ITRI
Industrial Technology
Research Institute

Flexible Electronics Development in Taiwan

Dr. Janglin (John) Chen
Vice President & General Director
Display Technology Center

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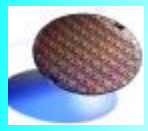
Speaker Introduction

- **Name: Janglin (John) Chen 程章林**
- **Present Position**
  - Vice President and General Director of Display Technology Center/ITRI (2006-present)
  - Chairman of TDMDA (Taiwan Flat Panel Display Materials & Devices Association, 2007-present)
- **Past Experience**
  - Chief Technology Officer, Kodak LCD Polarizer Films Business (2005)
  - Chief Technologist, Kodak Optical Display Films (2001)
  - Technical Fellow, Eastman Kodak Company (2000)
- **Education**
  - Stanford Executive Program, Graduate School of Business, Stanford University (2008)
  - Ph.D., Polymer Chemistry / Material, Polytechnic Institute of New York, USA (1982)
  - M.S., Polymer Chemistry, Polytechnic Institute of New York, USA (1981)
  - B.S., Chemistry, National Tsing Hua University, Taiwan (1975)
- **Professional Specialty**
  - Display material, substrates, flexible displays, optical function films

Global Presence of Taiwan's Industries

- A
- P
- G

Semiconductor



Foundry
IC Packaging
IC Testing
Mask ROM
IC design
DRAM
LCD Driver IC

3C Products

Motherboard
Notebook
Cell Phone
Digital Camera

Networking Products

SOHO Router
Wireless LAN
xDSL/Cable CPE
Ethernet LAN Switch

Display

TN/STN LCD
TFT LCD
OLED
Micro-display

Electrical Components

LED
PCB/Flexible PCB
Connector

Opportunity with Flexible Electronics

- Leverage Taiwan's fast integration capability to add value to ICT products by introducing 'flexible' new features

Paper-like Speaker Industry
(Consumer application)

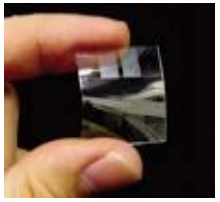
Flexible Display Industry

Flexible lighting
(Decoration application)

Fast Integration

Flexible Sensor Industry
(UI, Human-scale application)

Printed Electronics Device Industry
(Antenna, Circuit)



Portable Power Industry
(Flexible, thin embedded application)

Flexible Electronics Development in Taiwan

Industries

- **E Ink Holdings** and **AUO** are global major AMEPD suppliers

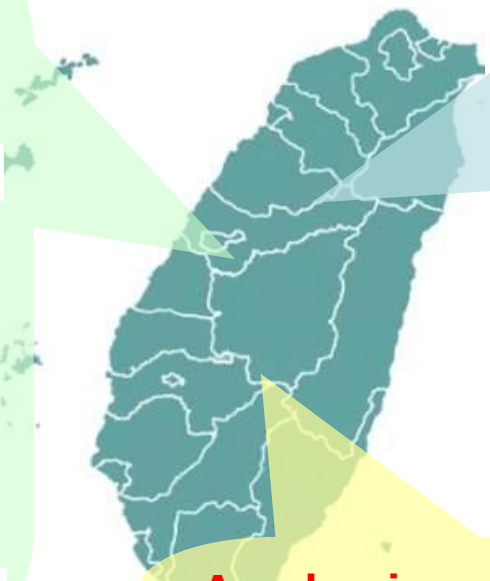
E Ink Holdings E·INK AUO SiPix

-**Delta** focuses on QRLPD e-paper.

DELTA BRIDGESTONE

- **Wistron (with Polymer Vision)** focus on foldable e-paper production

wistron Polymer Vision



R&D

- **MOEA** Project is the main R&D funding source.
- **ITRI** plays a leading role in developing R2R Ch-LCD and flexible OLED.
- **ITRI** also collaborates with domestic industry to establish industrial supply chain.

