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Industrial Technology
Research Institute

Flexible Electronics at ITRI

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Electronic and Opto-electronic System Research Lab.
ITRI

Sep. 9, 2019

Electronics/Optoelectronics Products Made-by-Taiwan lead Worldwide

No.1 Worldwide

Category	Production Value	Global Share
Motherboard	$4.1B	89.1%
Notebook	$59.4B	81.5%
IC Foundry	$39.7B	73.16%
IC testing & packaging	$15.7B	55.8%
Optic lens for mobile	$2.2B	50.0%
PND	$1B	39.5%
Printed circuit board	$19.3B	29.7%

No.2 Worldwide

Category	Production Values	Global Share
<10” LCD panel	$9.5B	33.0%
Printed circuit board	$19.3B	29.7%
IC carrier	$2.5B	26.3%
>10” LCD panel	$20.9B	25.7%
IC Design	$20.3B	18.0%
Server	$9.1B	18.0%

No.3 Worldwide

Category	Production Values	Global Share
LED	$3.0B	17.7%
OLED	$0.3B	2.53%

Source: MOEA ITIS Project (2018/04)

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Content

- Circular Economy Driving New Manufacturing
  - -Worldwide Activities
  - -Taiwan's view points
- **Initiating Flexible Electronics at ITRI (2006-2010)**
- R2R Challenges and ITRI's R2R Solutions (~now)
- Conclusions

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ITRI Overview

Total Staff: 5,583

Ph.D.：	1,324
Master：	3,027
Bachelor：	1,232
Alumni：	23,487

Total Patents

22,932

Startups & Spinoffs(2014)

260

Industry Services(2014)

Provided Services：15,086

Transferred Technologies：626

2015.07.01

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New Startups and Talents

UMC

tsmc

TAIWAN MASK CORP.

Vanguard International Semiconductor Corporation

EPISTAR AUSTRALIA

tBPC HEALTHCARE

HIT Hyper Immersion Technology

FlexUP We make life flexible

UNEO

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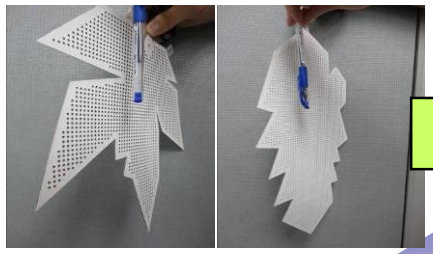
ITRI Flexible Electronics (2006~2010)

Reduce the Carbon Foot Print

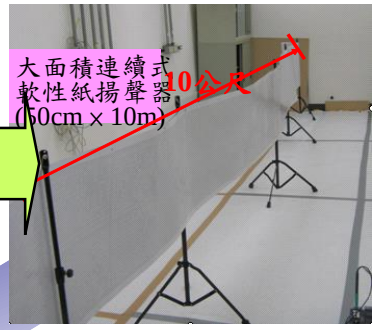
Cinaflex

color e book

Foldable mobile phone



2010 Taipei Flora Expo



10M paper speaekr

Vision

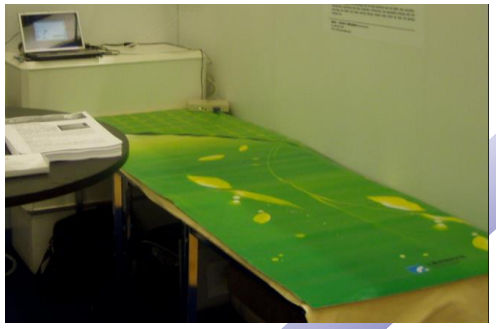
Hearing

Conformal
Ultra thin
Large area

Tactile

Energy

UNIQO



Health care bed

Automobile

Instrument

Scale

Flexible LED lighting

Portable energy

BIPV

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Becoming an Incubator for 2nd Generation Entrepreneurs

Universal Cement Corporation (UCC):
- USD $13 billion in assets.
- Cement (Since 1960)
- Electronics (Since 2010)

Uneo Inc.: (established in 2012)
- President: Dr. Johnson Ho.
- Pressure-sensing electronics
- Products: tablet keyboards, styluses, touch pads…
- Received a Gold Edison Award and a R&D 100 Award (2015)

ITRI's role:
- Hired Talent: Johnson as project manager ('08)
- Innovative team: developed >6 market-test prototypes ('09-'11)
- Honor: Received a Wall Street Journal TIA ('10)
- New business: spun-in UCC with 5 engineers and established the first production line (2011)

