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出國報告（出國類別：其他）

赴韓國參加 CCMR2017 國際研討會出國報告

服務機關：核能研究所
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派赴國家：韓國
出國期間：106 年 6 月 25 日~106 年 6 月 29 日
報告日期：106 年 7 月 24 日

摘　要

Collaborative Conference on Materials Research2017 國際研討會每年在韓國各大城市輪流舉辦。研討會主題包括生物材料、觸媒材料、複合氧化物材料、燃料電池、石墨烯、發光二極體、磁性材料、高分子材料、奈米材料、分子材料、太陽能及能源材料、感測材料、量子材料、理論模擬以及相關元件應用等，與本所電漿鍍膜及光電節能薄膜研究領域相關，藉由參與本次會議瞭解國際於薄膜元件研發現況、市場及趨勢。會議主要針對各種材料領域技術發展主題進行研討，並進一步以實現工程，物理，生物學，材料科學，化學和等材料研究跨領域合作的目標。本次除獲邀至研討會發表本所於電致變色薄膜元件近期研發成果，與不同領域的專家學者交流外，並獲邀主持一場會議研討，與國外學者交流，而藉由參與多場的不同領域的論文演講，則更進一步提供未來可行的研發的方向。其中，如來自英國威爾斯大學的曾教授所發表的可量產全印製製程的感測器製程技術，從金屬電極材料及感測材料的合成到元件印製的製程皆可達成量產的需求，所發展圖案化印製技術更可達 5 米/秒的印製速度，提供低成本感測器的量產平台。此外，來自波蘭 AGH 大學的奈米科技與材料中心的 Kollbek 博士發表利用電漿搭配惰性氣體凝結製程製作奈米球殼型材料等技術，皆是未來本所可以投入的研發方向。

目　　次

一、目　的

本次公差目的為赴韓國濟州島參加 CCMR2017 國際研討會，蒐集資料並發表電致變色元件研發成果論文，搜集電漿鍍膜綠色節能及光電元件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。作者受邀於 CCMR 2017 國際研討會發表「All-solid-state metal-oxide thin film devices fabricated with the plasma coating technology」研發成果演講，與業界及學術界專家學者討論儲能及光電元件相關技術，以及建立未來合作關係。研討會主題包括生物材料、觸媒材料、複合氧化物材料、燃料電池、石墨烯、發光二極體、磁性材料、高分子材料、奈米材料、分子材料、太陽能及能源材料、感測材料、量子材料、理論模擬以及相關元件應用等。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，並深入評估可撓式薄膜元件及未來相關光電及儲能產品應用整合。希望藉由參與此技術研討會，獲得更多可撓式製程技術資訊及應用相關發展方向，並與各國頂尖專家交流加速本所在可撓式製程設備技術及薄膜元件應用之開發。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，以獲得更多儲能及光電元件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

本次公差之行程如下：

6 月 25 日　　07:55 自桃園國際機場出發，於當地時間 11:05 抵達韓國釜山金海國際機場。並由國內機場轉機，於 13:45 搭乘韓國釜山金海國內機場至濟州島國際機場之航班，於當地時間 14:40 抵達濟州島國際機場，並搭乘高速巴士前往會議地點附近飯店，抵達飯店時間為當地時間 17:00，並前往 ICC 濟州國際會議中心完成研討會報到程序。

6 月 26 日~6 月 28 日　參加 CCMR2017 國際研討會及蒐集研發資料，並於 6/27 16:00 發表本所電致變色薄膜元件研發成果。

6 月 29 日　　於當地時間 11:00 自飯店出發，搭乘高速巴士前往濟州島國際機場。14:00 抵達濟州島國際機場，因天候因素導致飛機延遲導致原先預定 17:40 出發之班機延遲至 18:11 才由濟州島國際機場出發前往韓國釜山金海國際機場，進而導致無法搭乘 20:00 由韓國釜山金海國際機場返國班機，因此改搭乘 21:55 由韓國釜山金海國際機場出發返國，抵達台灣時間接近午夜 24:00，順利完成本次公差任務。

三、心　得

Collaborative Conference on Materials Research2017 國際研討會從 2011 年舉辦至今進入至第七年，每年在韓國各大城市輪流舉辦。主要針對各種材料領域技術發展主題進行研討，並進一步實現工程，物理，生物學，材料科學，化學和等材料研究跨領域合作的目標。CCMR 2017 為材料研究人員提供了與各頂尖材料領域的討論與最新研發資訊交流的機會。研討會主題包括生物材料、觸媒材料、複合氧化物材料、燃料電池、石墨烯、發光二極體、磁性材料、高分子材料、奈米材料、分子材料、太陽能及能源材料、感測材料、量子材料、理論模擬以及相關元件應用等，與本所電漿鍍膜及光電節能薄膜研究領域相關，可藉由本次參與會議瞭解國際於薄膜元件研發現況、市場及趨勢。本會議之內容以演講及海報為主，與材料相關之 14 個研發主題領域搭配 287 場演講，以及 325 篇研究論文，展示分散在 7 個主要的教室及 1 個海報展示會場，共計有 31 國 326 名專家學者與會。舉辦會議地點之濟州國際會議中心如圖一所示。會議場現場如圖二所示。

圖一、會議地點濟州國際會議中心

圖二、會議場現場照片

因各領域演講以平行議程的方式進行，因此就所參與的演講內容摘要進行本次公差心得撰寫。其中，如來自英國威爾斯大學的曾教授所發表的可量產卷對卷式全印製製程的感測器製程技術，如圖三示，從感測器所需金屬導線電極材料以及感測材料的合成到完成元件印製的製程皆可達成量產的需求，所發展圖案化印製技術更可達 5 米/秒的印製速度，提供低成本感測器元件的量產平台。會後與曾教授針對圖案化金屬氧化物材料進行討論交流，曾教授介紹該實驗室從印製的材料即進行研發與合成，包含金屬氧化物奈米線以及奈米點材料的合成。並針對未來評估之氣體感測器領域進行討論。根據曾教授的經驗指出，由於金屬氧化物材料應用於氣體感測器時需具鑑別氣體種類的功能，然而目前在鑑別氣體種類仍有相關的技術瓶頸急待解決，因此在氣體感測領域的應用上也較為複雜且較具研發挑戰性。而金屬氧化物奈米材料應用於生物感測器時，則可依據感測器所要偵測的生物官能基進行感測器薄膜表面改質，提供所需偵測的感測單元，因此在感測物種上較具針對性也較容易實現感測應用。因此該實驗室才以生物感測領域優先作為此低成本量產技術的應用。此外，其實驗室所發展之印刷製程厚度可控制薄膜厚度至 10nm，線寬精準度可達 100μm 極具應用價值。由於其印刷製程速度極快，在不需要圖案化的情況下製程速度甚至可達 15 米/秒的速度，且可印製金屬及金屬氧化物奈米等兩類材料，因此針對此技術與本所多層節能膜的應用也進行初步的討論與交流，未來有機會與本所在節能膜與感測器領域進行國際跨領域的研發合作。並於會後互相邀請參訪單位實及驗室，進行更進一步的研究領域交流。

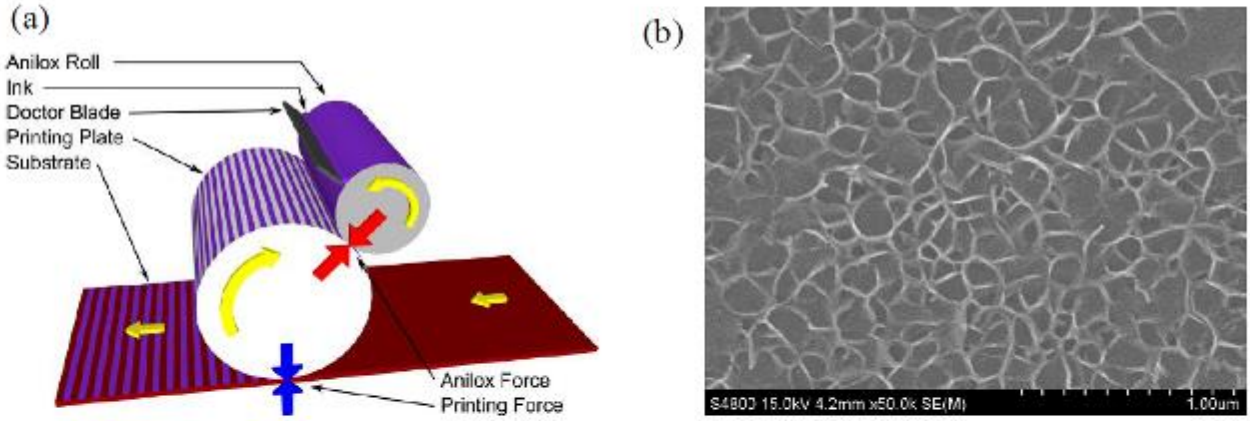

Figure 1 (a) show the schematic diagram of the flexographic printing technique and (b) show the SEM image of the nanotextured surface at ZnO thin film.

圖三、英國威爾斯大學的曾教授所發表的可量產卷對卷式全印製製程的感測器製程技術

此外，由於電漿共振子的應用為近年來許多材料領域的研發重點，藉由電漿共振子吸收外部的光產生共振，提供光電轉換之應用。來自波蘭 AGH 大學的奈米科技與材料中心的 Kollbek 博士則發表磁性材料的電漿共振子研究，如圖四所示。相較於傳統上所使用的技術為藉由多步驟濕式或是電子束及紫外光微影合成方式來製作磁性電漿共振子，而其研究則是主要利用電漿搭配惰性氣體凝結的製程方式，以單一步驟即達成製作磁性奈米球殼型材料，如圖五所示。此技術可應用於多種不同材料合成，提供球殼形奈米材料的合成，顯示以多種電漿製程製作新穎光電材料已是目前世界上材料研究的重點研究方向之一。

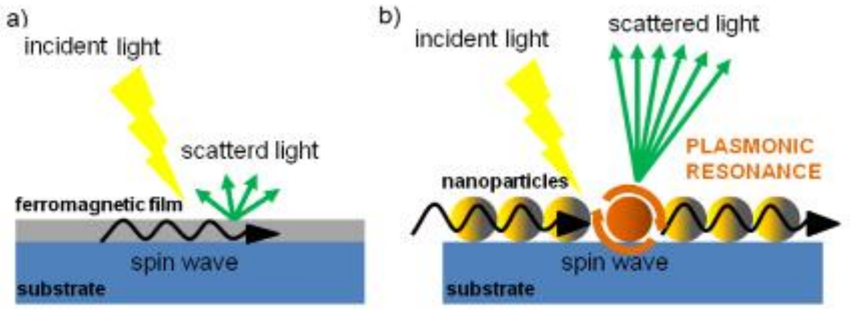

Fig1. Light interaction with a spin wave in a uniform ferromagnetic thin film sitting on a top of a dielectric substrate, (b) excitation of the plasmon resonance in a chain of magneto-plasmonic nanoparticles leads to enhancement of the intensity of light scattered from the spin wave.

圖四、波蘭 AGH 大學的 Kollbek 博士團隊發表磁性材料的電漿共振子研究

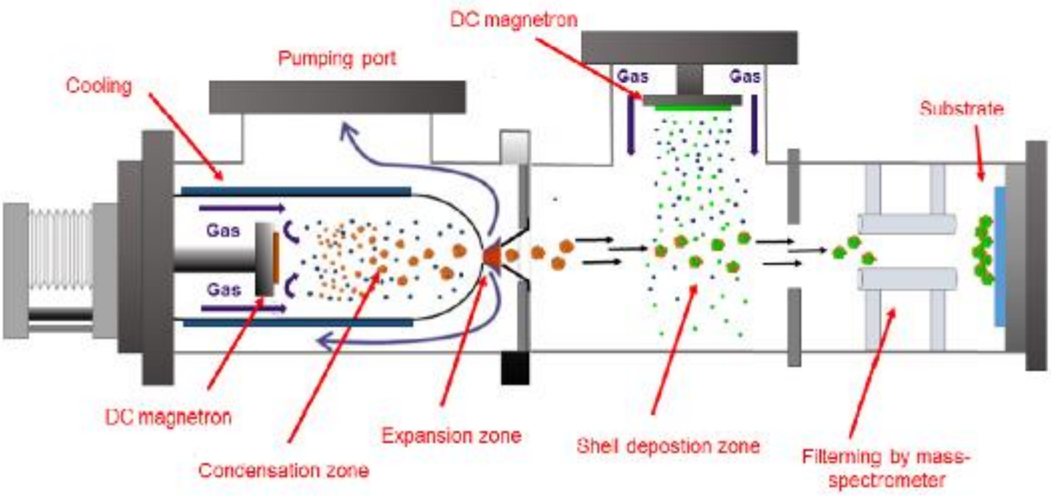

Fig2. Schematic diagram of the vacuum deposition system based on Inert Gas Condesation, IGC technique containing the nanoparticles source.

圖五、Kollbek 博士團隊利用電漿搭配惰性氣體凝結製程完成磁性奈米球殼型材料製作

針對金屬氧化物材料應用光觸媒的應用上，主要的發展已經由傳統第一代的單一金屬氧化物材料逐漸發展至應用兩種材料的平面型異質接面光觸媒材料的應用，包含金屬與金屬氧化物的異質接面以及半導體型異質接面的應用。而為了更進一步增加表面的反應面積，近幾年則朝向發展奈米球殼及奈米管等型態的異質接面型金屬及金屬氧化物材料。此新穎材料的發展主要以化學合成的方式製作，而來自波蘭 Gdansk 大學的 Medynska 教授提出以合金金屬的方式搭配陽極氧化的製程，完成異質接面型態的奈米管狀材料的製作。如圖六所示，Medynska 教授分別以 Ti/Ag 的金屬片完成 $TiO_2/Ag_2O/Ag$ 奈米管的製作以及藉由 TiMn 合金片及 TiV 的合金片完成 TiO_2/MnO_2 及 TiO_2/V_2O_5 等奈米管狀材料的開發，提供未來應用於光觸媒領域之應用。

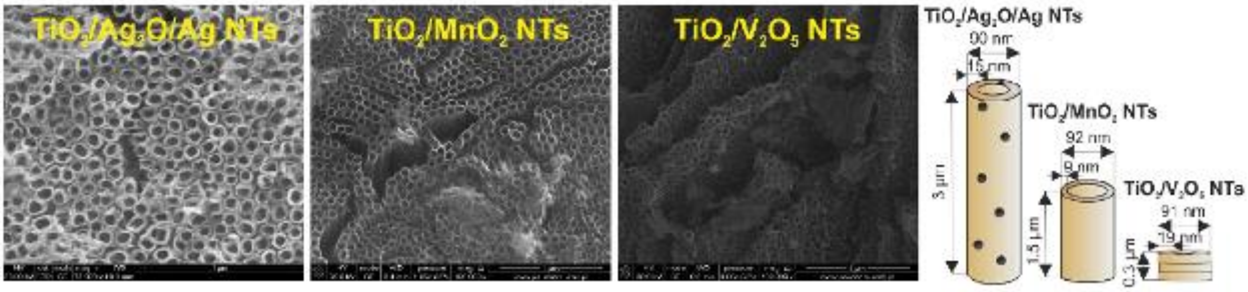

Fig 1. Morphology of nanotubes obtained by anodic oxidation of Ti/Ag, TiMn and TiV alloys

圖六、Medynska 教授以合金金屬搭配陽極氧化製程完成異質接面型態奈米管狀材料製作

另一方面，金屬氧化物材料目前應用於汙染去除、生物除汙、潑水應用以及有機合成等領域，對於金屬氧化物應用於光觸媒領域還需要考量因長時間操作所需的可靠度要求，但由於 TiO_2 本質屬親水性鍵結，因此也限制了許多材料應用上的限制。因此，來自德國 Max Planck Institute for Polymer Research 的 Wooh 博士針對 TiO_2 薄膜的表面進行改質，藉由常見的聚二甲基矽氧烷(PDMS)與 TiO_2 金屬氧化物薄膜的反應，如圖七所示，成功達成了 TiO_2 金屬氧化物薄膜表面改質的目標，使得 TiO_2 金屬氧化物薄膜表面為疏水性的鍵結，提供長時間應用在汙染去除、生物除汙、潑水應用以及有機合成等領域的應用，Wooh 博士並進行此表面改質材料進行汙染去除、生物除汙的長時間可靠度的測試，其研究結果也顯示藉由 PDMS 與 TiO_2 金屬氧化物薄膜的反應，可持續使 TiO_2 金屬氧化物薄膜表面具穩定且可靠的疏水性界面，在汙染去除、生物除汙等實測也都也獲得了不錯的研究效果。

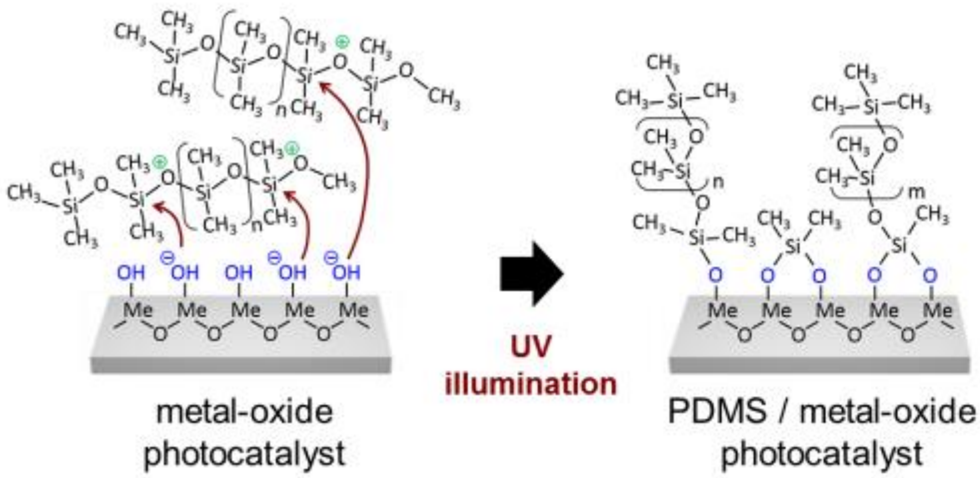

Fig. 1. Scheme of PDMS grafting on metal-oxide photocatalyst by illumination.

