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)

• 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

- Area: 35,980 square kilometers
- Population: 23 Million
- GDP: US$ 418 Billion

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

Display
- TN/STN LCD
- TFT LCD
- OLED
- Micro-display

3C Products
- Motherboard
- Notebook
- Cell Phone
- Digital Camera

Networking Products
- SOHO Router
- Wireless LAN
- xDSL/Cable CPE
- Ethernet LAN Switch

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

Fast Integration

Paper-like Speaker Industry (Consumer application)

Flexible lighting (Decoration application)

Printed Electronics Device Industry (Antenna, Circuit)

Flexible Sensor Industry (UI, Human-scale application)

Flexible Display Industry

Portable Power Industry (Flexible, thin embedded application)

Flexible lighting

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Flexible Electronics Development in Taiwan

**Industries**
- E Ink Holdings and AUO are global major AMEPD suppliers
- Delta focuses on QRLPD e-paper.
- Wistron (with Polymer Vision) focus on foldable e-paper production

**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.

**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
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
  - Joint Dev Project: 4 companies
  - Equipment: Joint Dev Project 5 companies
  - Panel: Panel Making 1 company
  - System & Application: In progress

- Flexible AMEPD Supply Chain Building
  - Material
  - Substrate
  - TFT
  - Display
  - IC
  - System

- Color AM Ch-LCD Chain Building
Highlights

- 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 in ITRI

**Milestones**

- **Paper-like flexspeaker**
  - Sep. 2008

- **50dpi OTFT backplane**
  - Mar. 2008

- **4.7" 85dpi OTFT backplane**
  - Dec. 2008

- **Printed sensor**
  - Sep. 2008

- **4.7" 150dpi OTFT backplane**
  - Jul. 2009

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

- **Luggage Scalar (Printed sensor)**
  - Apr. 2010

- **2m*0.8m Large area printed sensor**
  - Mar. 2010
Paper Thin fleXpeaker

- 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

- Application: Automobile, ICT products, Home theater…
Display Technology Center

- Founded in 2006
- Lab. Type: Gen. 2 Pilot Lab.
- Substrate Size: 20” (370×470 mm²)
- Clean Room: 3,124 m²

Inorganic TFT Array
- Laser crystallization
- PE-CVD
- Ion Shower

Organic TFT Process
- Evaporator
- O₂ Plasma Cleaner
- Ink Jet Printer

Cell
- PI Roller
- Rubbing

LCM
- COG
- COF

Roll to Roll Process
- Screen Printer
- Laser Etcher
- Sheet Coater
Flexible Display Technology Portfolio

**DIGITAL Life**
- Flexible EPD
- Flexible OLED
- Flexible Touch

**GO GREEN**
- Flexible substrate / Debonding
- Flexible TFT backplane

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

Flexible substrate / Debonding
Flexible TFT backplane
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

Plastic Substrate

ITO Laser Patterning
Slot Die Coating LC
Forming Protecting & Absorption Layer
Forming Conducting Layer
Cutting

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Read and Write Like Paper... yet re-writable

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

Photo Writing

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

Thermal Writing

Source: ITRI DTC
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/SiO₂ Hybrid

Substrate lamination
- Poor alignment
- Residual glue
- Low process temp.

Plastic Substrate

Glue

Substrate Holder (Glass)

Large size coating
- Good alignment
- No residual
- High process temp.

PI Solution

Slot Die Coater

Substrate Holder (Glass)
FlexUP: Flexible Universal Plane

Flexible Substrate

Flexible OLED Encapsulation

Substrate Debonding

Flexible Touch

Flexible TFT Backplane
Flexible Active-Matrix Display on PI

- Using existing glass line to fabricate flexible AM display
- Integrate 200°C 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
Hybrid Modes Flexible Display

Flexible AMOLED + Flexible AMEPD

Combine low power e-paper and high performance OLED screens in one display.
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.
Thank you for your attention!