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Key deliverables for High-end and Green products using R2R

For products:

- ✓ A common platforms for a concept to a prototyping
- ✓ Customizability of production technology
- ✓ Precise In-line metrology for quality control

For devices:

- ✓ Multi-layer coating/deposition
- ✓ Precise and continuous layer-by-layer alignment
- ✓ Fine line printing
- ✓ High performance substrate

For manufacturing:

- ✓ Equipment space requirement reduction
- ✓ Material utilization

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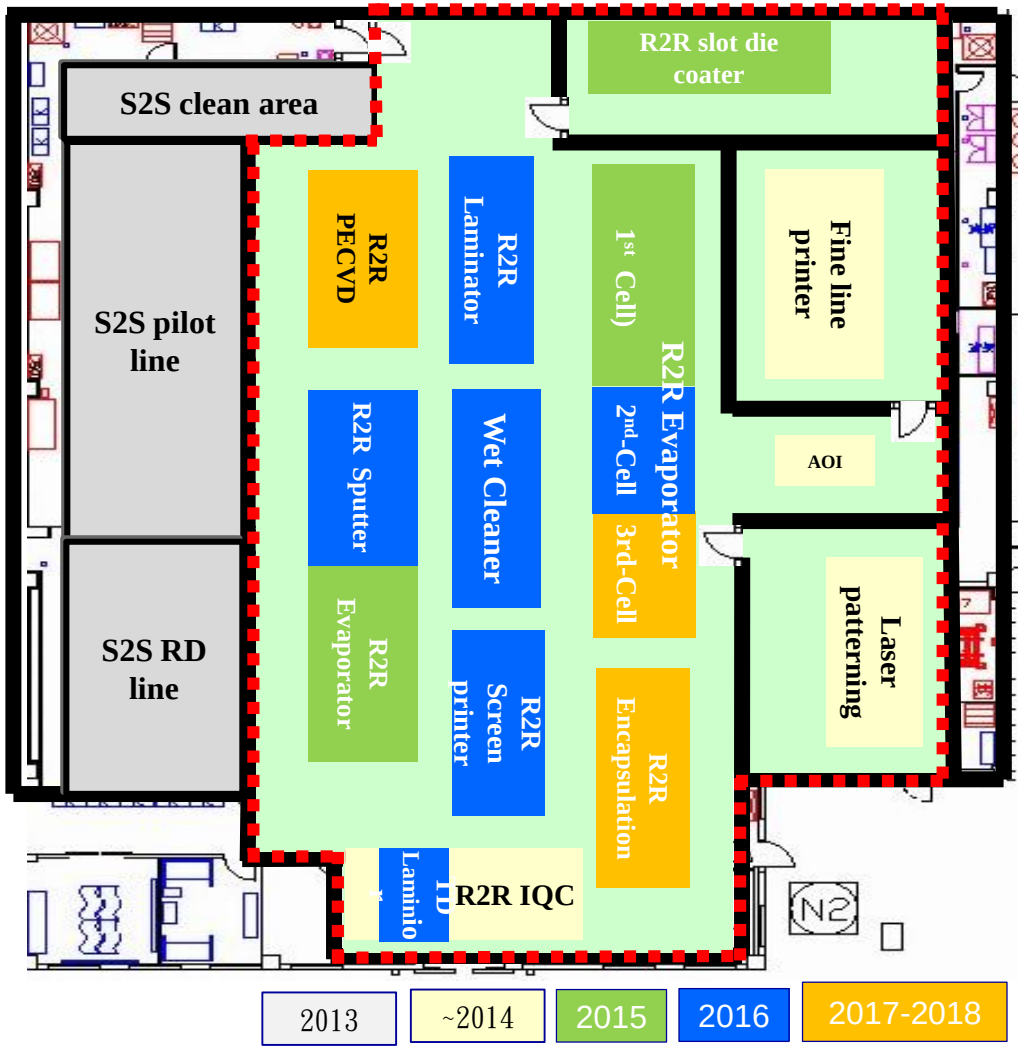
ITRI R2R Common Platform for Fast-prototyping (2011~now)



Functional substrate line

- 10 Ω/□ ITO/ITO replacement
- Laser Direct patterning
- Fine patterning
- Barrier coating

R2R digital manufacturing

- double-side printing
- Low-carbon emission process
- In-line metrology

OLED lighting

- Flexible OLED lighting
- Automotive lighting
- Fast evaluation platform

Bio-sensing platform

- Establish bio-sensing circuit on bio-compatible substrates
- Develop smart garment prototypes
- AI based system

