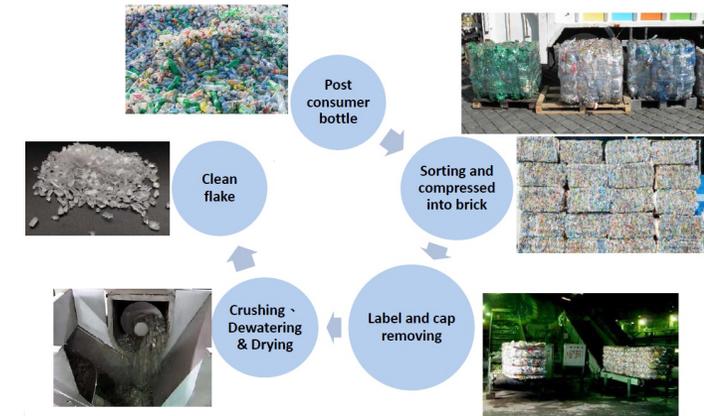
\*Supported by our industrial partner , video Authorized to announce

# ESG - ENVIRONMENT SOCIAL GOVERNANCE

Low-temperature backplane manufacturing is offering identical benefits for ESG production.

Material / Process		Unit	General	Recycled	Bio PET
Chip process	PTA	kg CO <sub>2</sub> e/ton	1744	-	1744
	EG	kg CO <sub>2</sub> e/ton	480	-	0
	PTA+EG→PET Chip	kg CO <sub>2</sub> e/ton	587	312	587
	Ratio of Reduction	%	-	88.90	17.08
Film process	PET Chip→PET Film	kg CO <sub>2</sub> e/ton	3664	3664	3664
	Total	kg CO <sub>2</sub> e/ton	6475	3977	5996
Total	Ratio of Reduction	%	-	38.58	7.40

\*Data from public company



In PET substrate, a recycle PET is possible to Reduce >88% CO<sub>2</sub> emission

# ESG - CONTINUOUS EFFORT FROM SMARTKEM

SmartKem's efforts go beyond that of organic electronics. We are continuously striving to help the planet by planting trees. SmartKem will donate over **11,500** trees in 2022!

Kenya (肯亞)



Peru – Quellccanca



Malawi (馬拉威)



Warwickshire, England, UK



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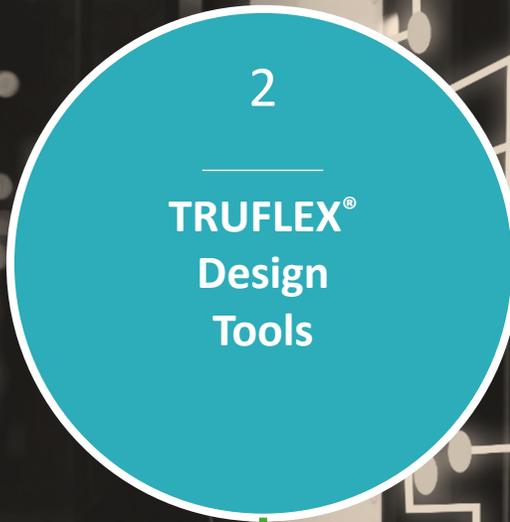
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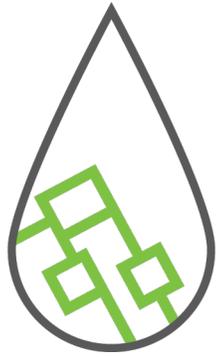
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**Mass Deployment**

SmartKem welcomes collaboration in the development of min-/u-LED applications!



Smartkem  
OUR TRANSISTORS YOUR ADVANTAGE

THANK YOU

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