

The fabrication of full solid state electrochromic device on flexible films

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CEO

LeapHigh inc.

Change
Your Way of Seeing!

LeapHigh Inc.

· Electrochromic Smart Windows ·





We can change COLOR!

Electrochromic Smart Glass

Brief History

2016

- Feb** ▶ Founded
- Mar** ▶ Award of "Up-creative audition" at Kyeonggi-do
- May** ▶ Award of "Challenge! K-Startup 2016"
- Aug** ▶ Perform "6-monthes Challenge Platform for startup"
▶ Selected as Priority Company for "Public Technology Transfer Project of National Research Institute"
▶ Perform national project "Startup technology management and development"
- Nov** ▶ Perform KOITA's "R&D investment for startup company growth" project
- Dec** ▶ Award of "K-Global Startup Mentoring Company" by K-ICT

2017

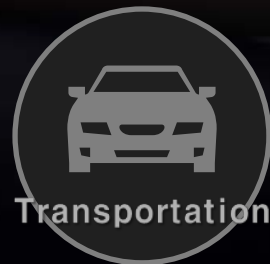
- Jan** ▶ Selected as "K-Global 300" from MSIP (Ministry of Science, ICT and Future Planning)
- Apr** ▶ Award of "Certificate of Creative & Innovative Enterprise" from Chungnam CCEI
▶ Perform TIPS(Tech Incubator Program For Startup)



Paradigm Shift

The Era of Autonomous Vehicles

Window of vehicles is no more just a physical barrier
It becomes a tool for both communication & privacy protection



Transportation



Living Room

Only Our Smart Glass Technology makes it possible

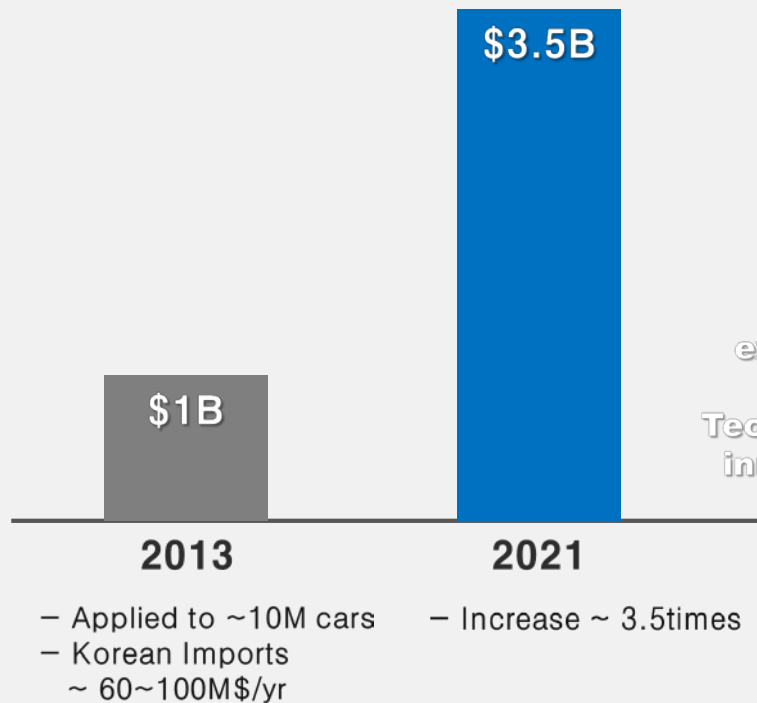
From My Own Private Area To the space to communicate with the world



FUTURE MARKET

▶ Market forecasting (2014, nanomarkets)

– Interior Mirrors are main



Market
expansion
By
Technological
innovations

▶ Market Expansion



MORE APPLICATIONS

Automotive Mirror/window



Rear View Mirror

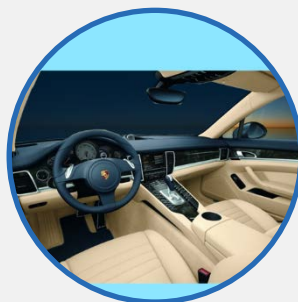
- Auto-dimming mirror
- Currently Biggest Market (~\$2B)

Exterior Mirror



- Difficult to create these Markets for the technical limitations of the conventional tech

Window & Sunroof



Architecture Glass

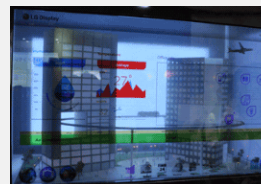


Clear when you want it. Tints when you need it.

