



***In situ* Plasma Polarization of Electroactive Polymer Thin Films for Mass Production**

电活性高分子薄膜原位极化的量产工艺

More than Moore · More than Innovation

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Outlines 内容提要

- Electroactive polymers as multi-functional materials
 - Ultrasonic fingerprint sensors
 - Manufacturing process for ultrasonic fingerprint sensors
 - *In situ* plasma polarization (poling)
 - Conclusions and outlook
- 多功能电活性高分子材料
 - 超声指纹传感器
 - 相关生产工艺
 - 等离子体原位极化技术
 - 小结与展望

Physical Parameters Vary with Stimuli 物理量随输入刺激的变化

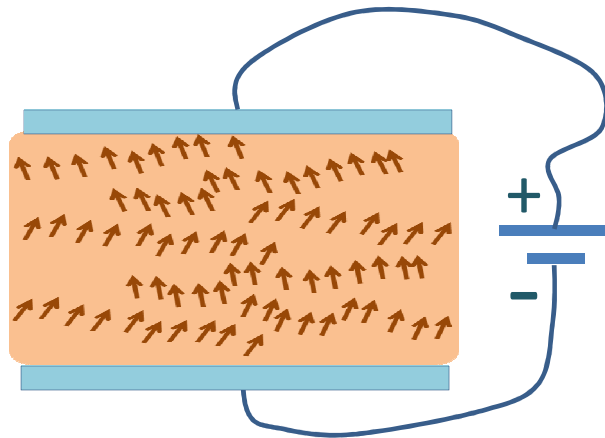
Pressure



Polarization
Surface charge (\sim Pressure)

[Piezoelectric effect]
[压电效应]

Electrical field



Strain (\sim E field)

[Reverse piezoelectric effect]
[反向压电效应]