MOEA ITRI Industrial Technology Research Institute

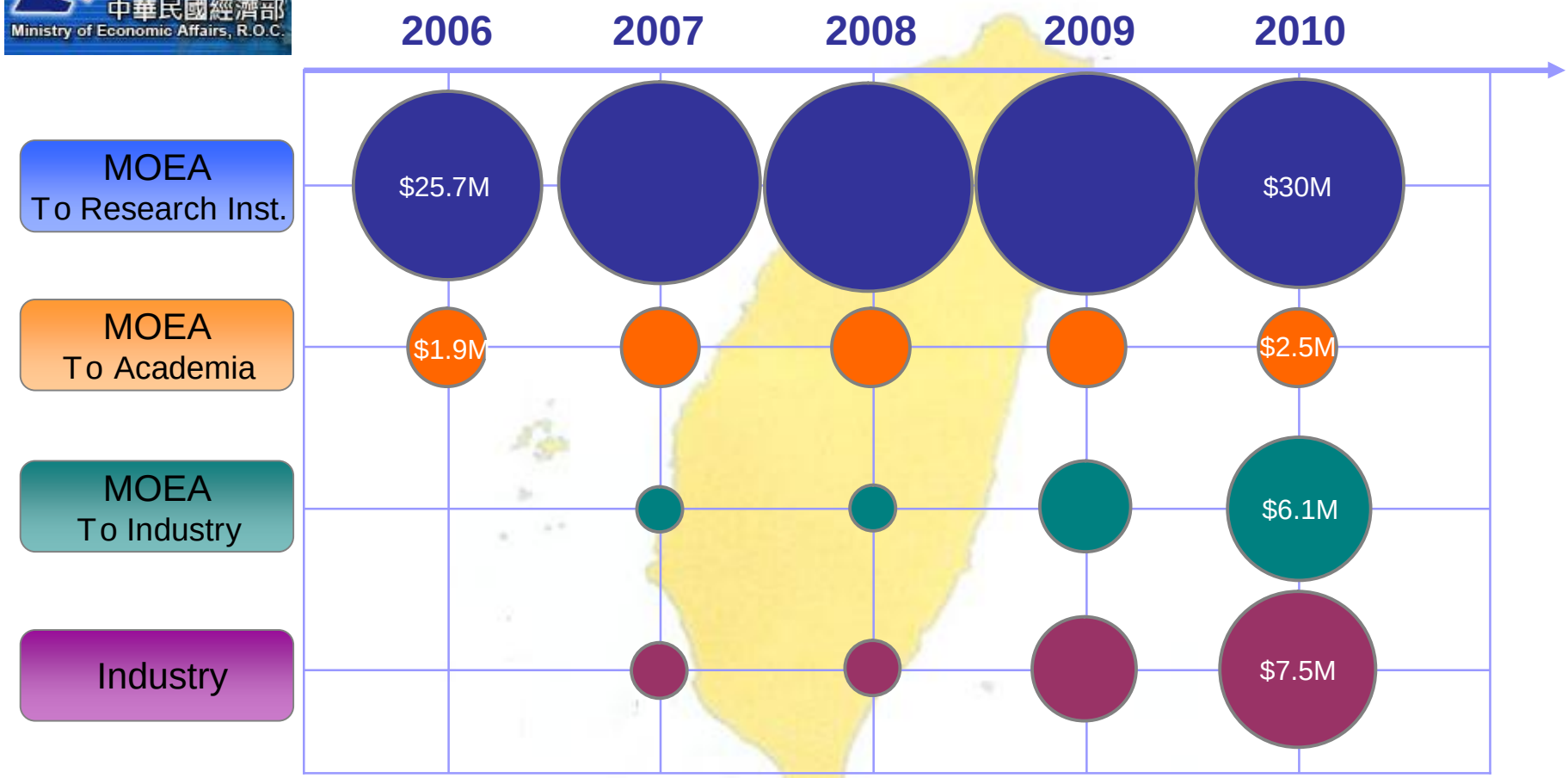
Academia

- Various resources to support academic R&D in e-Paper and flexible display technologies, such as **NTU, NTHU, NCTU, NCKU, NTUST**,

- R&D primarily supported by the government, with contribution from industries.
- Increasing number of Taiwan companies enter the e-Reader, e-Paper business.