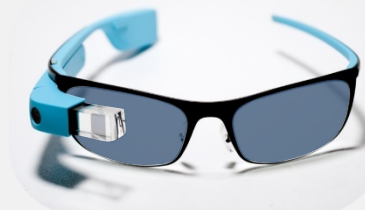
viewglass.com

Anything You Can Imagine...

Transparent Display

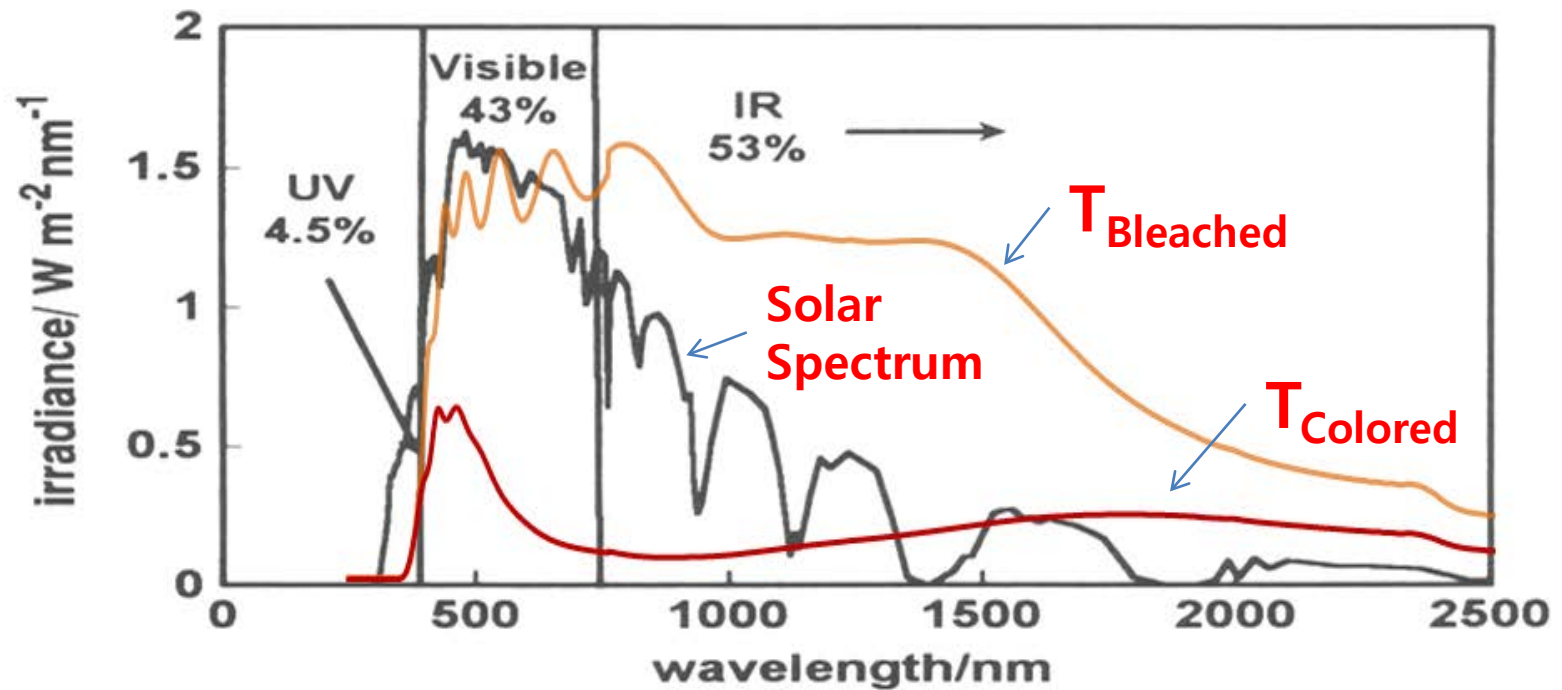


Glasses

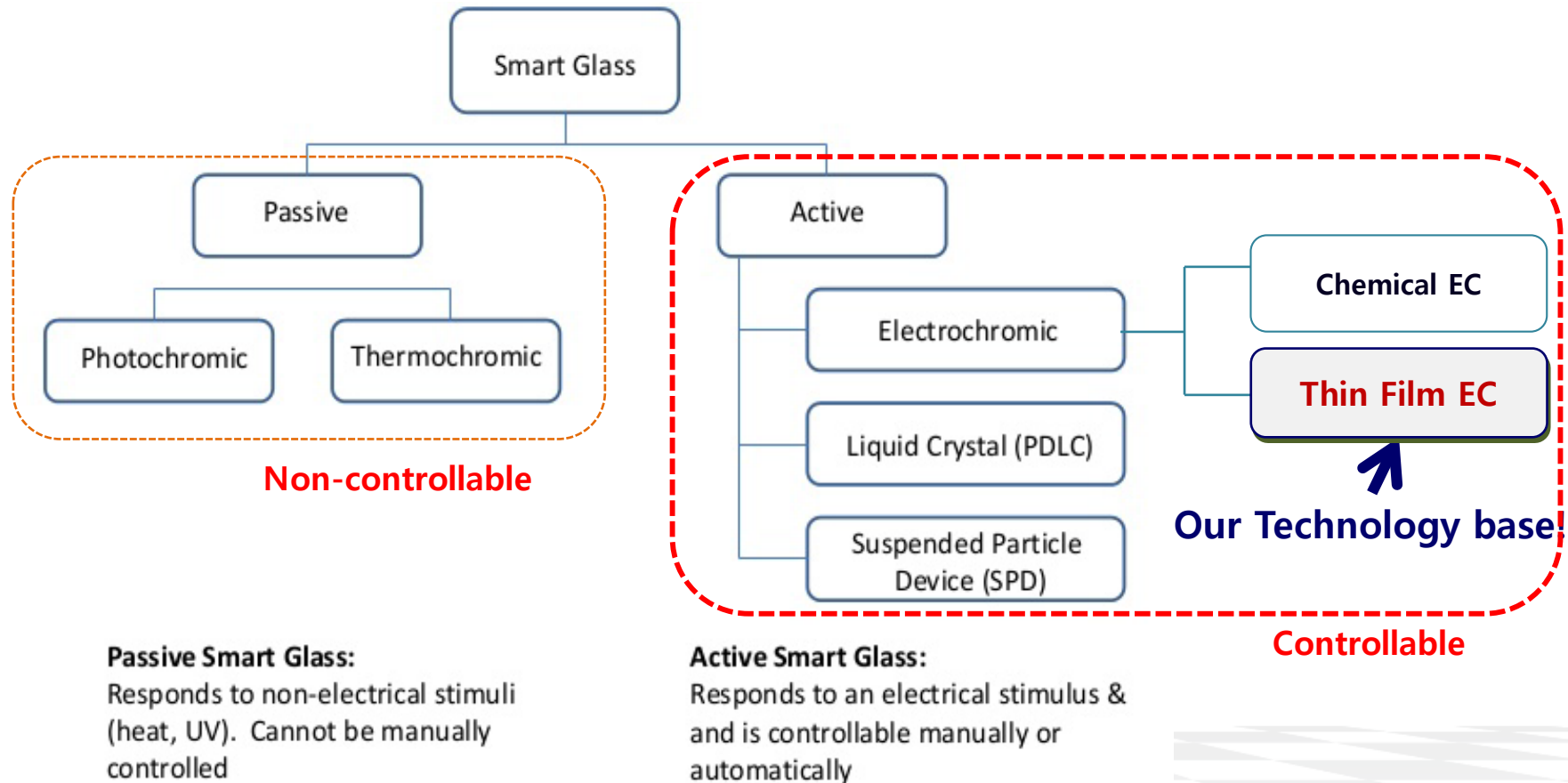


SMART GLASS ?

