INER-F0930 **INER-F0930**

出國報告（出國類別：其他）

赴日參加 AMFPD2015 國際會議與參訪產業技術總合研究所出國報告

服務機關：核能研究所
姓名職稱：王敏全　副工程師
派赴國家：日本
出國期間：104 年 6 月 30 日~104 年 7 月 7 日
報告日期：104 年 7 月 28 日

摘 要

本次會議為可撓式電漿鍍膜技術應用於光電產業相關技術相關之研討會。AM-FPD”15 為日本光電業及學術界每年一度的重要會議，所發表之論文與論壇皆為目前世界上最新技術及應用發展為主。會議內容包含光電科技技術及新穎元件的發表。其中，電漿製程技術仍為光電元件鍍膜發展主流，利用電漿沉積薄膜於可撓式元件仍是會議論文發表重點項目。而研討會針對透明半導體元件應用、開發及導入仍是重點研發項目，主流技術為濺鍍技術，與本所現有的電漿開發經驗相符。因此，可針對此材料於可撓式基板上進行先期開發研究。而本所藉由在會議中發表全固態電致變色元件於光圈應用研發成果論文，與國內外多家光電大廠包含蘋果公司、友達光電等研發主管針對應用部分進行交流，皆獲得不錯之評價，有效提升本所於可撓式節能薄膜元件及設備研發之國際能見度。此外，在卷對卷式連續製程技術應用於可撓式基板鍍膜發展的方向上，圖型化薄膜的技術的引入將可提升整體技術層次，有利於技術應用上的推廣，並拓展本所於薄膜光電元件之研發領域。而在研討會結束後，藉由參訪日本產業技術總合研究所(AIST)名古屋分部針對電致變色智慧窗更多未來應用之可行性及發展趨勢進行交流，會中由 AIST 光熱制御研發部山田組長針對變色材料之研發歷程及應用進行簡報介紹，山田組長強調 AIST 所發展之技術研發期程以中長期為主，專注於材料面的開發與應用，並與地方相關特色產業搭配結合，於研發階段即開放產業投入先期研發合作，發展技術較易為業界應用。而針對變色材料領域，目前該單位與愛知地區的汽車大廠豐田合作，主要以應用於氫能環保車為主要目標，與本所以電致變色應用為導向之發展方向一致。

目　　次

附　圖　目　錄

一、目　的

參加 2015 年主動式矩陣顯示元件國際研討會及參訪日本產業技術總合研究所，發表電致變色元件研發成果論文，並搜集電漿鍍膜綠色節能相關技術暨設備應用之最新資訊，進而瞭解國際研發現況、市場及趨勢。可撓式類紙化產品的研發關鍵，皆以適用於可撓式(Flexible)基板之電漿鍍膜設備為其關鍵核心技術。本所規畫發展大面積高速率可撓式薄膜元件整合製程及相關工業型裝置，並深入評估以可撓式薄膜元件與相關節能應用整合。希望藉由參與此技術研討會以及參訪日本產業技術總合研究所，獲得更多可撓式製程技術資訊及相關發展方向，並與各國頂尖專家交流加速本所在可撓式製程設備技術之開發。並藉由參與此研討會及發表論文之機會，與來自世界各地的相關領域傑出的研究者及工業界人士互相交流汲取知識，以獲得更多電漿鍍膜綠色節能技術之資訊及相關發展方向，對本所技術之提升和創新有相當助益。

本所電漿在綠色節能環境之開發與應用計畫是發展光伏及節能之薄膜元件製程和整合系統為主軸。希望藉由參與此研討會及發表論文及參訪日本產業技術總合研究所機會，與來自世界各地的相關領域傑出的研究者及工業界人士互相交流汲取知識，以獲得更多電漿鍍膜綠色節能技術之資訊及相關發展方向，對本所技術之提升和創新有相當助益。

二、過　程

(一) 行程

本次公差之行程如下：

6 月 30 日 8:30 自桃園國際機場出發，當地時間 6 月 30 日 12:00 時抵達日本大阪關西機場。並於當日 13:00 自關西機場搭乘機場電車至京都車站附近飯店，15:30 抵達飯店，並完成註冊。

7 月 1 日~ 7 月 3 日 參加 2015 年主動式矩陣顯示元件國際研討會並發表研究論文。

7 月 4 日 整理研析研討會相關資料

7 月 5 日 搭乘新幹線前往日本產業技術總合研究所(AIST)所在地名古屋分部。

7 月 6 日 10:00 參訪日本產業技術總合研究所(AIST)進行電致變色應用研發交流，會後搭乘新幹線返回大阪。

7 月 7 日 當地時間 14:30 時抵達日本大阪關西國際機場，並於 18:50 自日本大阪關西國際機場出發，20:40 時飛抵達桃園國際機場返回台灣。

(二) 參加 2015 年主動式矩陣顯示元件國際研討會

2015 年主動式矩陣顯示元件國際研討會是由日本應用物理協會(Japan Society of Applied Physics)主辦，及國際知名研究協會 IEEE Electron Devices Society、ECS Electronics and Photonics Division 及 ECS Japan Section 所共同協助舉辦，研討會會場如圖 1 所示。本屆會議為第 22 屆，專題講座邀請來自德國、英國、香港、美國、韓國、日本、台灣等各國專家學者及光電產業界技術研發主管。本次研討主題包括(1)平面顯示器及可撓式元件相關製程設備製程技術；(2)薄膜電晶體元件技術；(3)太陽能電池元件相關技術；(4)創新薄膜元件及材料製程技術等，會議時程如圖 2 所示。由於光電領域所使用之設備及相關元件開發有一定程度的同質性，因此藉由參加會議蒐集國際上相關研究主題可做為本所規劃後續研發方向之參考依據。

圖 1、 AM-FPD 15 研討會會場

AM-FPD '15 Time Table

	Wednesday, July 1		Thursday, July 2		Friday, July 3		Saturday, July 4
Registration	9:30-17:00		9:00-17:00		9:00-14:00		7:00-19:00
Tutorial	10:00-12:00	*Tutorial in Japanese*					
Workshop			9:00-10:30	**Symposium 1 :** Advances in TFT Technology for Future Application	9:00-9:50	**Session 4 :** High Performance FPD Technologies	Excursion
			10:30-10:45	*Coffee Break*	9:50-10:05	*Coffee Break*	
			10:45-12:15	**Symposium 2 :** 2D Materials for Flexible Electronics	10:05-11:05	**Session 5 :** Novel Approach on Photovoltaics	
					11:05-11:35	Late News	
	12:00-13:00	*Lunch*	12:15-13:35	*Lunch*	11:35-13:00	*Lunch*	
	13:00-13:15	Opening Session	13:35-15:05	**Symposium 3 :** Emerging Flexble Solar Cells	13:00-14:10	**Session 6 :** New Materials for Thin Film Devices	
	13:15-14:45	**Session 1 :** Keynote Address					
	14:45-15:05	*Coffee Break*			14:10-14:30	*Coffee Break*	
	15:05-16:10	**Session 2 :** Technology for Flexible Devices			14:30-15:55	**Session 7 :** Oxide and LTPS TFTs	
	16:10-16:25	*Break*					
	16:25-17:25	**Session 3 :** Oxide TFTs			15:55-16:00	Closing Remarks	
Author Interviews	17:25-17:55	Author Interviews	15:05-15:35	Author Interviews	16:00-16:30	Author Interviews	
Poster Session			15:35-18:00	**Poster Session :** FPDp / TFTp / TFMDp / PVp			
Banquet	18:10-20:10	*Banquet*					

Workshop : "Ryukoku University Avanti Kyoto Hall" (Avanti, 9th Floor)
Registration : Entrance (Avanti, 9th Floor)
Poster Session : Mariage Grande "Glove" (Avanti, 8th Floor)
Author Interviews : Lobby (Avanti, 9th Floor)
Banquet : Mariage Grande "Glove" (Avanti, 8th Floor)
Tutorial : "Ryukoku University Avanti Kyoto Hall" (Avanti, 9th Floor)

圖 2、 研討會議時程表

(三) 參訪日本產業技術總合研究所(AIST)名古屋分部

日本產業技術總合研究所(AIST)名古屋分部如圖 3 所示，主要以永續發展的材料研究領域為主，研究 領域包含材料固化、節能智慧窗及應用、奈米材料、陶瓷材料等相關研發領域。其中節能智慧窗及應用領域與本所研發之電致變色智慧窗相關，為本次主要參訪目標，希望藉由拜訪於 AIST 電致變色研究團隊了解電致變色智慧窗更多未來應用之可行性及發展趨勢。

圖 3、日本產業技術總合研究所(AIST)名古屋分部

三、心　得

本次會議主要以邀請演講論文為主，會議一開始的訓練課程即以太陽能電池訓練課程拉開序幕，內容包含太陽光電現狀、原理、製作方式、高效率太陽能電池及最新的研究結果進行課程的訓練，會議開幕的第二場演講即邀請 AIST 的再生能源中心主任 M. Kondo 針對太陽能電池研發領域方面發表演講，針對太陽能電池技術，早期在太陽能電池占整體系統成本 60%時以低成本製程技術及材料為發展重點，而根據 2015 年的文獻指出，目前矽基太陽能電池仍占有市場 90%以上的市占率，而相關太陽能電池效率研發近況為 HIT 單晶矽太陽能電池效率可達 25.6%，雙接面薄膜太陽能電池光電轉換效率達到 13.4%，CIGS 薄膜太陽能電池所得光電轉換效率 21.7%，目前最熱門的 Perovskite 薄膜太陽能電池效率則可達 20.1%，但仍需克服低成本材料及長期可靠度的關鍵問題，如圖 4 所示。隨著太陽能電池成本大幅降低，研發將導向低系統建置系統成本為研發主軸，因此針對長期再生能源的儲能技術則建議以再生能源產氫的方式為主要發展方向。

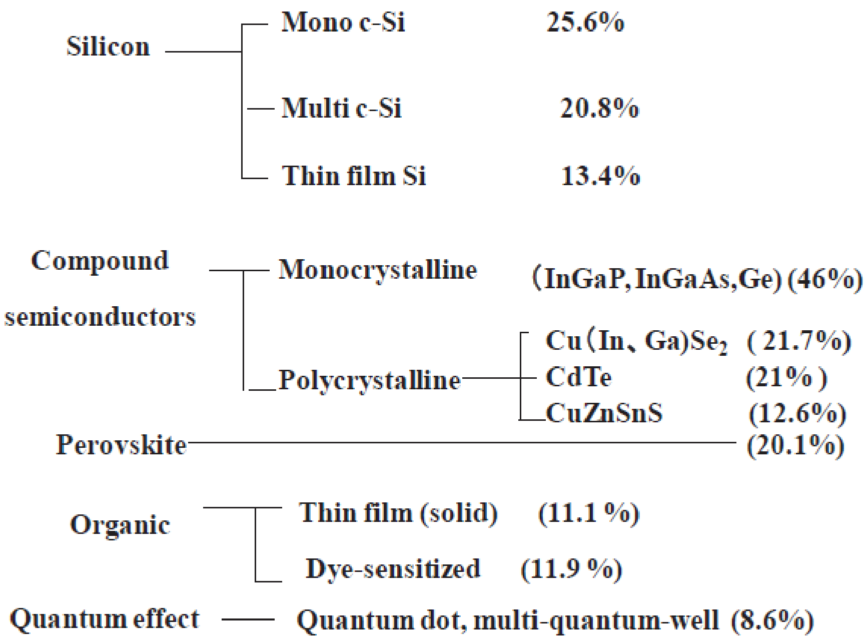

圖 4、2015 年太陽能電池光電轉換效率

會議開幕的第二場演講即邀請美國 Taxas A & M 大學的 Y. Kuo 教授針對新穎全固態矽基發光二極體(LED)元件發表演說，主要可應用於平面顯示器以及光電晶體的應用，如圖 5 所示為郭教授所提出的新穎全固態矽基發光二極體(LED)元件結構及其研發成果，與傳統的全固態無機發光二極體材料及元件結構全然不同，所應用的理論為藉由不同絕緣層薄膜的導入，以施加電壓形成電流路徑的方式，完成全固態矽基發光二極體的元件製作。此外，不同的絕緣層亦可產生不同的發光光譜，此研發成果於國內尚未有相關文獻出現，由於其元件結構簡單，本所可評估投入此先期研發領域。

