Development of Conductive Polymer Film and R2R Coating Process

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RADTECH
THE ASSOCIATION FOR UV&EB TECHNOLOGY

Outline

1. Background
2. Develop a conductive polymer film
3. Scratch resistance film
4. Future plan

Background

Multiple High Growth Markets
Opportunity for conductive Film

2011+ **2012+**

Display

2012 / 2013+

Lighting

Smart Phones / Tablet

- Lower power consumption
- Superior display aesthetics
- Thinner/flexible form factor
- Cost advantages at scale

TV

- Thinner/flexible form factor
- Better display contrast
- Wider viewing angle
- Perfect for 3D TV
- Lower power consumption
- Less heat generation

- PHOLEDs are more energy efficient
- Diffuse, pleasing light source
- Thinner/flexible form factor
- Environmentally friendly

UNIVERSAL DISPLAY CORPORATION

Market and Manufacturing Directions…

Thinner, Lighter.

Glass to Plastic

Large display area.

Si → Carbon

Flexible, Rugged.

ITO → Polymer, Ag, C, Others

Touch interface.

Roll to Roll Coating

Lower cost.

Why R2R Manufacturing?

Flexible
Formable
Weight
Ruggedness

High cost

Low Cost

Roll-to-Roll Production?

Because it may be essential to enable the high volume applications of flexible displays!

Key Issues: ITO film

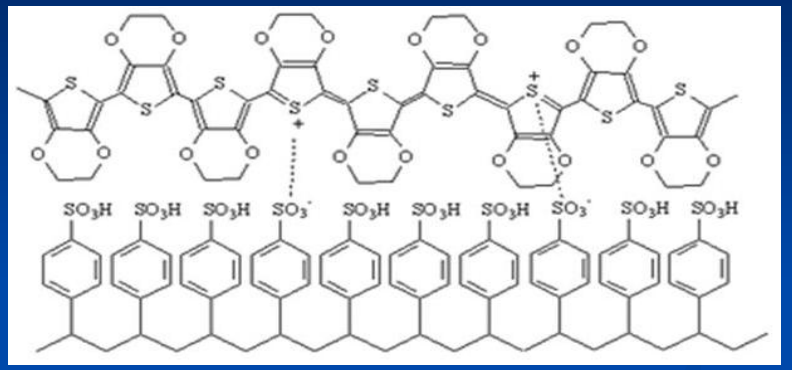
1. Brittle
Limited Compatibility with Flexible Devices
bending results in increased sheet resistance

2. Requires expensive vacuum based deposition process
Increases MFG Complexity / Cost

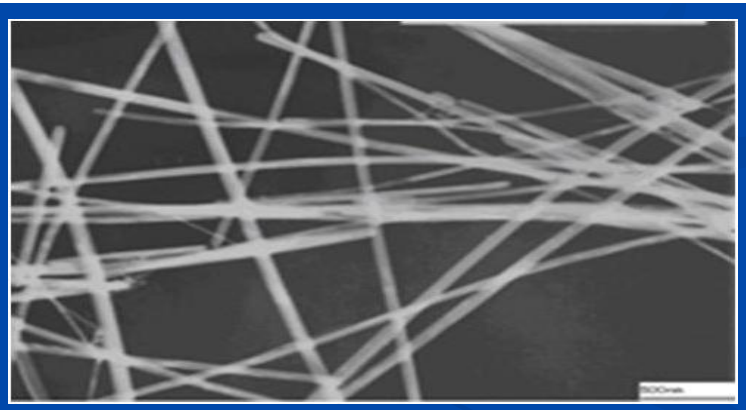
3. Inorganic material: **Indium is a rare metal**
Significant Price Fluctuations
($250 to $1000 per kg)

Opportunity for ITO Alternative

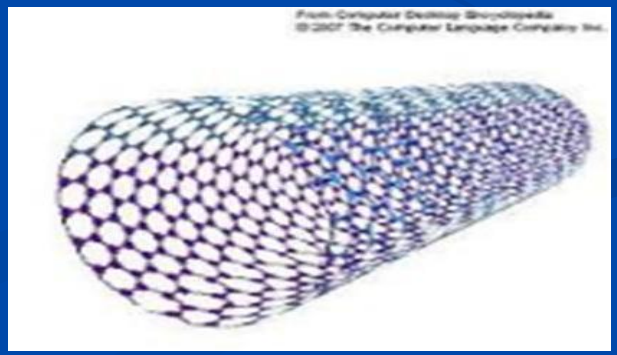
Conductive Polymer (CP)



Silver Nanowires (SNW)



Carbon Nanotube (CNT)



Characteristics

Material	Mfg. method	Cost	Conductivity	Transparent	Flexibility
ITO	Dry	X	10 -	75 - 90	X
CNT	Wet	△	60 -	75 – 95	○
SNW	Wet	△	20 -	80 - 90	△
CP	**Wet**	○	**150 -**	**80 - 90**	○