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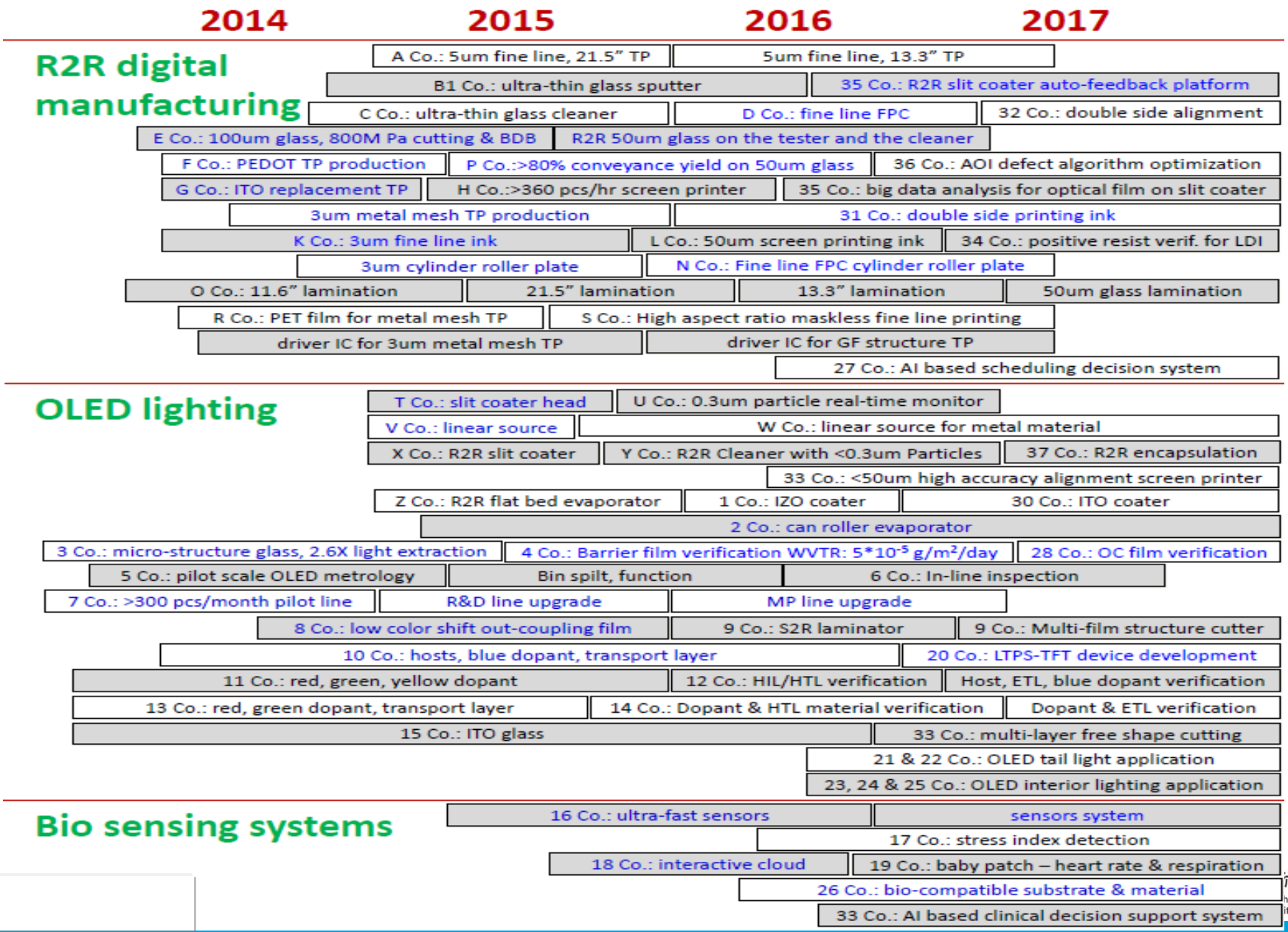
Co-creation with Worldwide Partners



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Case Studies: ITRI's R2R Solutions Co-creating with the Partners

- **Handling High Performance Substrates**
- A Fine Line Printing for Metallization
- A In-Line Metrology for Quality Control
- Cost-effective Patterning for Customized Products
- A Multi-Layer Coating for a High-end Product
- Future Product - Bio-sensing for a Health Society