Heat

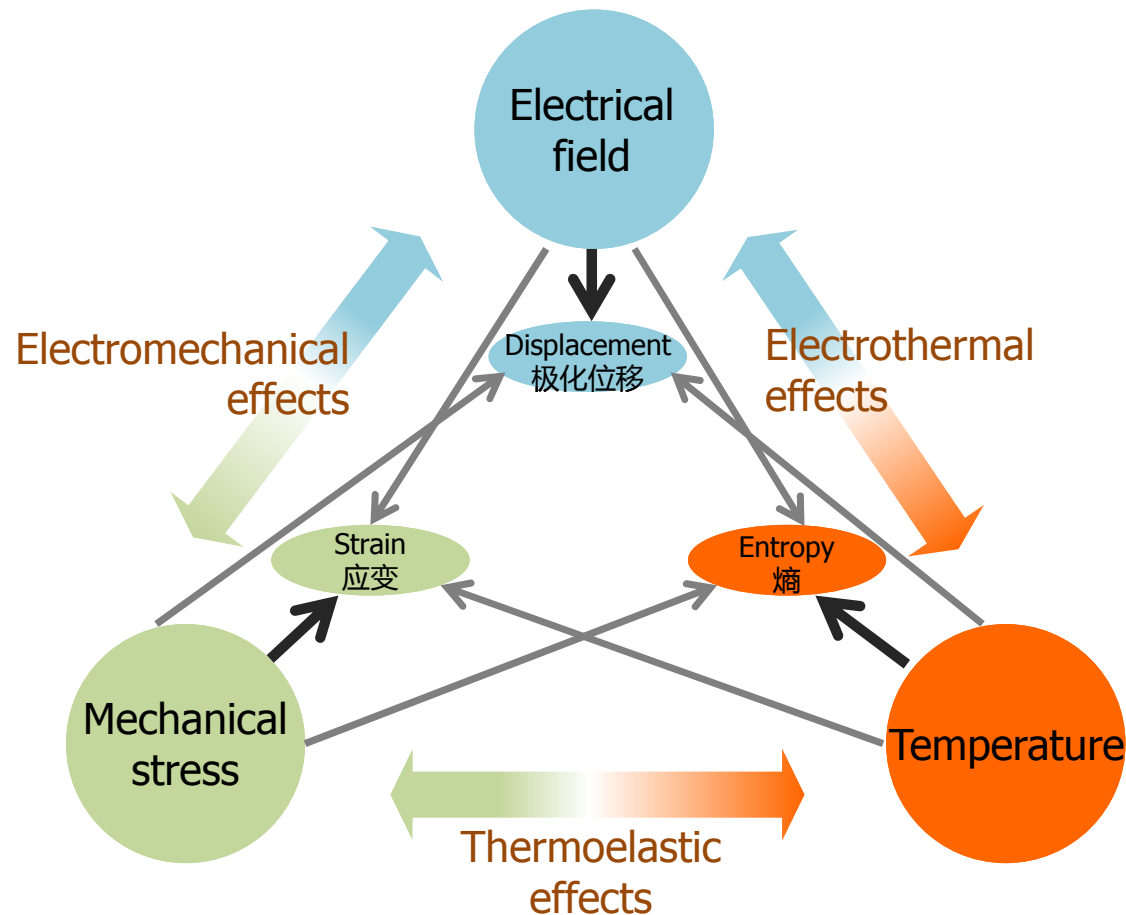


Polarization
Surface charge (\sim Temperature or IR)

[Pyroelectric effect]
[热释电效应]

Electroactive Polymers' Multi-functionality

电活性高分子材料的多功能性



- Complex systems involving many interrelated physical parameters
- Great for multi-functional sensors or actuators
- Low temperature (<150C) process comparing to ceramic materials, e.g. ZnO, PZT, AlN
- Compatible with flexible electronics
- Large area and printable process
- Opportunities for low cost integration with Silicon- or glass-based CMOS and MEMS devices