Flexible Electrodes Enhances New Applications

Extraordinary Readability
All lighting conditions
Any illumination angle

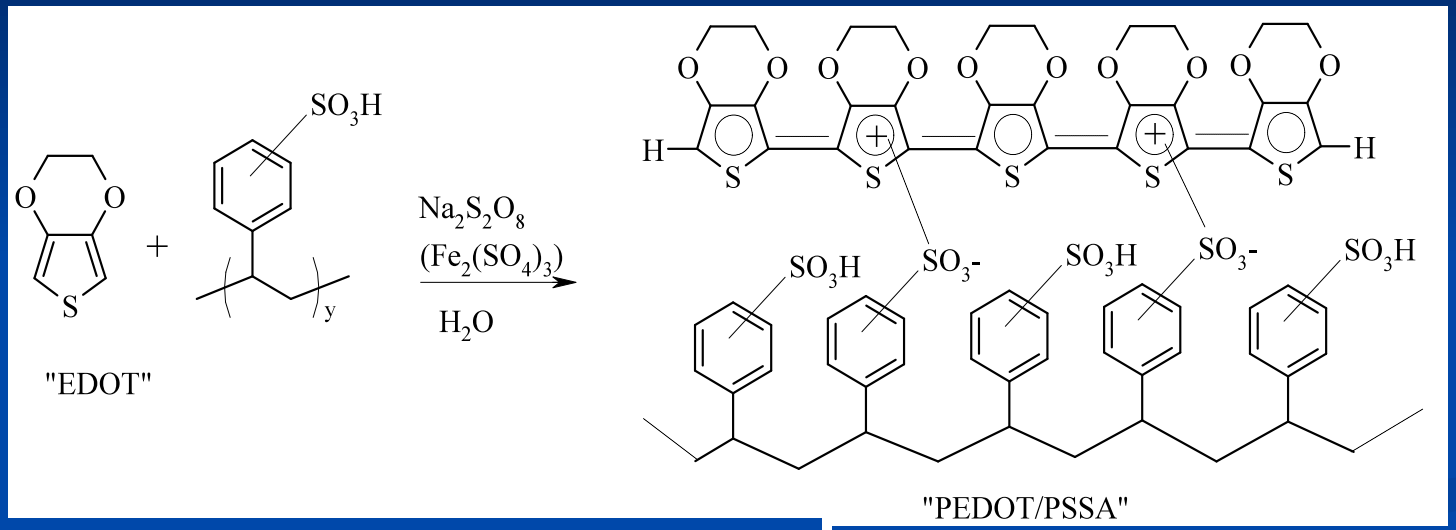
Ultra-Low Power
“Zero-Power”
Image Stability

Exceptional Portability
Thin, Light & Rugged

Low-Risk Manufacturing
Uses existing display infrastructure -materials, components & processes
Simple assembly
Fast-to-Market with minimal capital

Develop a conductive polymer film

Chemical structure of PEDOT/PSS



Poly(3,4-ethylene dioxylene thiophene)

Poly(4-styrene sulfonic acid)

Trade name for the water-based dispersion of the polymer complex poly (3,4-ethylenedioxythiophene)/ polystyrene sulfonate

Conductive Polymer Coating Process

1. Formulation: Additive

2. Primer **coating**

3. Corona treatment

Factors for Water Resistance

	Additive	Thick ness	Temp.	Drying Time
Water Resistance	↑	↓	↑	↑

What is Main Factor ?