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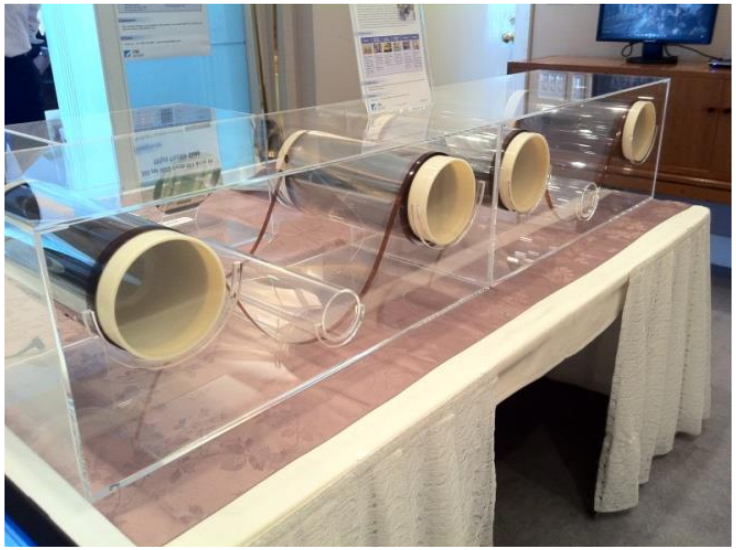
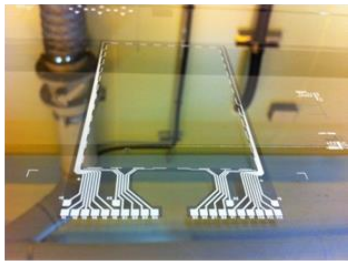
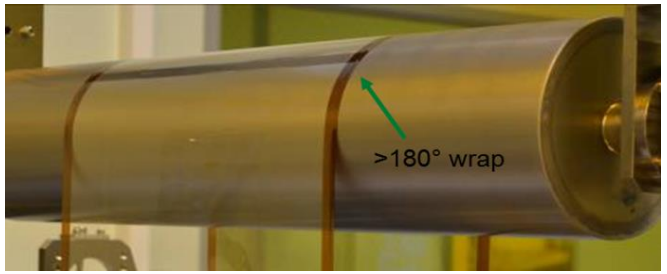
A High Performance Substrate Touch Panels on Ultra-Thin Glass (C Co., 2012)







2012 Yokohama Show – 2012/10/31 ~ 11/2

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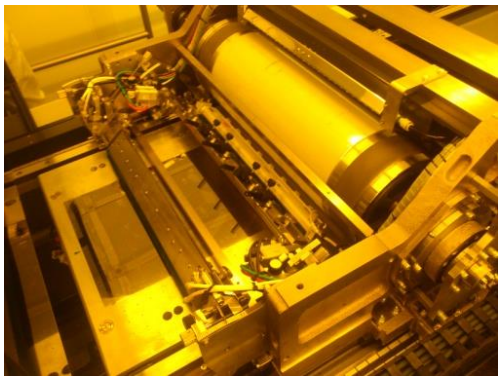
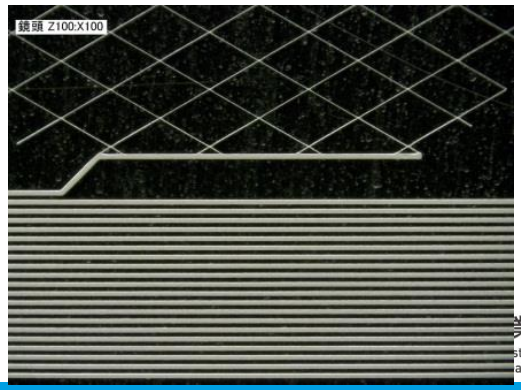
3μm Fine Line Additive Printing Process

K Co.

Past		As It
7-step process	>>>	
film deposition	>>>	
photo resist coating	>>>	1-step
resist baking	>>>	fine-line direct printing
photo exposure	>>>	
resist development	>>>	
film etching	>>>	
resist stripping	>>>	

- **Replace 7 process equipment with 1**
- **Increase material usage from 5% to 95%**
- **Industry status: sheet process, > 30μm**
- **roll-to-roll process, 3μm**