Piezoelectric Polymer for Ultrasonic Fingerprint Sensors

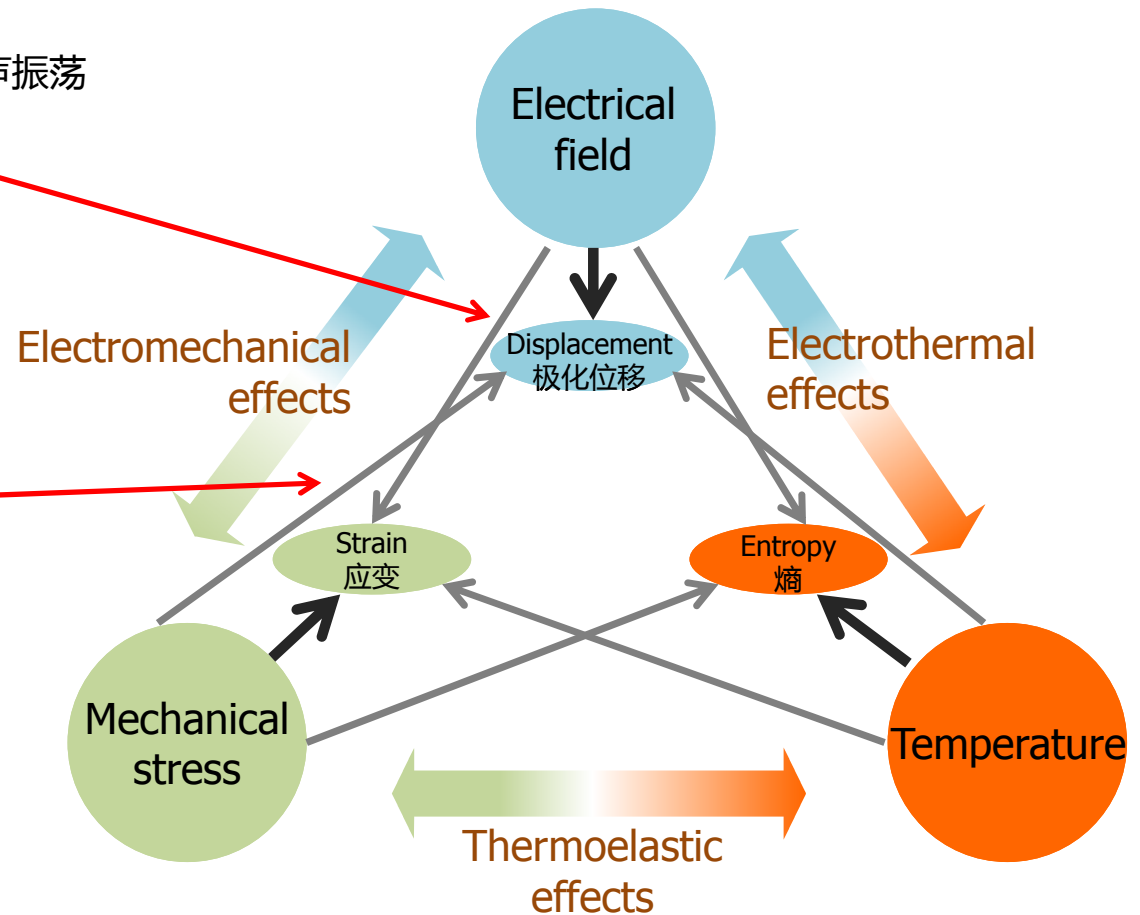
压电高分子超声指纹传感器

Reverse Piezoelectric Effect 反压电效应测试超声振荡

Apply changing electrical field to cause change of strain and thus ultrasound [Tx] to actively generate ultrasound

Piezoelectric Effect 压电效应感应超声振荡

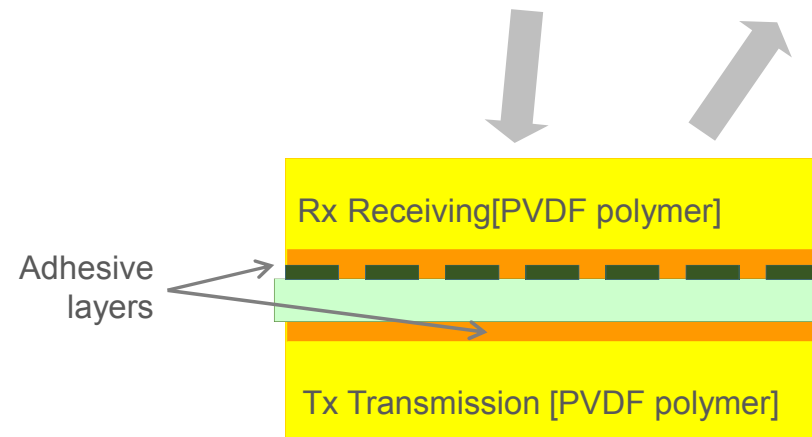
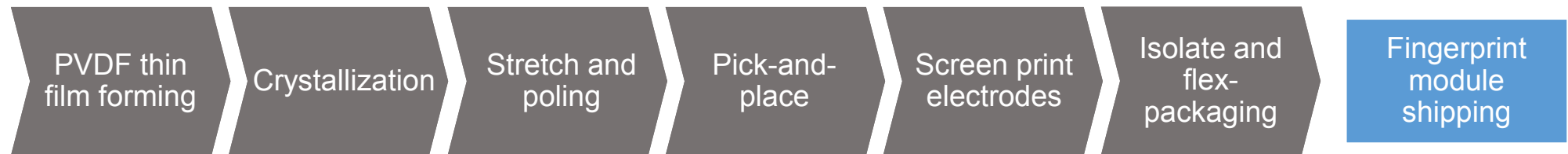
Sense change in mechanical stress and converts into charge density change [Rx] to receive reflected ultrasound



Conventional Manufacturing Process 超声指纹芯片制造工艺

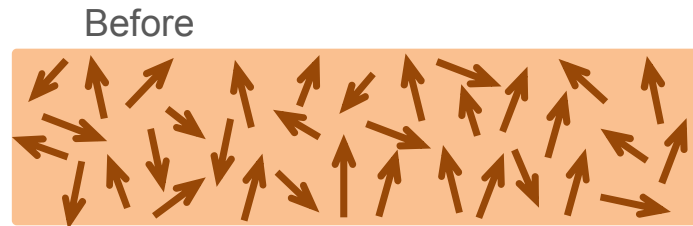
Incoming TFT
CMOS array
backplate

TFT CMOS pixel array
Glass array
substrate

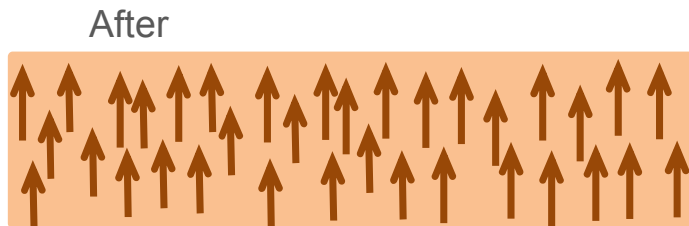


- Two sheets of thick PVDF
- Adhesive layers
- Device performance
- High production cost
- Up to 200mm size