Source: ITRI DTC

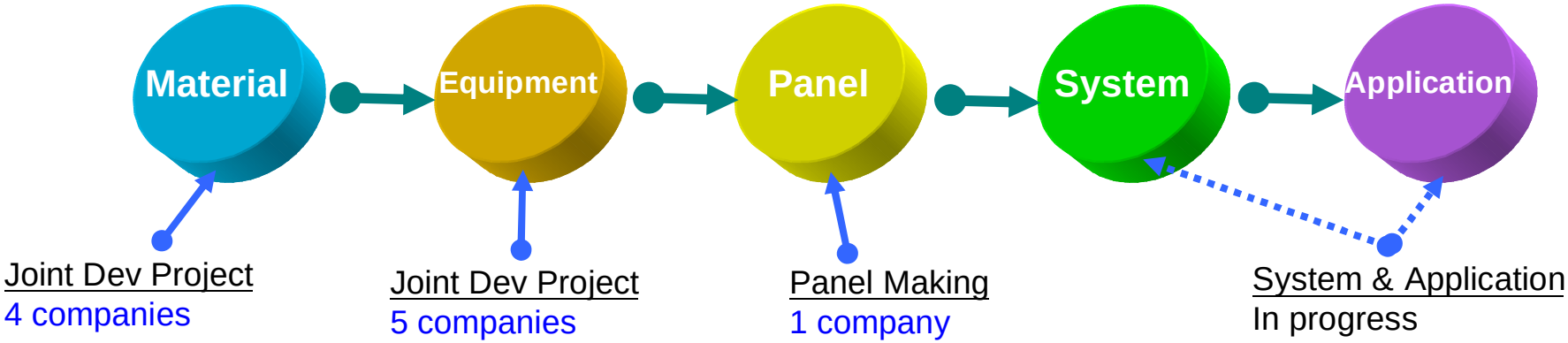
Investment by Government & Industry



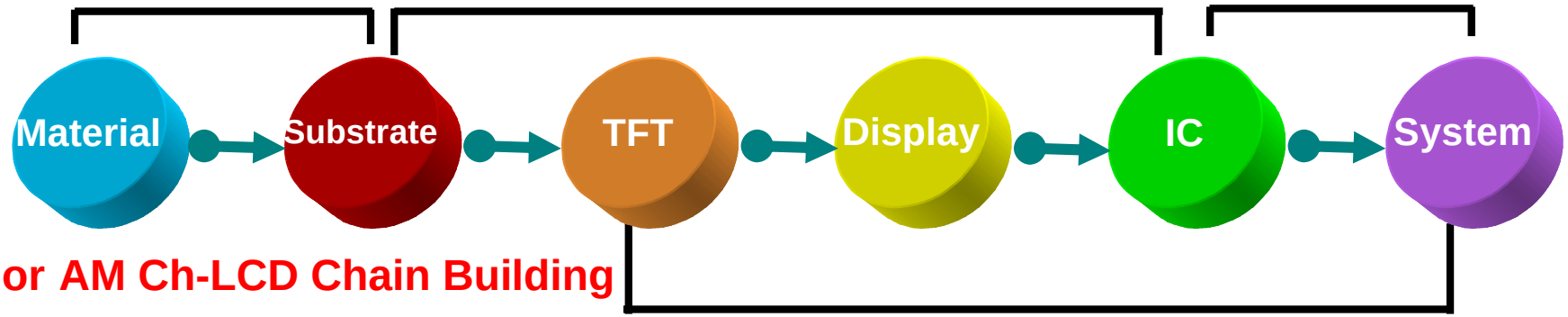
- **Following a SRB decision in 2006, MOEA began to fund R/D projects in flexible display、electronics、lighting、PV, and related material、process & equipment development**

Joint Dev. Programs for Commercialization

- **Large Area ChLCD Supply Chain Building**



- **Flexible AMEPD Supply Chain Building**



- **Color AM Ch-LCD Chain Building**

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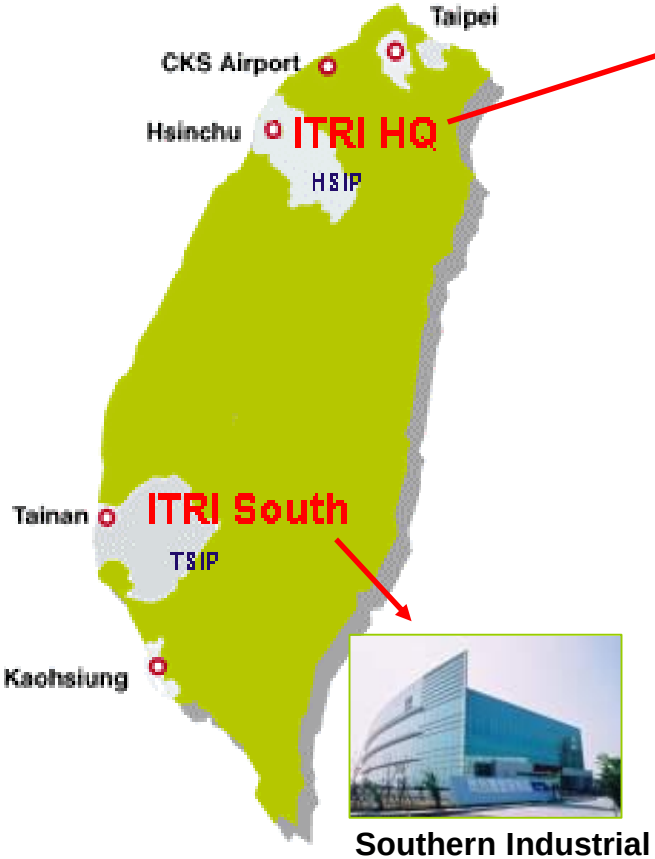
ITRI Highlights