圖七、藉由表面改質技術達成 TiO_2 金屬氧化物薄膜可提供穩定且可靠的疏水性界面

此外，針對金屬氧化物材料半導體特性的開發，主要追求的是以同一種金屬氧化物材料同時達成電洞型 P 型及電子型 n 型的目標，除了可降低成本外，由於金屬氧化物半導體材料相較於現有的非晶矽材料除了有更高的載子移動率外，更可減少製程上使用兩種材料的複雜性，而未來在 CMOS 的電路的應用更是此技術發展的終極目標。來自中國山東大學的 Xin 教授則藉由調控 SnO_2 濺鍍時的電漿功率達成了上述的目標，如圖八所示，雖然達成了電洞型 P 型及電子型 n 型的半導體甚至是雙極性半導體材薄膜的製作，然而實際搭配元件的製作後，在電子的載子移動率及整體元件的起始電壓上仍有許多改善的空間。

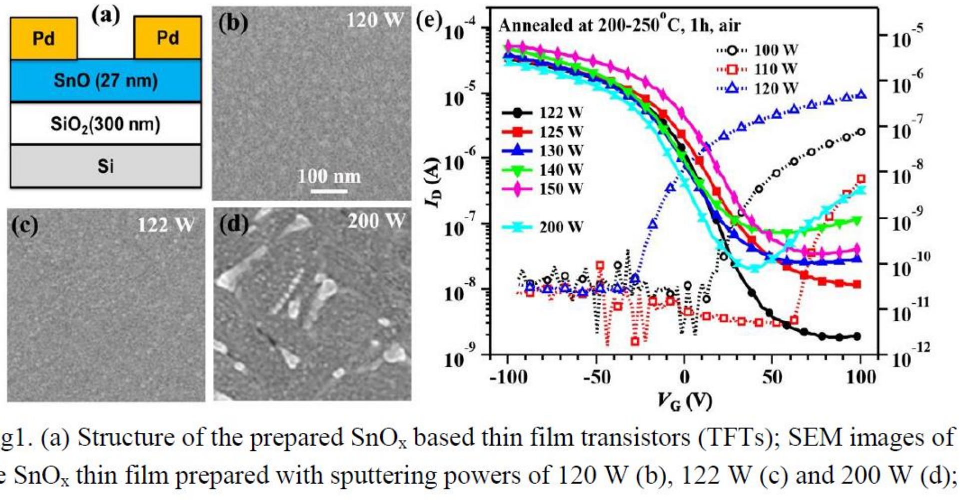

Fig1. (a) Structure of the prepared SnO_x based thin film transistors (TFTs); SEM images of the SnO_x thin film prepared with sputtering powers of 120 W (b), 122 W (c) and 200 W (d); (e) The transfer curvers of TFTs with SnO_x active layer prepared at sputtering powers of 100 ~ 200 W. The TFTs prepared at 100-120 W shows n-conductivity, the TFTs prepared at 122-150 W shows p-conductivity, and the TFT prepared at 200 W show bipolar conductivity.

圖八、山東大學的 Xin 教授藉由調控濺鍍功率達成控制半導體材料特性的目標

針對電漿鍍製感測器薄膜的應用方面，由於本所目前亦進行電漿鍍感測薄膜之研究評估，擬藉由電漿鍍至高感測特性之薄膜，而氫氣感測一般為氣體感測最常的測試應用，在此研討會議中，來自日本 Kochi 大學的 Yamamoto 教授採用離子鍍膜的方式鍍製 ZnO:Ga(GZO)薄膜，如圖九所示。主要藉由電弧電漿產生不同狀態的氧離子進行 GZO 薄膜的改質，提供高速氫氣感測應用，主要的機制為藉由帶負電荷特性的氧離子進行 GZO 改質，改變薄膜的載子濃度，但目前仍需在高溫 330℃進行感測，後續仍需朝室溫感測應用開發，如圖九所示。

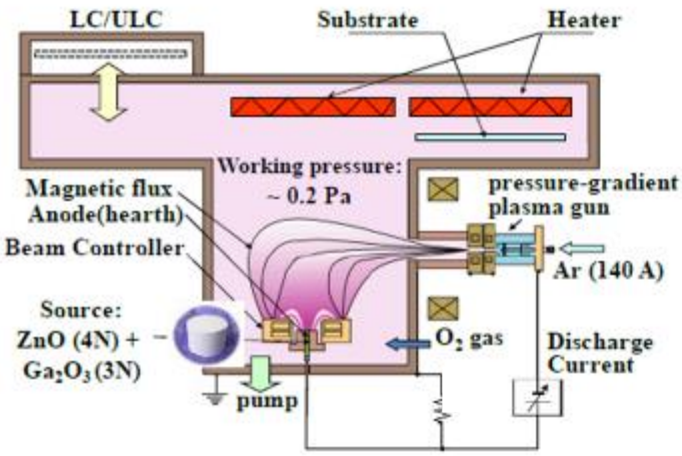

Fig 1. Schematic diagram of ion-plating with direct-current arc discharge.

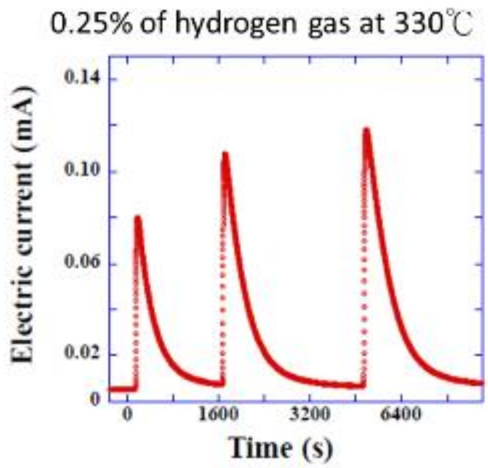

Fig 3. Performance of hydrogen gas sensor based on GZO films.

圖九、採用離子鍍膜的方式鍍製 GZO 氫氣感測薄膜

針對新穎半導體二硫化鉬(MoS_2)的應用，來自美國 Texas 大學材料工程的 Young 博士發表了以高介電常數材料如氧化鋁(Al_2O_3)以及氧化鉿(HfO_2)薄膜作為電晶體元件的閘極材料，並分別製作上電極以及下電極的元件結構進行特性分析，藉由採用半導體元件常用的電容-電壓(C-V)量測方式分析半導體薄膜 MoS_2 與高介電常數材料界面之缺陷密度，根據其研究指出以氧化鋁(Al_2O_3)與半導體 MoS_2 的界面可獲得較佳之元件特性，所製作完成之元件場效載子移動率可高達 32.7cm^2/Vs，並可藉由後續在(5%H_2/95%N_2)的混合氣體中進行熱退火提升整體元件的特性。此外，於沉積金屬電極時採用高真空製程則可更進一步提升整體元件特性，如圖十所示。

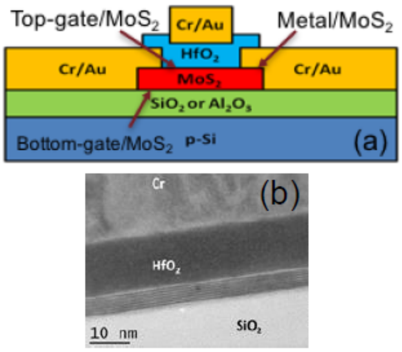

Fig.1. (a) Schematic of the top-gated MoS_2 field-effect transistor structure, (b) TEM image of the cross section of a typical transistor gate stack.

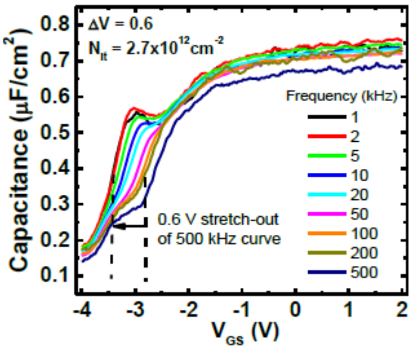

Fig. 2. C-V: frequency dep. showing a "hump" indicating interface defects. The 0.6V stretch-out of 500 kHz curve indicates Fermi energy pinning at MoS_2/HfO_2 interface.

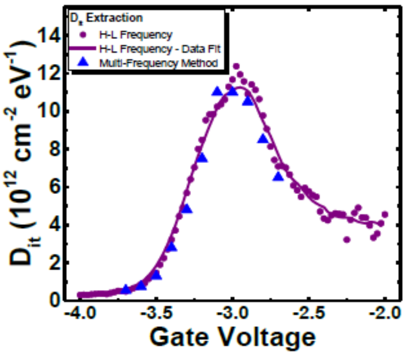

Fig. 3. D_{it} extraction: Comparison of High-Low and multi-frequency D_{it} extraction methods that show similar D_{it} distribution, with a D_{it} peak at 1.2×10^{13} cm^{-2} eV^{-1}.

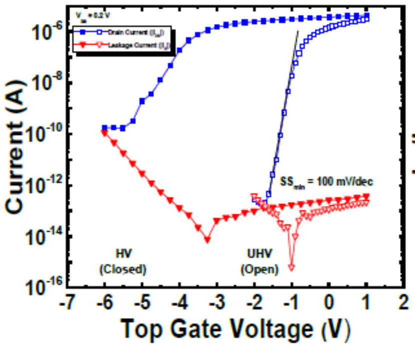

Fig. 4. I_D-V_G of top-gate, few-layer MoS_2 FETs with Cr contacts deposited in HV and UHV, demonstrating a subthreshold swing of 100 mV/dec for a UHV device.

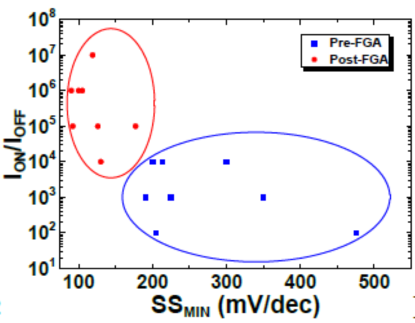

Fig. 5. On/Off ratios and subthreshold swing values for several MoS_2backgate FETs on Al_2O_3 pre- and post-forming gas ($5\%H_2/95\%N_2$) anneal.

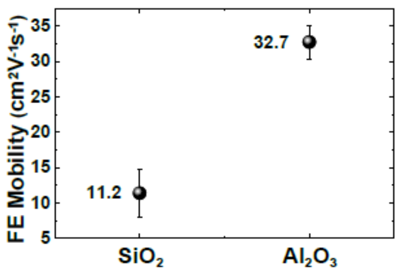

Fig. 6. Field effect mobility statistics between several top-gate FETs on SiO_2 and Al_2O_3 shows an increase in μ_{FE} of ~3×. Forming gas anneal post metal deposition on MoS_2 shows improvement in I-V characteristics for Cr deposited in high vacuum (HV).

圖十、新穎半導體二硫化鉬(MoS_2)的元件開發

另一方面，針對目前最火紅的電阻型非揮發性記憶體resistance random access memory (RRAM)元件開發，來自南韓首爾國際大學的Kim博士以現有半導體業界常用的材料進行電阻型非揮發性記憶體的開發，所採用薄膜材料為氮化矽(Si_3N_4)及氧化矽(SiO_2)，而記憶體薄膜主要的記憶操作機制為薄膜中與氫相關的缺陷相關，藉由電壓及電流的寫入與抹除達成薄膜電阻特性的改變，達成記憶體元件的記憶效果，並針對元件的電流-電壓(I-V)特性分析其物理機制，如圖十一所示。

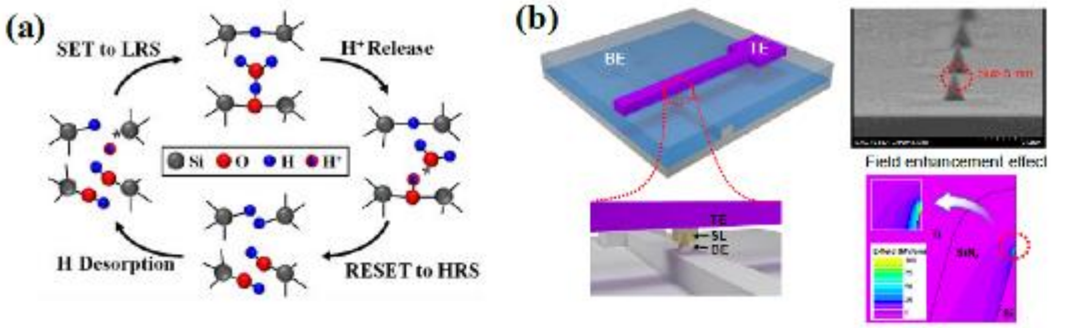

Figure (a) Proton exchange induced resistive switching behaviors and defect transitions in silicon oxide, and (b) nano cone-type SiN_x-based resistive switching memory.