3μm

30μm

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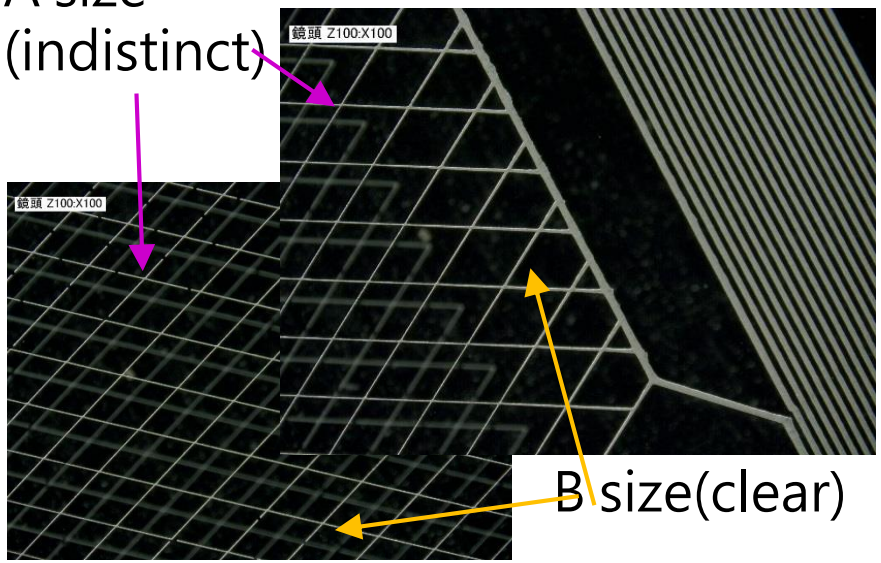
Fine Line Printing for all printed TP+FPC (S Co.)

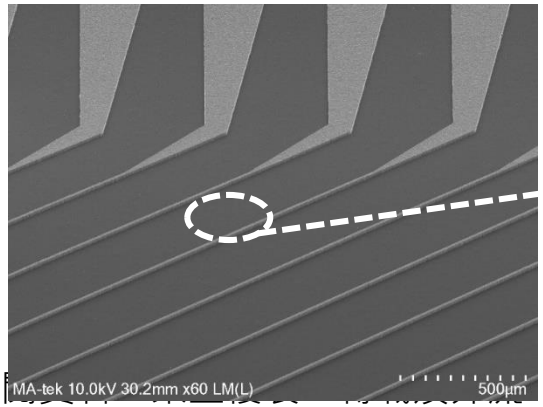
Peeling force >500 gf/cm
Bending test : >200k times
(ΔR: < 4% in radius 3.5mm)

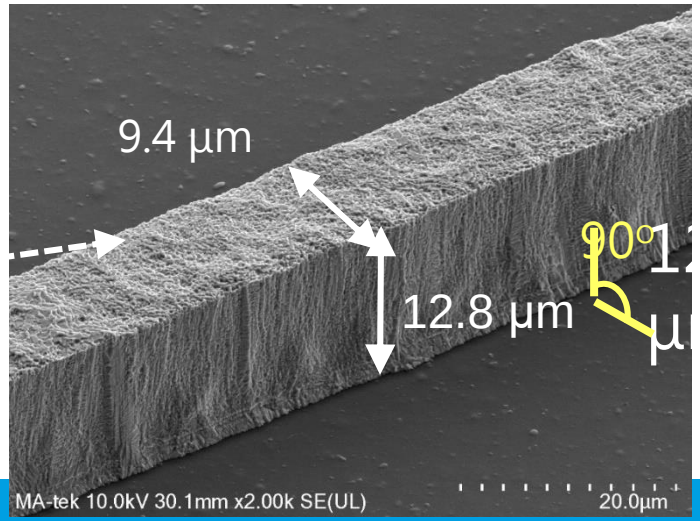
A size (indistinct)



Double sided with 5μm line
(2016 JPCA show)

Printed FPC with >1.1 high aspect ratio Cu trace
(2016 TPCA show)