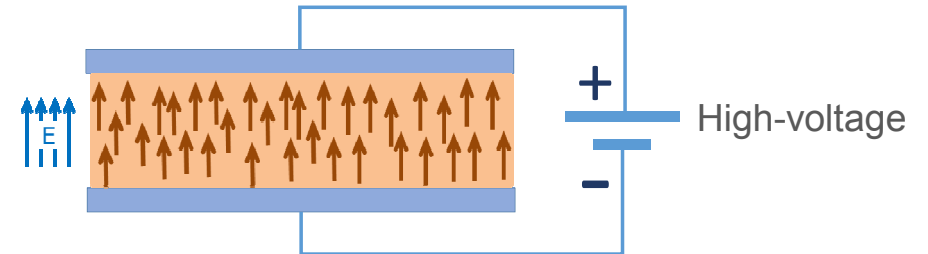
Polarization (Poling) of Polymer Thin Films 高分子薄膜极化



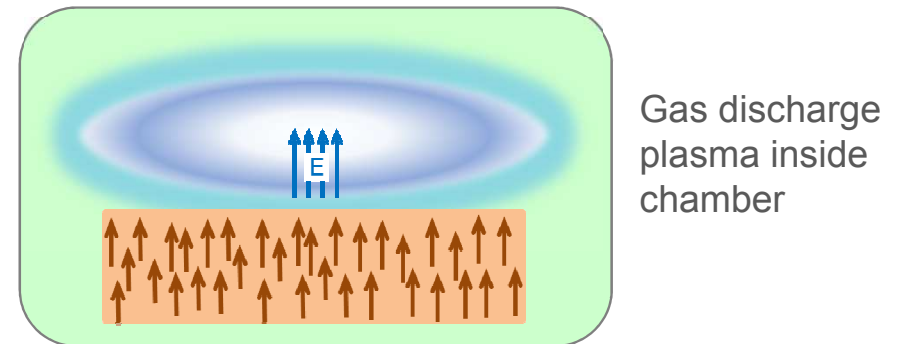
Poling:
Process to apply
electrical field on
polymer to re-align
dipoles