圖十一、南韓首爾國際大學的 Kim 博士發表與 RRAM 相關之研究成果

此外，韓國的 Chung-Ang 大學的 Jun 教授藉由傳統陽極氧化及蝕刻技術製作具有 2D 結構之電漿共振奈米點矩陣薄膜，所採用的技術皆為傳統的陽極氧化技術以及蝕刻薄膜轉移技術，其實驗結果顯示可藉由傳統技術達成具 2D 結構之電漿共振奈米點矩陣薄膜，並將其轉移至透明導電玻璃上，如圖十二所示。

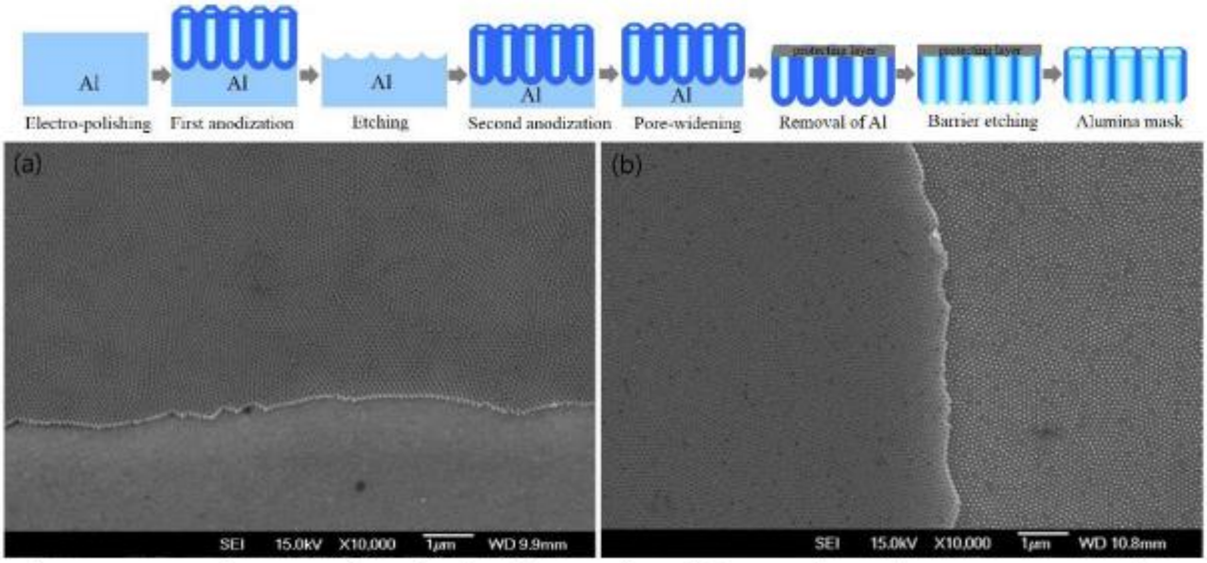

Fig 1. FE-SEM images of (a) the alumina mask and (b) metal nanodot array on ITO glass

圖十二、以傳統陽極氧化及蝕刻技術製作具有 2D 結構之電漿共振奈米點矩陣薄膜

會議中針對環境獵能器的開發亦有所涉略，來自日本 Fujitsu 公司的 Kawaguchi 博士，針對 RF 環境獵能器的應用提出以 III-V 族材料所組成的反向操作型奈米線二極體作為獵能元件，目前 Kawaguchi 博士團隊已能成功成長出 GaAsSb/InAs 異質接面奈米線，主要以有機金

屬化學氣相沉積法(MOVPE)搭配金奈米點的催化達成奈米線的製作，而在其製程中引入 HCl 氣體進行 III-V 族材料奈米線的成長控制，獲得了不錯的奈米線成長結果，如圖十三所示。但目前在反向操作型奈米線二極體元件的特性上仍無法達成所需求的二極體元件特性，後續仍需持續投入研發，實現 RF 環境獵能器的應用。

Fig 1. (a) Schematic view of position-controlled growth of GaAsSb/InAs nanowires. (b) SEM image of GaAsSb/InAs nanowires.

圖十三、日本 Fujitsu 公司針對 III-V 族元件應用於 RF 環境獵能器應用進行開發

此外，來自德國 IMT 的 Kohl 博士針對磁性型態的記憶體合金材料於熱磁能源轉換元件應用發表了相關的研究成果，主要藉由電漿濺鍍的方式鍍製 Ni-Co-Mn-In、Ni-Mn-Ga、Ni-Co-Mn-Ga 等鐵磁性材料並搭配線圈可應用於小尺寸熱磁能源轉換應用，如圖十四所示。根據 Kohl 博士估計，有機會可產生能量密度約 100mW/cm^3 的能量。

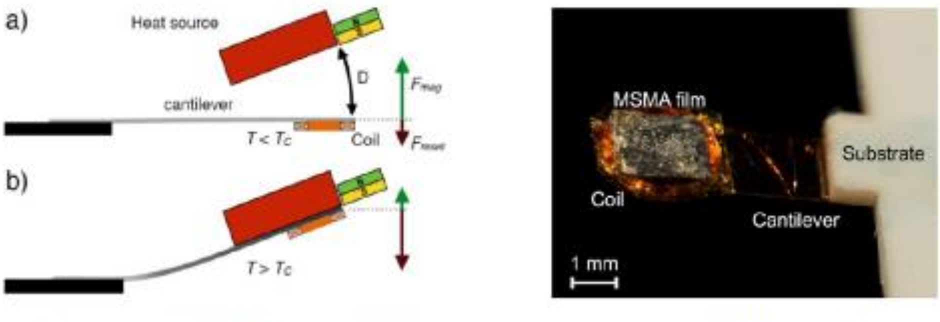

Fig. 1. Operation principle: (a) ferromagnetic state ($T < T_C$); (b) paramagnetic state ($T > T_C$). Fig. 2. Demonstrator for thermo-magnetic energy generation.

圖十四、德國 IMT 的 Kohl 博士針對磁性型態的記憶體合金材料於熱磁能源轉換元件應用

而在議程中，也受邀主持一場電子材料相關領域的論文研討，如圖十五所示為會議議程。內容涵蓋奈米線異質接面元件，新穎二硫化鉬半導體元件，以及電阻型記憶體元件，而藉由與不同領域學者的交流，可以更進一步了解各個領域的研發重點，提供未來新技術發展的評估依據。

Electronic Materials			Chair: Min-Chuan Wang
14:00-14:30	169	**Alois Lugstein**	Room Temperature Quantum Ballistic Transport in Monolithic Al-Ge-Al Nanowire Heterostructures
14:30-15:00	171	**Chadwin D. Young**	Device Performance Evaluation of Critical Interfacesin Few-Layer MoS2 Field Effect Transistors with High-k Dielectrics
15:00-15:30	175	**Yao-Feng Chang**	Resistive Switching Characteristics and Mechanisms in Silicon Oxide and Silicon Nitride Memory Devices
15:30-16:00	***Session Break***		

圖十五、受邀主持電子材料相關領域的論文研討會議議程

四、建　議　事　項

(一)、感測器薄型化所需之感測薄膜開發為將來應用於物聯網無線感測器元件發展重點，可針對高性價比之感測薄膜領域投入製程先期研發驗證。

(二)、電漿搭配惰性氣體凝結製程製作奈米球殼型材料等技術，以及複合型電漿技術為未來奈米複合型材料開發重點項目，可積極投入研發佈局。

(三)、金屬氧化物材料為目前世界上研發之重點項目，包含能源、環境、儲能以及光電等領域可藉由電漿製程技術即早佈局相關領域應用。

五、附　錄

(一) 、邀請演講投影片

(二) 、CCMR2017 研討會資料

All-solid-state metal-oxide thin film devices fabricated with the plasma coating technology






Min-Chuan Wang

Institute of Nuclear Energy Research

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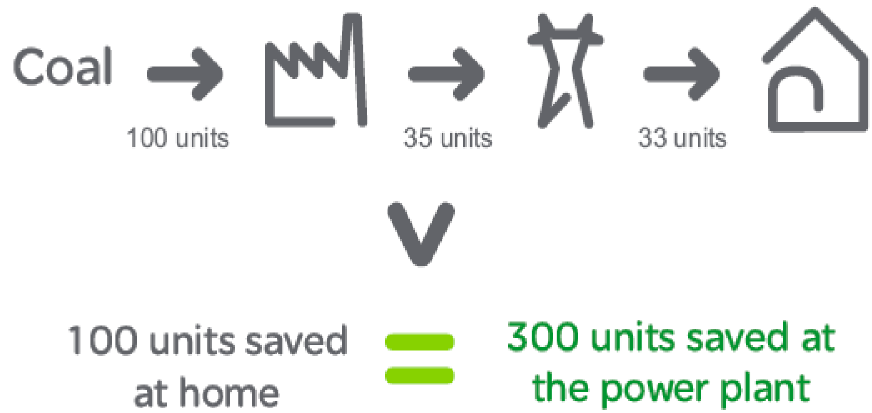
No. 1000, Wenhua Rd., Jiaan Village, Longtan Township,Taoyuan County 32546, Taiwan (R.O.C.)

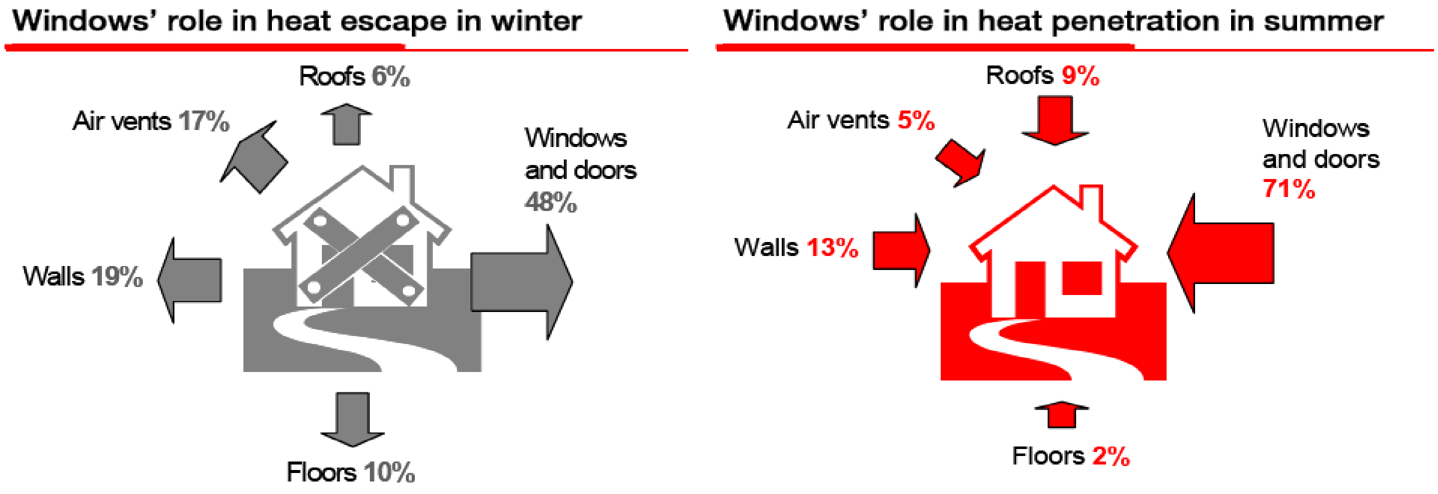
OUTLINE

- Introduction
- Electrochromic Device R&D in INER
- Conclusion

Introduction (Background)



✓a small save at home is a big save at the power plant !

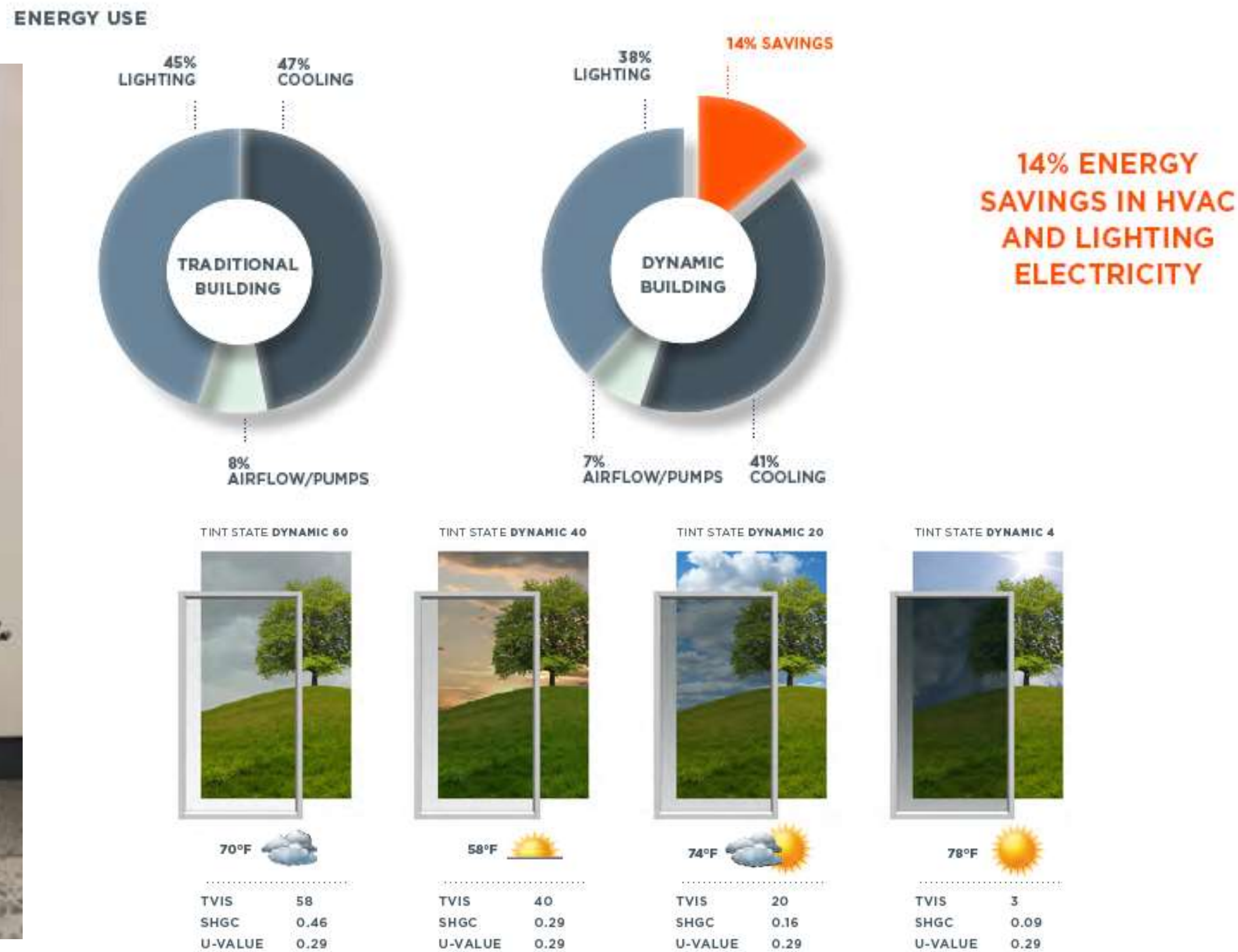


Source: NSG Group, SG Equity Research

- Heating, cooling, and lighting are substantial costs in a building.
- Energy-efficient windows play an important role for energy-saving buildings.

Introduction (Electrochromic Window)

- Dynamic Electrochromic window is an energy efficient product that drives down HVAC (heating, ventilation, and air conditioning) and lighting costs.