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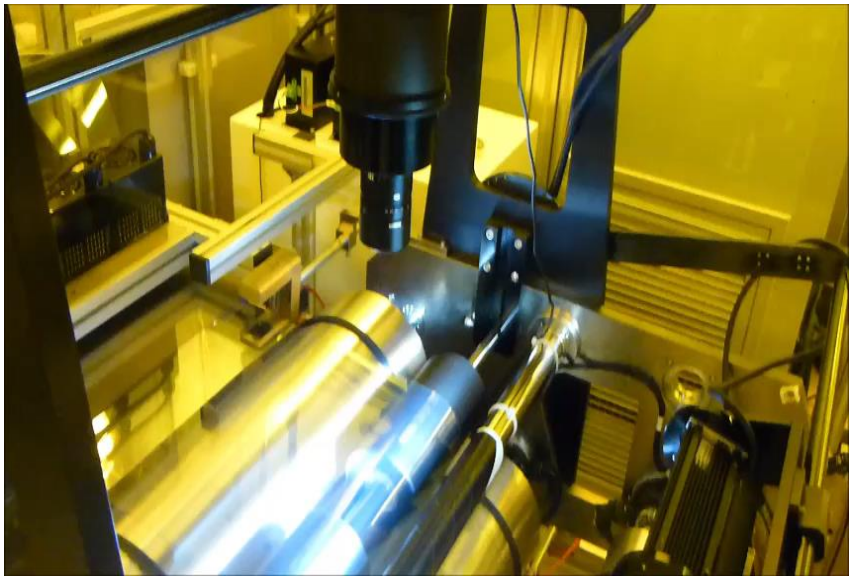
In-Line 0.3um Particle Counter for R2R Cleaner
(M Co., 2018~)

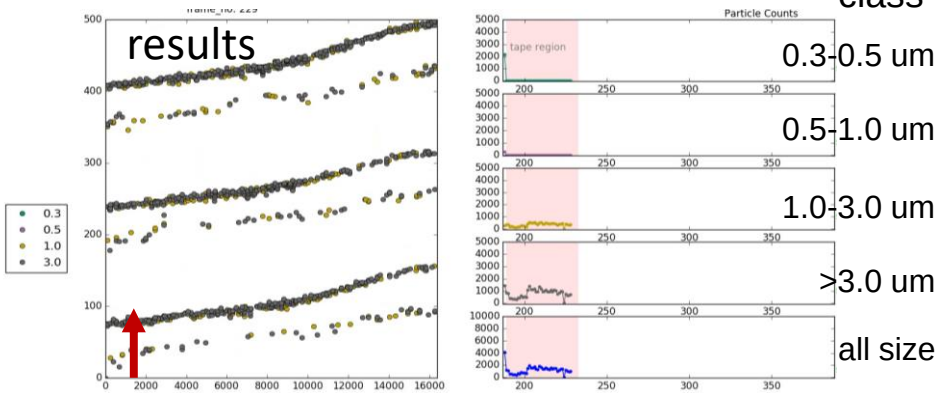
Capabilities:

- Convey vibration < 40um
- Continuous monitoring
- 84% detection rate (0.5um@Si wafer)
- 80% sizing accuracy (on glass)