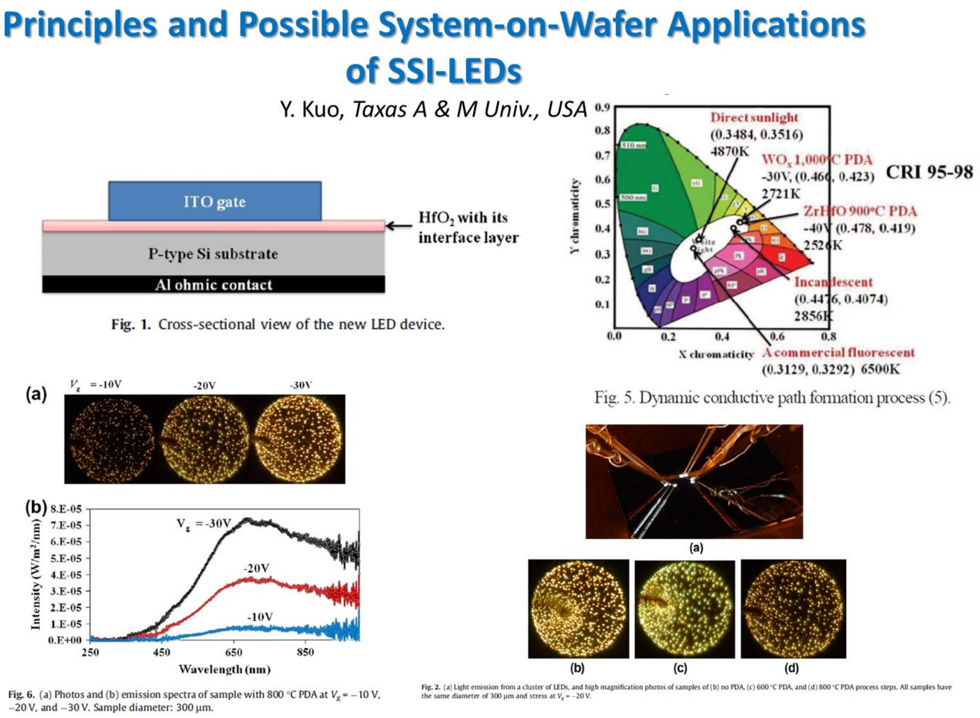

圖 5、新穎全固態矽基發光二極體(LED)元件相關研發成果

針對太陽能電池的表面鈍化部分，日本 Kanagawa 大學的 T. Nakamura 教授提出以 110℃水鈍化處理矽晶片表面的方式，如圖 6 所示，藉由水氣鈍化的方式所製作出之二氧化矽其氧/矽比為 1.57 高於矽晶片二氧化矽自生氧化層之氧/矽比 1.3，顯示其薄膜氧化程度較為完全，其實驗結果顯示在鈍化前 P 型及 N 型矽基板的載子生命期分別為 0.1~5.1μsec 及 0.59~12μsec，而在以水氣鈍化後 P 型及 N 型矽基板的載子生命期分別為 120~600μsec 及 830~3000μsec，具顯著提升的效果，並以此製作出金屬/氧化層/半導體(MIS)太陽能電池元件，此製成方式的優點在於以低溫低成本的方式形成鈍化層，可作為本所未來在高效能太陽能電池鈍化層研發的另一種鈍化方式。

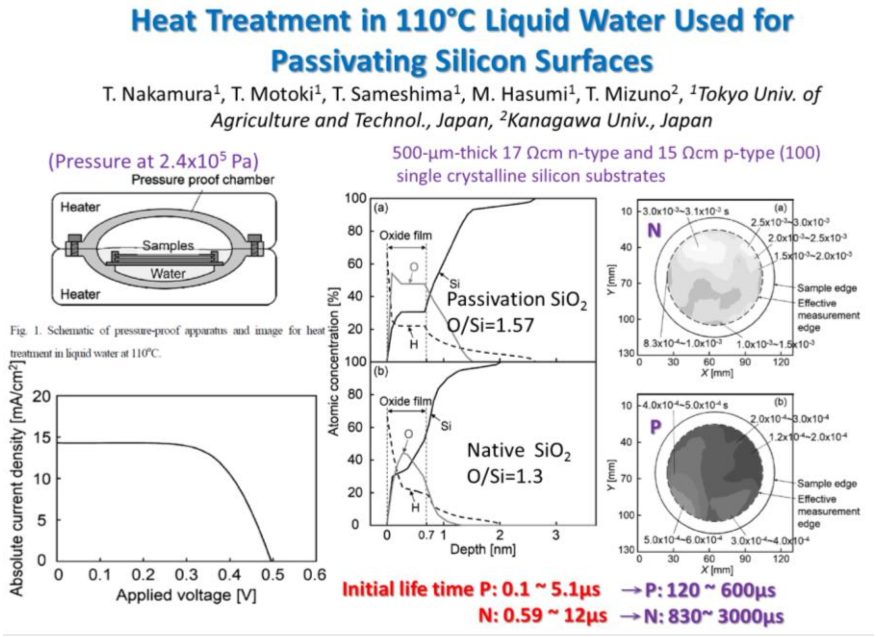

圖 6、以水氣鈍化太陽能電池元件之相關研發成果

此外，針對透明半導體的研發有多篇論文發表，其中包含中國北京大學的 P. Shi 針對室溫濺鍍時不同氧分壓製程所製作之鉬(Mo)摻雜於氧化鋅(ZnO)薄膜部分提出討論，如圖 7 所示，其研究結果發現當氧分壓提升時，將導致薄膜所含之氧空缺數量降低。由於氧空缺為薄膜中自由電子的主要來源，因此，當氧空缺數目降低時，薄膜之自由電子的數量亦大幅降低，將使薄膜的特性由導體轉變成製作透明電晶體元件所需的半導體薄膜，而鉬金屬的摻雜可使氧化鋅薄膜內的氧空缺數目發生變化，其實驗結果顯示於氧分壓為 10%可得最佳半導體特性，以此薄膜製作成電晶體元件可得最佳電子載子移動率為 5.8cm^2/V.s。而另一篇論文則為韓國的 Kyung Hee 大學 T. Lin 所發表的 P 型透明氧化物半導體氧化鎳(NiO)的研究，如圖 8 所示，以溶液合成薄膜的方式於 300℃成功製作出能隙 3.53eV 的 P 型氧化鎳透明氧化物半導體薄膜，並實際製作出 P 型電晶體元件，其最佳電洞載子移動率可達 0.077cm^2/V.s，此載子移動率數值與一般文獻所發表之數值接近但仍舊偏低，顯示 P 型透明氧化物半導體薄膜此領域仍有很大的進步空間，因此可考慮投入相關研發及應用。此外針對金屬氧化物應用的部分，本所亦發表電致變色薄膜元件於光圈應用之論文，並與包含蘋果研發主管張博士、友達光電研發主管黃副理、大陸及日本多所大學教授於現場進行簡介及交流。

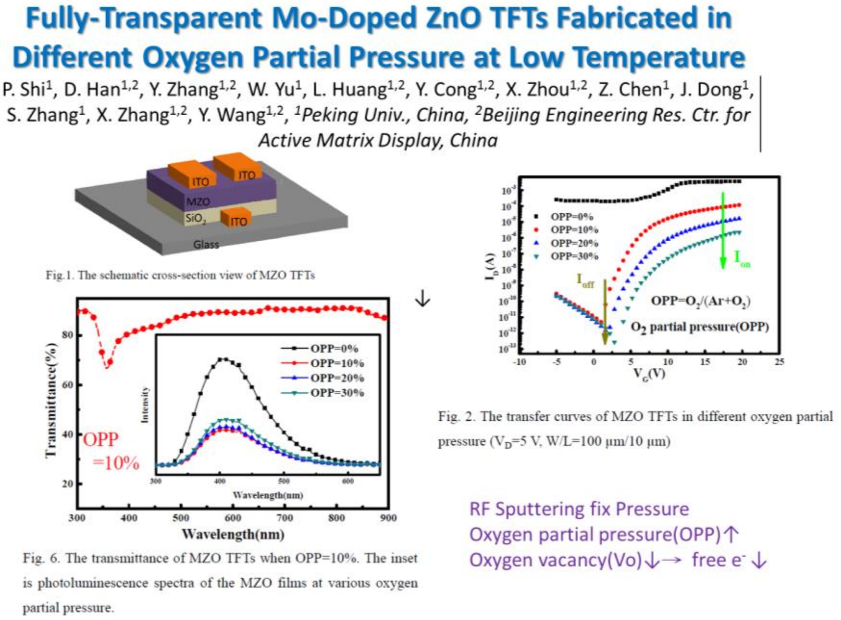

圖 7、鉬(Mo)摻雜於氧化鋅(ZnO)薄膜及元件之研發成果

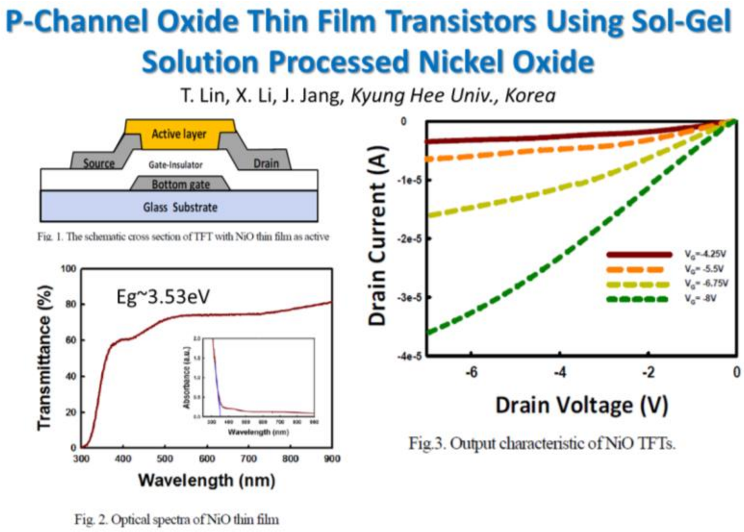

圖 8、P 型氧化鎳(NiO)透明氧化物半導體薄膜及元件之研發成果

而針對顯示器元件結合感測器應用方面，為了提供顯示面板於不同環境操作之最佳化，日本的 Ryukoku 大學 H. Hayashi 及 K. Kito 等人，以低溫複晶矽半導體薄膜本身對於光及熱所具有的敏感度，以及低溫複晶矽半導體薄膜可同時製作 P 型及 N 型電晶體元件的優勢，藉由簡單的電路設計達成顯示器元件結合感測器之應用，如圖 9 所示，所設計之電路同時具有偵測環境照度及溫度之感測功能，說明未來整合多樣元件及功能於同一物件上的發展趨勢。

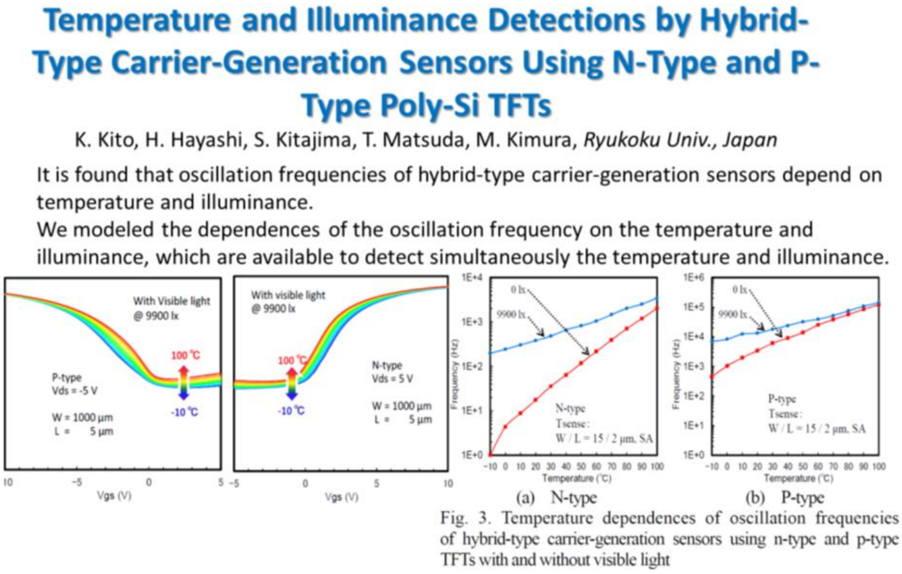

圖 9、顯示器元件結合感測器應用之研發成果

此外，在新穎元件研發方面，美國 IBM 公司研發中心的 B. Hekmatshoar 博士針對低溫沉積非晶矽二極體薄膜應用於顯示器電晶體元件發表其研發成果，如圖 10 所示，藉由低溫電漿輔助化學氣相沉積系統所沉積之非晶矽二極體薄膜達成矽異質接面薄膜電晶體的製作，主要技術突破點在於以低溫電漿沉積技術取代傳統高溫活化及高成本摻雜的製程，未來可應用於取代現有低溫多晶矽元件及應用於可撓式電子元件，元件結構以本所目前開發中之單接面型薄膜太陽能電池結構及評估中之背對背型(Back to Back)薄膜感測器元件結構相似，而發展此技術所需之關鍵設備為本所目前所發展之卷對卷式電漿輔助化學氣相沉積系統，建議本所可提前佈局此元件之相關製程應用及設備專利。