► Transparency controllable windows or mirrors



TYPES OF SMART GLASS

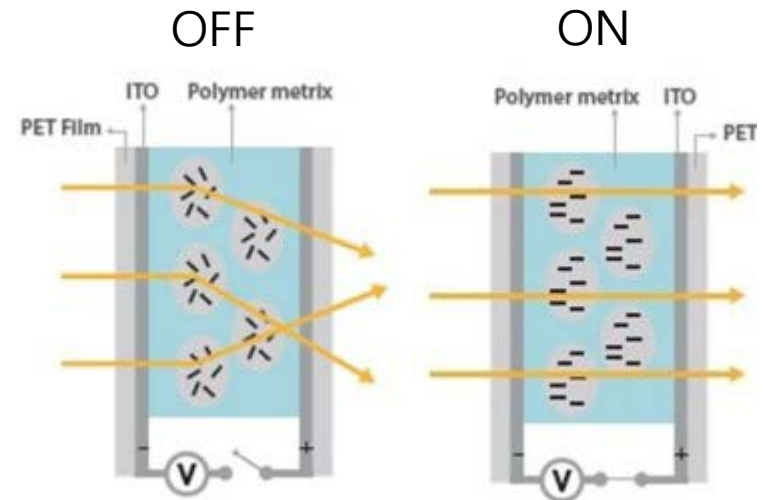


PDLC(POLYMER DISPERSED LIQUID CRYSTAL)

▶ Principles

- When a voltage is applied to the electrodes, the electric field causes the liquid crystals to align
- allows light to pass through the droplets and resulting in a transparent state

- ▶ Use Liquid crystal
- ▶ Only scattering of the light(milky white)
- ▶ High transmittance of UV & IR
- ▶ Use 100~ 200V AC power
- ▶ On – off states only
- ▶ Normally opaque
- ▶ Suitable to Interior window: Conference room,
- ▶ Bath room
- ▶ Expensive
- ▶ Needs 2 sheets of substrate



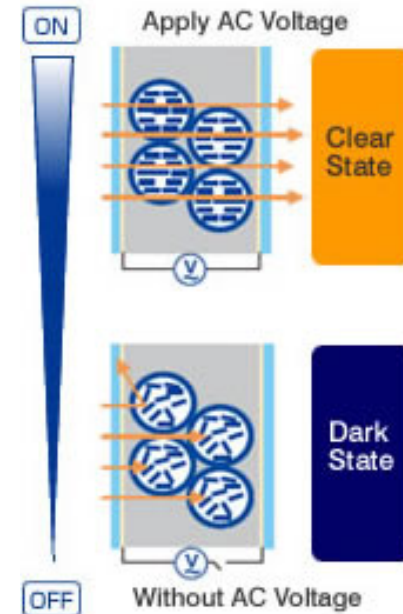
Transparent when ON
→ Continuous energy consumption

SPD (SUSPENDED PARTICLE DEVICE)

► Principles

- nano-scale particles is suspended in a liquid and placed between two pieces of glass or plastic.
- When no voltage is applied, the suspended particles are randomly organized, thus blocking light.
- When voltage is applied, the suspended particles align and let light pass

- ▶ RFI (Research Frontier inc.)' s unique technology
- ▶ Need license to use, produce, and sales
- ▶ Needs AC voltage (50V ~ 100V) to operate
- ▶ Can not block UV & IR throughly
- ▶ Need 2 sheets of substrate
- ▶ Complex structure
- ▶ High Power consumption
- ▶ No memory effect



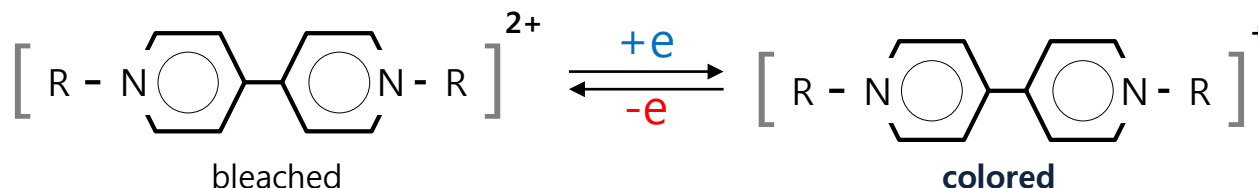
WHAT IS ELECTROCHROMISM?