↓

Quantitative Evaluation

Main Factor for Water Resistance

$$W = 0.0025 \times A^{1.0} \times H^{-1.5} \times T^{2.0} \times \theta^{1.2}$$

A : Amount of Additive

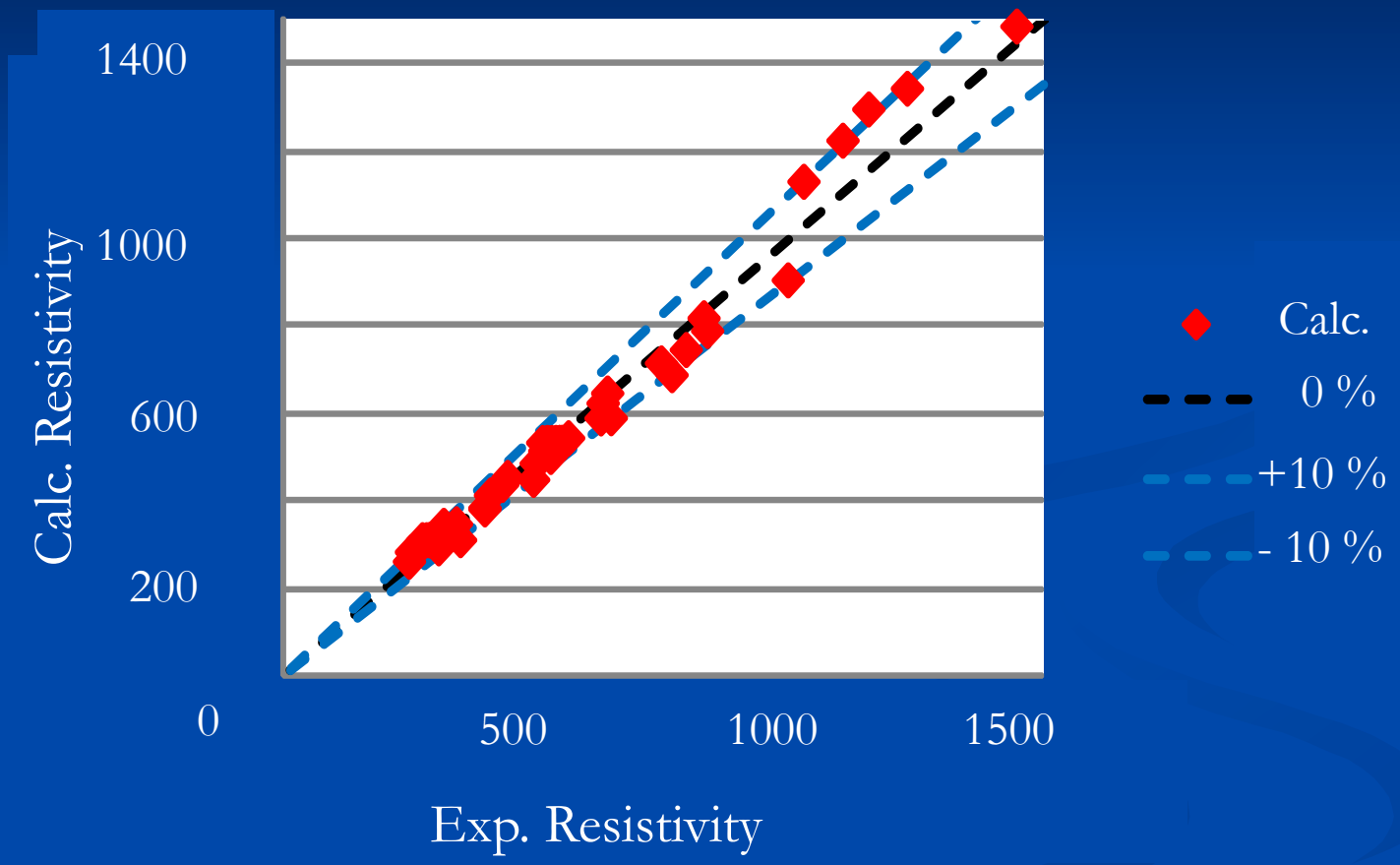
H : Thickness

T : Temperature

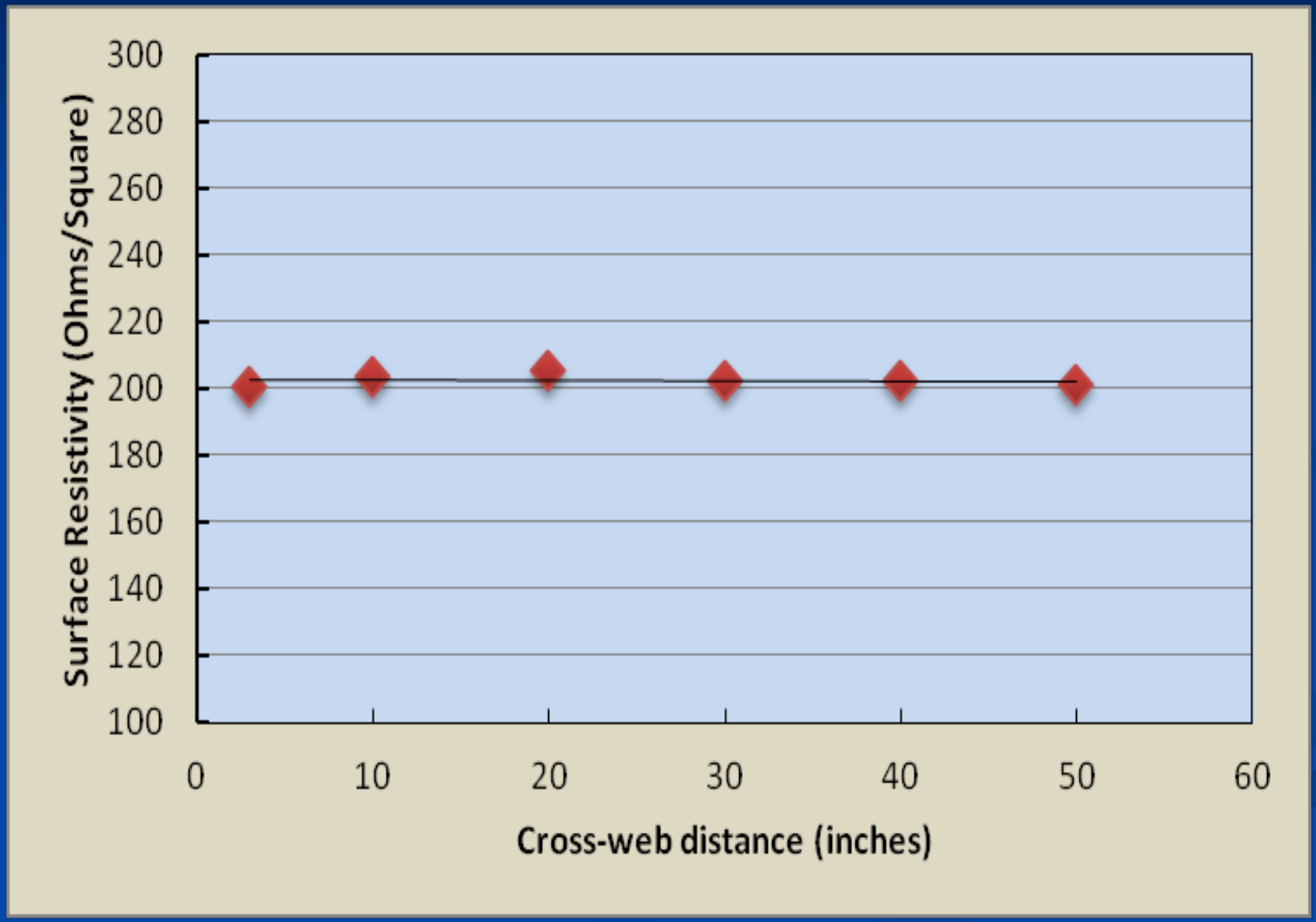
θ : Time

Drying Condition is the most important factor

Main Factor for Resistivity



Cross-web Surface Resistivity Uniformity Conductive film



Key property :
low surface resistance – high VLT

Different formulation types