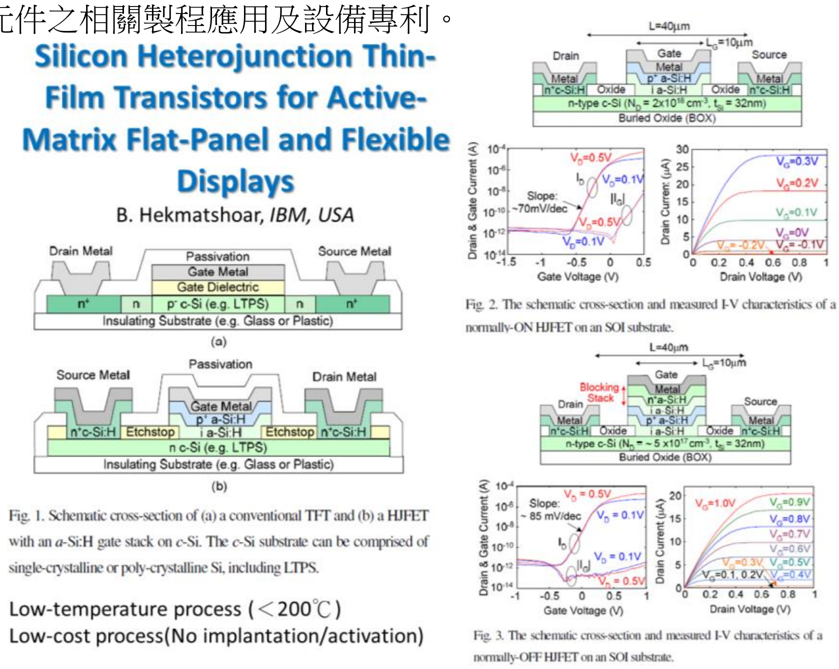

圖 10、矽異質接面薄膜電晶體元件之研發成果

本次國外公差於研討會結束後安排參訪 AIST 名古屋分部，由於 AIST 於日本約有 10 個分部，總部位於東京，各分部依據當地的產業屬性進行研發，該分部有 100 多名研發人員，所拜訪之單位以隔熱材料主要的研發重點，而在該地區為豐田的汽車產業研發中心，包含先進的氫能車開發，因此 AIST 名古屋分部配合當地產業屬性發展相關的材料及應用，而 AIST 也僅針對材料進行開發，後端的系統及應用方面則由參與先期研發之企業自行發展及開發。其中在節能領域，該單位預估使用相關隔熱材料可大幅降低空調負荷達 30%，圖 11 為會後與光熱制御研發部山田組長、首席研究員吉村博士、研究員胡博士合影。

參訪AIST名古屋分部

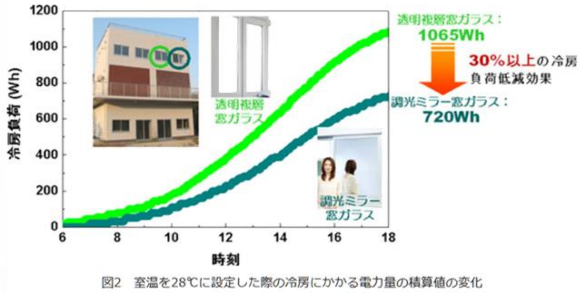

圖 11、與 AIST 名古屋分部之光熱制御研發部人員合影

此外，於會議中雙方針對所發展之變色薄膜元件技術進行初步簡介，AIST 由田保誠組長進行簡報，簡報內容針對 AIST 研發歷程進行說明，其中在變色薄膜研發領域該單位已佈局相關技術研發達 15 年左右，近期開始進行產業應用推廣。如圖 12 所示，該單位所開發之變色材料由一開始的透光度變化率僅 25%提升至 35%，壽命由 10 次操作大幅提升至 30 年的可靠度，展現出該單位對於材料長期開發的投入與累積的研發能力。

AIST研發歷史

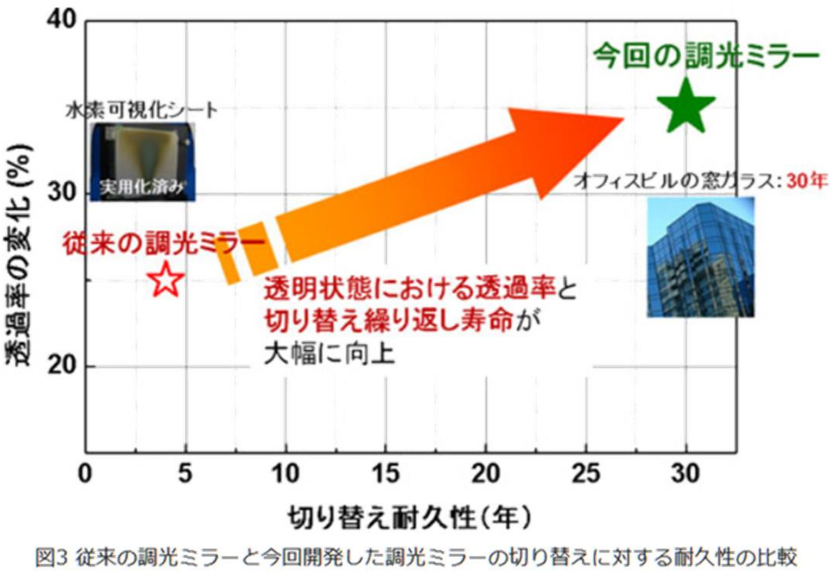

圖 12、AIST 於變色材料之研發歷程

而針對單基板型全固態電致變色元件，如圖 13 所示，元件的組成架構以氧化鎢(WO_3)為氫離子儲存層及氧化鉭(Ta_2O_5)為離子傳導層搭配該單位自行開發之 MgNi 合金變色薄膜所組成，主要操作的方式為施加電壓時將薄膜之氫離子推向氧化鎢，使氫化之 MgNi 合金薄膜還原為 MgNi 合金達成變色的效果，可見光穿透度變化可達 40%，變色時間約 60sec。此外，針對雙基板膠合型全固態電致變色元件，如圖 14 所示，所發展之膠合電解質材料取代全固固電解質材料可有效縮減製程時間及簡化製程。

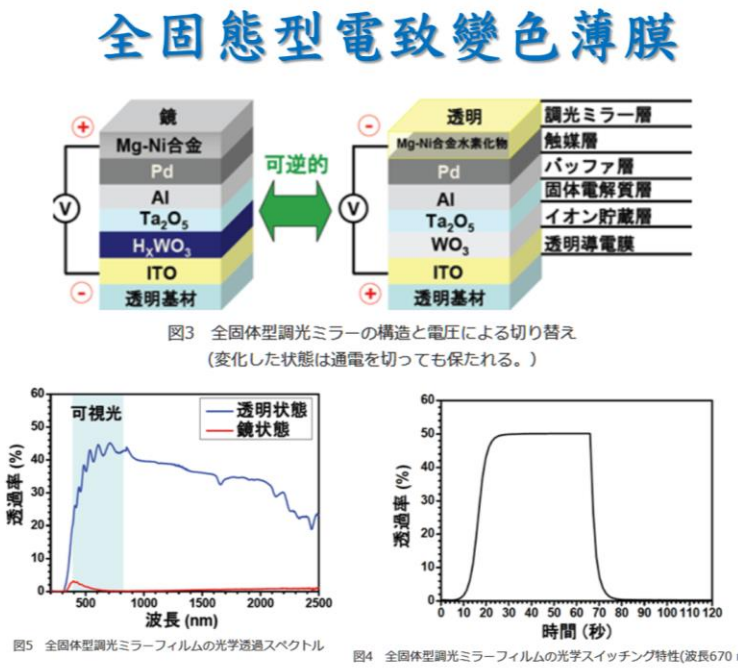

圖 13、單基板型全固態電致變色元件研發成果

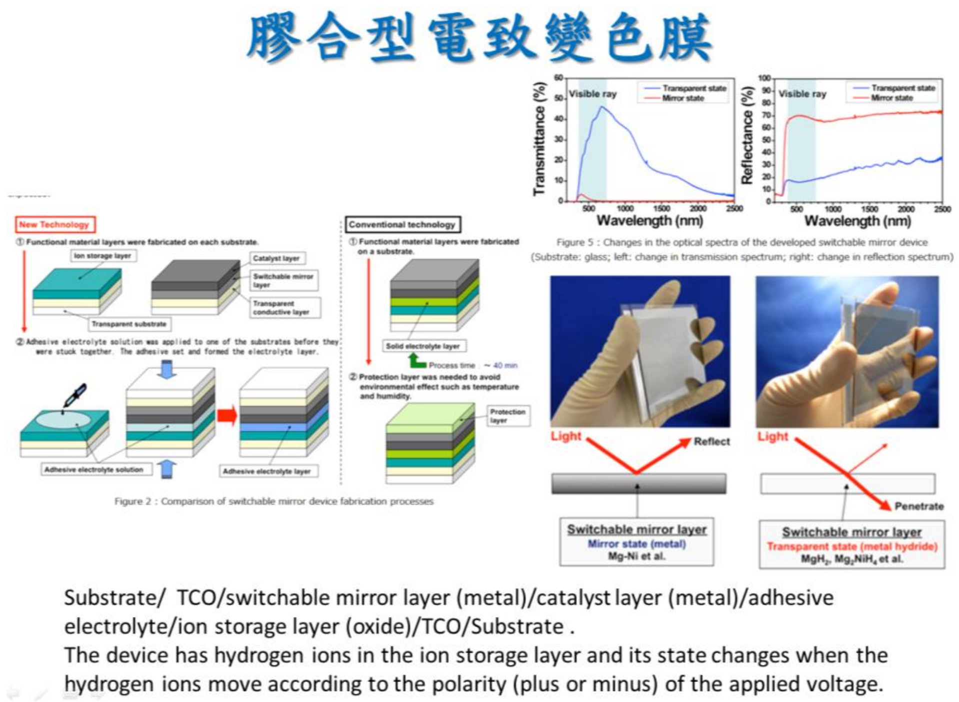

圖 14、雙基板膠合型全固態型電致變色元件之研發成果

目前研發氣致變色的方式搭配汽車隔熱窗之應用，亦是目前進行產業投廣的主要項目，如圖 15 所示，其架構為簡單的氣致變色膜搭配氫氣混和氣的方式來達成變色的效果，並於會後現場實地展示以 PEN 薄膜鍍製之氣致變色膜貼附於一般玻璃通入氫氣混和氣達成變色特性之應用。此外，針對隔熱薄膜於建築的應用，該單位亦推出隨季節自動調整光穿透度的全反射型薄膜設計，如圖 16 所示，主要的設計原理為不同季節的陽光入射角度的不同，藉由光學的模擬及設計達成控制陽光進入室內的總量。而在會後胡博士亦代表該單位組長說明該單位歡迎研發單位的國際合作及交流，若有適當的研發題目亦歡迎到該單位進行實驗及研究。