- An **electrochromic material** is the one that **changes color** in a persistent but reversible manner **by an electrochemical reaction** and the phenomenon is called electrochromism.
- Electrochromism is the **reversible** and visible change in transmittance and/or reflectance that is associated with an **electrochemically induced oxidation–reduction reaction**

From : P. R. Somania et al, Materials Chemistry and Physics 77 (2002) 117–133

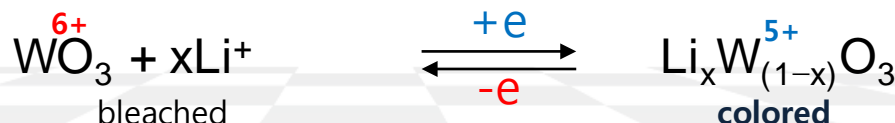
Examples

▶ Viologen

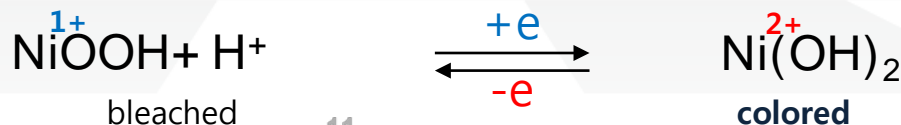


▶ Thin Film

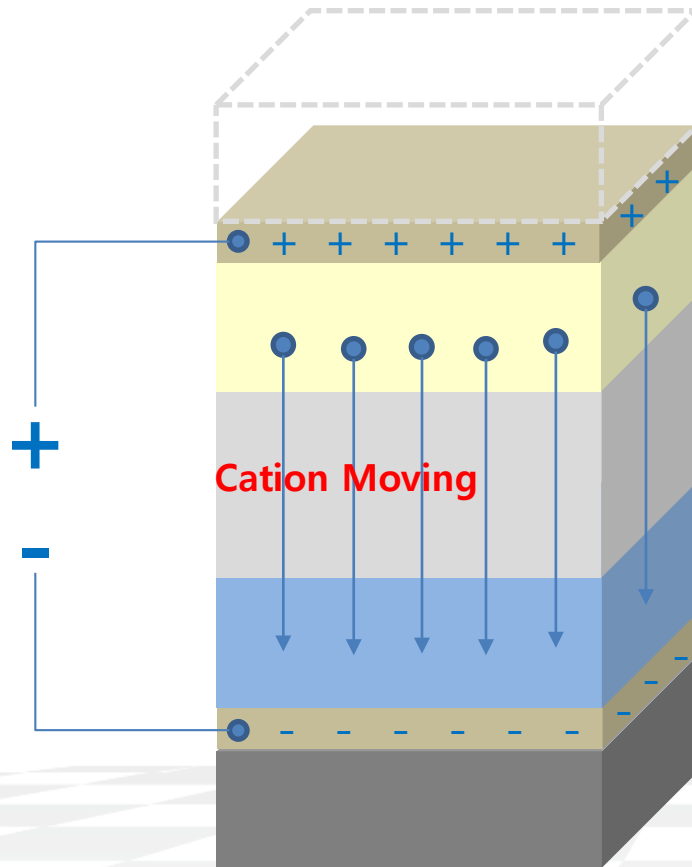
Cathodic material (Reduction state : colored)



Anodic material (Oxidation state : colored)



BASIC STRUCTURE OF THIN FILM EC DEVICE



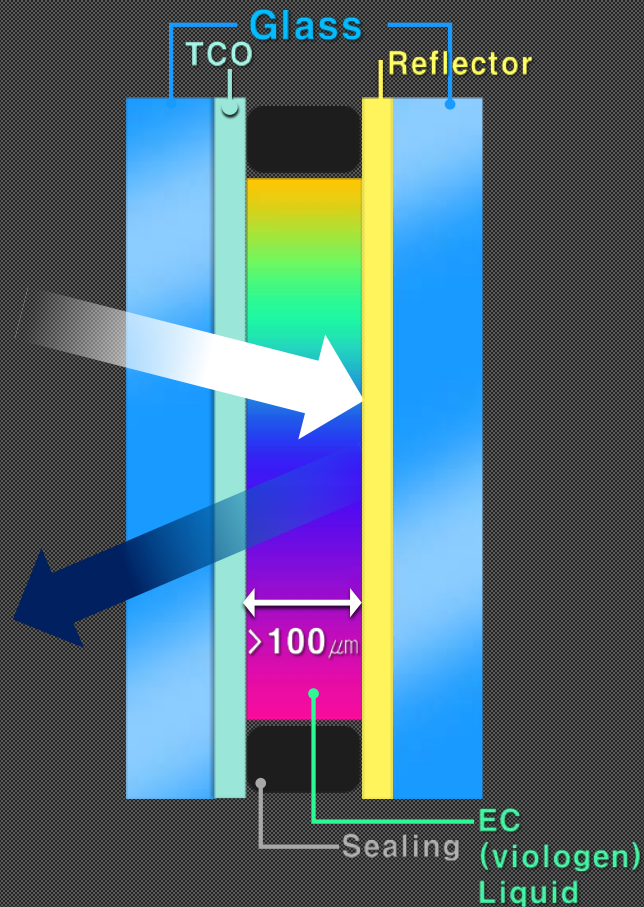
- w/ or w/out (Glass, Flexible Film)
- TCO
- **Ion Storage Layer (Counter EC, Anode)**
- **Ion Conductor (Electrolyte)**
- **Electrochromic layer (Cathode)**
- TCO
- Substrate (Glass, Flexible Film)