Coating formulations & coated film

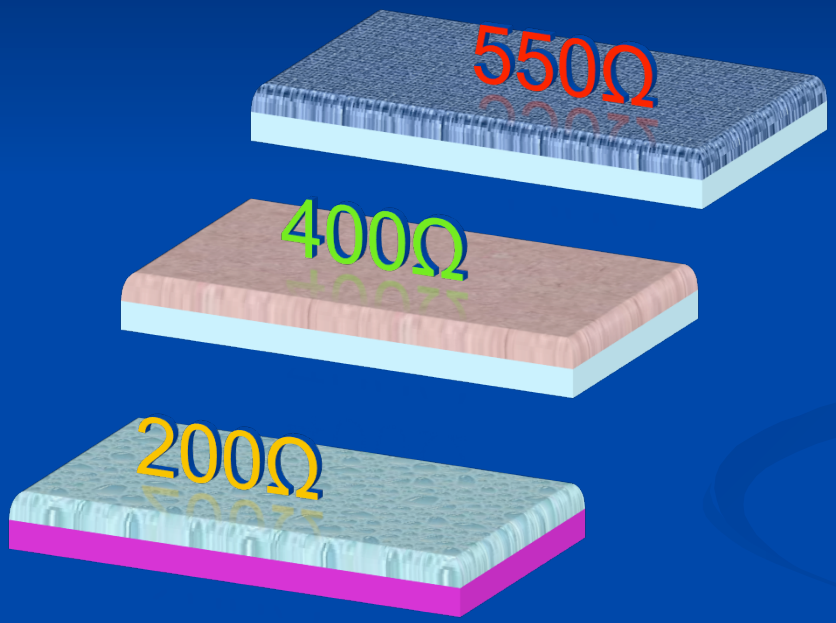
Property	ITO	Orgacon S305	Orgacon S305plus
SER (Ohm/sq)	300-500	450	450
VLT (%) on 188µm PET	> 86-90%	91,4%	90%
Stability (ratio R/R0)			
240hr@60°C/90%RH	<1,1	1,3	0,9
240hr@80°C	<1,1	1,4	0,8

Temperature & UV-stabilized

SELECTION of Support

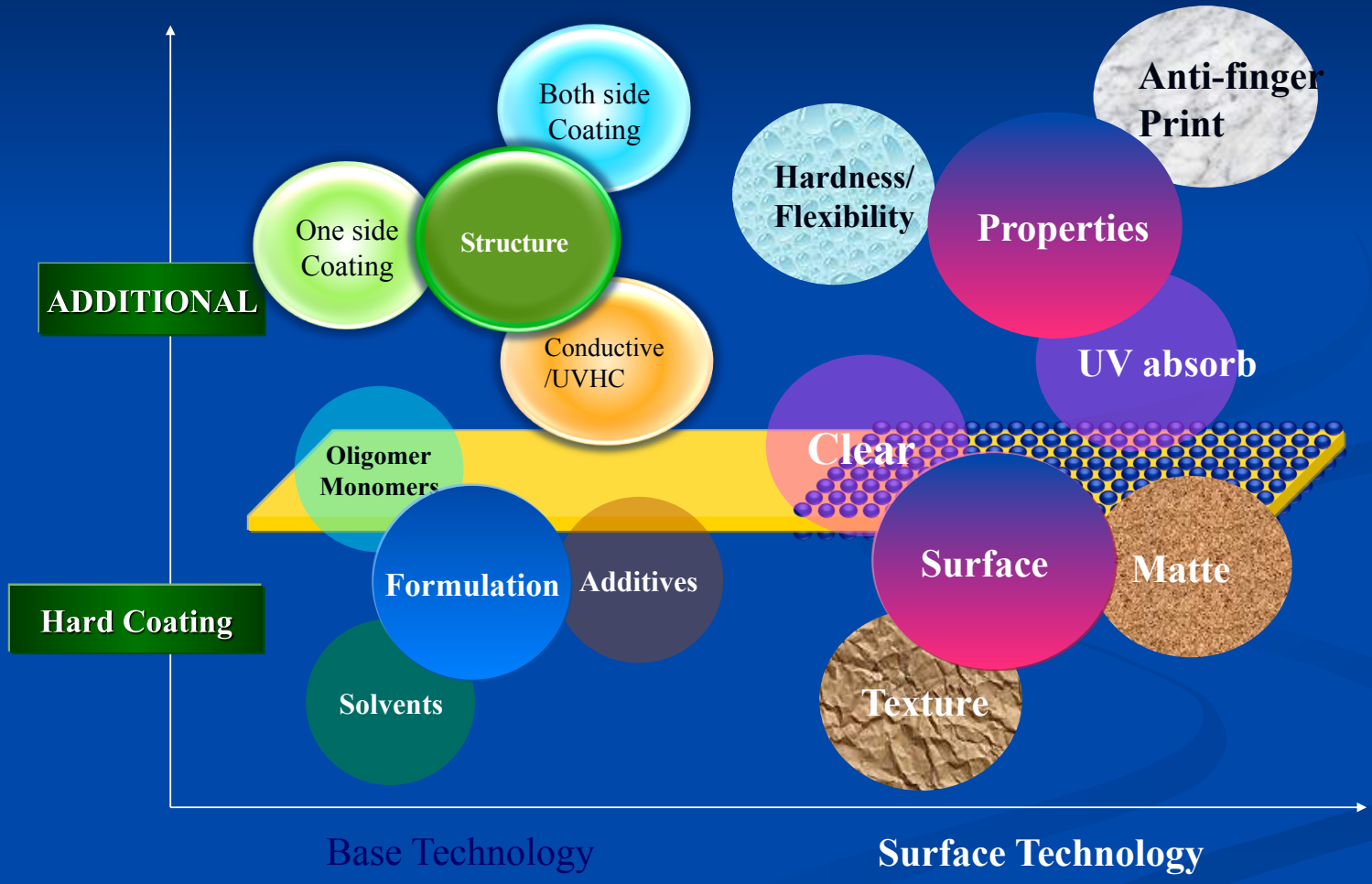
PET		SER Ohm/ sq	VLT% (hazeguard)	a*	b*	Haze %
Optical grade PET	Ref		94.5	-0.19	0.38	0.8
	+ S305plus	260	88.0	-0.81	-0.52	1.4