全固態型氣致變色薄膜

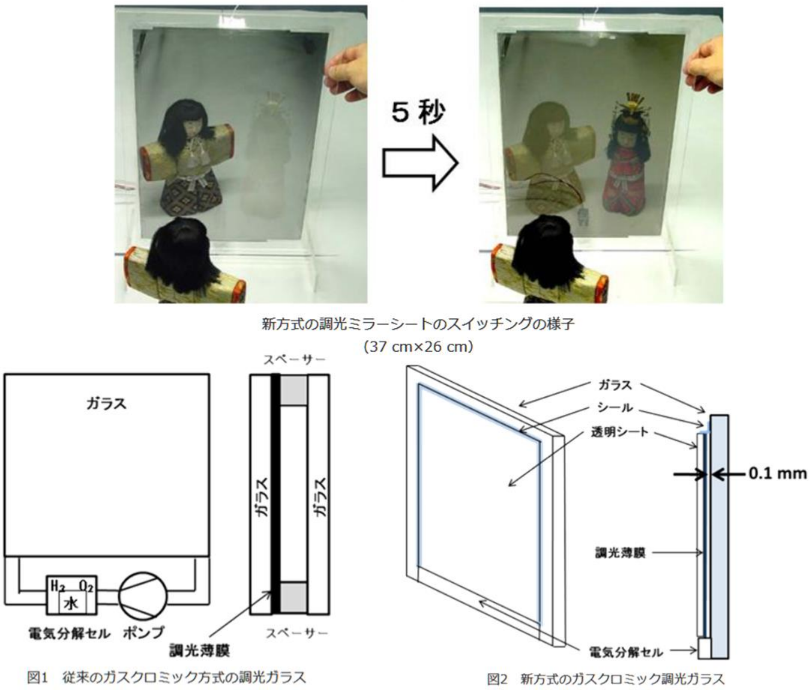

圖 15、氣致變色元件之研發成果展示

隨季節自動調光型薄膜

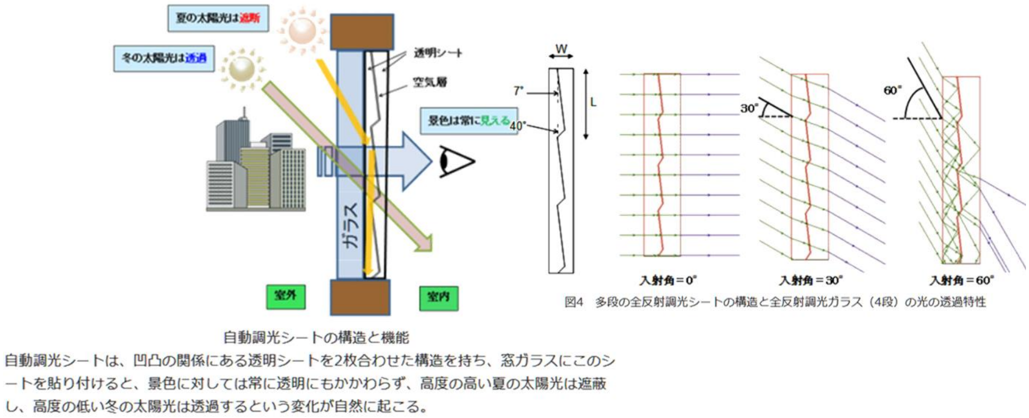

圖 16、隨季節自動調整光薄膜研發成果

四、建　議　事　項

(一) 電漿製程技術仍為光電元件鍍膜發展主流，利用電漿沉積薄膜於可撓式元件仍是會議論文發表重點項目，此研發方向與本組目前電漿領域發展方向一致。

(二) 透明半導體元件應用、開發及導入仍是重點研發項目，主流技術為濺鍍技術，與本組現有的電漿開發經驗相符，可針對此材料於可撓式基板上進行先期開發研究。

(三) 在 R2R 連續製程技術應用於可撓式基板鍍膜發展的方向上，圖型化薄膜的技術將可提升整體技術層次，有利於技術應用上的推廣，並拓展薄膜光電元件之研發領域。

(四) AIST 所發展之技術研發期程以中長期為主，專注於材料面的開發與應用，並與地方相關特色產業搭配結合，研發階段即開放產業投入研發合作，發展技術較易為業界應用。

五、附　錄

1. AMFPD”2015 會議議程資料http://www.amfpd.jp/

2. AMFPD”2015 會議與會人員及單位名冊

3.核研所簡介 ppt 檔

4. AIST 名古屋分部之光熱制御研發部介紹 https://unit.aist.go.jp/mrisus/ja/group/ecttg.html

Electronics and
Photonics Division

Japan Section

AM-FPD 15

THE TWENTY-SECOND INTERNATIONAL WORKSHOP ON
ACTIVE-MATRIX FLATPANEL DISPLAYS AND DEVICES
− TFT Technologies and FPD Materials −

THE PROCEEDINGS OF AM-FPD '15

July 1-4, 2015
Ryukoku University Avanti Kyoto Hall,
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-TFT Technologies and FPD Materials-
（AM-FPD '15）

Printed in Japan

PREFACE

Welcome to AM-FPD '15, the 22nd International Workshop on Active-Matrix Flatpanel Displays -TFT Technologies and FPD Materials- (AM-FPD '15) and to Ryukoku University Avanti Kyoto Hall, Japan. Sponsored by the Japan Society of Applied Physics and technically sponsored by Electronics and Photonics Division and Japan section in The Electrochemical Society (ECS), The Institute of Electrical and Electronics Engineers (IEEE) Electron Devices Society, AM-FPD '15 marks the twenty-second event in the workshop series. Since its inception in 1994, the workshop has been providing important opportunities for people engaged in the research and development of devices, materials, processes for FPDs (Flat Panel Displays), and photovoltaics. The active-matrix displays and solar cells are the key devices for facilitating the safety and sustainable society.

Our committees have prepared an attractive program focusing on topics such as thin-film transistors (TFTs), other thin-film devices, solar cells, circuitries and systems, LC technology, and crystallization, thin film materials and devices based on the workshop scope of “New Stages of Thin Film Devices towards Flexible Era”. Our program will start at the keynote addresses by Ms. Lori Hamilton of Corning, USA and Dr. Michio Kondo of AIST, Japan and Prof. Yue Kuo of Texas A&M Univ., USA. 74 papers are scheduled to be presented, including 19 invited papers, 38 regular papers and 17 late-news papers. In addition to the regular sessions, three symposia are scheduled. The symposia are composed of “Advances in TFT Technology for Future Application”, “Emerging Flexible Solar Cells” and “2D Materials for Flexible Electronics”, in which innovative and important technologies for future displays, solar cells, electronic devices will be discussed. Our proceedings will contain all papers detailing the results of the latest outstanding quality achievements.

Our committees have also separately arranged a tutorial session in Japanese on Wednesday morning about “A Perspective of Next Generation Displays” and “Basis and Recent-Progress of Solar Cells”.

We have planned the publication of the proceedings into IEEE Xplore digital library and a special issue of the Japanese Journal of Applied Physics in conjunction with AM-FPD '15. Our Award Committee has even awarded honorable citations such as Best paper award, Poster award, Student award, and AMFPD-ECS young researcher award.

I would like to express my heartily gratitude to all committees, for their efforts in making the workshop a success, all the companies and organizations that have financially supported this workshop, and last but not least, all the authors and attendees, without whom this workshop could not have taken place.

July, 2015

Hiroki Hamada
IEEE Fellow,
SID Medal Laureate
Chairperson
Organizing Committee, AM-FPD '15

ACKNOWLEDGEMENTS

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- Applied Materials, AKT Display Group
- JSR Corporation
- NLT Technologies, Ltd.
- Panasonic Liquid Crystal Display Co., Ltd.
- SEMICONDUCTOR ENERGY LABORATORY CO., LTD
- SHARP CORPORATION
- Silvaco Japan Co., Ltd.
- ULVAC, Inc.

Foundations

- Foundation for Promotion of Material Science and Technology of Japan
- Nippon Sheet Glass Foundation for Materials Science and Engineering
- Support Center for Advanced Telecommunications Technology Research, Foundation
- The Telecommunications Advancement Foundation
- Yashima Environment Technology Foundation
- The Murata Science Foundation

(As of June 12, 2015)

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Wednesday, July 1

Thursday, July 2

Poster Session (15 : 35 〜 18 : 00)

Chairpersons : S. Kuroki, *Hiroshima Univ., Japan*
A. Heya, *Univ. of Hyogo, Japan*
S. Horita, *JAIST, Japan*
H. Okada, *Univ. of Toyama, Japan*
W. Yeh, *Shimane Univ., Japan*

Friday, July 3

－ *Coffee Break* －

Session 7 : Oxide and LTPS TFTs (14 : 30 ～ 15 : 55)

Chairpersons : H. J. Kim, *Yonsei Univ., Korea*
T. Noguchi, *Univ. of the Ryukyus, Japan*

Closing Remarks (15 : 55 ～ 16 : 00)

Author Interviews (16 : 00 ～ 16 : 30)

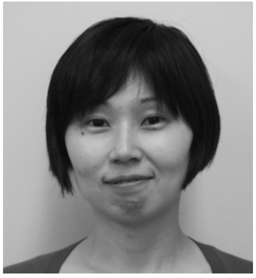
AM-FPD '14 Best Paper Award

(6-3) Effect of Aluminum and Indium Composition on the Bias-Illumination-Stress Stability of Solution-Processed Transparent Al-In-Zn-O Thin-Film Transistors
Min-Ji Park, Jun-Yong Bak, Jeong-Seon Choi, Sung-Min Yoon, *Kyung Hee University*, *Korea*

Min-Ji Park

AM-FPD '14 Poster Award

(P-19) Effects of Etch Stop Layer Deposition Conditions on Stress Stabilities in Amorphous In-Ga-Zn-O Thin Film Transistors
Aya Hino, Hiroaki Tao, Yasuyuki Takanashi, Mototaka Ochi, Hiroshi Goto, Kazushi Hayashi, Toshihiro Kugimiya, *Kobe Steel, Japan*



Aya Hino

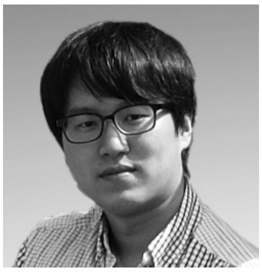
AM-FPD '14 Student Paper Award

Yana Mulyana

(3-3) Oxidation of Graphene Film by Non-Thermal Treatment for New Sensing Devices Thin-Film Transistors on Glass Substrate
Yana Mulyana, *Nara Institute of Science and Technology, Japan*

AM-FPD '14-ECS Japan Section Young Researcher Award

(3-4) Formation of Quasi-Single-Crystal Ge on Plastic by Nucleation-Controlled Au-Induced Layer-Exchange Growth for Flexible Electronics
Jong-Hyeok Park [1,2],
[1]*Kyushu University, Japan,* [2]*JSPS Research Fellow, Japan*



Jong-Hyeok Park

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(Apr. 13, 2015)

Photo shows, back row left to right,

H. Kitakado, A. Okada, T. Fujino, H. Tanabe, S. Horita, S. Kuroki

And front row,

H. Ohmae, N. Sasaki, H. Tsutsu, H. Hamada, Y. Uraoka, M. Ohkura, T.Arai

J. Kiyota	Y. Kuo	T. Matsuo	K. Sera	M. Hatano
T. Kamiya	M. Kimura	J. Koyama	A. Masuda	N. Matsuo

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(Apr. 13, 2015)

Photo shows, back row left to right,

Y. Ishikawa, A. Sato, M. Mitani, M. Furuta, T. Matsuda

And front row,

H. Okada, T. Noguchi, S. Horita, S. Kuroki, A. Heya, W. -C. Yeh

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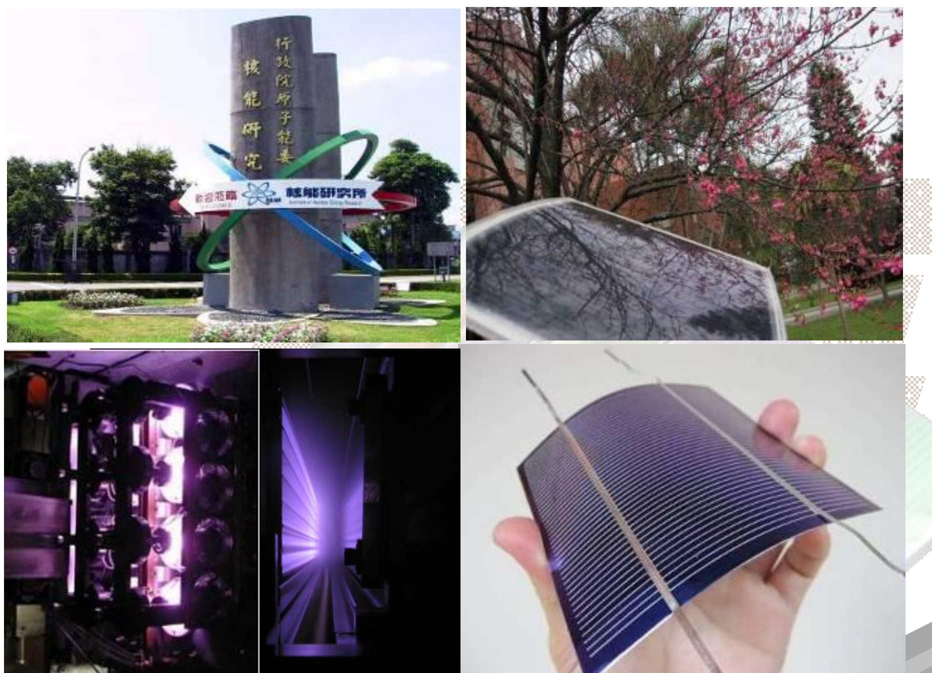
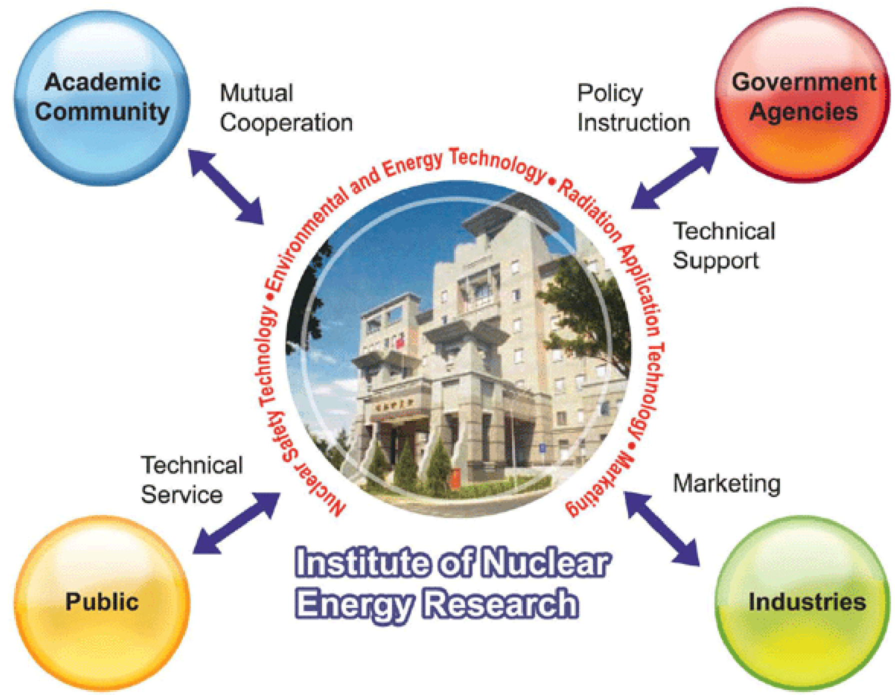
M. Nakata	K. Ohdaira	T. Sadoh	R. E. I. Schropp	T. Someya
K. Takechi	T. Takenobu	M. Tao	Y. -H. Yeh	

R2R Plasma Coating Platform and Energy-saving Films Study in INER





Min-Chuan Wang Ph.D.