Southern Industrial Innovation Park
since 2004

- **Founded: 1973**
- **Employees: 5,852 (as of Jan. 2010, Ph.D. 1,126)**
- **Headquarters: Hsinchu**
- **Major Research Field:**
  - **Information and Communications**
  - **Material, Chemical and Nanotechnologies**
  - **Biomedical Technologies**
  - **Advanced Manufacturing and Systems**
  - **Energy and Environment**
- **Total Patents: 10,132**
- **Start-Ups: 158**

Flexible Electronics Pilot Labs

Printed Circuit

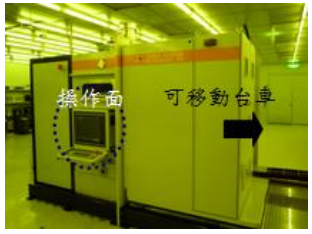
Paper-like speaker

Touch Sensors

Printed Sensors

Flexible Lighting

Flexible PV Films



R2R Sputter

R2R Exposure

R2R DES

R2R Laminator

Measurement

Flexible Electronics in ITRI

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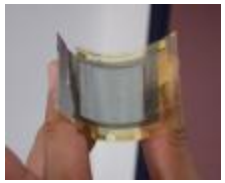
Milestones

2.2m×50cm

Paper-like flexpeaker
Sep. 2008

50dpi OTFT backplane
Mar. 2008



Printed sensor
Sep. 2008

4.7" 85dpi OTFT backplane
Dec. 2008

4.7" 150dpi OTFT backplane
July. 2009

7" flexible Lighting
Nov. 2009

E-Drum (Multi-area printed sensor)
Nov. 2009

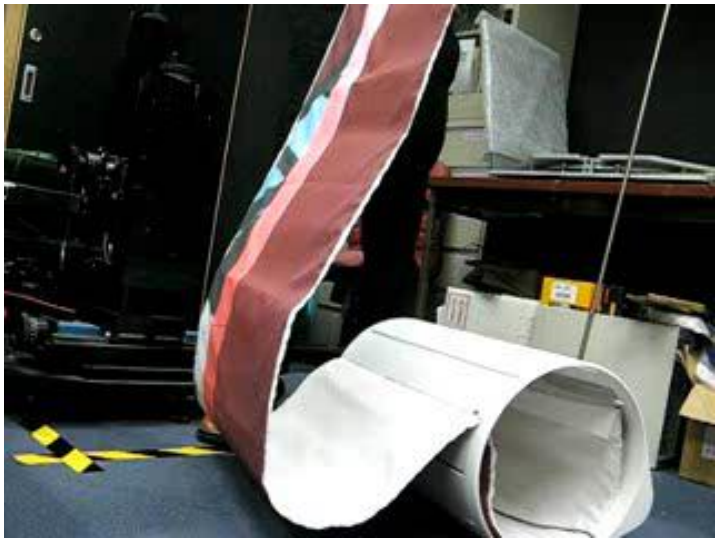
Luggage Scalar (Printed sensor)
Apr. 2010

2m*0.8m Large area printed sensor
Mar. 2010

2008 2009 2010

Paper Thin *fleX*peaker

2.2m×50cm large area speaker



ø Breakthrough

- **Demo 2.2m×50cm large area loud speaker (95dB@1m)**
- **Power consumption is only 1/5~1/10 times of traditional speaker**
- **Patented device structure for enhancing low frequency response**

ø Application: Automobile, ICT products, Home theater…

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Display Technology Center

- Founded in 2006
- Lab. Type: Gen. 2 Pilot Lab.
- Substrate Size: 20” (370×470 mm^2)
- Clean Room: 3,124 m^2