Ohmlex Film
Conductive Polymer Coated Film

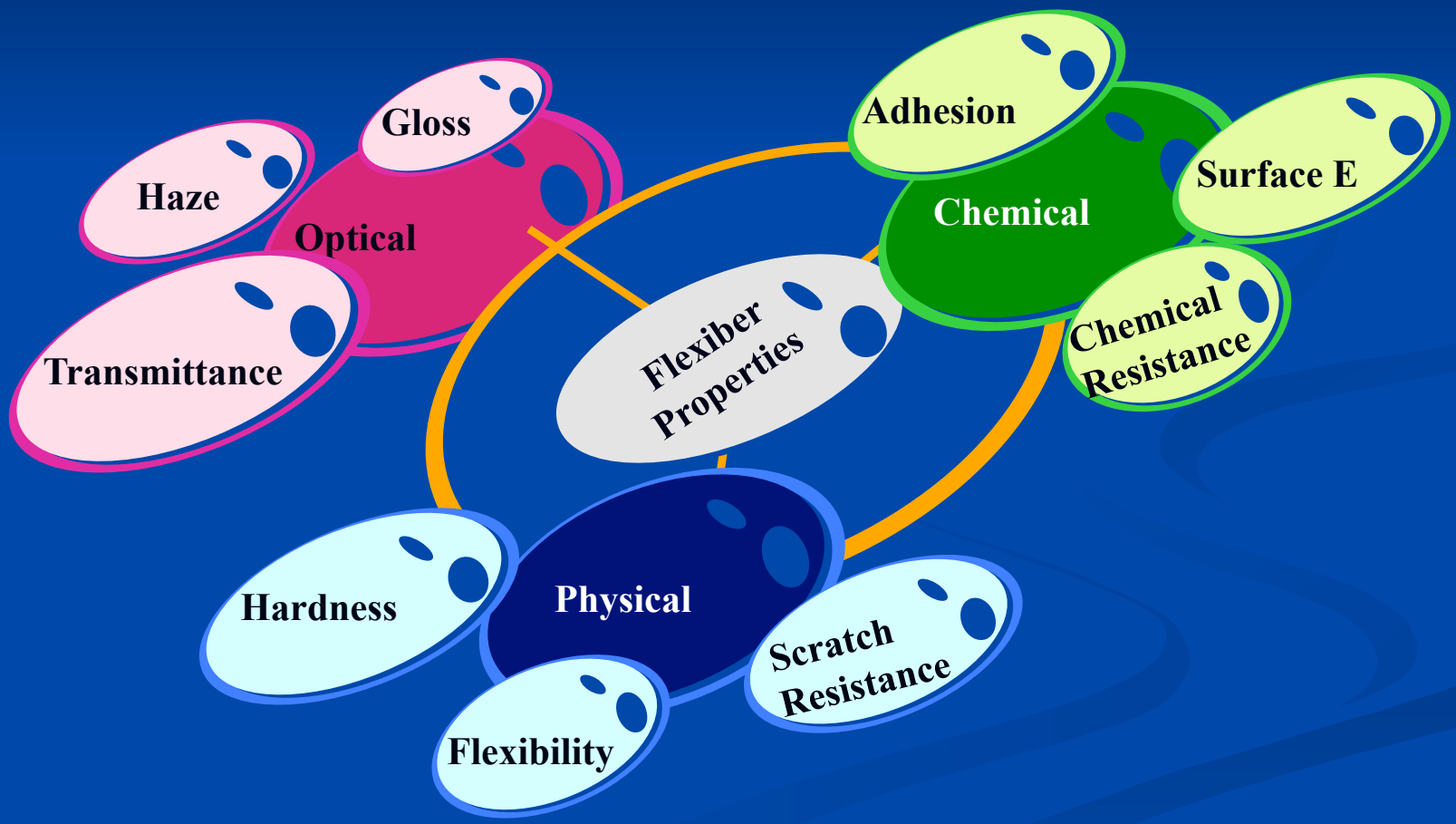


3 Scratch resistance film

Development Concept of KTI UV Hard Coat Film



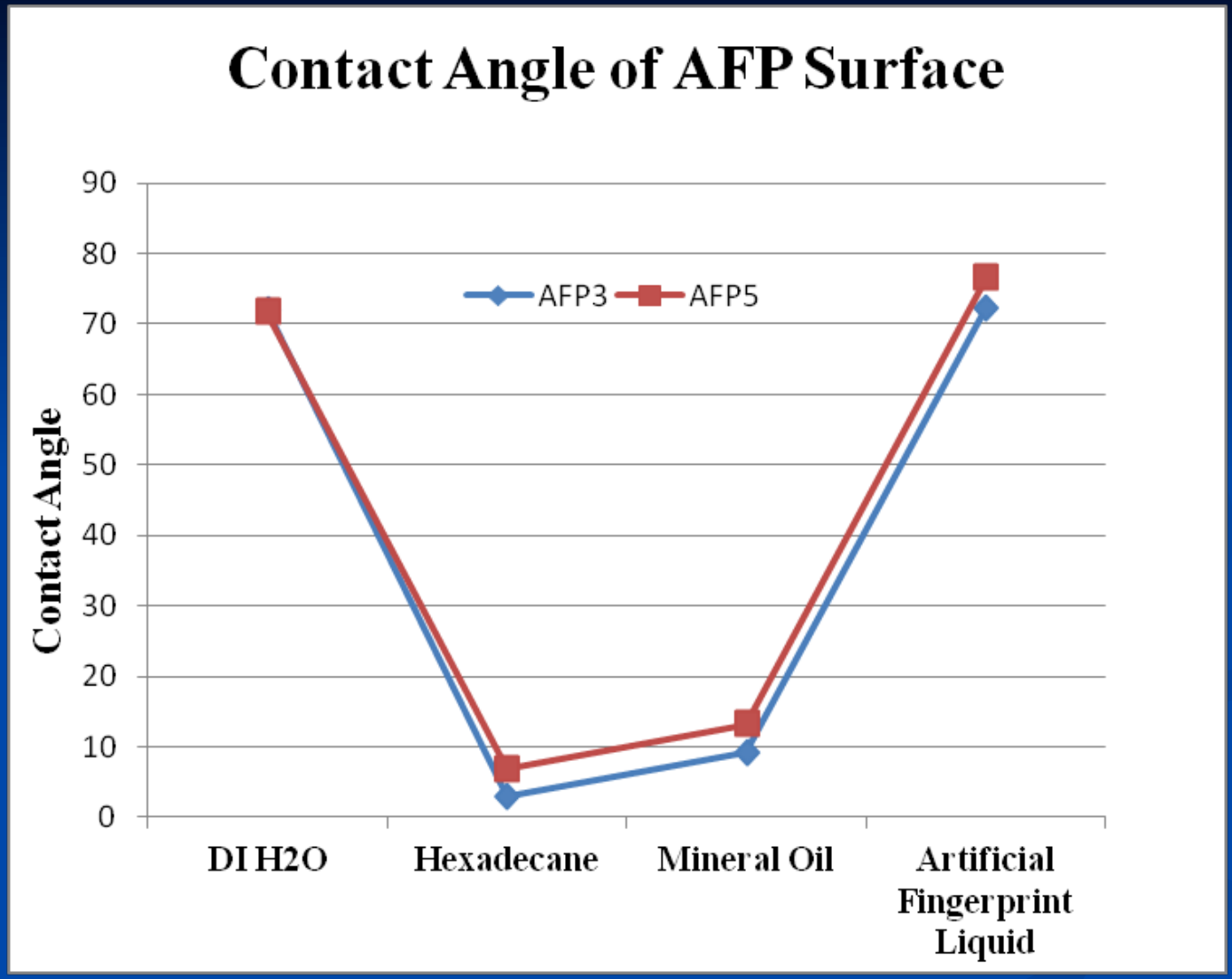