CANDIDATE MATERIALS OF THIN FILM EC

Oxide type	Coloration	Color change	
TiO_2	C	Transparent	\leftrightarrow Blue-black
V_2O_5	C/A	Yellow	\leftrightarrow Pale blue
Cr_2O_3	A	Yellow	\leftrightarrow Pale blue
MnO_2	A	Yellow	\leftrightarrow Brown
FeO_2	A	Transparent	\leftrightarrow Yellow / Green
CoO_2	A	Blue	\leftrightarrow Brown
NiO_2	A	Pale green	\leftrightarrow Brown black
Nb_2O_5	C	Yellow	\leftrightarrow Pale blue
MoO_3	C	Transparent	\leftrightarrow Blue
RhO_2	A	Yellow	\leftrightarrow Green
WO_3	C	Transparent	\leftrightarrow Blue
IrO_2	A	Transparent	\leftrightarrow Blue-black

TECHNOLOGY INNOVATION

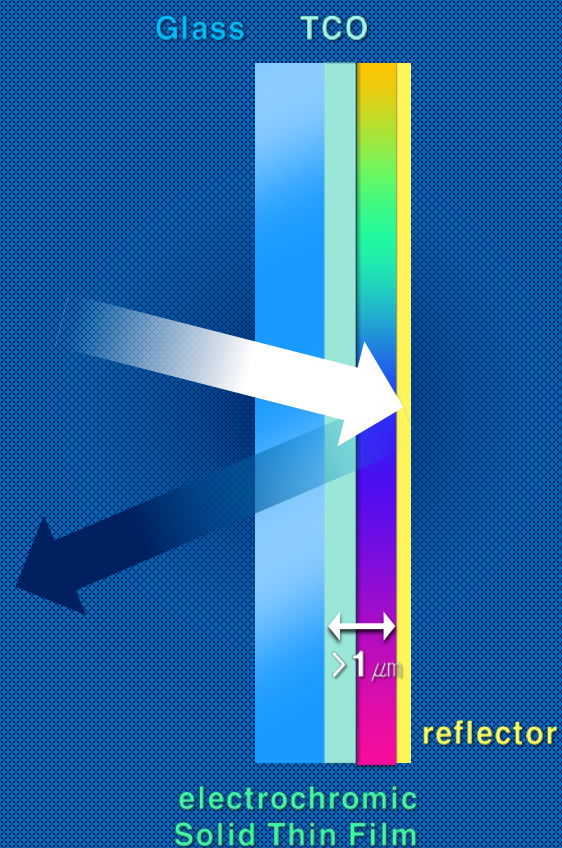
conventional



- ▶ **Liquid Type EC material(viologen)**
 - : Need 2 sheets of Glass
- ▶ **Vulnerable to**
 - : large size, Curved & Flexible films
 - : control the gap between 2 sheets of Glass
- ▶ **High Cost, Low durability**
- ▶ **Complex Structures & manufacturing Process**
- ▶ **Poor performance**
 - : Bad Reliability @ Low & High Temp.
 - : No Memory Effect
 - (need power to maintain color status)
- ▶ **Old Tech – commercialized in 1987**