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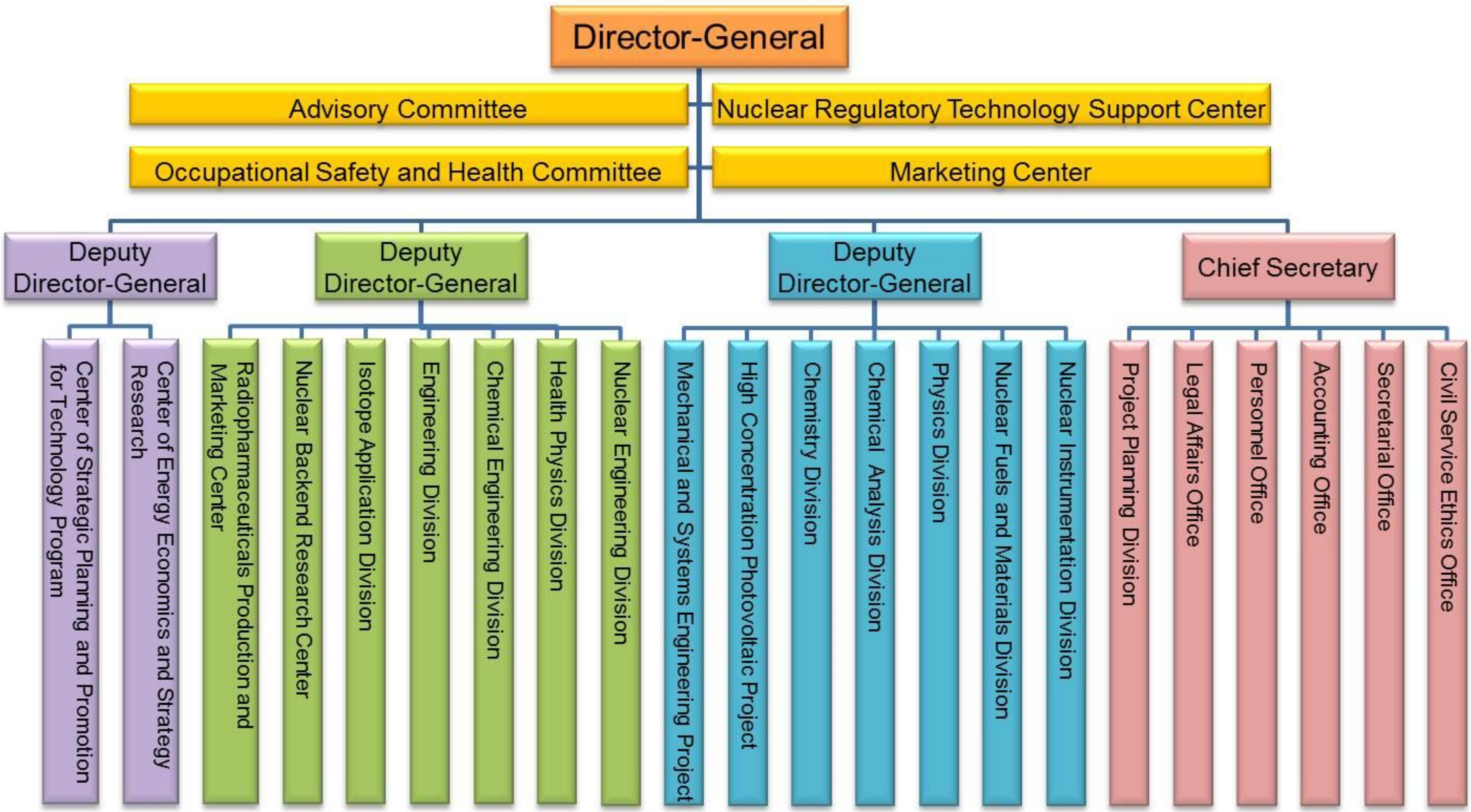
No. 1000, Wenhua Rd., Jiaan Village, Longtan Township,Taoyuan County 32546, Taiwan (R.O.C.)

Organization Chart of INER



INER, as founded a national laboratory on nuclear technology research, in recent years extends into the development of carbon-free energy, low-carbon energy, and industrial radiation applications.

Project Structure

Development and Applications of Green Plasma Technology

- **(1)System integration and application of the flexible energy-saving and energy devices with the plasma thin film technology**
- **(2)Development and applications of combing light-to heat and light-to-electricity with thin- film concentrating solar system**
- **(3)Verifications of the products of green plasma technologies in an integrated carbon-neutral environment**
- **(4) Development and establishment of plasma technologies and an integrated system platform for relevant industrial applications**

From 2013/01 to 2016/12 (4 years)

Development and Applications of Green Plasma Technology

Based on the conceptual scheme of green energy-saving environment, the main program objectives are set to adequately apply the core plasma technologies and the advantages of clean plasma processes in the earlier phases of the " Development and applications of environmental plasma technology" program , to further develop integrated systems with the light-weight, flexible and energy-saving devices, including all solid-state thin-film photovoltaics, thin-film light-controlled devices, thin-film energy-storage devices, and thin-film solar energy concentrators for photo-to-electricity and photo-to-heat, and to effectively apply them onto green energy-saving products and zero-carbon installations for the next generation green energy -saving industries.

OUTLINE

- R2R Plasma Coating Platform in INER
- Energy-Saving Devices Development in INER

Technology Revolution

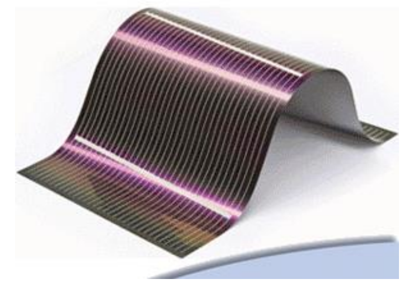
CRT

TFT-LCD

Flexible Display

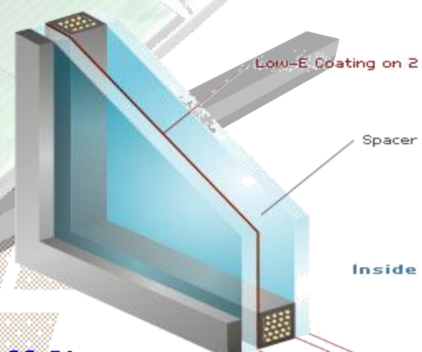
Wafer type-PV

TFSC

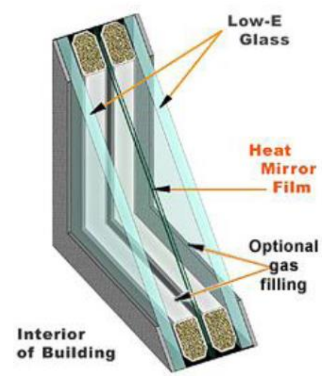


Flexible TFSC

On-Line Low-E Coating On Glass



Off-line Low-E &EC Coating On Glass

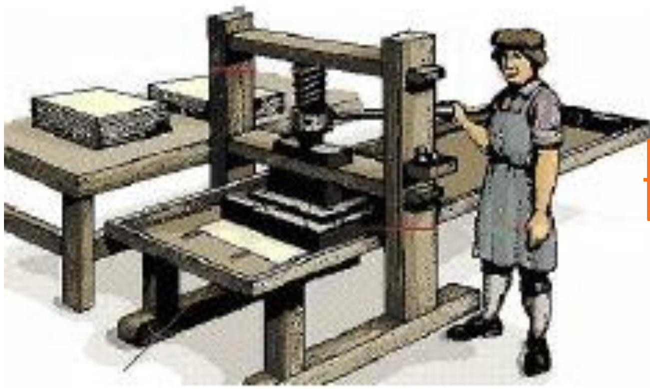


Film-type Low-E &EC

Roll to Roll Process Toward Low Cost Production

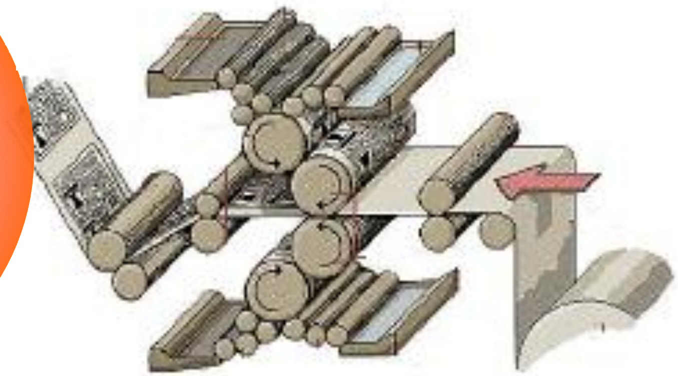
Plasma Technology

Core Technology (INER)



Flexible Process

Development



Low Cost

Excellent Experience (INER)

Equipment Development

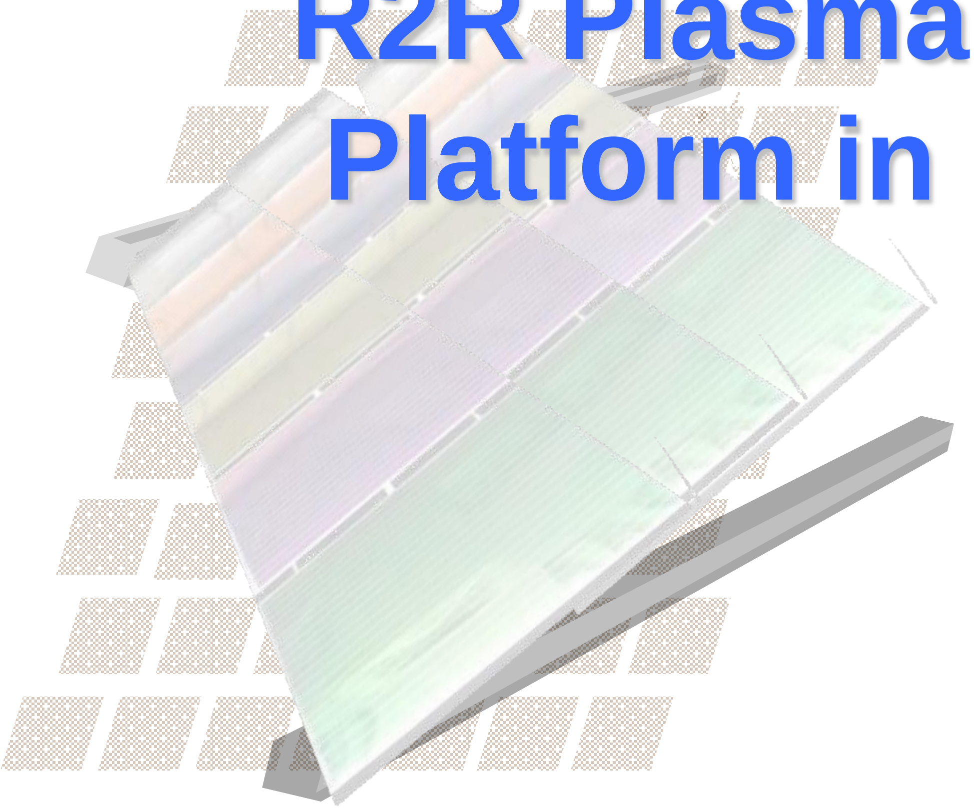
Research & Development

Thin Film Device

Technology Focus

- Novel Plasma Source and System Integration
- In-Line Sheet to Sheet Plasma Process System Integration
- Flexible Roll to Roll Plasma Process System Integration
- Energy-Saving Thin Film Device Process Integration