KTI UV Hard Coated Film Properties



Anti-Fingerprint UV Hard Coated Film

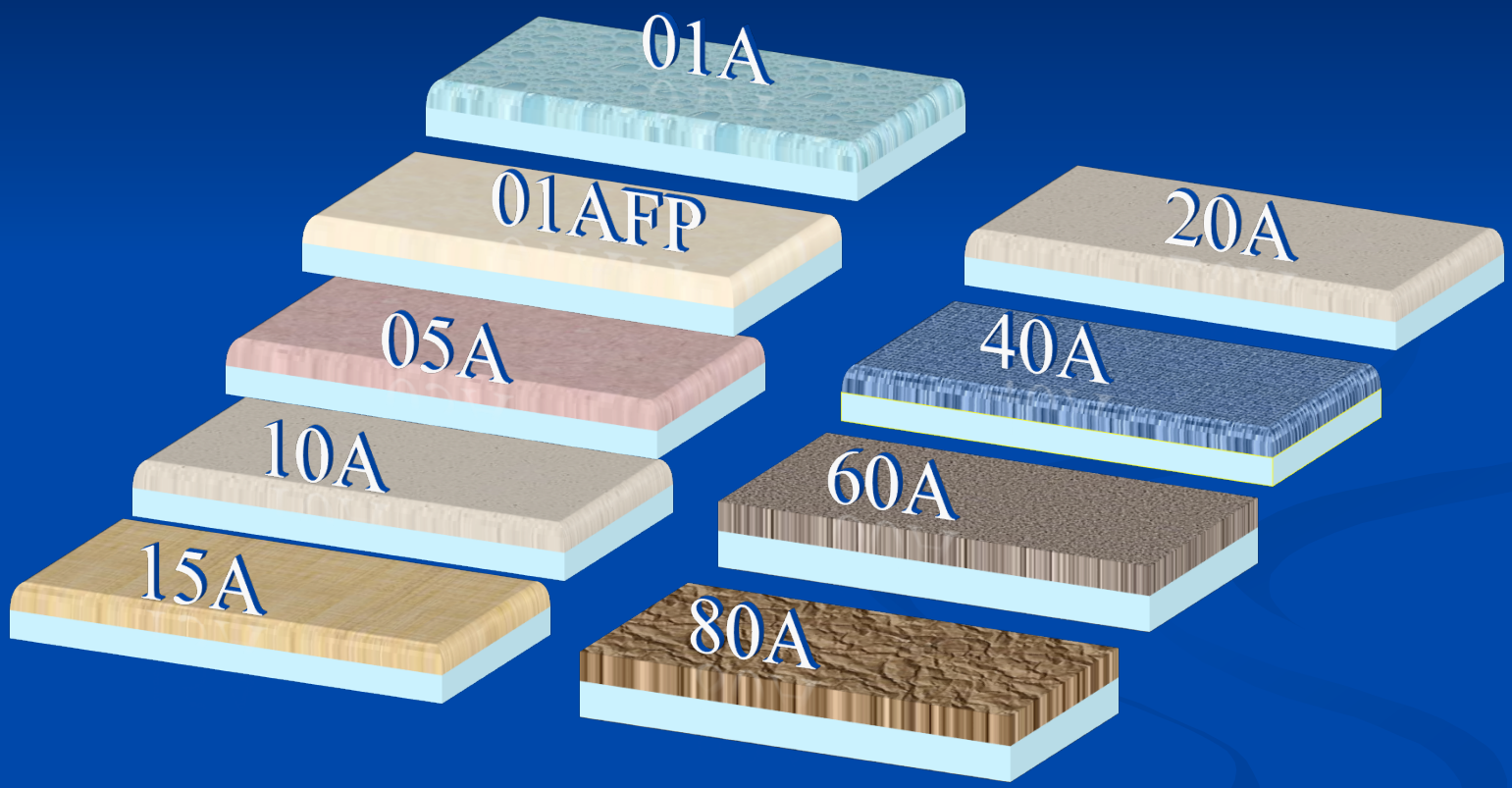
Formulation : Acrylic polymer 30 %
Pigment A : 1~ 15 μm, 1 ~ 3 %
Pigment A : 5~ 50 nm, 1 ~ 3 %
Photo initiators: 1 ~ 2 %