Smart Window
For Smart Building Application

Ref: SAGE Electrochromics

Main Market

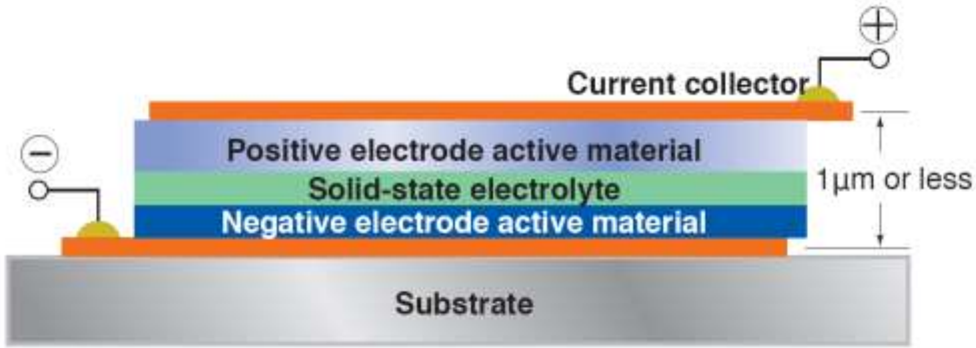
The technologies and markets covered by the smart glass and smart windows analysed in this report are mainly concerned with buildings and vehicles

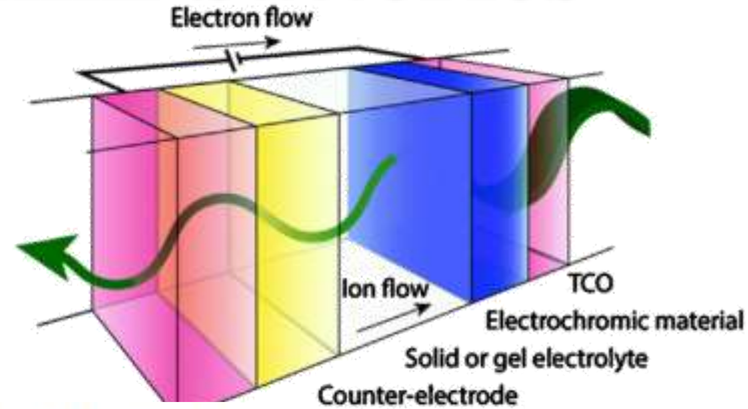
Ref: www.IDTechEx.com

	Electricity generating windows	Electrical smart window shading	Windows and structural elements doubling as displays or light-emitting surfaces	Self-heating, radio wave emission, detection, sensing and other electrical smarts in windows and structural glass
Buildings	Some interest but plenty of other area on most buildings is available for electricity production. Potentially useful for glass buildings	Premium product	No strong interest	Little interest but could become interesting if made autonomous with transparent battery and photovoltaic layers
Vehicles	Becoming very important because area available on a vehicle body to generate electricity is limited	Premium product becoming mainstream	No strong interest	Largely mature and widely adopted as embedded demister, de-icer, antenna

Ref: View Glass

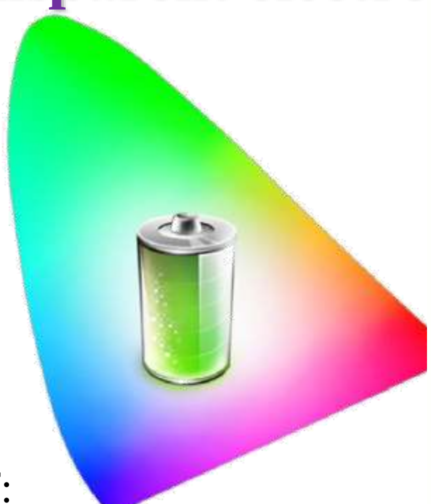
Similarities between electrochromic devices and thin film batteries

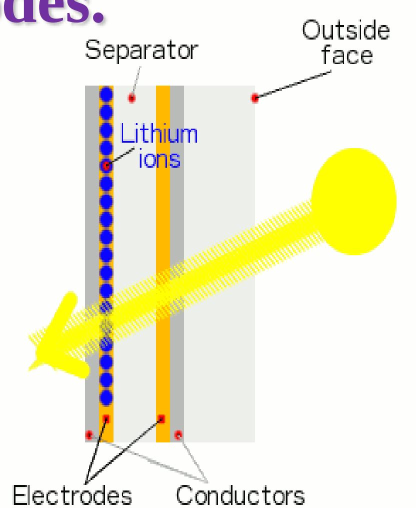


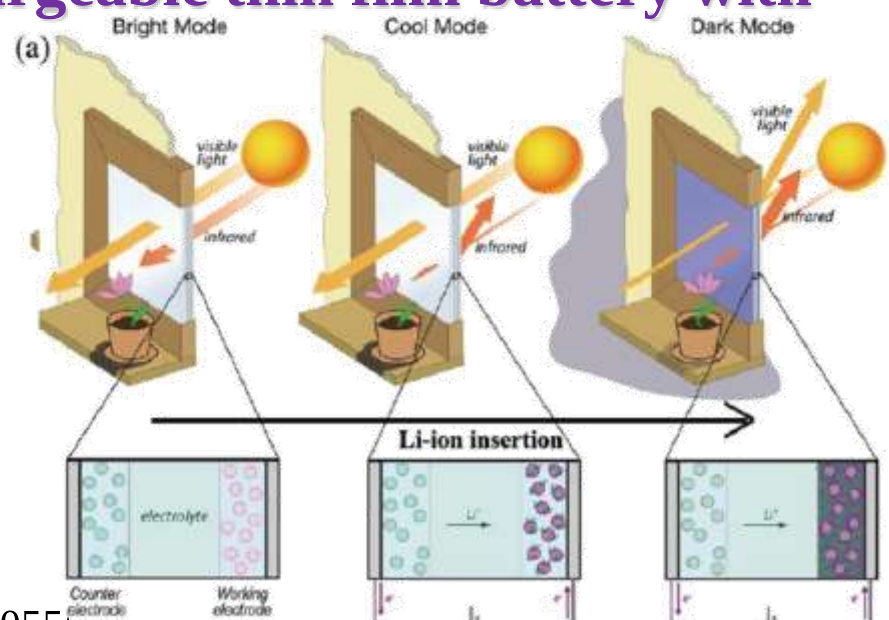


$$MO_y + xA^+ + xe^- \leftrightarrow A_xMO_y (A: H, Li, Na, K)$$

An electrochromic device is a rechargeable thin film battery with transparent electrodes.

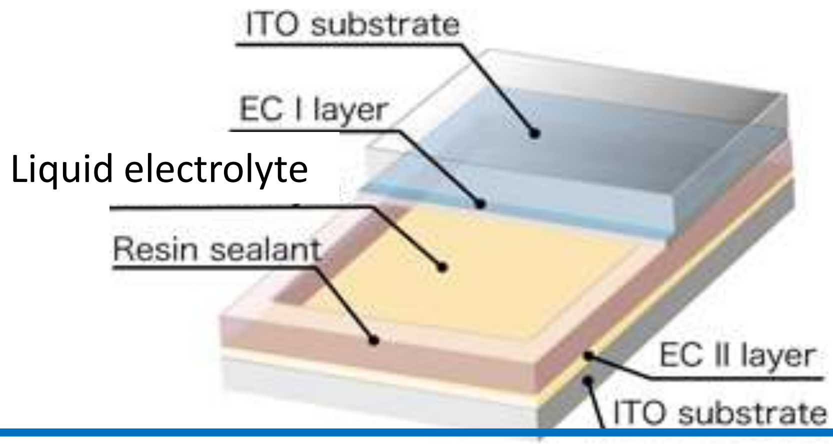


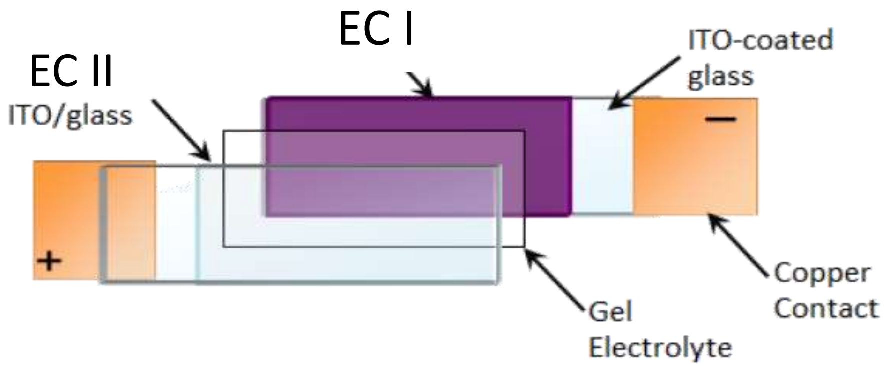




Ref:
E.L. Runnerstrom, et al. Chem. Commun. 50 (2014) 10555.
Peihua Yang, Peng Sun and Wenjie Mai , Materials Today Volume 19, Number 7 September 2016

Conventional Electrochromic Device Structure
(Two Substrates)





Construction schematic of an electrochromic device.

Advantages

- ✓ Easy process
- ✓ High response time (liquid electrolyte)
- ✓ Low cost
  (non-vacuum process and high coating rate)

Disadvantages

- ✓ Process limited by the organic electrolyte
- ✓ High quality (cost) lamination process
- ✓ High precision electronic control unit
- ✓ High cost TCO substrates (SnO_2:F FTO)
- ✓ Heavy (Two glass substrates)
- ✓ Reliability issue (Organic material)
- ✓ Low response time (Gel electrolyte)
- ✓ Over 500+ patents owned by one company

Technical Barriers and Challenges to the Development and Cost Reduction of Dynamic Windows or Window Films

	Topic/Barrier	Description
R&D Barriers	Improved materials performance	• Color control in visible- and low-contrast ratio in the infrared (IR) • Spectral and thermal truncation • Glare mitigation • Switching speed (particularly to reach fully dark [block-out])
	Materials cost reductions	• Transparent, conducting materials (e.g., transparent conducting oxides such as indium tin oxide) **Low sheet resistance and high transparency** • Photovoltaics, batteries, and actuators to improve the ease of installation of electrochromic technologies
	Daylighting performance improvement	• Solar hear gain modulation without adverse impacts on daylighting • Ability to redirect or reflect, not absorb, light to reduce thermal damage in window and surrounding structures
	Coating manufacturing processes	• Reduce cost of glazing coating processes ○ Coatings with improved yields, durability, and quality ○ Faster deposition methods ○ Alternatives to indium tin oxide
	Customized product manufacturing at high throughputs	• Ability to produce fabricator-friendly products that are adaptable to a range of sizes. • Lacking mass production technologies (homogenizes electric field, reduced irising) for electrochromic materials

Ref: R&D Roadmap For Emerging Window And Building Envelope Technologies ,DOE , 2014

OUTLINE

- Introduction
- **Electrochromic Device R&D in INER**

✓ EC device fabricated with all-DCMS method

✓ High performance energy-saving windows

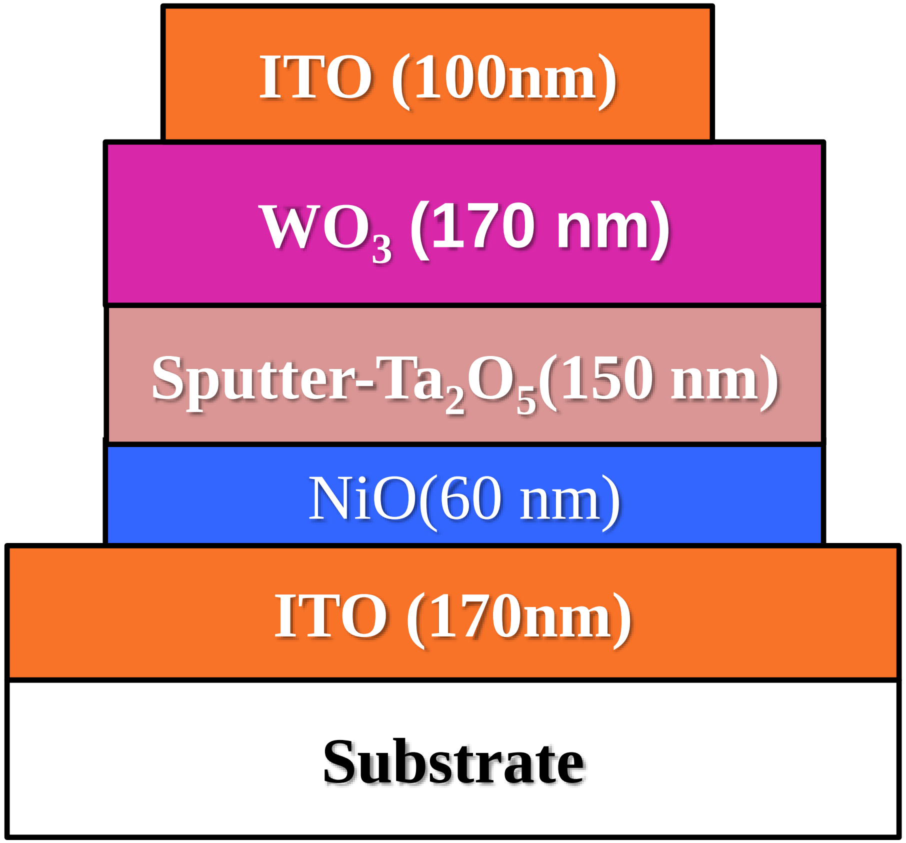
✓ ARC plasma coating technology for EC device

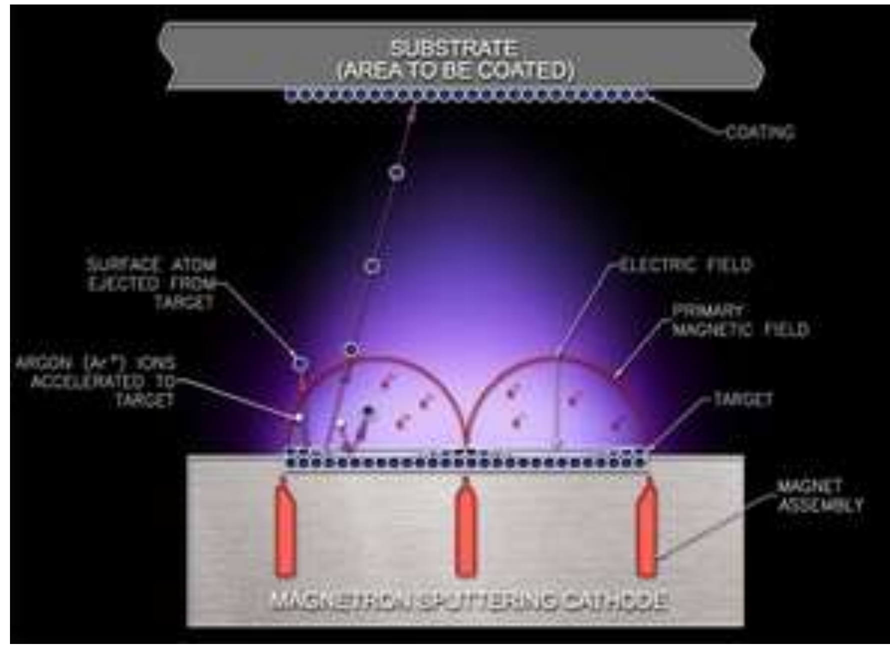
✓ Conclusion

List of the Global Electrochromic Technologies

	EC Coating Vacuum	EC Coating Non-vacuum	Inorganic electrolyte	organic electrolyte	# of substrate	Note (Status)
INER	WO_3 & NiO (New Plasma)		Ceramic (New Plasma)		One substrate structure	
SAGE Electrochromics	WO_3& NiO		Ceramic	PVB (Li)	**Two Laminated Glass**	**Production**
EControl-Glass	WO_3			Li	**Two Laminated Glass**	**Production**
Gesimat		WO_3& PB		PVB(Li)	**Two Laminated Glass**	**Production**
ChromoGenic AB	WO_3 & NiO			PMMA(Li)	**Two Laminated Glass**	**Found~ Production**
View Glass	WO_3			Li	**Two Laminated Glass**	**Production**
Kinestral	WO_3 & NiO	NiO(Li)		Li	**Two Laminated Glass**	**Found ~ Production**