R2R Plasma Coating Platform in INER



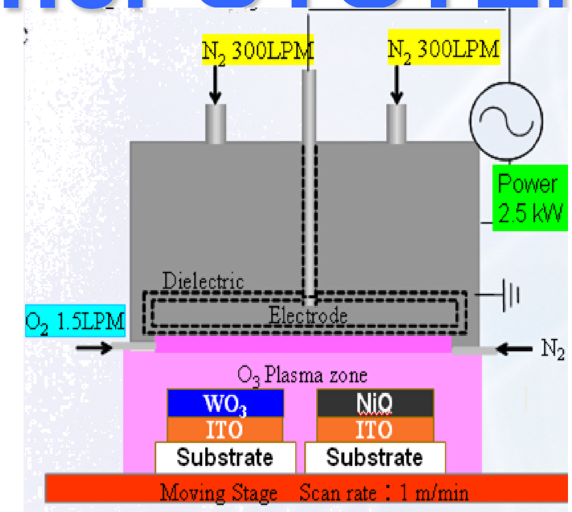
Overview of INER R2R pilot coating platform & process

R2R AP Plasma & Cleaner SYSTEM

R2R PECVD SYSTEM

R2R PVD SYSTEM

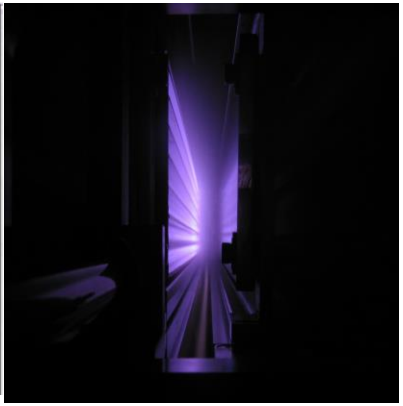
R2R AP Plasma & Cleaner SYSTEM



- ◆R2R Substrate Cleaning Technology
- ◆R2R Substrate AP Plasma Cleaning Technology
- ◆R2R Substrate Etching Technology
  (Substrate texture)

AP Plasma Cleaning Technology

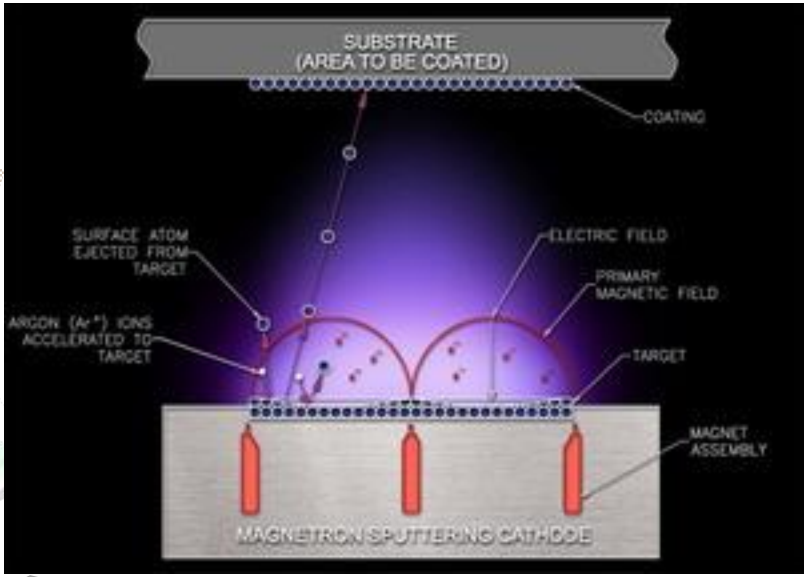
R2R PECVD SYSTEM



◆R2R ICP、RF 、VHF Plasma Technology
(a-Si:H 、μ-Si:H)
◆Inline OES Process Control Technology
◆Gas Gate Technology
(Reduce the Chamber contamination)

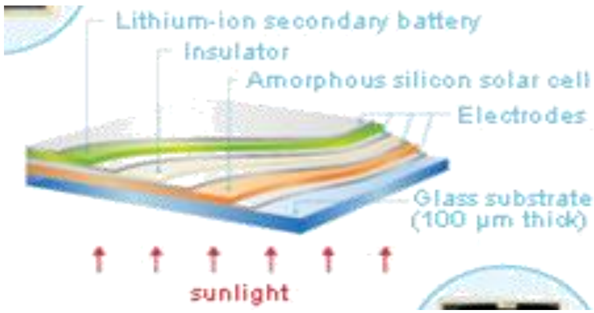
Plasma deposition of the thin film silicon materials in a vacuum (Plasma Enhanced Chemical Vapor Deposition-PECVD)

R2R PVD SYSTEM

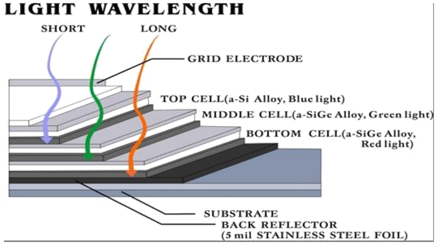


- ◆R2R Plasma Pre-treatment Technology
- ◆RF & DC Sputtering Technology
  (Metal、TCO 、EC film)
- ◆Inline OES Process Control Technology

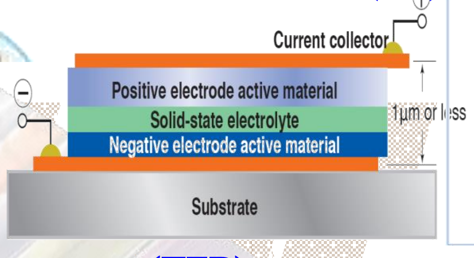
Plasma Deposition of metal materials in a vacuum
(Physical Vapor Deposition-PVD Sputtering)



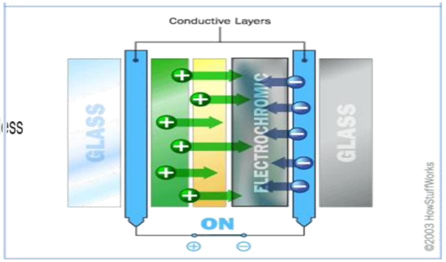
(PV+TFB)



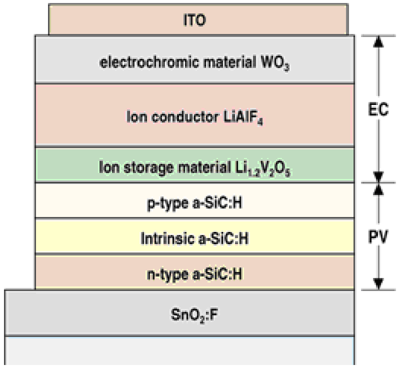
(PV)



(TFB)



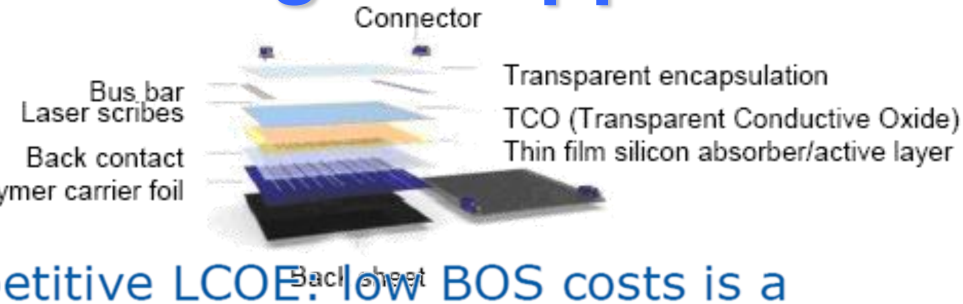
(EC)



(PV+EC)

Energy-Saving Devices Development in INER

Flexible Thin Film a-Si:H Solar Cell : Unique characteristics for advantage in applications



The flexible PV has four distinguished specifications:

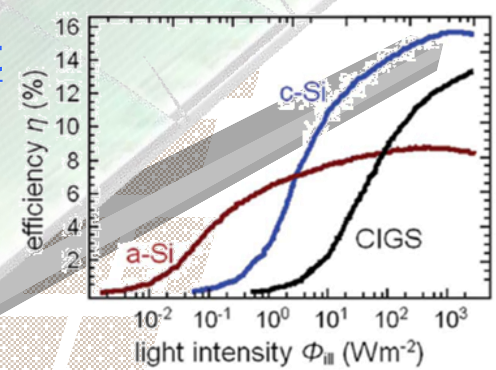
- ✓ lightweight
- ✓ flexible
- ✓ unbreakable
- ✓ easy to customize

For competitive LCOE: low BOS costs is a key factor

- 201x - System cost breakdown (c. 1.5 -1.8 €/Wp)

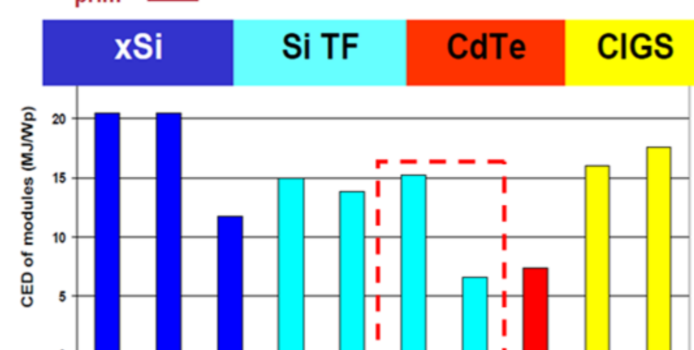
- ◆ 10% Module Price Cost down Potential
- ◆ Indoor Application
- ◆ Low Energy Payback Time

Solar Cell for PIPV Application



Outdoor conditions at light intensities of 10-1000 Wm^{-2} result in similar areas for CIGS, c-Si, and a-Si, while indoor use down to 1 Wm^{-2} favors the Si cells, with a-Si being most efficient below 0.1 Wm^{-2}.

Cumulative Energy Demand MJ_{prim} / Wp of modules



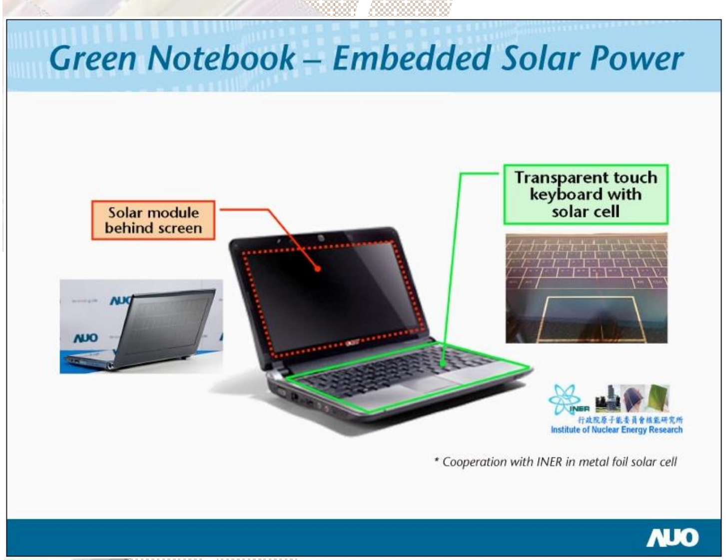
	mono 2008 14.0%	multi 2007 13.2%	ribbon 2009 13.2%	a-Si 2008 6.6%	µm-Si 2008 8.5%	a-Si on steel 2006 5.7%	a-Si on PEN 2008 3.8%	CdTe 2009 10.9%	CIGS (1) 2009 10.5%	CIGS (2) 2007 11.0%
MJ/Wp	20	20	12	15	14	15	7	7	16	18

www.ecn.nl

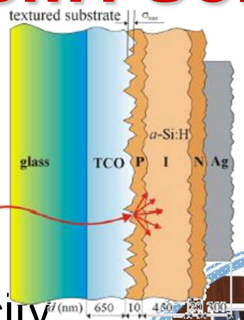
Flexible solar cells for clothing, materials today, JUNE 2006 | VOLUME 9 | NUMBER 6, p42-50

BIPV & PIPV Application

Due to the niche market character of BIPV (Building Integrated PV) and PIPV (Product Integrated PV), many different PV types that could theoretically be incorporated into building & (electronic) products for different applications.