Properties : Surface tension 25 mN/m ~
Ra 0.05 μm ~
Rz 0.2 ~ 2.0 μm
Haze: 1.5 % ~
Hardness: 2H
Finger print: less visible & easy wipe out

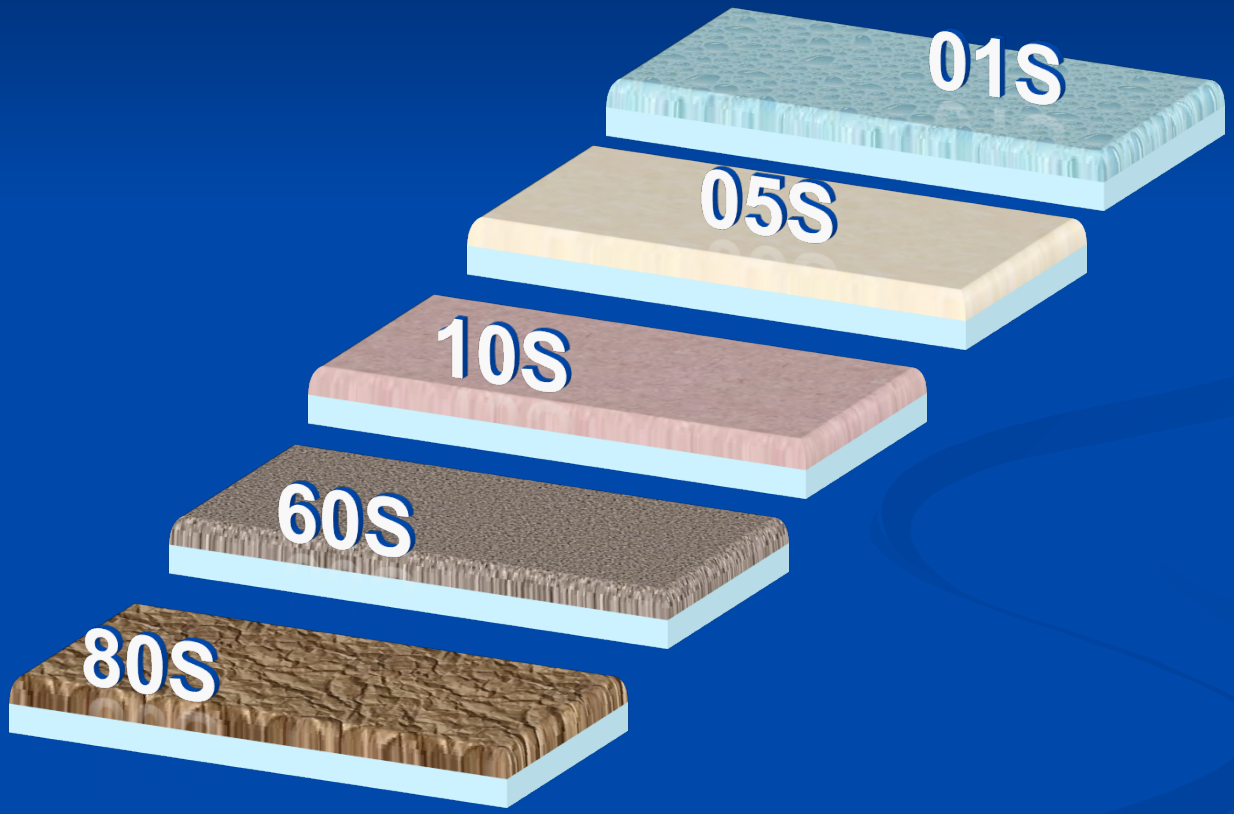


Urea	Lactic acid	Sodium pyrophosphate	Sodium chloride	Ethanol	Water
Formulation of 'Artificial Fingerprint Solution'					
1.0	4.6	8.0	7.0	20	1000