Electrochromic Device Structure & Technology developed in INER





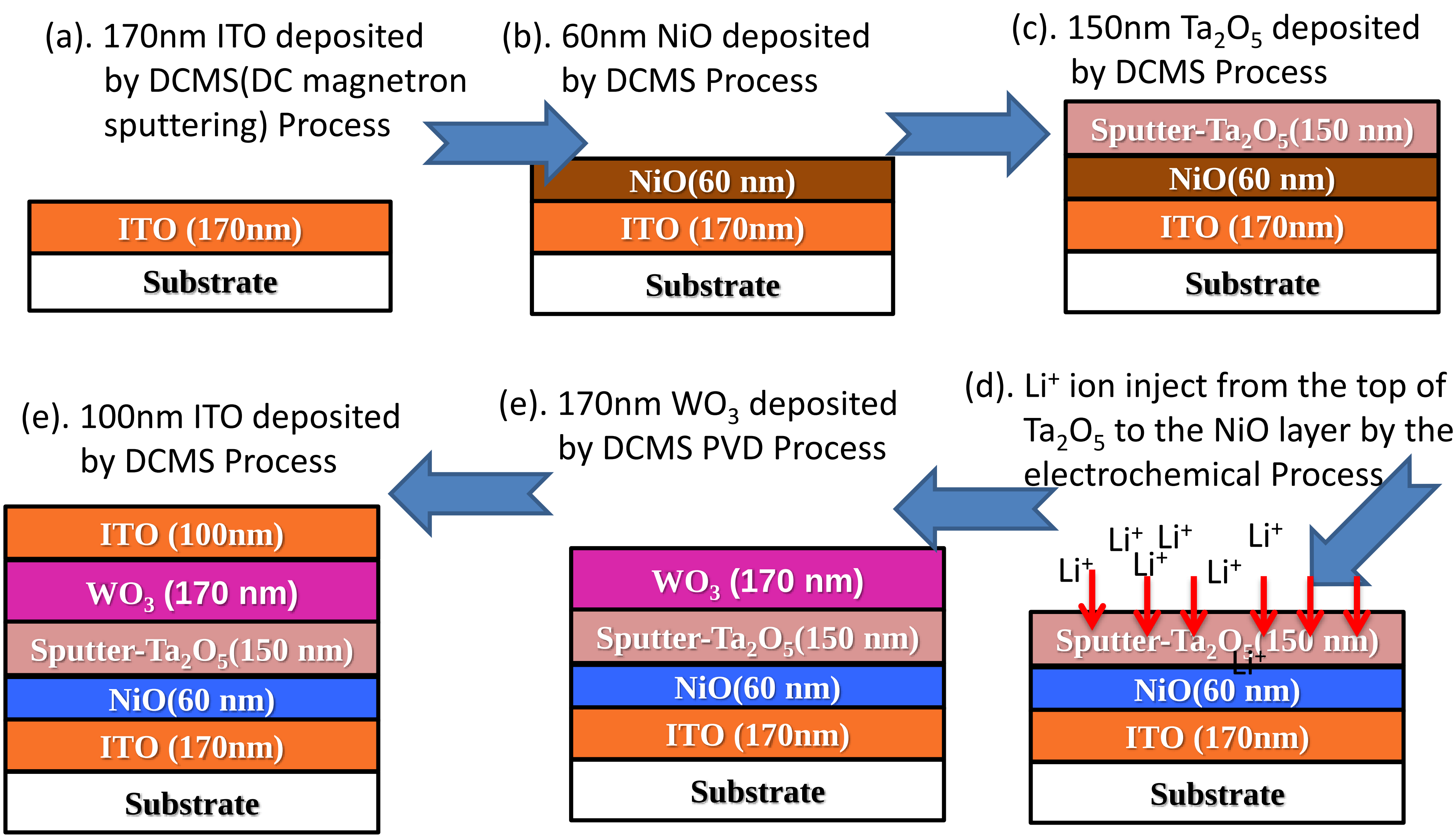
One Substrates Structure

Plasma Coating Process

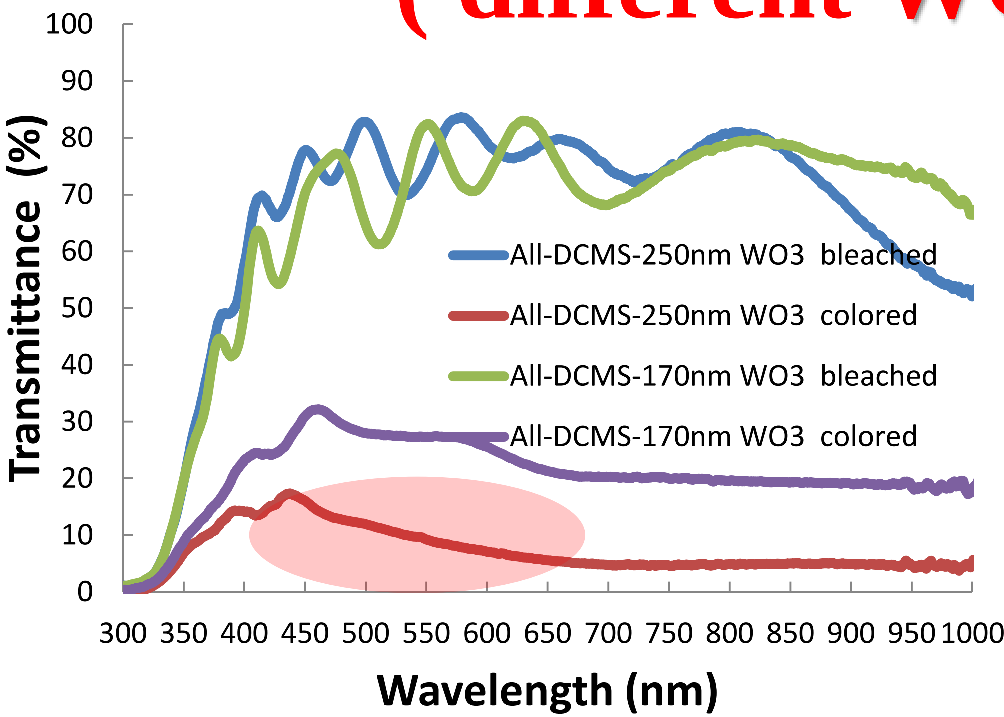
In-Line PVD SYSTEM

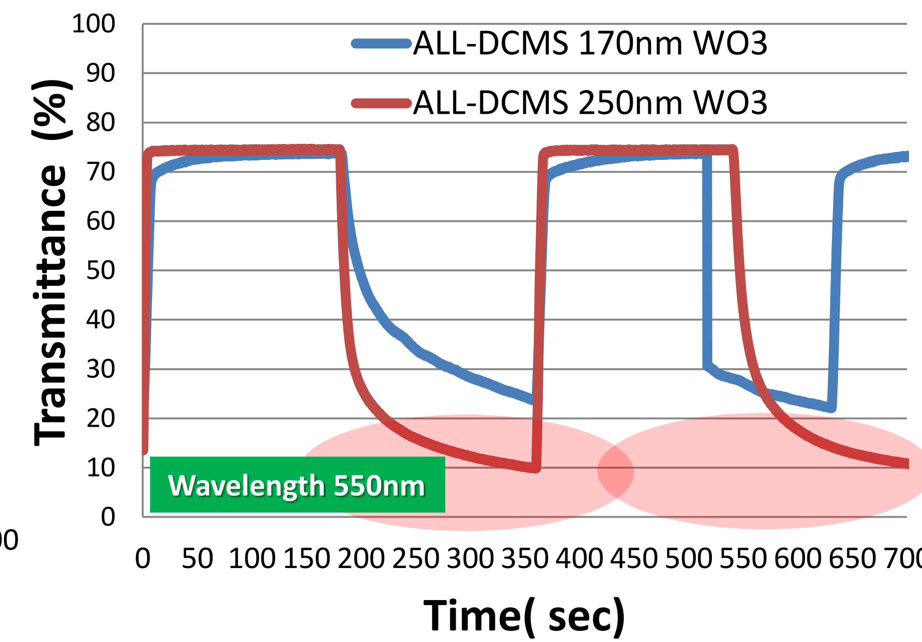
DCMS(DC magnetron sputtering) System

Electrochromic Device Process Flow



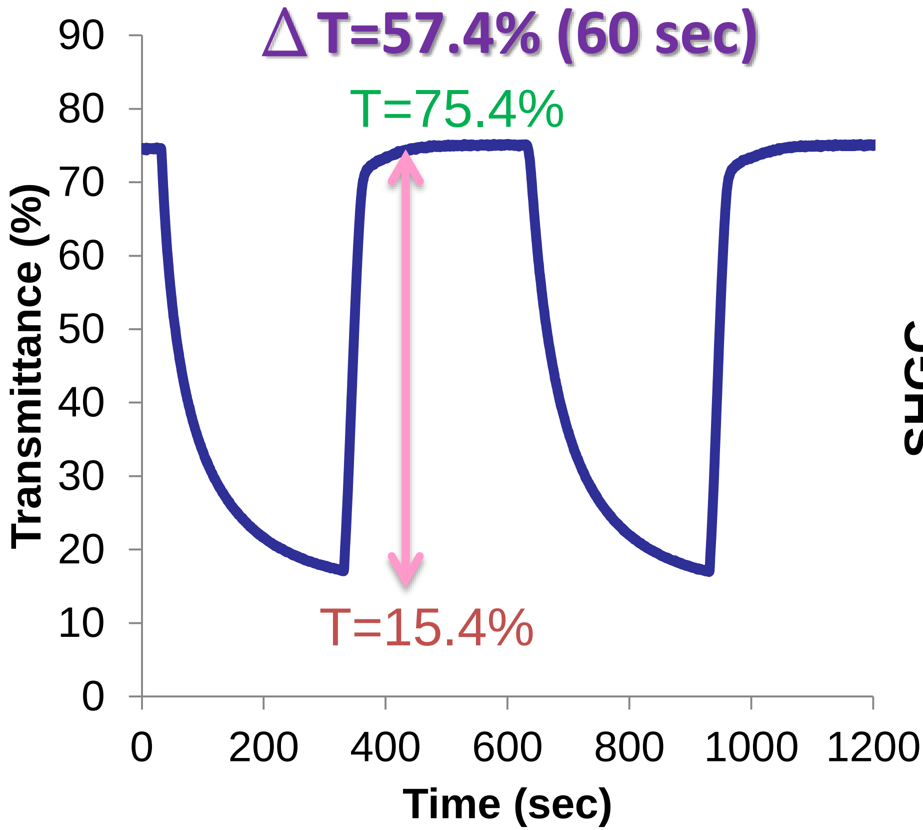
EC Device with all-DCMS method
(different WO_3 thickness)

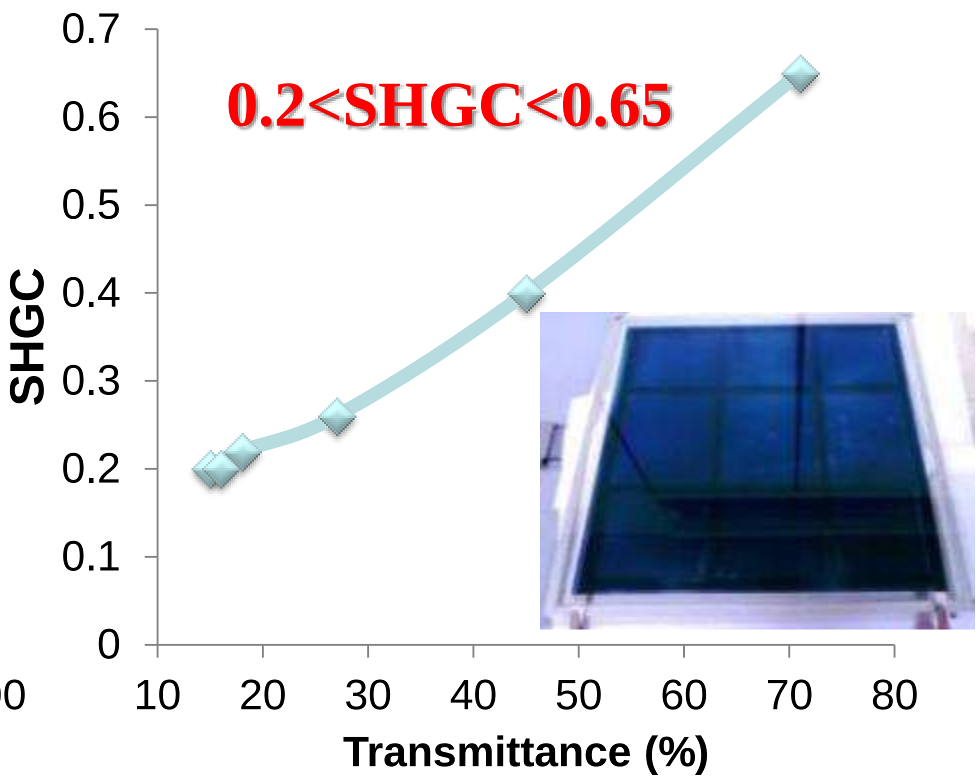




- ✓ **The benefits of the ion injection from the top of the Ta_2O_5 film are the activation of the ion path in Ta_2O_5 and the NiO electrochromic characteristic.**
- ✓ **The colored characteristic of the EC device has been improved ($T_{colored}$<10%) with the increase of WO_3 thickness.**
- ✓ **The best transmittance variation (△T) is 65% @ 550 nm with the 250 nm WO_3 layer.**

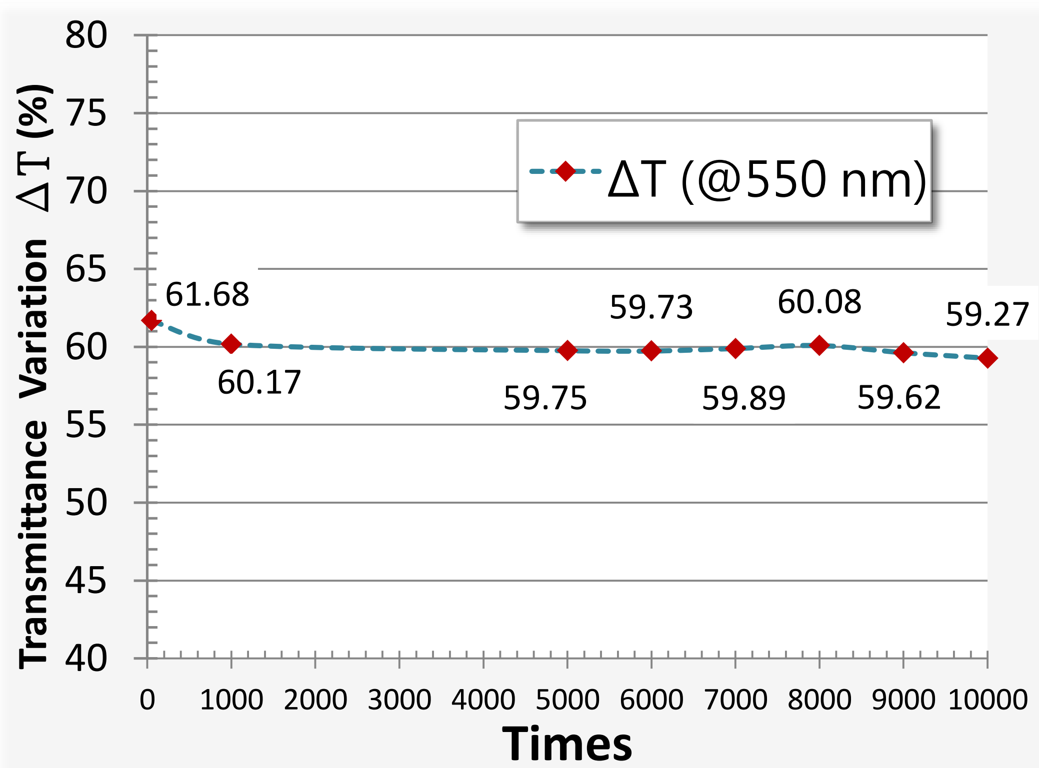
The Characteristic of 20cmx 20cm ($400cm^2$)EC Window Fabricated with all-DCMS Method

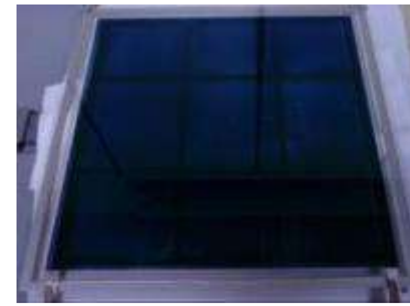


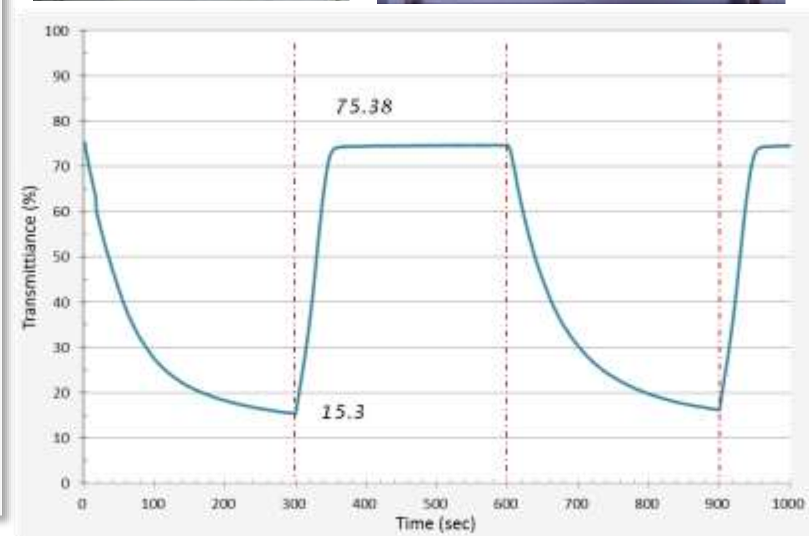


- ✓ The 400 cm^2 EC window has been demonstrated with the transmittance variation (△T) of 57.4% @ 550 nm under a driving voltage of ± 5.5 V 60 sec.
- ✓ The Solar Heat Gain Coefficient (SHGC) value of the EC window could be dynamically controlled from 0.2 to 0.65. (The general requirement of energy-saving film is the SHGC value <0.3)

Reliability Test







✓ The 400 cm² EC window without any lamination has passed 10,000 reliability test and maintained the transmittance variation (△T) of 60% @ 550 nm.