Inorganic TFT Array


Laser crystallization


PE-CVD

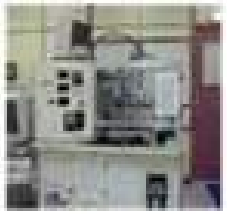

Ion Shower

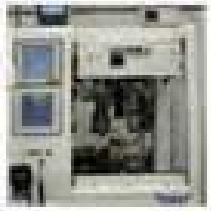
Cell


PI Roller


Rubbing

LCM

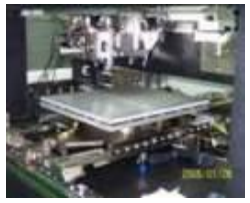

COG


COF

Organic TFT Process


Evaporator


O_2 Plasma Cleaner


Ink Jet Printer

Roll to Roll Process


Screen Printer


Laser Etcher

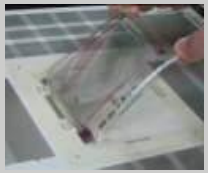

Sheet Coater

Flexible Display Technology Portfolio

DIGITAL Life

- Flexible EPD
- Flexible OLED
- Flexible Touch

- Flexible substrate / Debonding
- Flexible TFT backplane



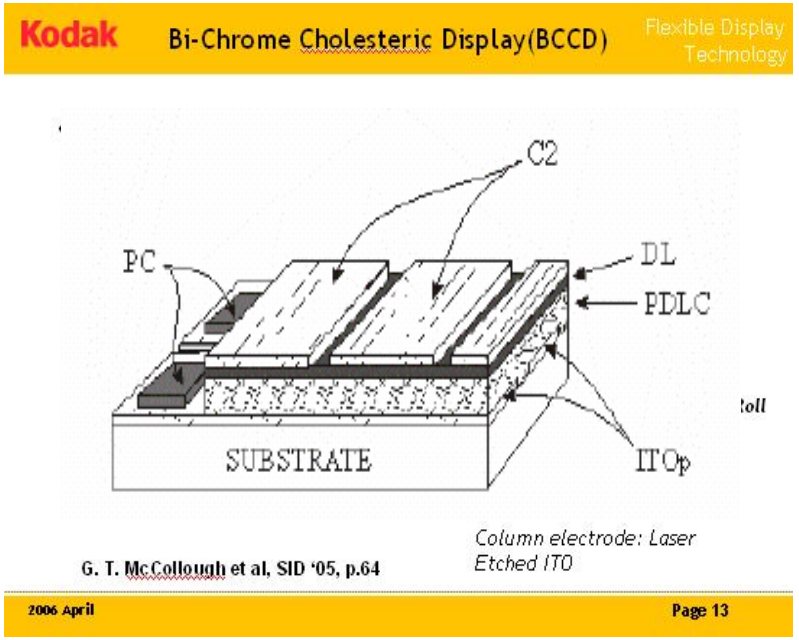
GO GREEN

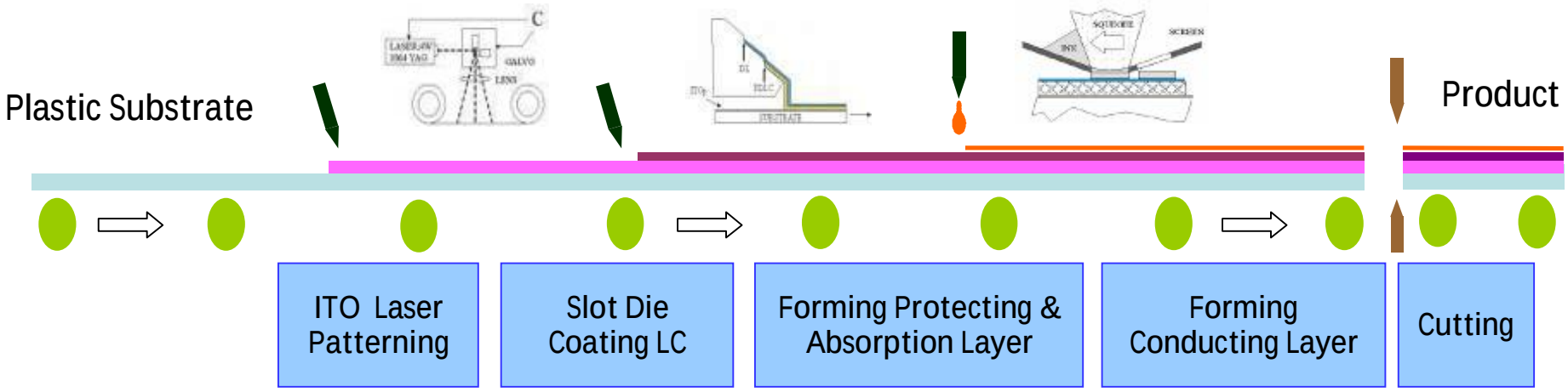
- Large area R2R Ch-LCD
- Color Ch-LCD
- EWD

Large Area R2R Ch-LCD

Collaborated with Kodak to expedite technology development

- **Liquid Crystal Design**
- **Limited Coalescence Emulsion Making**
- **R2R Laser Etching**
- **R2R Slide Coating**
- **R2R Screen Printing**
- **Standard & Rolling Driving**





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Read and Write Like Paper… ,