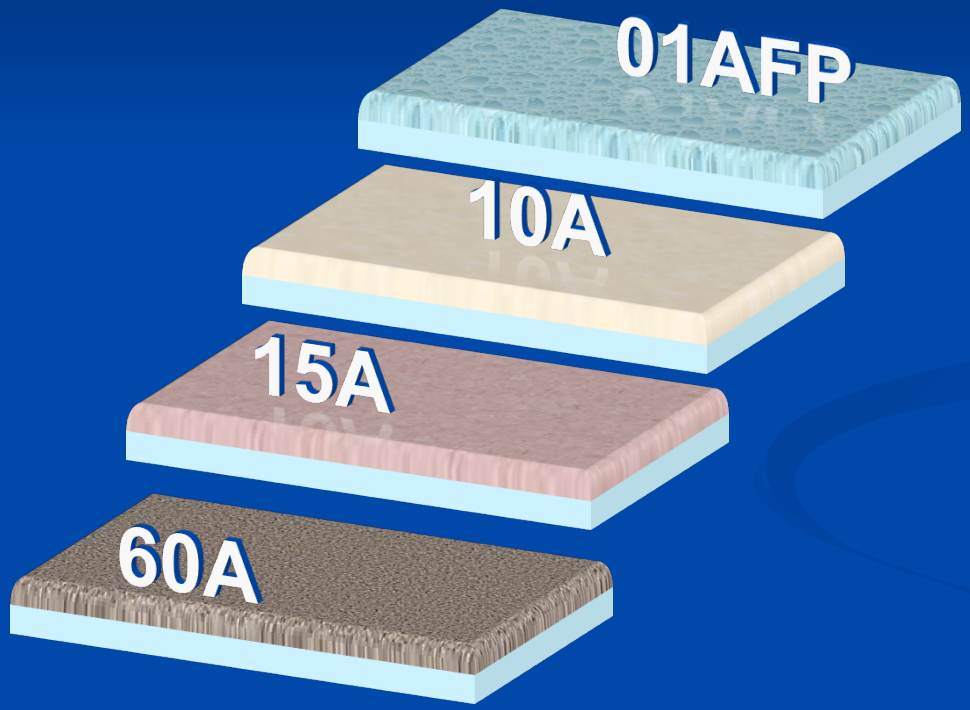
Kimoto Tech UV Hard Coated PET



Kimoto Tech UV Stabilized, UV Hard Coated PET



Kimoto Tech UV Hard Coated PC



Future Plan

•Current Performance

Resistivity : 150 – 1500 Ω/sq.

Other Market Requirements :
Less than 100 Ω/sq.

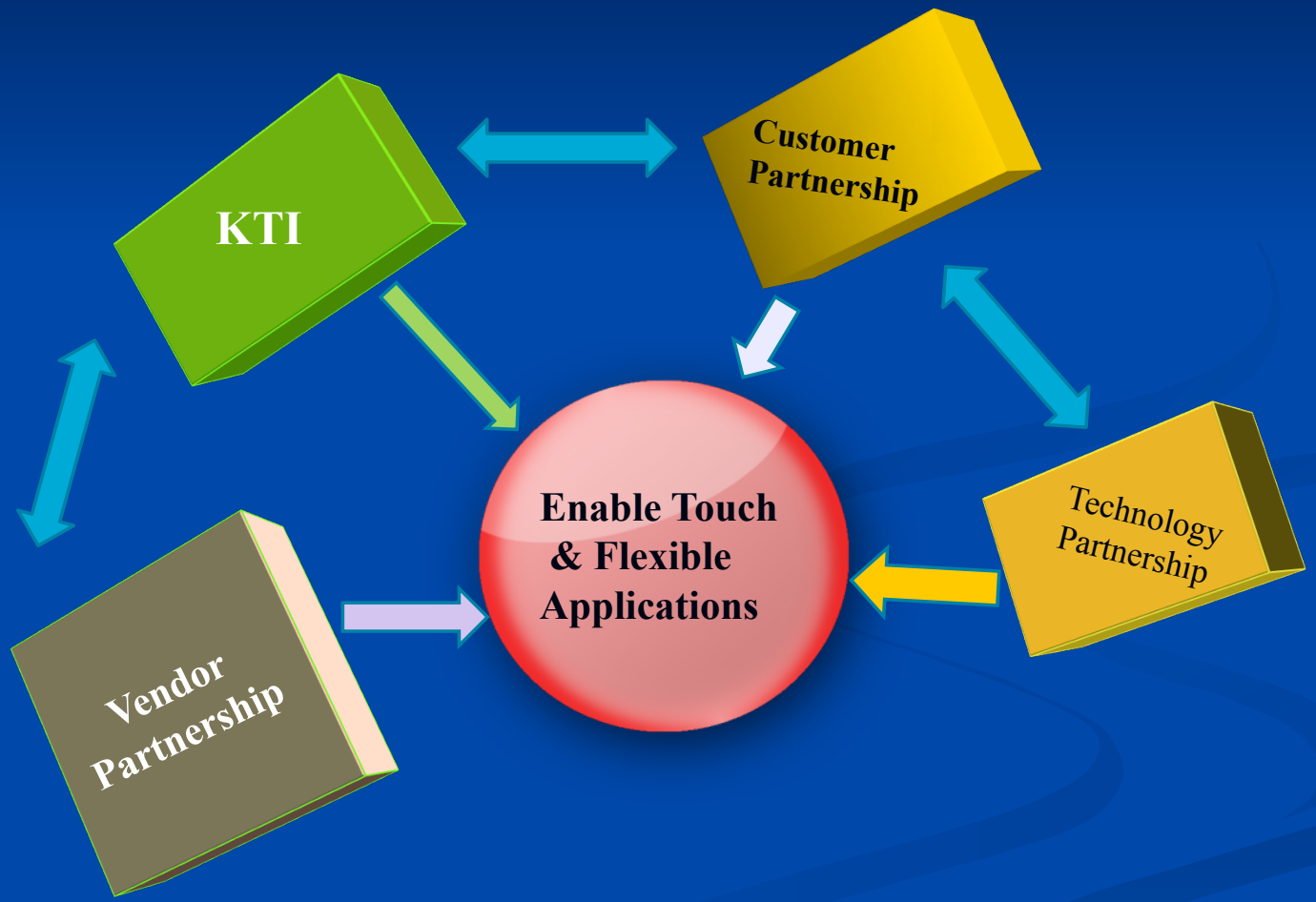
Conclusions

- CP products are good alternatives for any transparent conducting material on the market today
  - The SER/ %VLT ratio is closing the gap with ITO
- CP products are well suited in AC EL / OLED's/ OPV
  - Very flexible and stretchable
  - High conductivity + high efficiency
  - Good stability to T/RH and light
  - R2R compatible

KTI Product Offering For Touch Applications

	Ohmlex	Flexiber	PSA	Prosave
Touch Panel	√	√	√	√
E-Reader	√	√	√	√
E- Tablets	√	√		√
Membrane Switch		√		√
Flex Solar cell	√	√		

KTI Will Form Partnerships to Enable New Touch, Flexible Electronics & Energy Applications



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THANK YOU FOR YOUR ATTENTION

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