Direct poling 直接极化



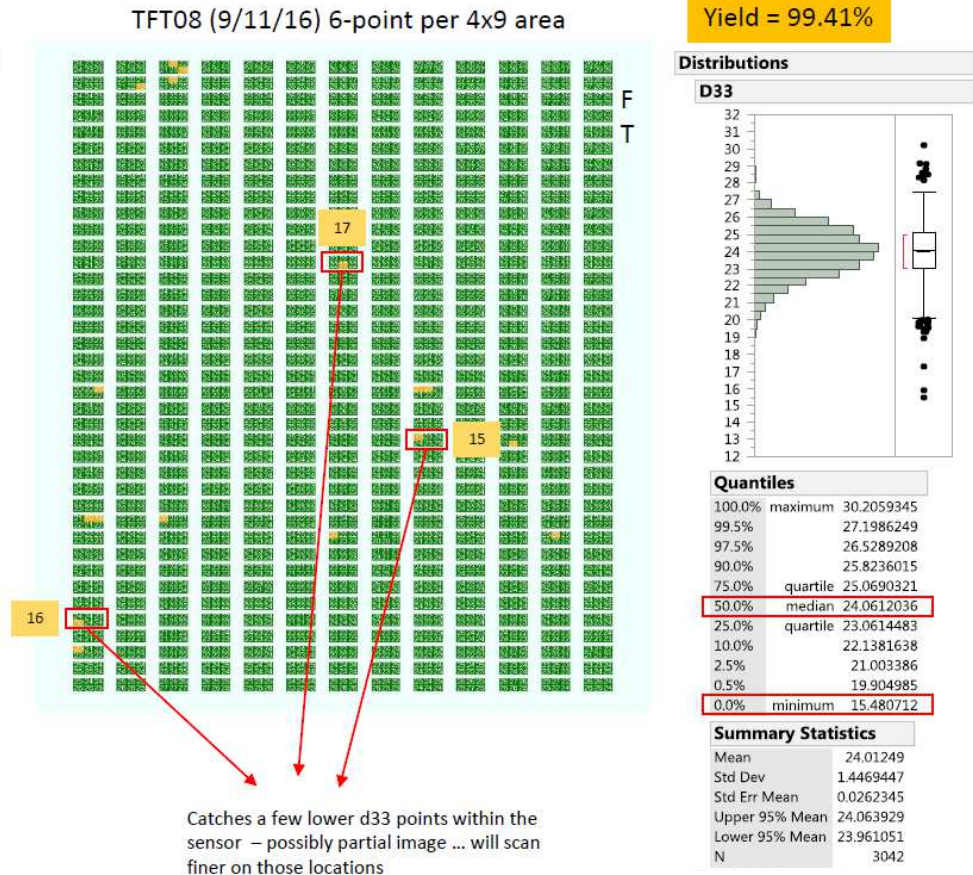
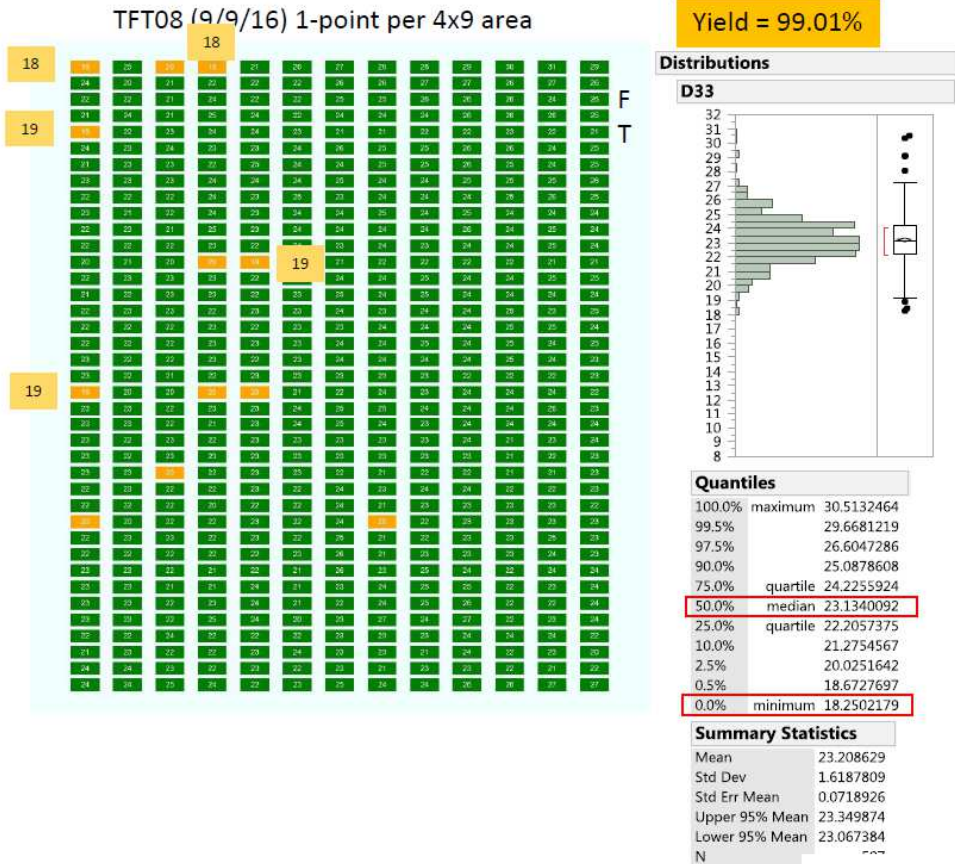
Plasma poling 等离子极化