Flexible Thin Film a-Si:H Solar Cell R&D In INER



- With the blinds closed during the day blocking the rays of the hot sun, the PV generates the electricity and once the sun goes down, the stored electricity could be used in the night time.

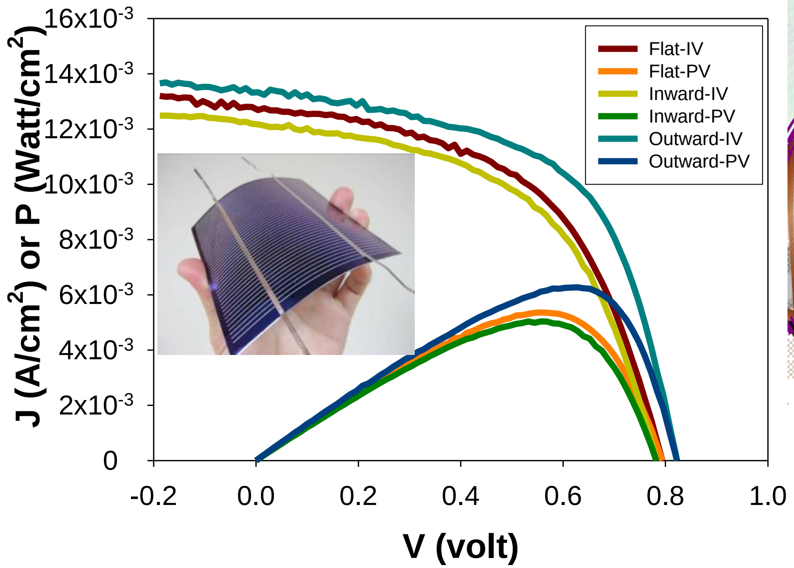
In a sunshine day, the blades with solar panels are set to face outside against the sun light to generate electricity. Even in a cloudy day or night, they are turned to face inside to generate electricity as well from indoor lighting

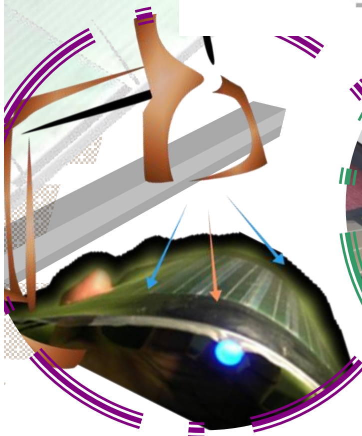
Low installed cost, Flexible, Infrangible and High safety

Favorable colors and Customized electric requirements

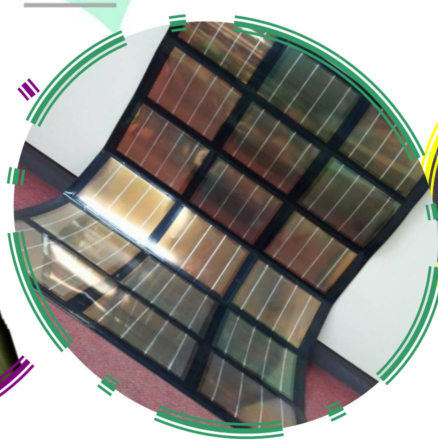
It's possible to combine the three elements, energy-saving, electric generation, and artistry altogether into a solar energy-saving blinds for green-living atmosphere.

Flexible and colorful energy-saving thin film solar blind modules demonstrated in 2013 Taipei International Invention Show & Techno mart

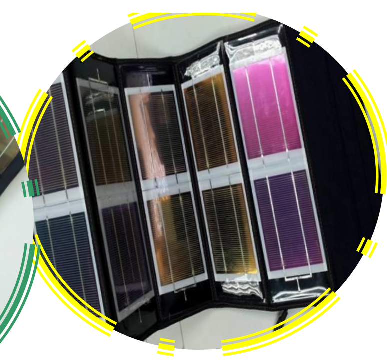




Solar cell With LED



BIPV

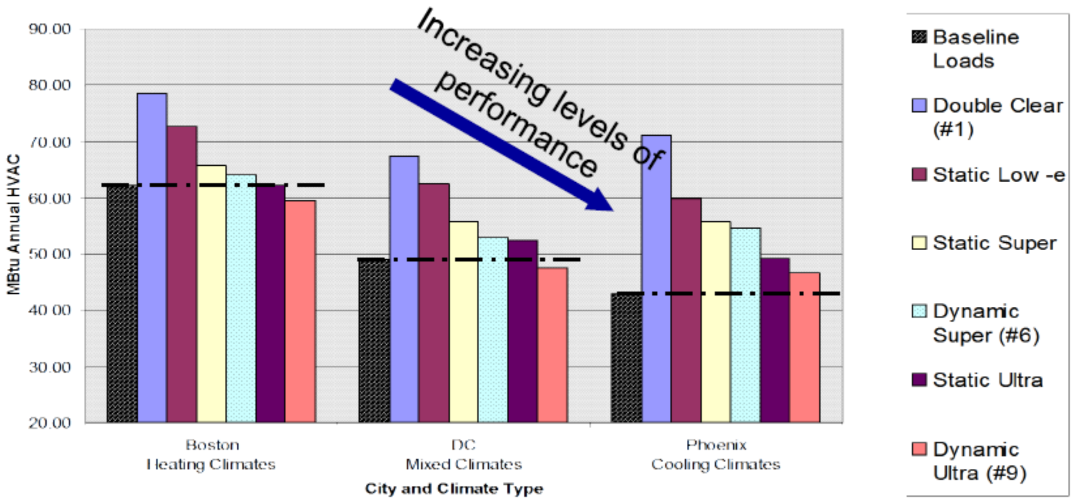


Solar Charger

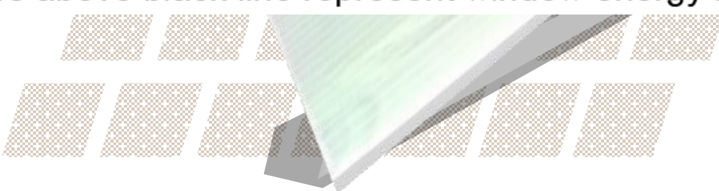
Energy-Saving Film for Zero Energy Building

Super Insulating and Dynamic Windows

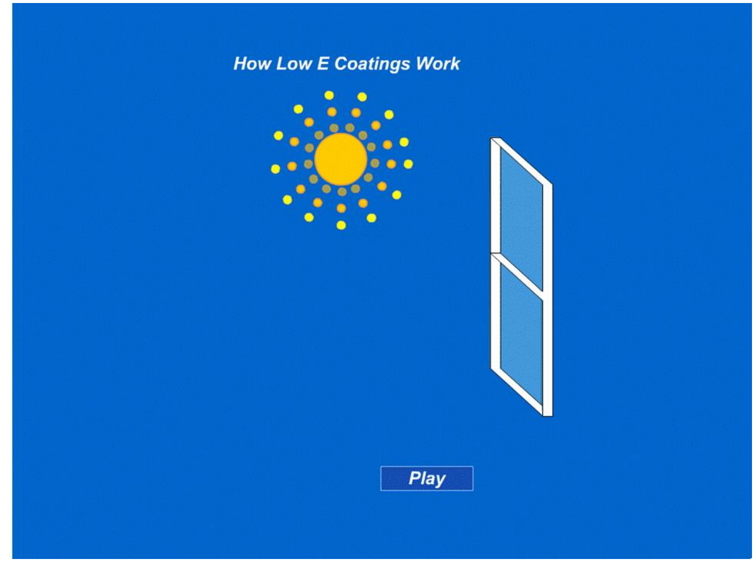
– Needed to Achieve Zero Energy Buildings



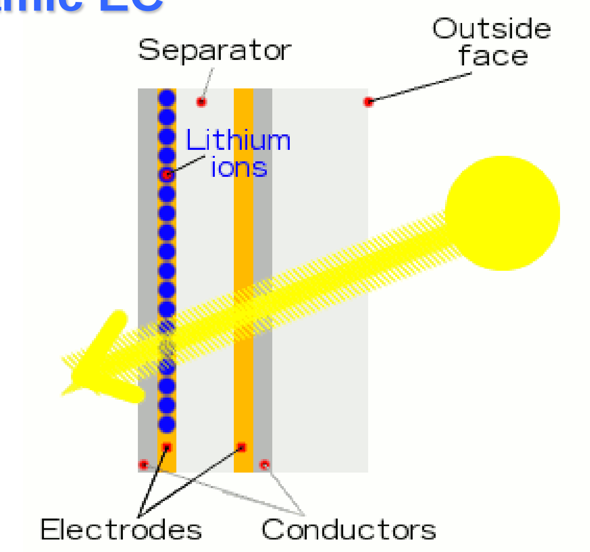
Bars above black line represent window energy load



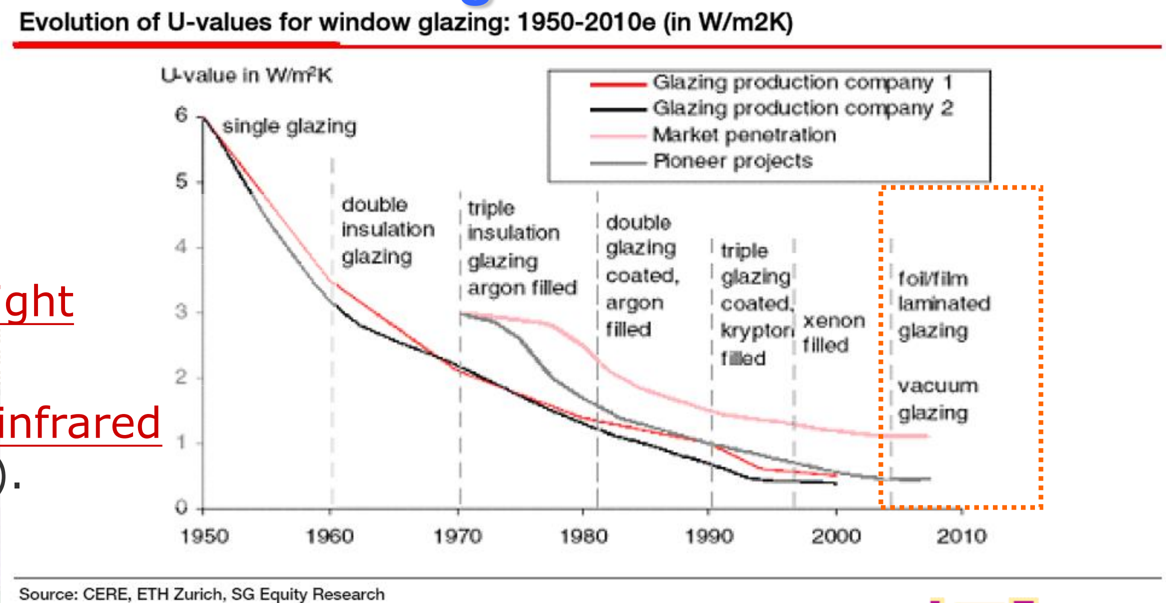
Static Low-E



Dynamic EC

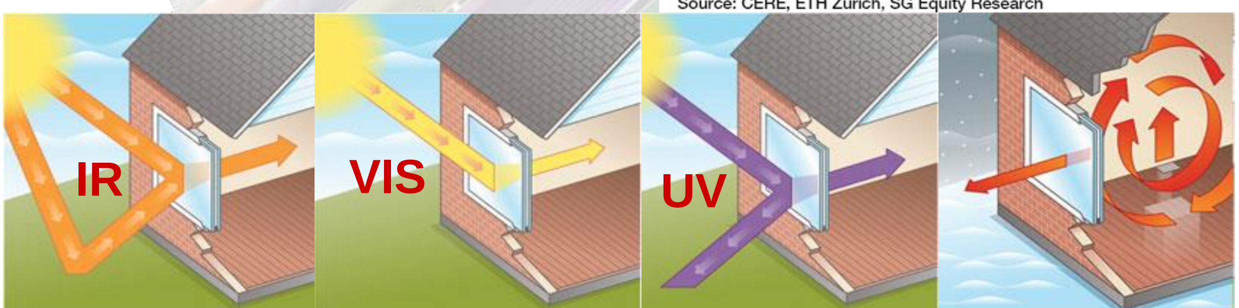


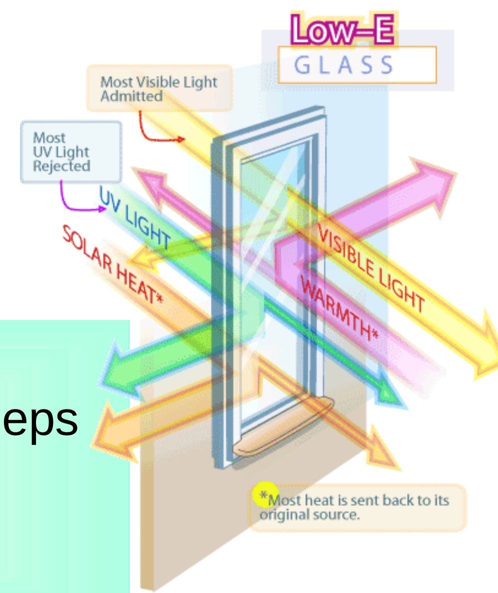
Low-E Window : Minimize the amount of ultraviolet and infrared light that can pass through glass without compromising the amount of visible light that is transmitted



Benefits

- Neutral in color.
- Highly transparent to visible light (380nm ~780nm).
- Relatively high reflectance of infrared radiation (780nm ~ 3,000nm).