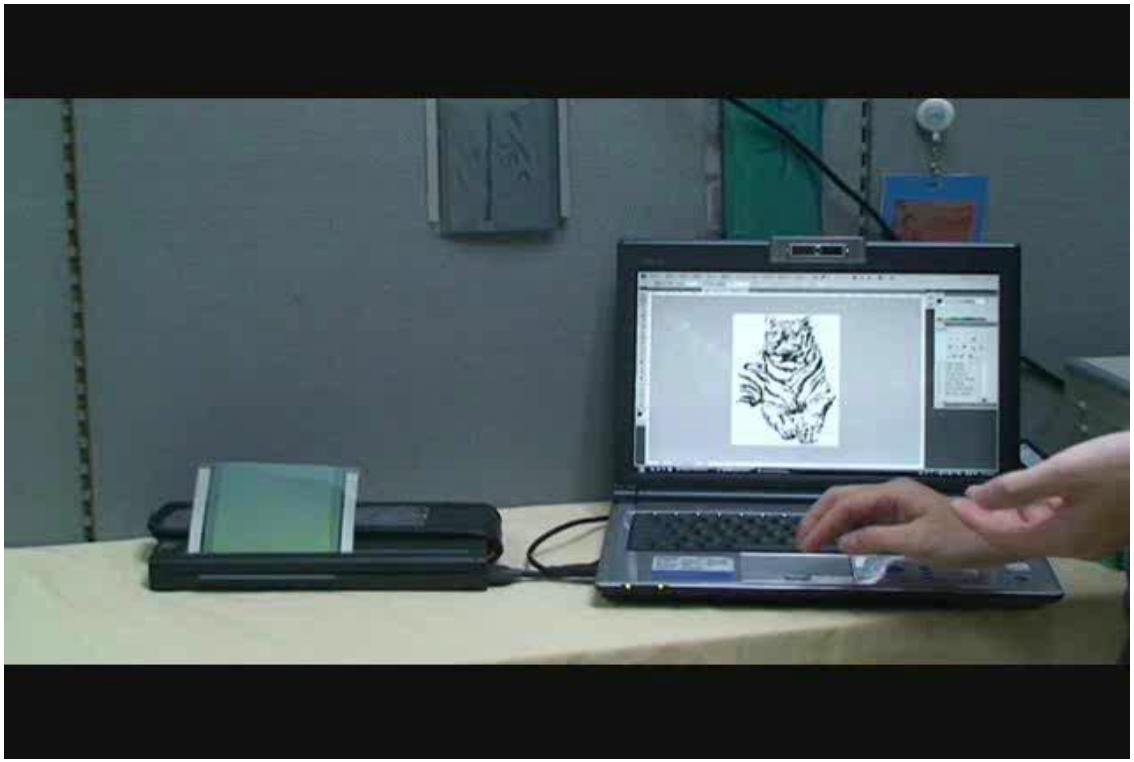
yet re-writable

Photo Writing

Specifications:
- Size : 3.5” x 4.5”
- Resolution: 300dpi
- Gray level:2

Thermal Writing

Specifications:
- Size : 3.5” x 40”
- Resolution: 200dpi
- Gray level: > 2



Source: ITRI DTC

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Novel Applications

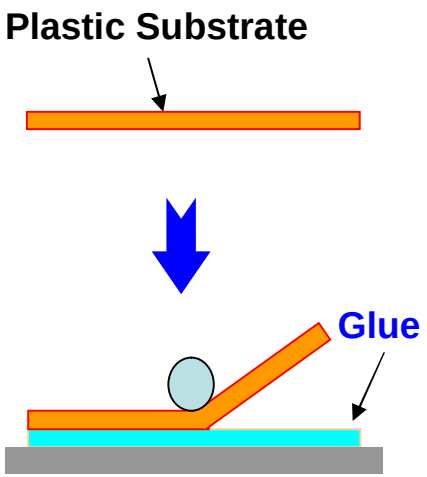
Chinese Landscape Painting **24cm ´ 300cm, 300dpi**

"*Pure and Remote View of Streams and Mountains,* 溪山清遠圖", Xia Gui, National Palace Museum