Continuous Yield Improvement 持续良率改进

Sept 2016: Yield 99%

- D33 probing station mapping (1-point/chip vs. 6-point/chip)



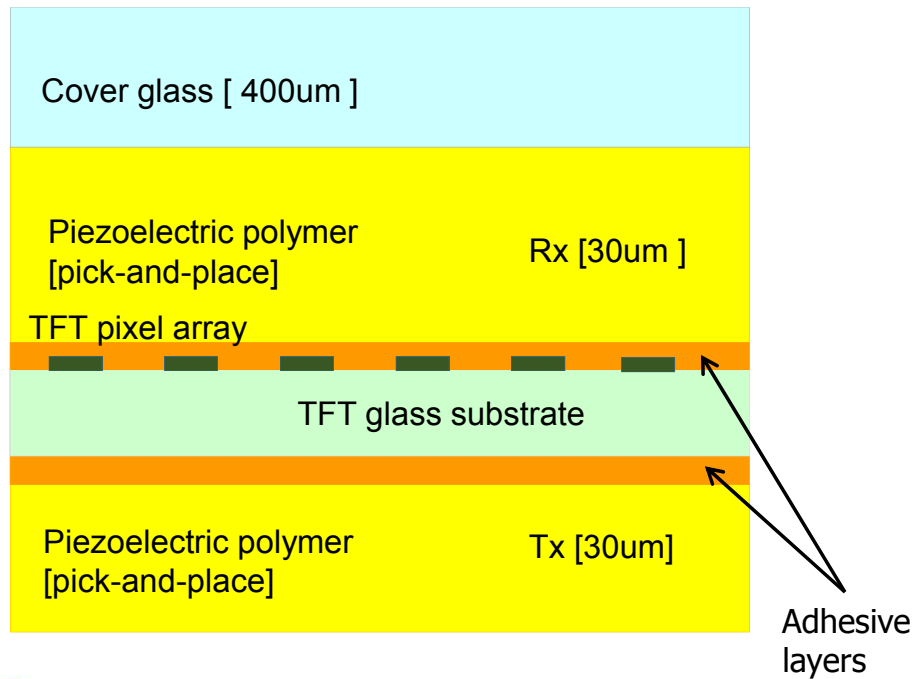
Release to Mass Production 2017 交付量产

- Excellent process performance: d33 up to 28pC/N
- No plasma damage to CMOS underneath polymer
- High yield in mass production, > 99%
- High throughput, fast cycle time
- Scalable to larger backplate sizes (Gen 6, *i.e.* 1.85 X 1.5 meter)
- Successfully applied to FP modules for mobiles phones

Comparison of Old and New Processes 与旧工艺的比较

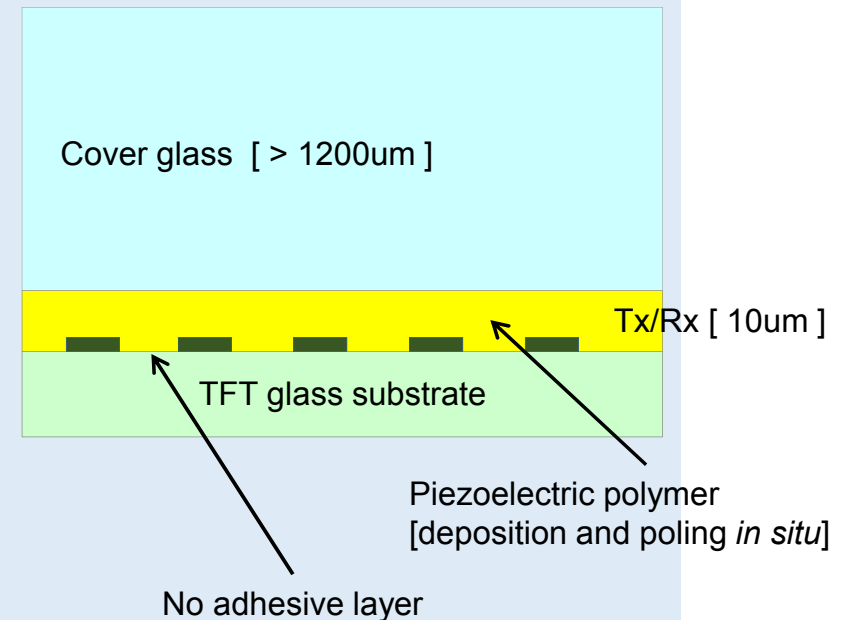
Old Pick-and-place Process

- High production cost (>10X)
- Low resolution (1X)
- Low S/N ratio (3.5 : 1)
- Penetrate only 400um cover glass