OUTLINE

- Introduction
- Electrochromic Device R&D in INER

✓ EC device fabricated with all-DCMS method

✓ High performance energy-saving windows

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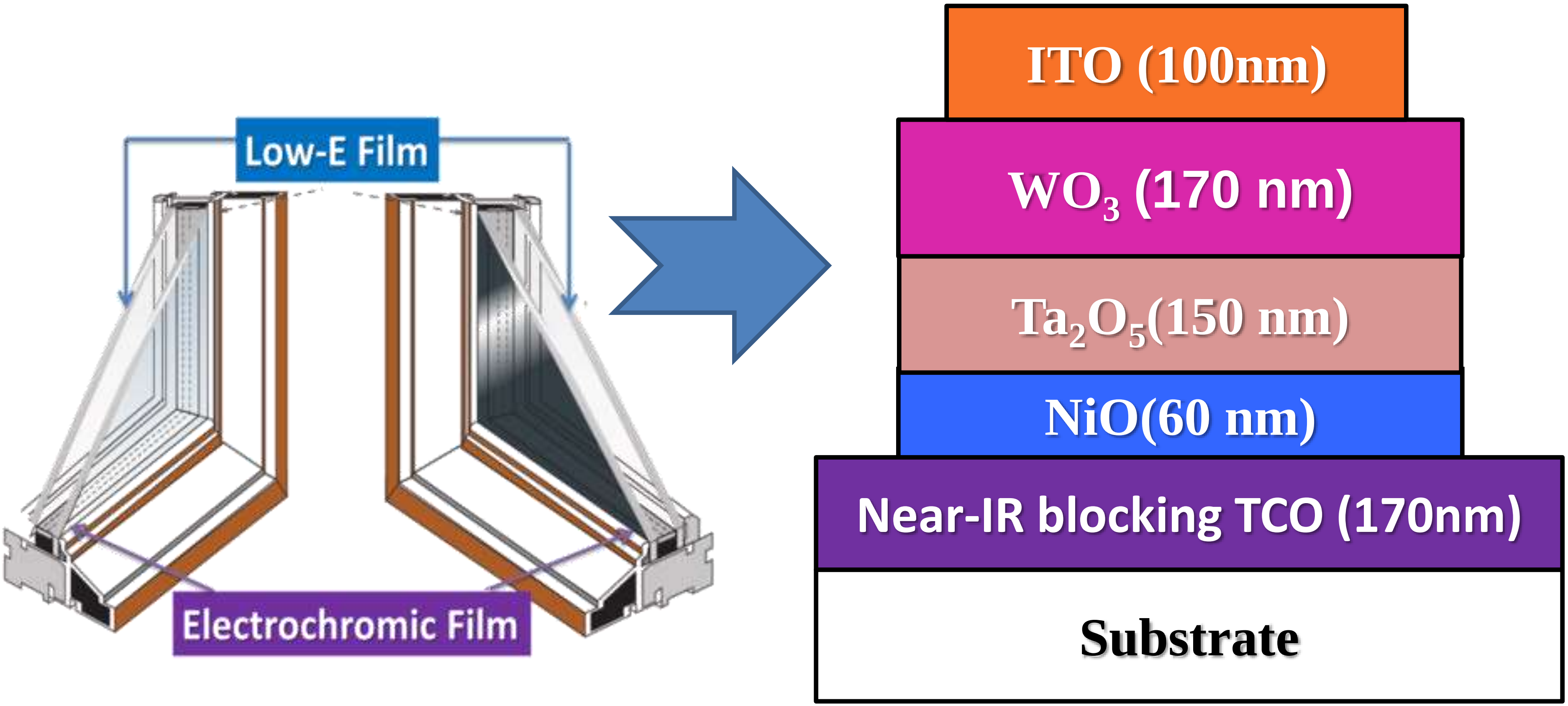
✓ Conclusion

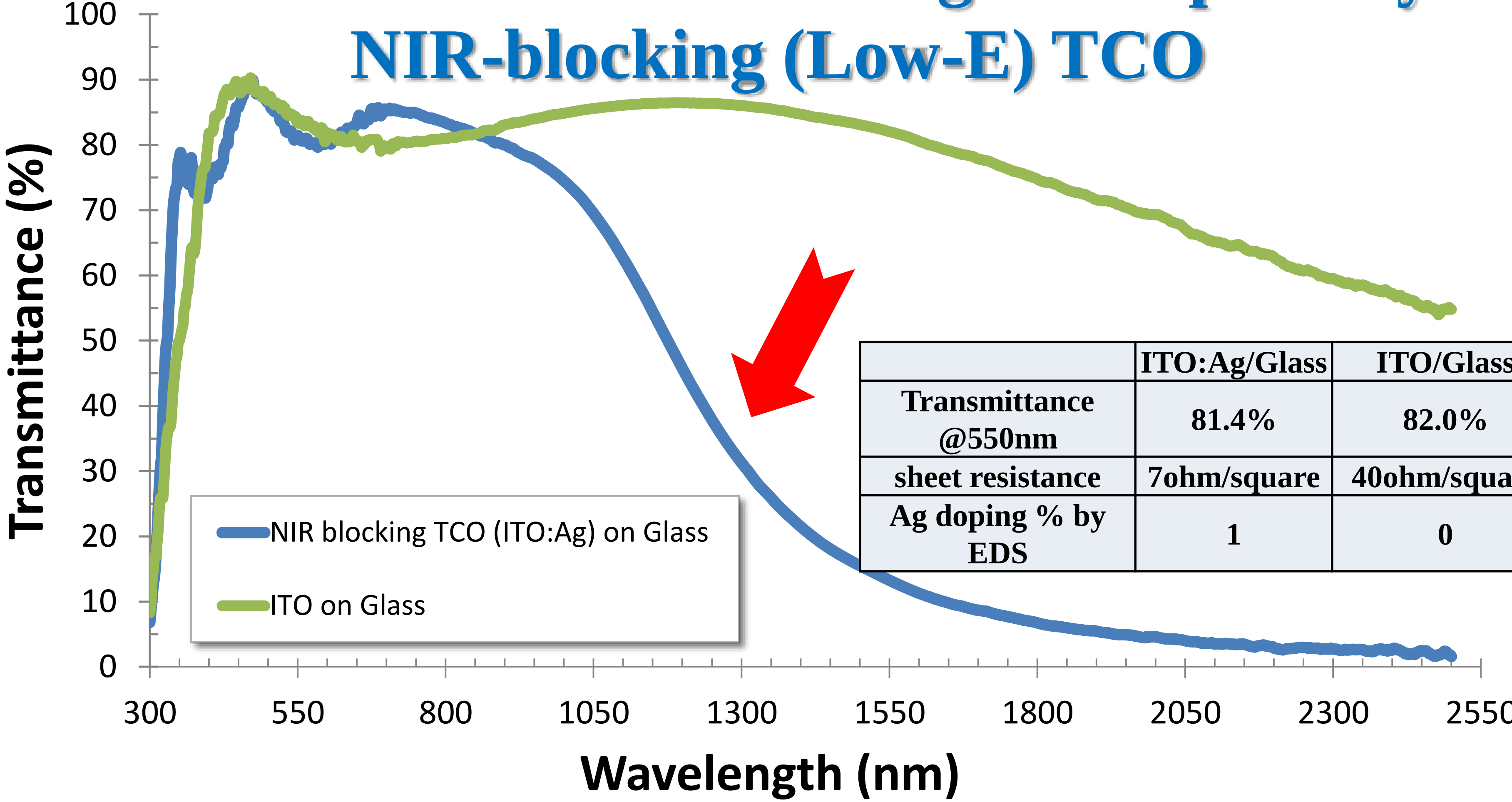
High Performance Energy-saving Windows



Regarding the previous research of energy-saving electrochromic glasses , spectral selectivity, that is, independent modulation of visible and near-infrared (NIR) radiation, is still considered a 'holy grail' for reducing the energy needed to light and thermally regulate building interiors.

Ref: Anna Llordés,Guillermo Garcia,Jaume Gazquez,Delia J. Milliron, Nature **500**, 323 (2013).

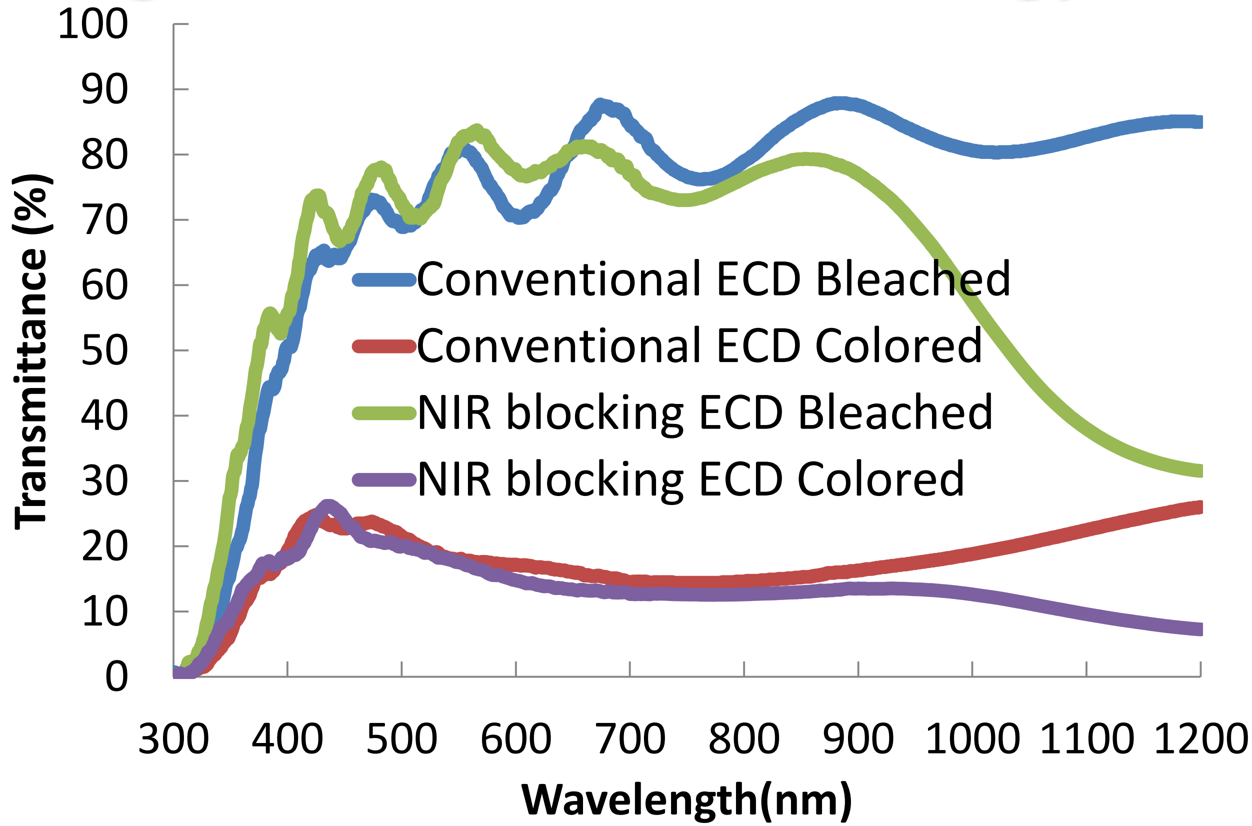
Low sheet resistance and high transparency NIR-blocking (Low-E) TCO

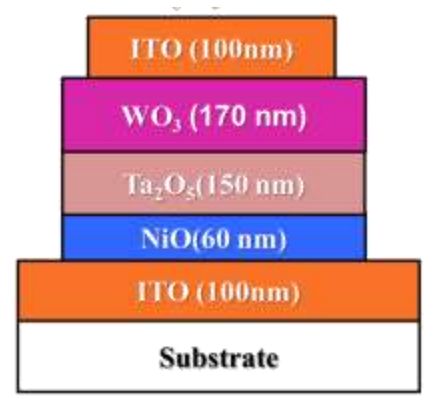


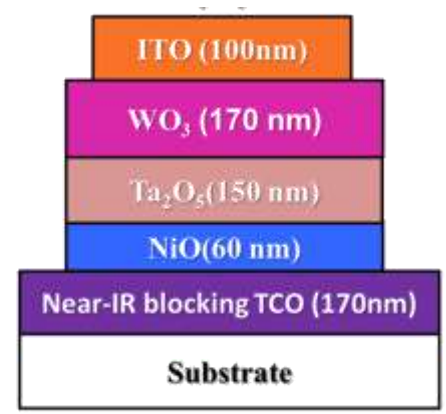
	ITO:Ag/Glass	ITO/Glass
Transmittance @550nm	81.4%	82.0%
sheet resistance	7ohm/square	40ohm/square
Ag doping % by EDS	1	0

- ✓ According to the plasma frequency theory, the transparency limlt of the long wavelength in TCO is determined by the carrier concentration. With the increase of the carrier concentration, the blue-shift of the cut-off wavelength could be modulated.
- ✓ The NIR-blocking TCO also provides the lower power consumption for large area applications in the switching cycle.

High Performance Energy-saving Windows





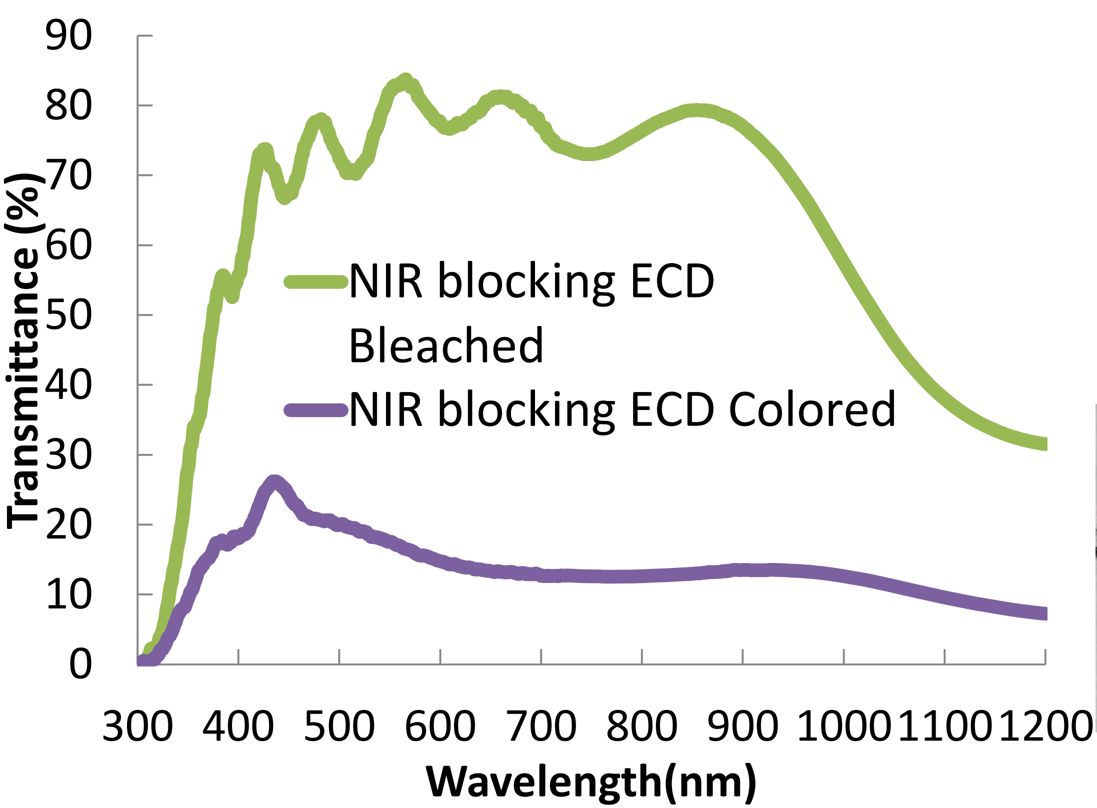


Structure	SHGC	Transmittance (at 550nm)			Transmittance (at 1100nm)		
		colored	bleached	ΔT	colored	bleached	ΔT
Conventional ECD	0.82 0.27	18.0%	80.6%	62.6%	22.5%	82.7%	60.2%
NIR blocking ECD	0.61 0.26	17.5%	81.9%	63.4%	9.5%	38.0%	28.4%

✓ It is possible to directly apply the device onto energy-saving glass with the NIR rejection function even in the bleached state.