Soft Clock **emotional appeal, advertisement**

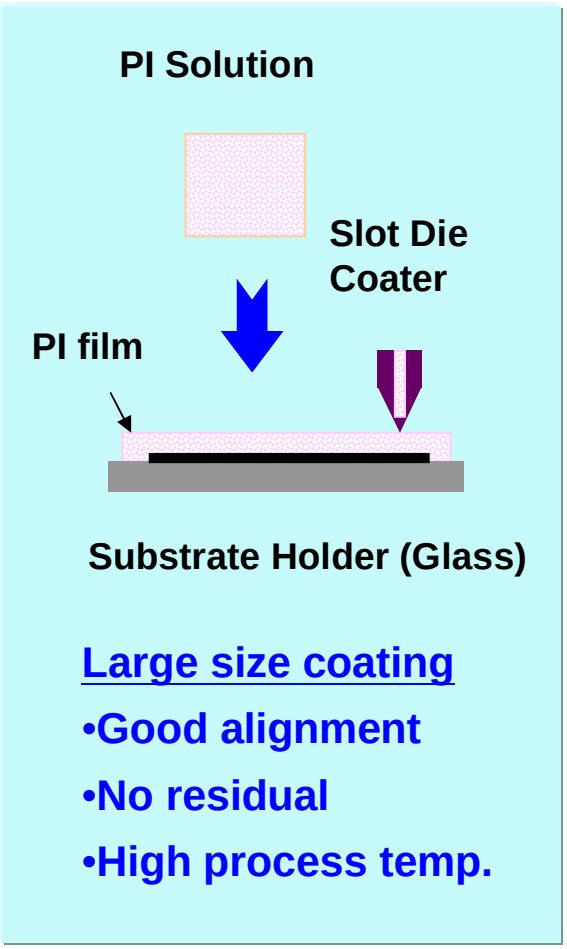
e-Signage **instant product message with multi color**

Flexible Substrate with Polyimide (PI)



•Transparent PI

•PI/SiO_2 Hybrid



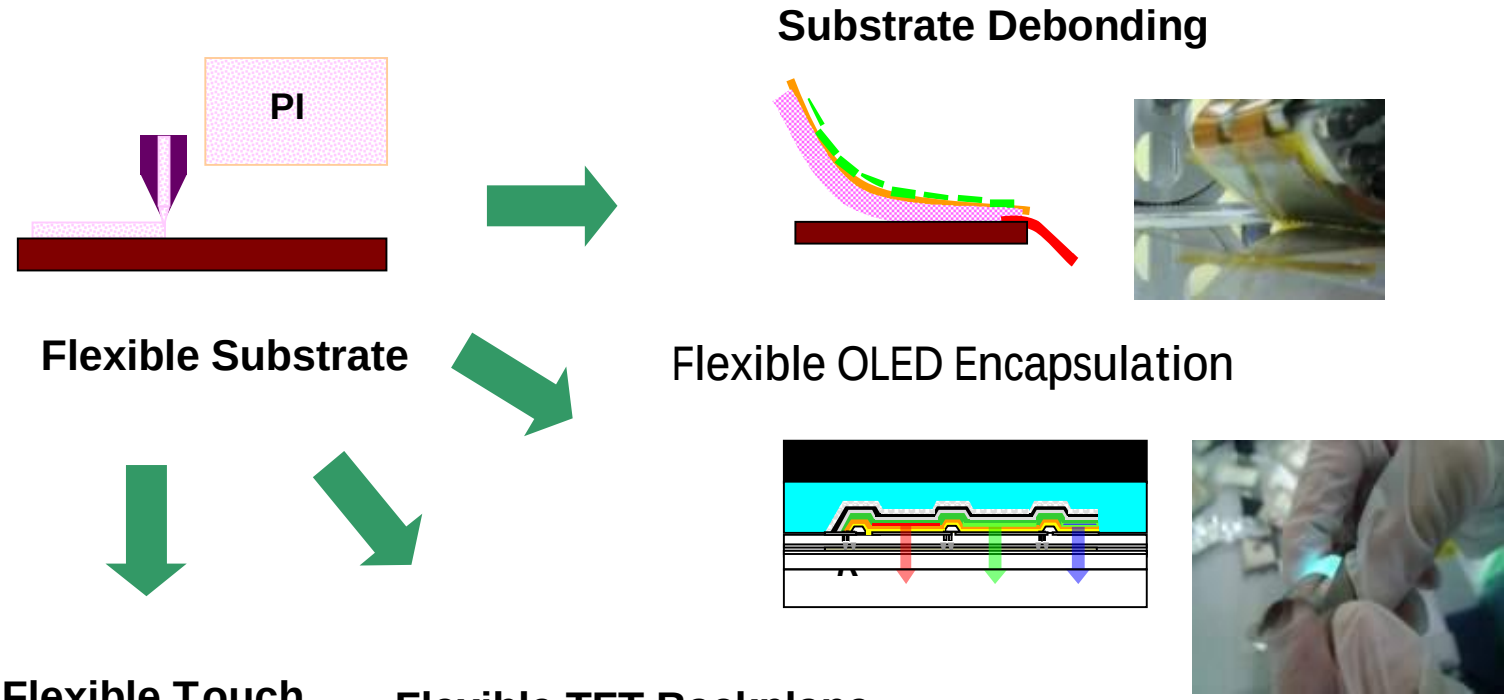
Substrate lamination

- Poor alignment
- Residual glue
- Low process temp.