Con

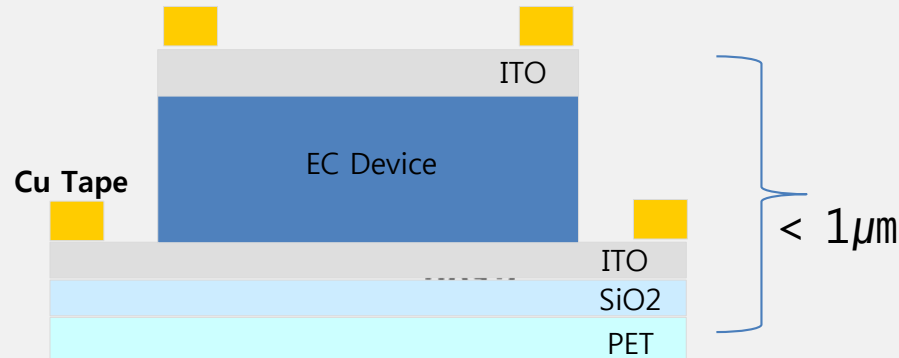
Our tech



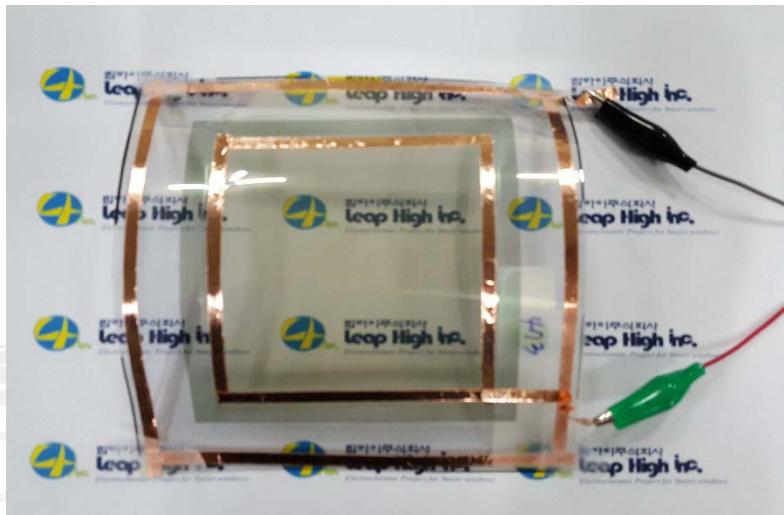
- ▶ Thin films on Glass surface ($< 1 \mu\text{m}$)
 - : Full solid state
 - : only 1 sheet of glass
 - : Vacuum process
- ▶ Advantageous to
 - : large size, Curved & Flexible films
 - : control gap width between 2 sheets of Glass
- ▶ Low Cost (1/4 of competitor' s)
- ▶ High Performance
 - : fast, high reliability @High & Low Temp.
 - : Memory Effect, Low E consumption
- ▶ State-of-the-art technology

FLEXIBLE EC DEVICE

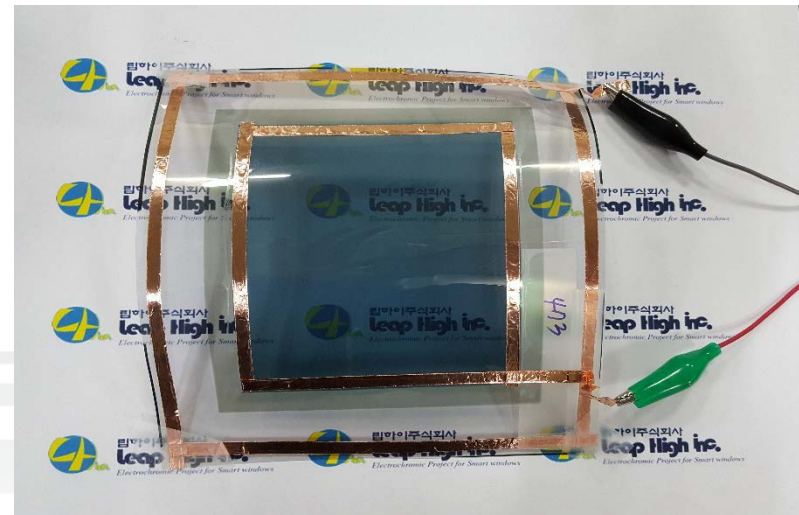
Schematic structure



- ▶ Substrate : SiO₂ coated PET
- ▶ WO₃ based EC material
- ▶ All materials are deposited by sputtering
- ▶ Total Thickness is under 1 μm
- ▶ Active Area 10× 10 cm²