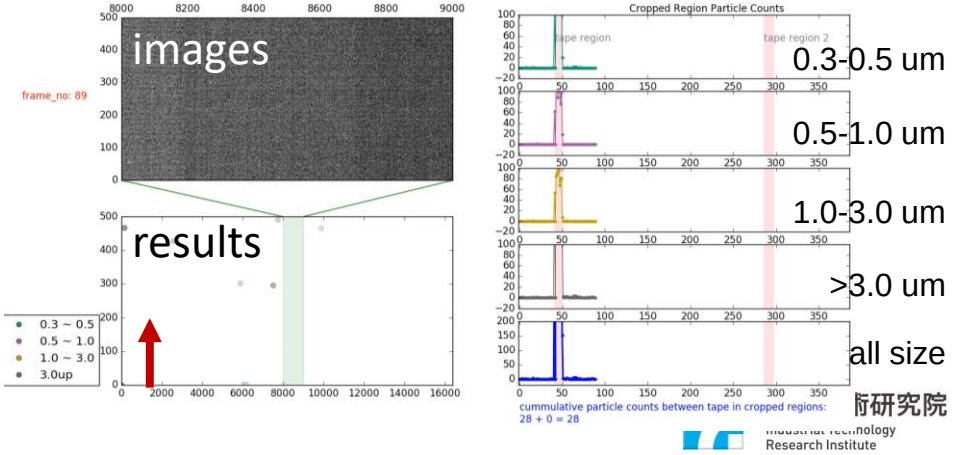


R2R in line particle counter in cleaner

2017: **Serious Noise**



2018: **Stable Counting**



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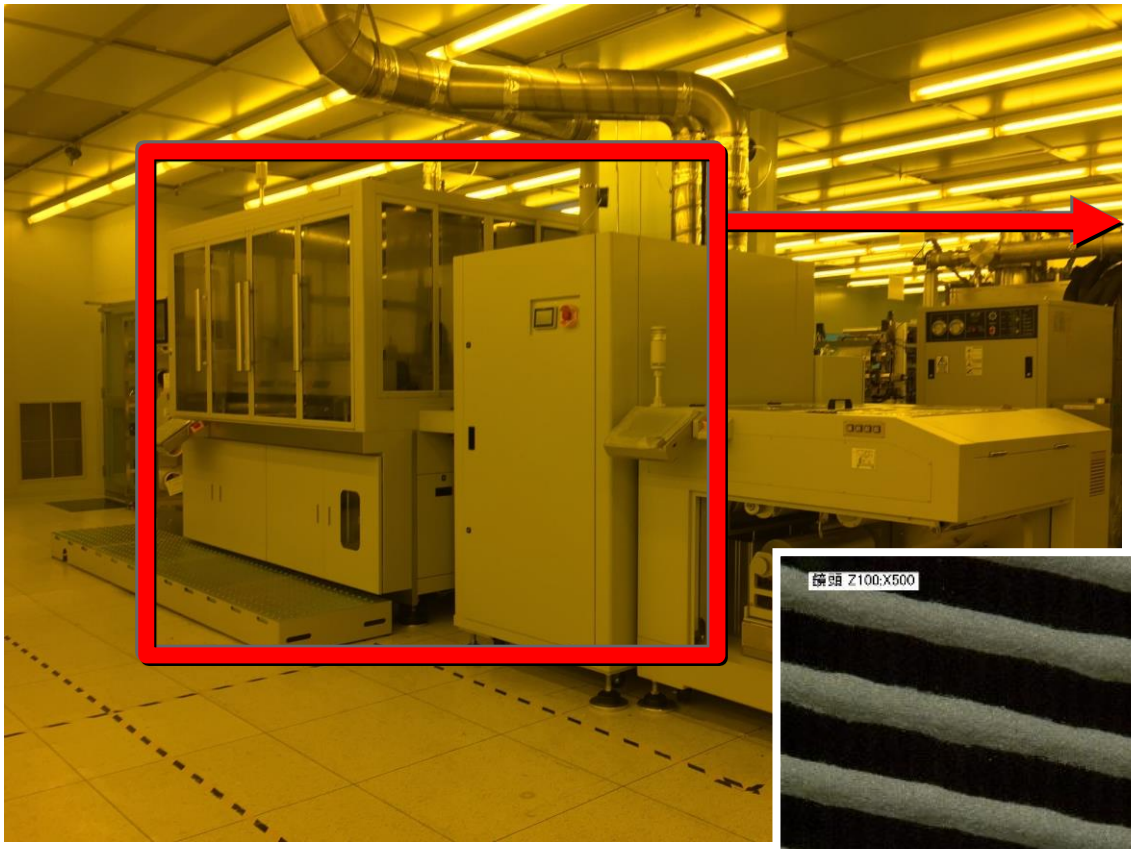
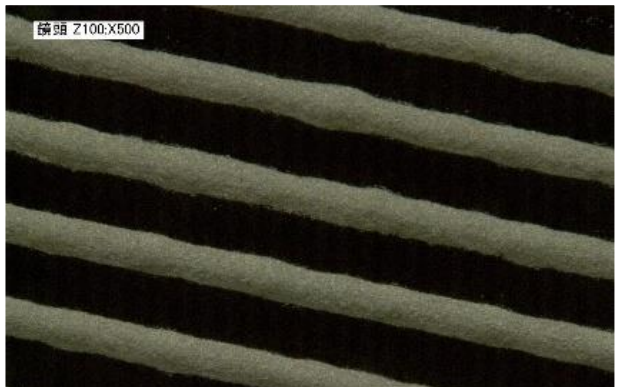
R2R High Speed Screen Printer with <50um LW

A Co.



- ✓ 40% foot print reduction
- ✓ **Contactless transportation**
- ✓ 50um silver paste
- ✓ Multiple substrates:
  - ultra-thin glass
  - Hybrid film
  - PI/PET/PEN



50um line width with silver paste

Floating mechanism

Applications：

- Touch panel frame wire, Solar electrode, Lighting electrode, ESD protection

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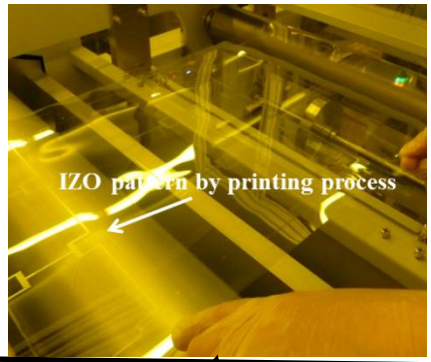
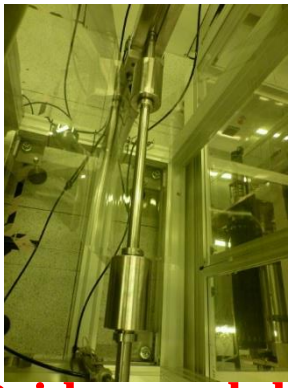
Bridge design for two R2R process stations