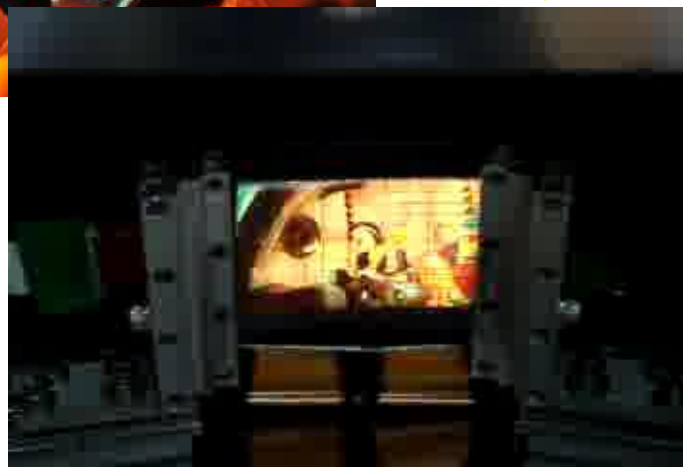
Large size coating

- Good alignment
- No residual
- High process temp.

FlexUP : Flexible Universal Plane



Flexible Active-Matrix Display on PI



4.1” 108xRGBx240 Flexible Color AMOLED

6” 800x600 Flexible B/W AMEPD

- Using existing glass line to fabricate flexible AM display
- Integrate 200ºC a-Si:H and µC-Si:H TFT with EPD and OLED on PI substrate
- Demonstrate flexible AMOLED with bending 18000 times at R=5cm

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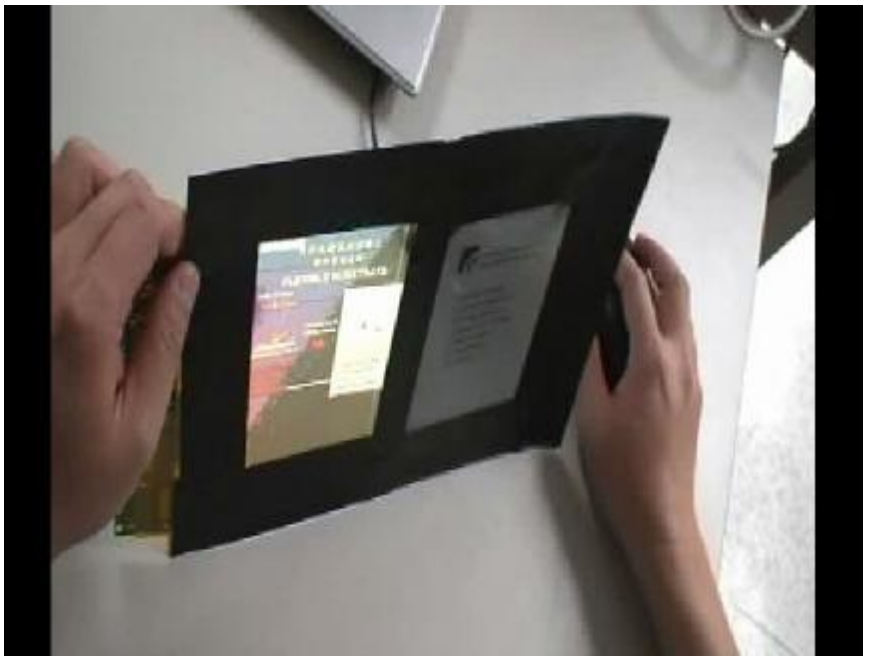
Hybrid Modes Flexible Display

Flexible AMOLED + Flexible AMEPD



Opto Taiwan 2010

- **Combine low power e-paper and high performance OELD screens in one display.**

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Conclusion

- Leveraging the experience and sound infrastructure of ICT manufacturing, Taiwan is well positioned for developing next generation flexible electronics.
- Development activity in Taiwan is propelled by the government's seed funding. ITRI's role is to develop, along with research universities, the fundamental technologies and, subsequently, transfer the capability to the industries in building a complete supply chain.
- Presently, flexible display is the most promising market opportunity for launching flexible electronic manufacturing. Large area, flexible sensors could be the next.
- Recent financial difficulty drove a wave of western start-up firms to seek fund infusion, or manufacturing partners in Asia. This trend has helped to bring to Taiwan a few important technologies in the flexible electronics area.

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Thank you for your attention!