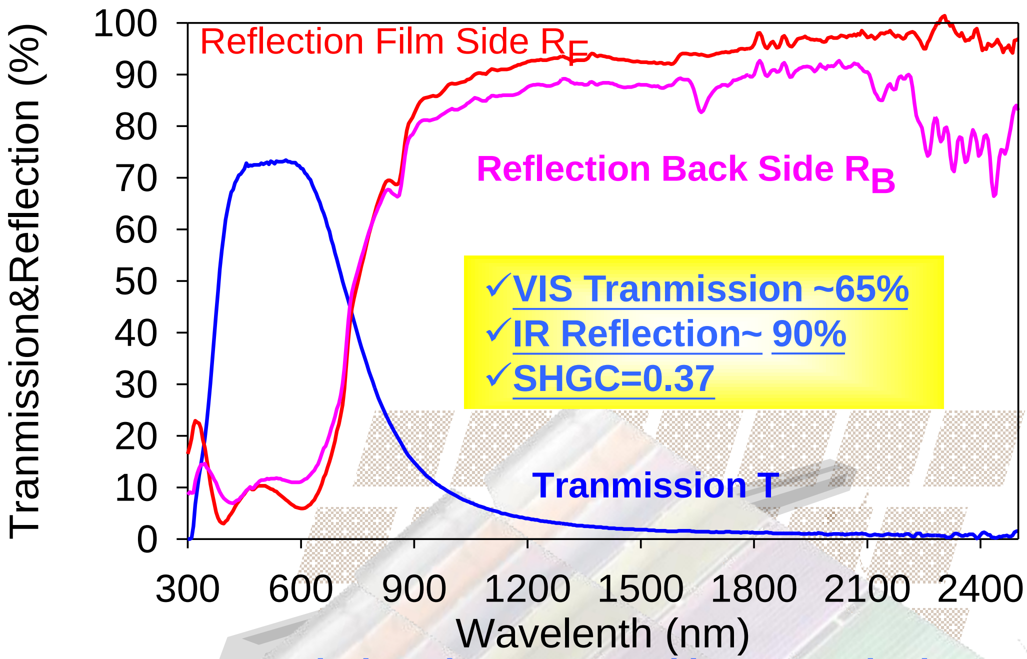




Summer:
Blocks the transmission of most solar heat radiation; keeps room pleasantly cool by allowing only a small amount of heat in.

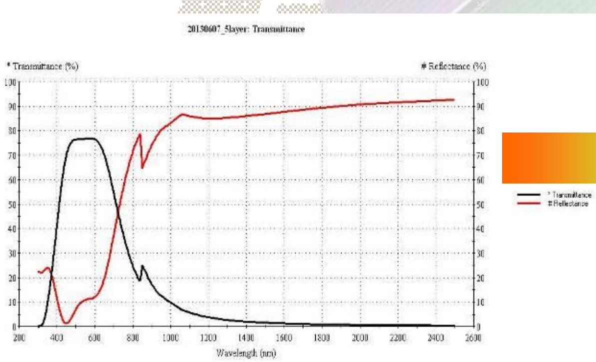
Winter:
Low-E insulating glass keeps interior warm by blocking outward radiation of heat.

Low-E Window R&D in INER

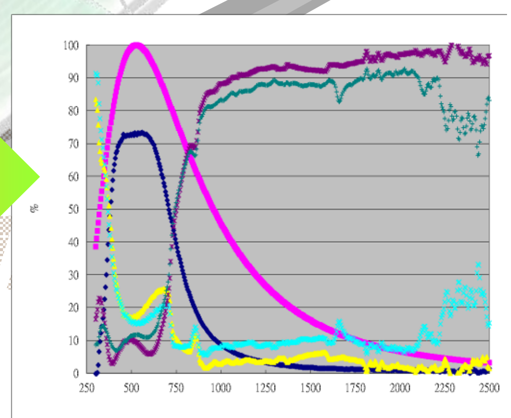


Low-E window demonstrated in 2013 Taipei International Invention Show & Techno mart

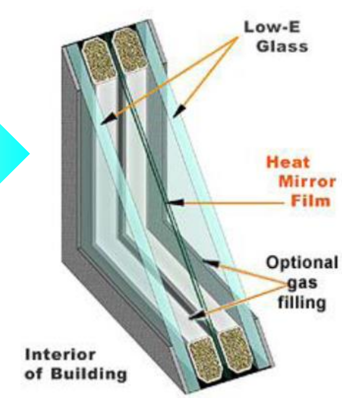
Simulation



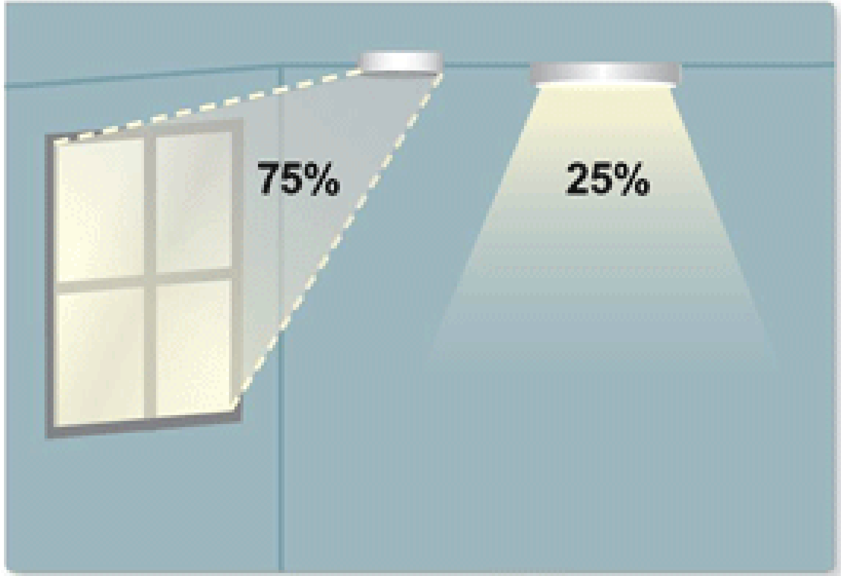
Verification



Triple Low-E Component

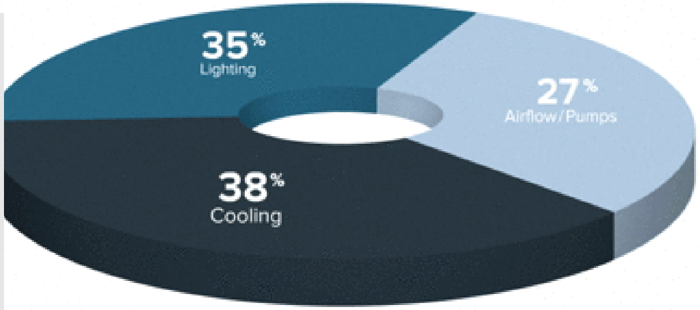


EC Window: A new level of design freedom for a revolutionary experience



EC foil-based devices offers

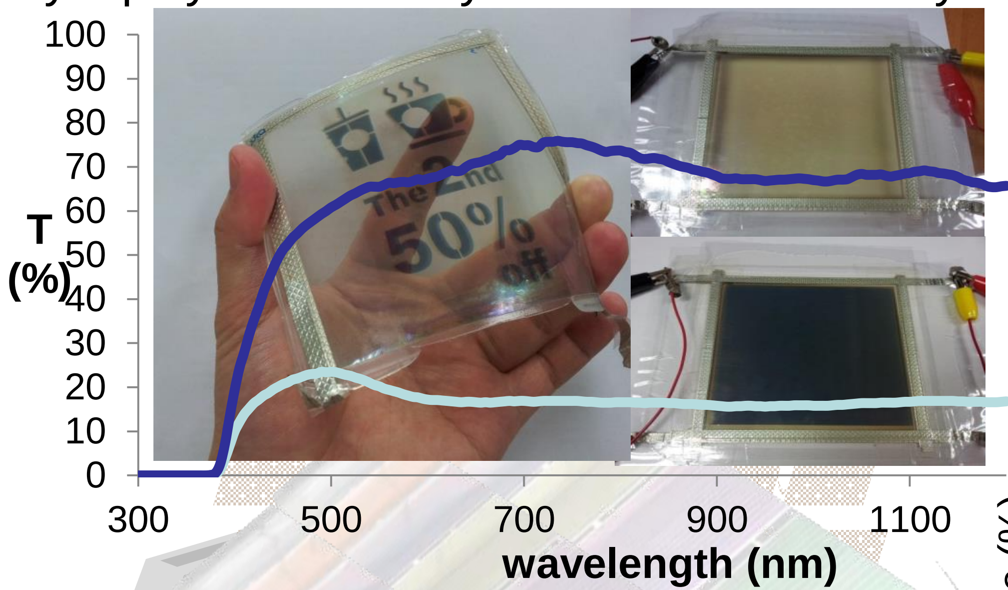
✓A better view
✓Natural light
✓Freedom of design
✓Energy efficiency

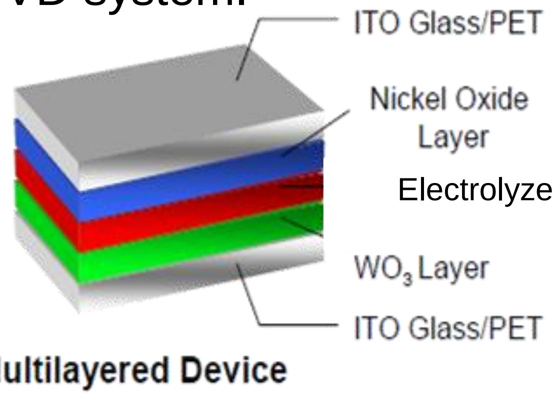


- Heating, cooling, and lighting are substantial costs in a building.
- Dynamic Glass is an energy efficient product that drives down HVAC and lighting costs.

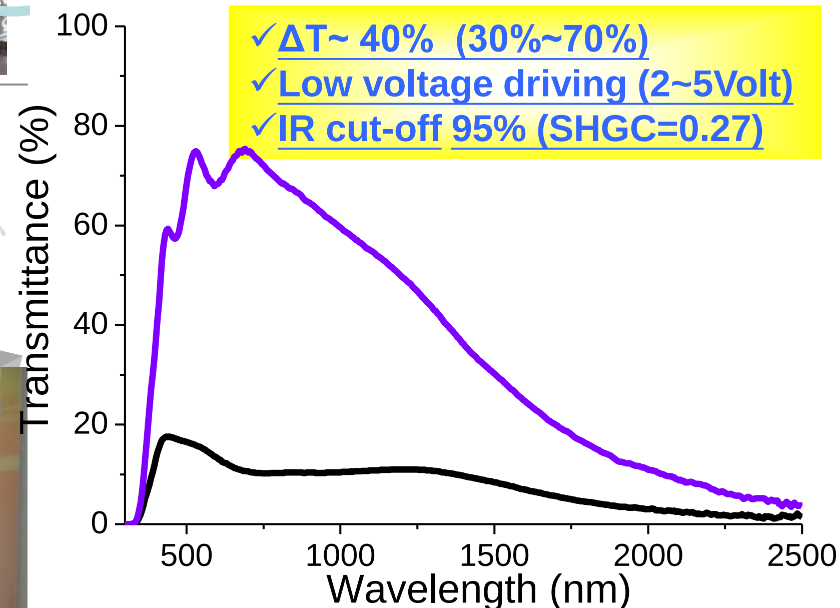
Dynamic EC Window R&D in INER

The EC foil-based devices embodying sputter deposited WO_3 and NiO films joined by a polymer electrolyte have been made by the R2R PVD system.





The light transmission and IR cut-off of the EC device with the solar radiation were optimized up to 40% and more than 95%, respectively.



EC window demonstrated in 2013 Taipei International Invention Show & Techno mart

Thank you!