Advanced *in situ* Process

- ✓ Low production cost (1X)
- ✓ High resolution (>3X)
- ✓ High S/N ratio (10 : 1)
- ✓ Penetrate > 1200um cover glass, good for under OLED display



Honor 10 荣耀10



honor 10^{AI}
BEAUTY IN AI

Samsung S10 三星S10

Galaxy S10

HIGHLIGHTS

DESIGN

PERFORMANCE

CAMERA

INTELLIGENCE

Ultrasonic Fingerprint ID protects and unlocks with the first touch.

We moved the Fingerprint Scanner from the back to the front, creating a revolutionary, on-screen sensor. Using ultrasonic pulses, it detects the 3D ridges and valleys of your fingerprint, so only you can access your phone. It's secure and convenient — even allowing you to unlock, drag, and hold to open the app you want.

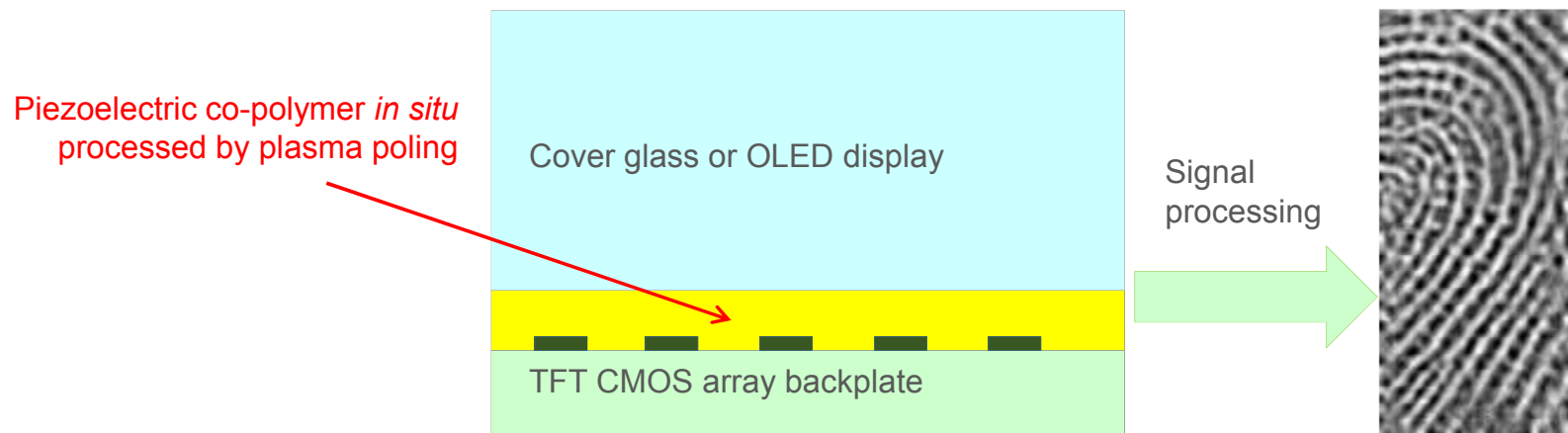


Ultrasonic
Fingerprint

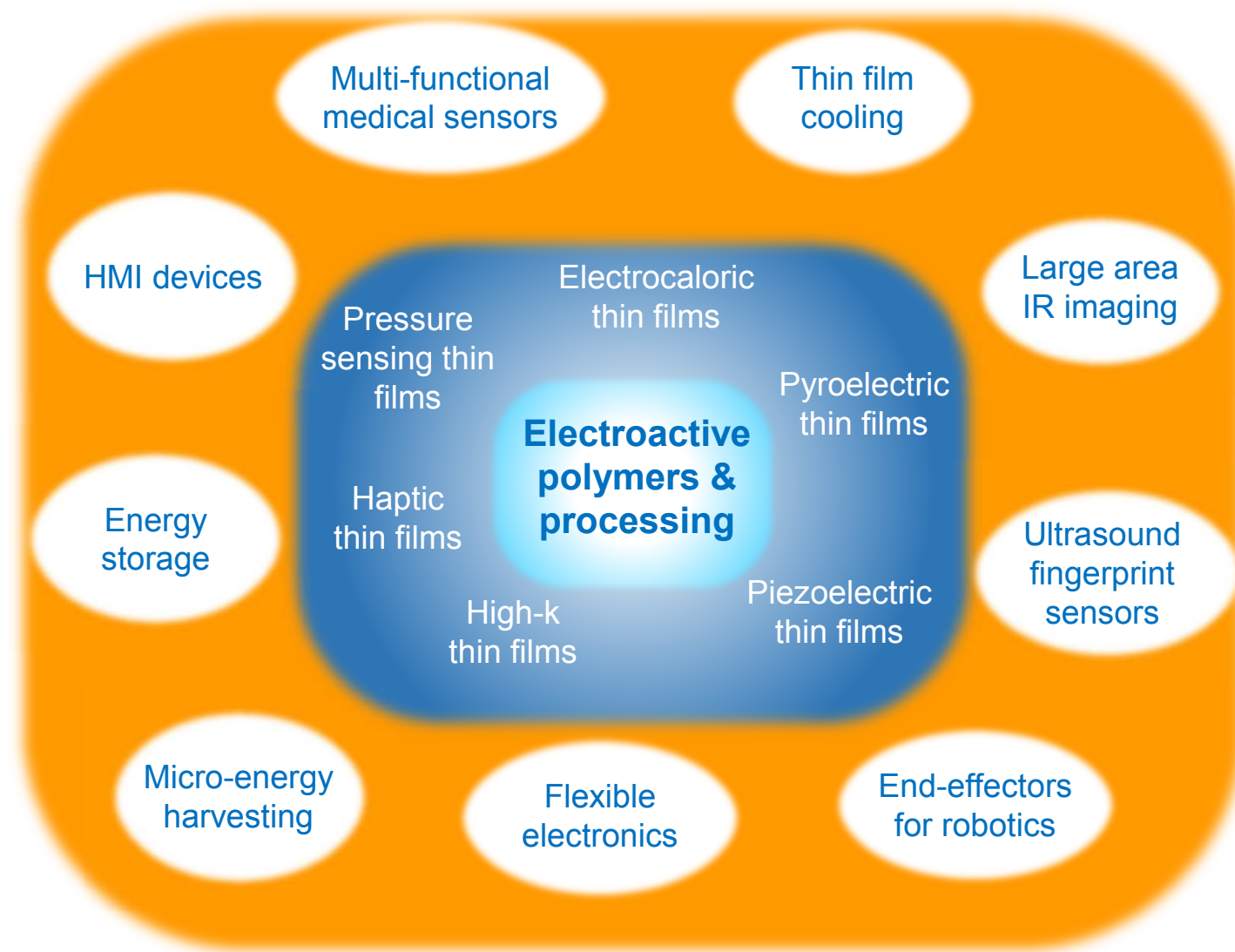


Conclusions 小结

- Electroactive polymers hold many potential applications, thanks to their multi-functionality
- Polymer-based ultrasound fingerprint sensor is one such application; the only ultrasound FP technology used in mobile phones on market
- As an enabling technology, *in situ* plasma polarization (poling) has been proven to be a high-performance, high-yield process for mass production



Outlook for Potential Applications 应用展望



ASE(Advanced Semiconductor Equipment) at SITRI 先进设备

An open platform to industrial partners
Enable better devices with better processes and tools

Active Materials

- AlN
- PZT
- Electroactive polymers

Substrates

- Wafers
- Glass
- Flexibles

Opportunities in Specialty Processes

- Thin-film depositions
- Nano-particles
- Etch and trimming
- Annealing
- Polarization (poling)
- Packaging
- Metrology

THANKYOU

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