EC Device for iris Application

For real cases, sensors based on silicon (including CCDs and CMOS sensors) have sensitivities extending into the near-infrared (NIR). Digital cameras are usually equipped with IR-blocking filters to prevent unnatural-looking images.



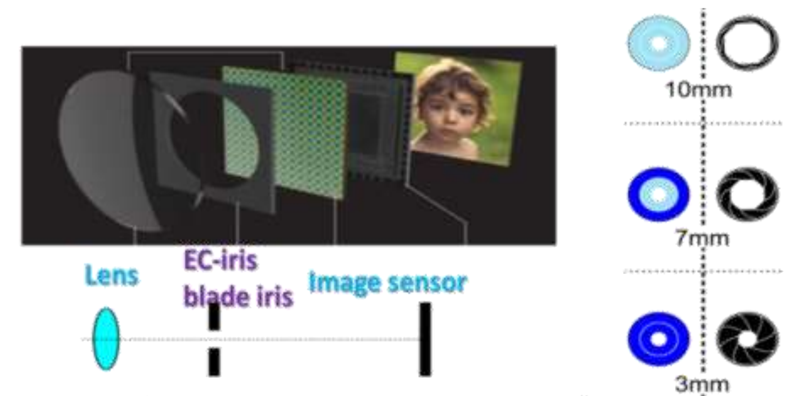


Illustration of camera structure and the application of EC-iris.

✓ **With the application of NIR blocking ECDs, it's possible to directly apply the device onto the image sensors for digital cameras.**

AIP Applied Physics Letters

All-solid-state electrochromic device integrated with near-IR blocking layer for image sensor and energy-saving glass application

Min-Chuan Wang, Ming-Hao Hsieh, Yung-Chih Chen, and Jen-Yuan Wang

Citation: Applied Physics Letters **109**, 123501 (2016); doi: 10.1063/1.4962842
View online: http://dx.doi.org/10.1063/1.4962842
View Table of Contents: http://scitation.aip.org/content/aip/journal/apl/109/12?ver=pdfcov
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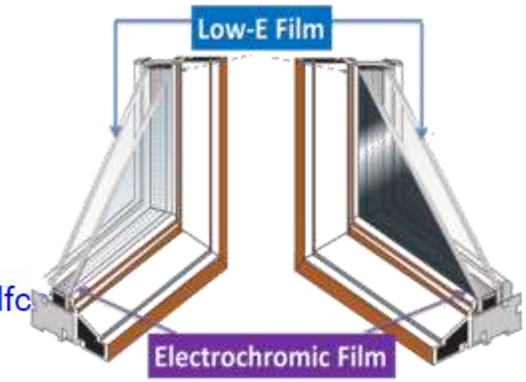
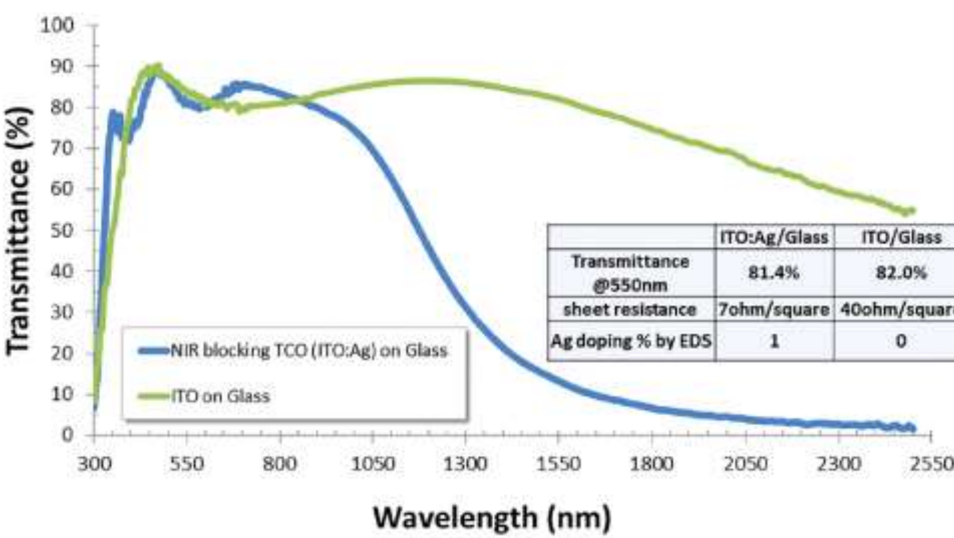
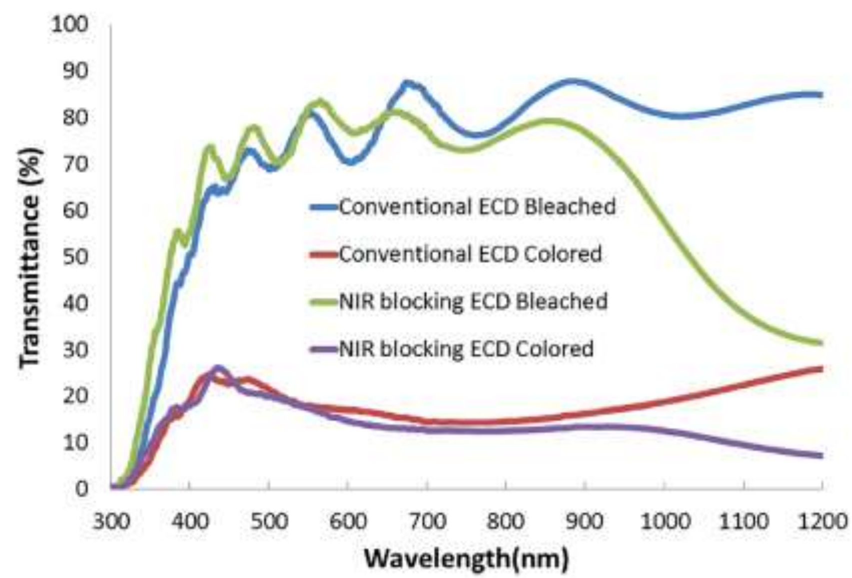




	ITO:Ag/Glass	ITO/Glass
Transmittance @550nm	81.4%	82.0%
sheet resistance	7ohm/square	40ohm/square
Ag doping % by EDS	1	0



OUTLINE

- Introduction
- Electrochromic Device R&D in INER

✓ EC device fabricated with all-DCMS method

✓ High performance energy-saving windows

✓ ARC plasma coating technology for EC device

✓ Conclusion

Cathodic Arcs Plasma

Property	(Pulsed, filtered) cathodic arcs
Cathode voltage drop (the difference of cathode potential and plasma bulk potential, the latter being close to the anode potential)	Typically 12–28 V for currents less than 1 kA, depending on cathode material [105,106,262]. Such low voltage is the best "fingerprint" to distinguish arcs from magnetron discharges.
Current density at cathode (target)	Transient, fractal, up to 10^{12} A/m^2 in cathode spots [104,263–265].
Power density at the cathode (target)	Transient, fractal, up to 10^{13} W/m^2 in cathode spots [89,266,267]
Plasma density	Transient, in the initial explosive phase close to solid state density, 10^{26} m^{-3}, and may become less than 10^{18} m^{-3} in the expanded plasma near the substrate [89,269,270].
Deposition in reactive gas atmospheres	Widely practiced for the deposition of hard, decorative, and protective coatings, often based on nitrides [285,286], carbides [287], oxides [247,288], oxynitrides [289], and sometimes complex compounds [138,290].
Deposition rates	Very high deposition rates by standards of physical vapor deposition, can be as high as 15–20 nm/s for unfiltered process. Filtering reduces rates typically by 3/4. Example of a high rate filtered arc process is AZO: about 4–5 nm/s [247]; and for Al_2O_3: 2 nm/s [305] and 3–4 nm/s [306]. For pulsed systems, using high currents (~1 kA): about 1 nm/pulse [307], or 3–5 nm/s for filtered high current arc with a graphite cathode [308].

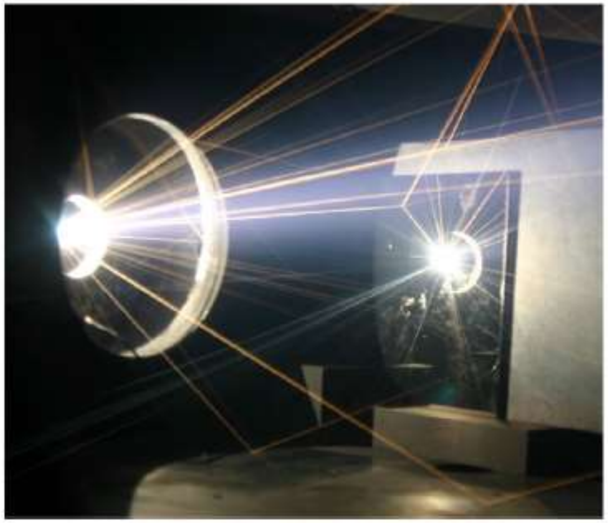


Fig. 3. Open-shutter photograph, taken through a vacuum chamber window, of a flange-mounted cathodic arc source and mirror placed inside the chamber. The discharge was a cathodic arc discharge in vacuum (vacuum arc) using a graphite cathode. The plasma of vacuum arc appears relatively dim as excitation collisions far from the cathode spot are rare. Hot macroparticles are ejected from the explosive processes at the cathode spot, and easily visible by the bright straight lines. Note that macroparticles tend to be reflected from solid surfaces, an issue to be addressed when filtering cathodic arc plasmas.

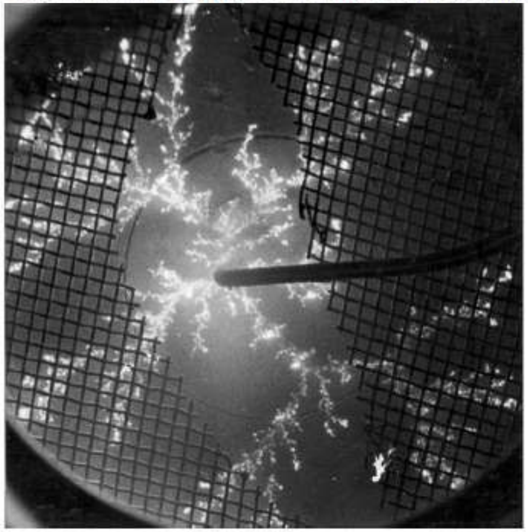
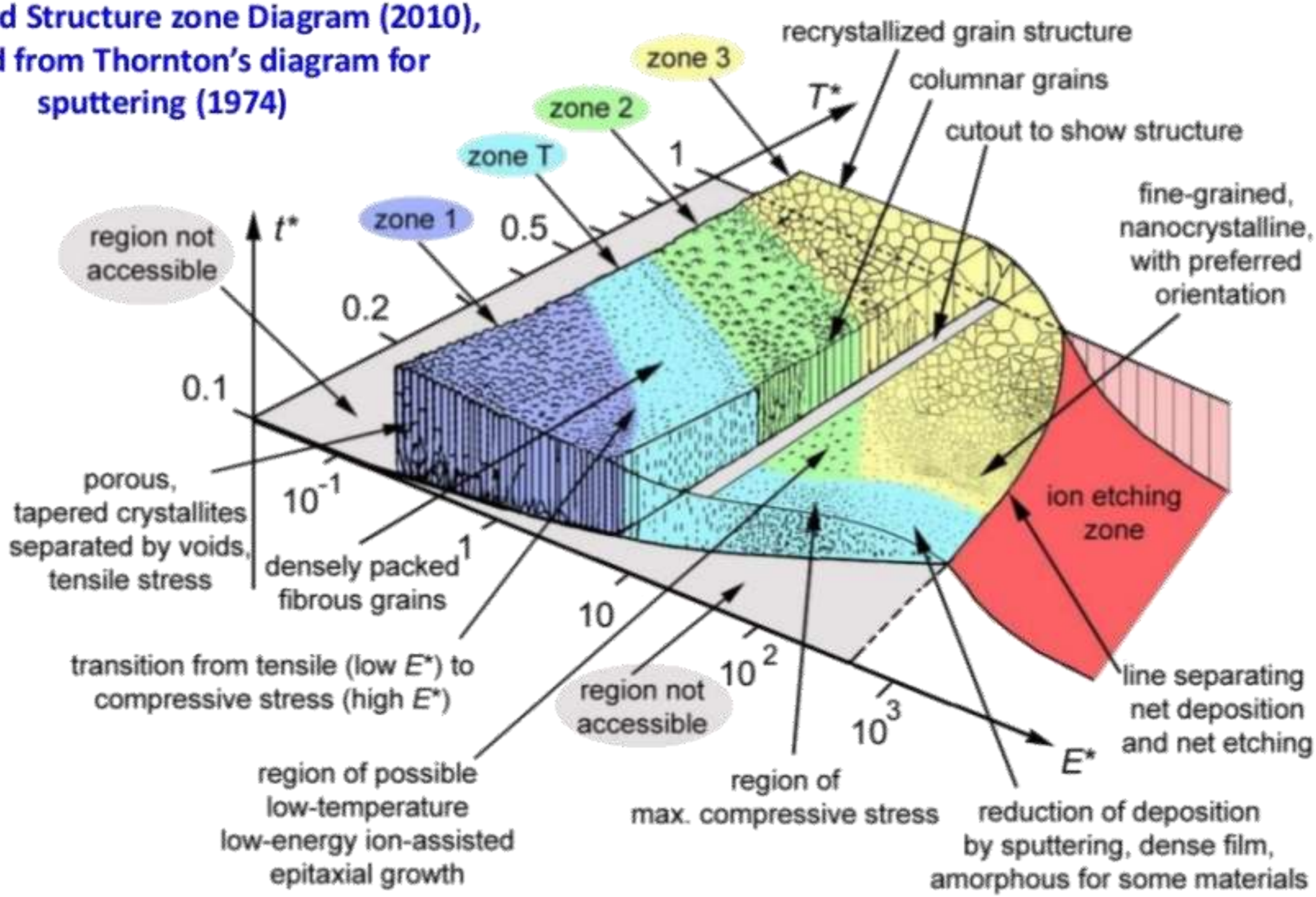


Fig. 8. Open-shutter photograph of a pulsed high current cathodic vacuum arc: the central electrode was the trigger, and the mesh is the anode of the discharge. Several arc spots start at the trigger pin and move away driven by the magnetic field (image from the 1980s, courtesy of B. Jüttner, Berlin).