- Two R2R process (Pinter and Cleaner) stations conveying speed arrangement
- Conveying tension balance between R2R screen printer and R2R cleaner
- <1Kg low tension self-guided step roller





R2R screen printer

Bridge module

R2R cleaner

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The first OLED lighting modules using full roll-to-roll process (2018) (M Co., H. Co.)

Taiwan INT'L Lighting Show 2018

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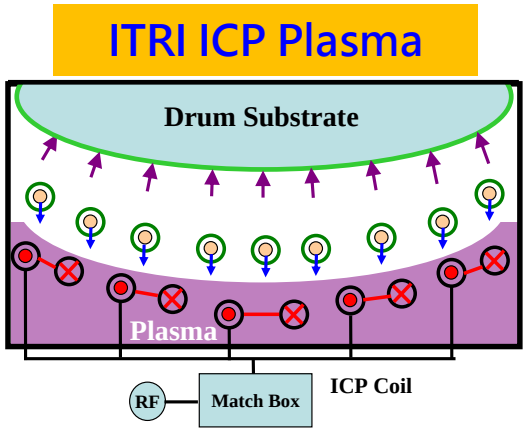
R2R PECVD for Encapsulation (C Co.)

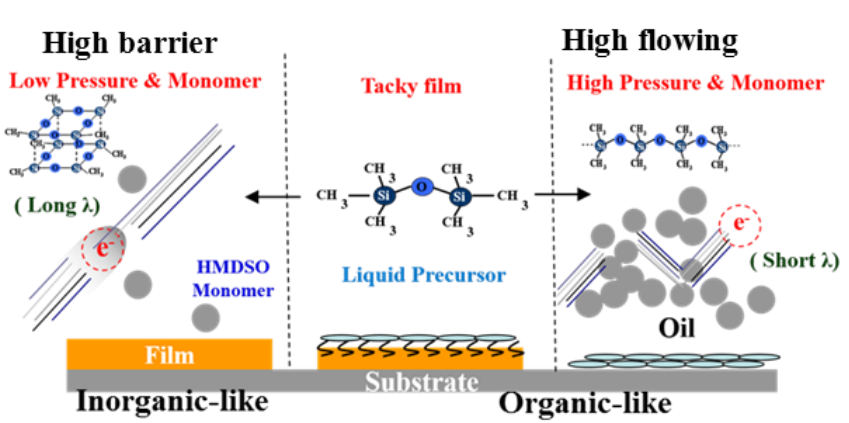
☐ R2R PECVD pilot line in ITRI:

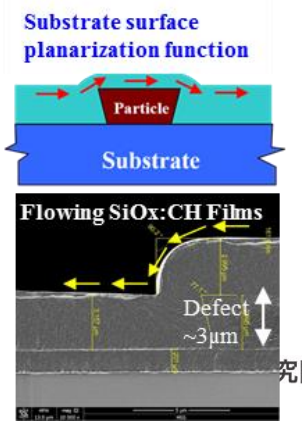
- **3** main chambers
- **6** plasma reactors
- Processing temperature **< 100˚C**
- Non-uniformity: **≦±5%**
- WVTR **< $5x10^{-4}$ $g/m^2/day$**

Plasma Polymerization Parameters:

- Processing pressure
- Monomer flow rate
- Plasma RF power







*PECVD: plasma enhanced chemical vapor deposition

Conclusions

- Over twenty global partners co-created with ITRI's **roll-to-roll common platform** for fast-prototyping innovations.

- **High-end R2R solutions** generate the double benefits of increased environmental friendliness and low-cost, affordable product.

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Welcome to Taiwan

ICFPE 2019

October 23 – 25, 2019 @ Taipei, Taiwan

5F, Taipei Nangang Exhibition Center (Hall 1)

Joint with

TPCA Show
| EAssembly | Green Tech | PCB | Thermal |

IMPACT
International Microsystems , Packaging, Assembly and Circuits Technology conference
Research Institute

ICFPE:International Conference on Flexible and Printed Electronics