Bleached Mode



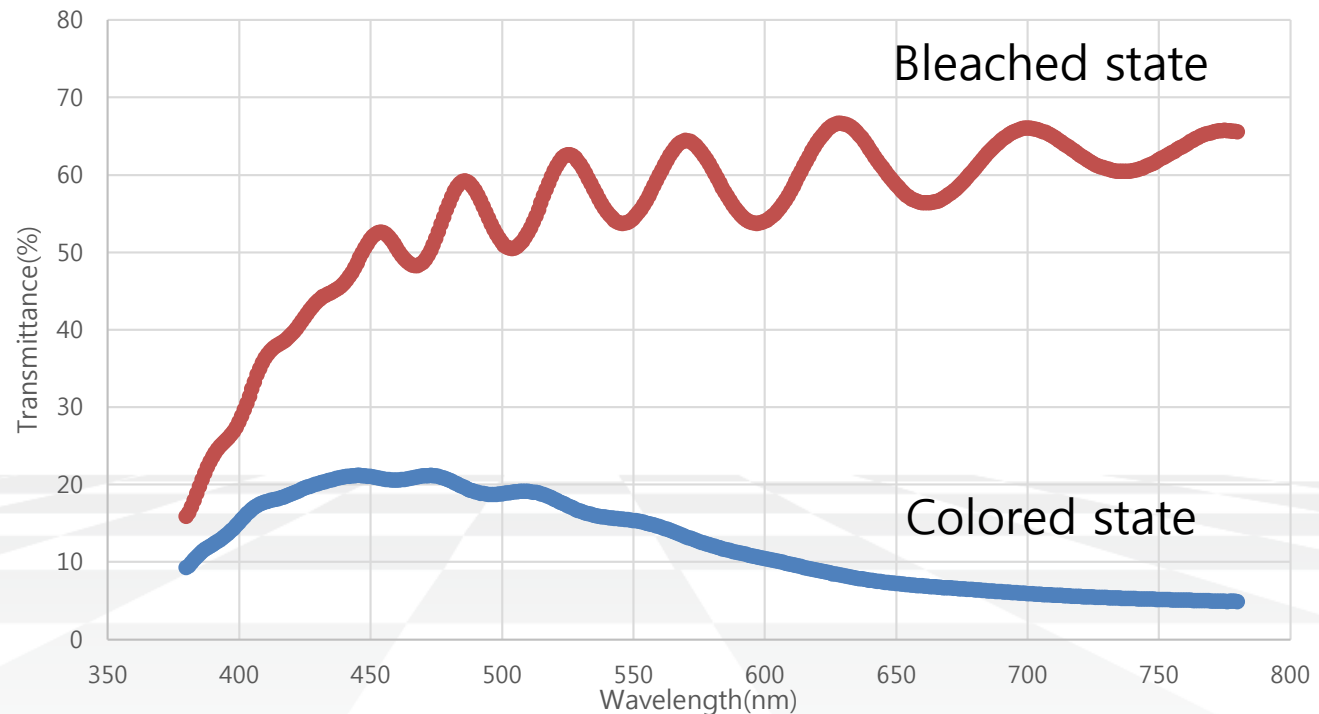
Colored Mode

SAMPLE MOVIE



TRANSMITTANCE

- ▶ Measuring range : 380nm ~ 780nm
- ▶ Average Transmittance
 - Bleached state : ~ 56%
 - Colored state : ~ 12%
- ▶ Applied Voltage : -1.2V ~ 1V



CO-WORK WITH_KRICT/YUOUNGNAM UNIV.

Innovative Tech.



Thin Film Hard Coating
By KRICT

EC Core
Technology
By Leaphigh

High Hardness, moisture proofing,
anti-contaminating

Patent Application Number

10-2016-0013829

10-2015-0130675

► Innovative Product

► Economics

- Using Sputter Process
- Low Cost
- No need additional facilities
- Inline process with EC process

Change
Your Way of Seeing!

립하이와 함께라면,
세상을 바라보는 방식이 바뀝니다

Thank You

· Electrochromic Smart Windows ·

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