Ref: A. Anders / Surface & Coatings Technology 257 (2014) 308–325

Approach:
Use a plasma-based technology for "Energetic Condensation"

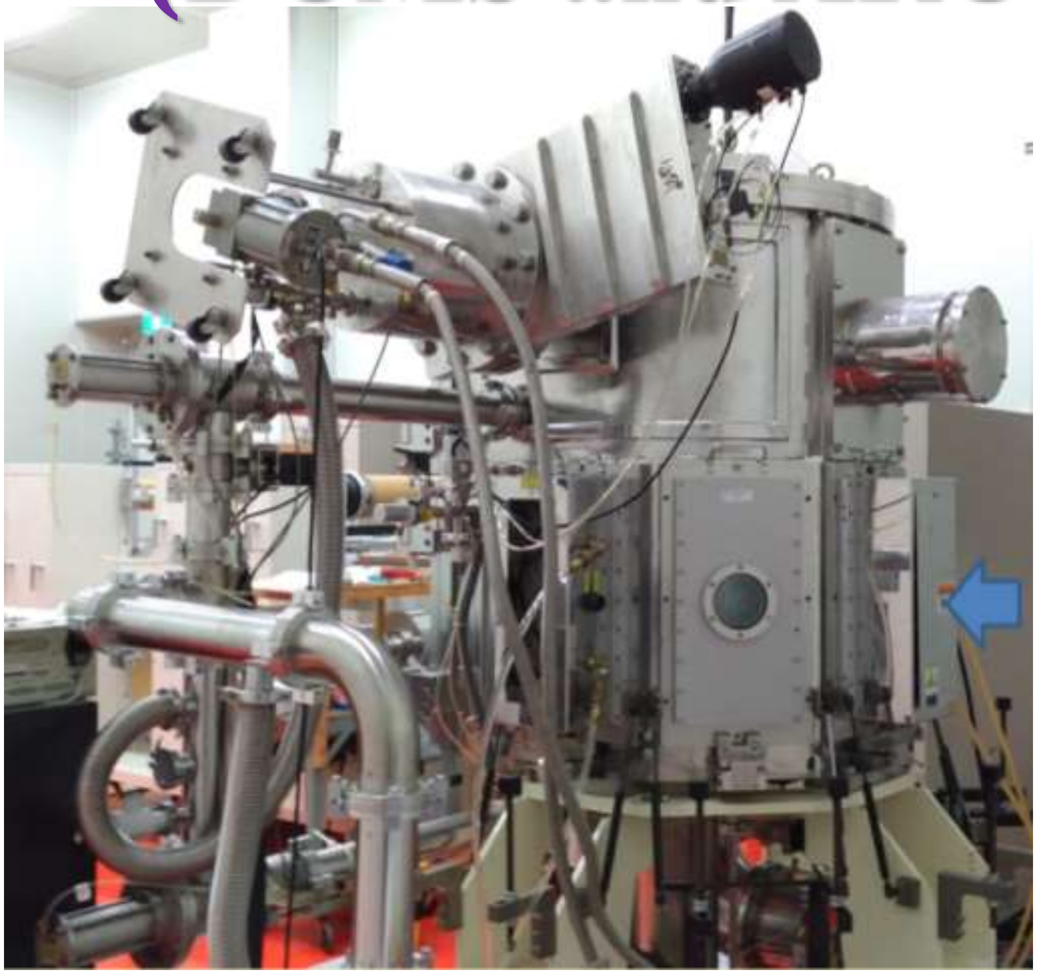
Generalized Structure zone Diagram (2010), derived from Thornton's diagram for sputtering (1974)

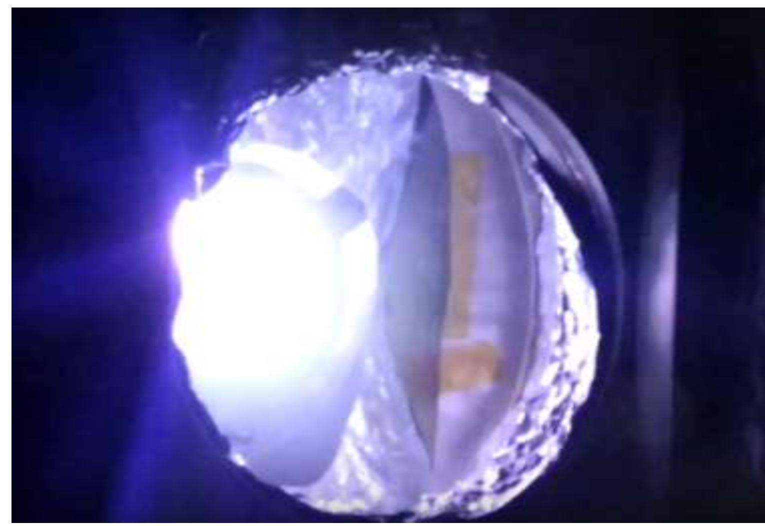


The suitable material structure for EC devices could be achieved by different plasma conditions.

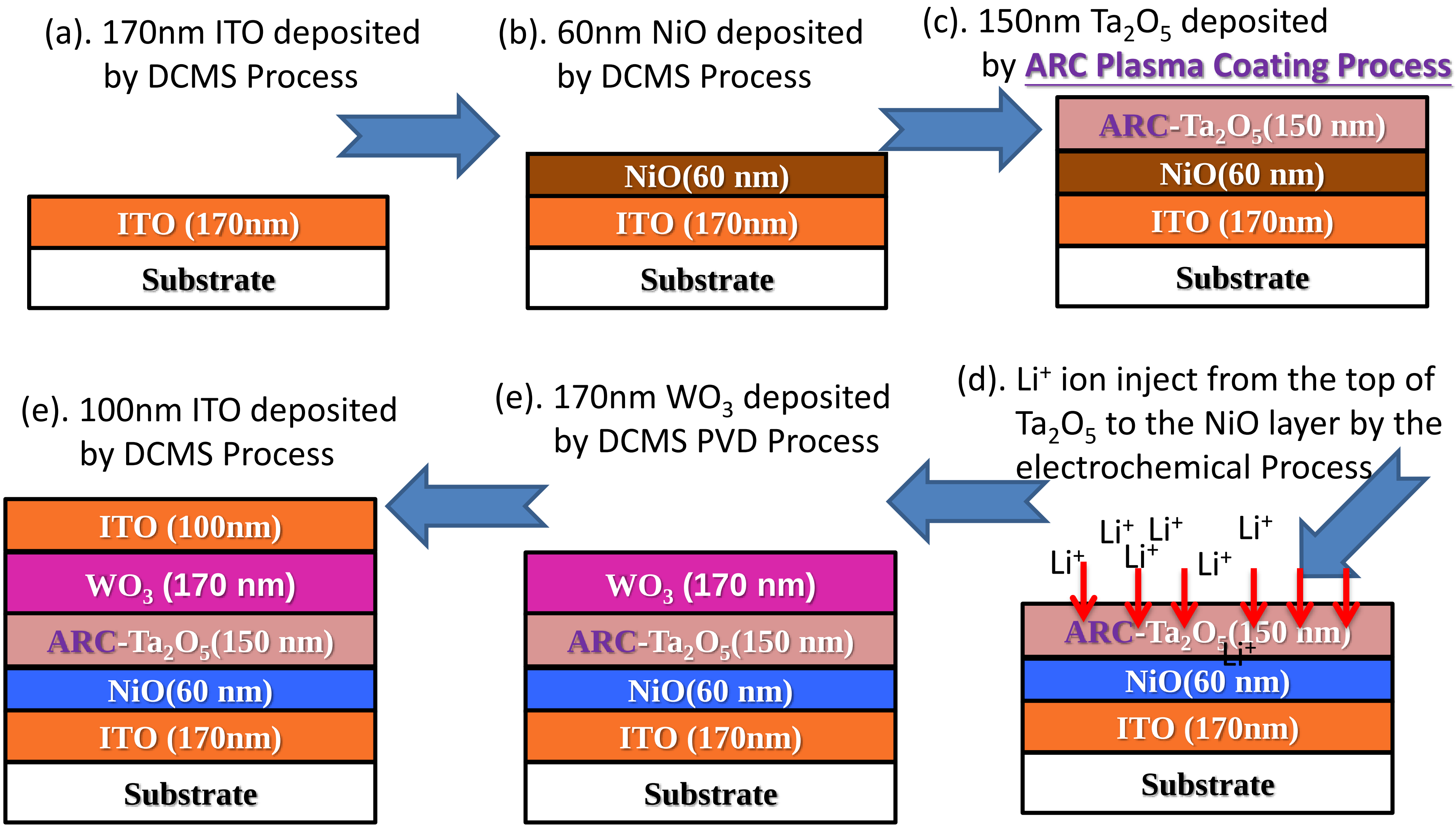
A. Anders, Thin Solid Films **518** (2010) 4087

Load-Lock type PVD SYSTEM
(DCMS and ARC Plasma System)

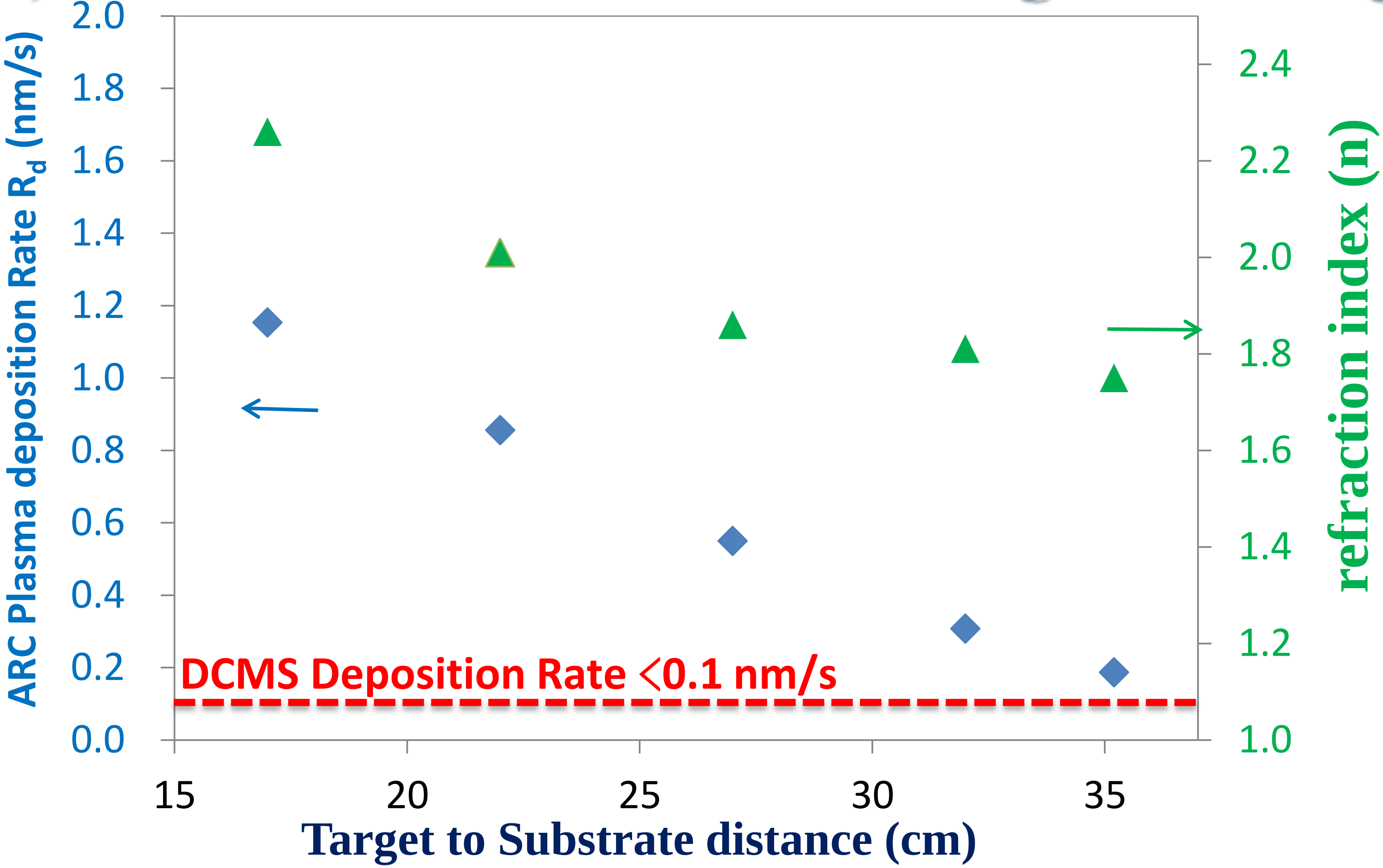




Electrochromic Device Process Flow
(Ta_2O_5 with ARC Plasma Coating Process)

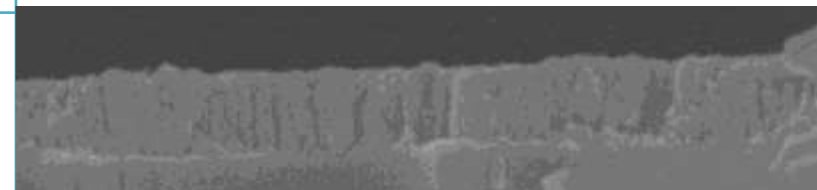
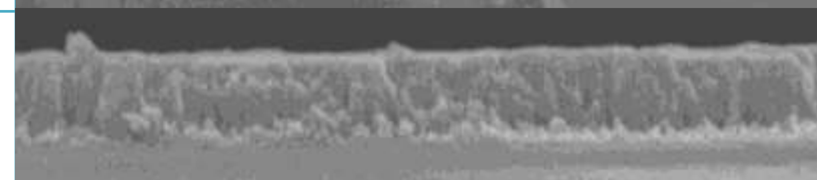


Ta_2O_5 Deposition rate(R_d)and refraction index (n) with the ARC Plasma Coating Technology



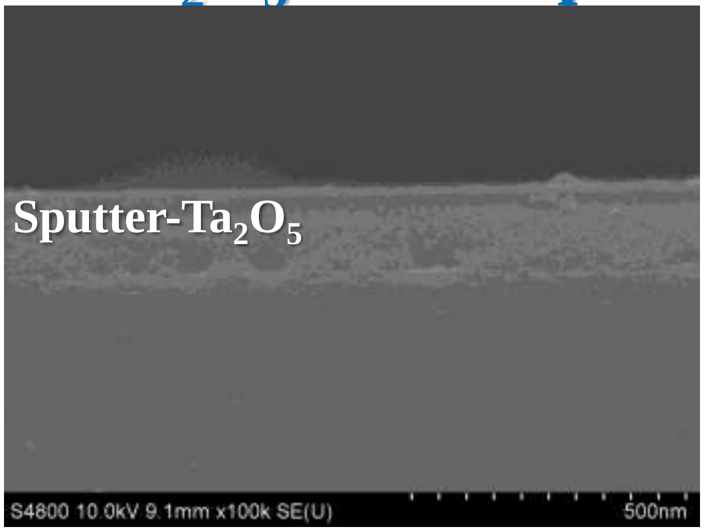
- ✓ The ARC Plasma coating process has demonstrated the higher deposition rate compared to conventional DCMS technology.
- ✓ The refraction index (n) of the Ta_2O_5 film is controllable from 2.26 to 1.75.

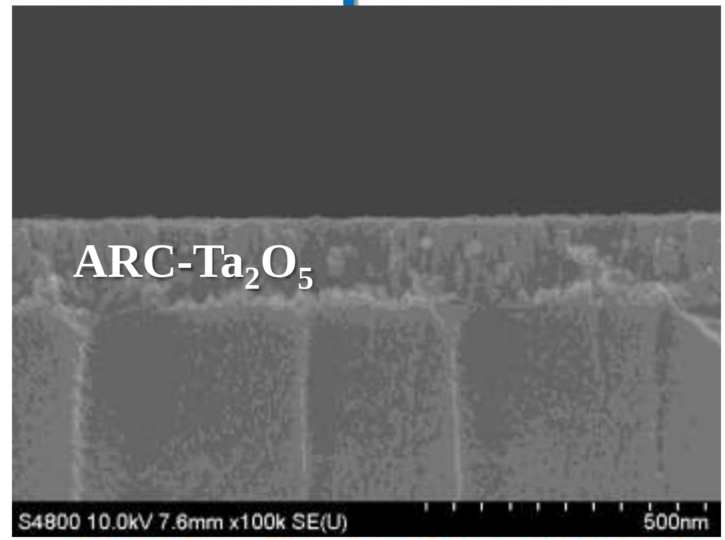
The characteristic of the Ta_2O_5 deposited by the ARC Plasma Coating Technology

Substrate to Target distance (cm)	refraction index (n)	transmittance variation ΔT(%)	Cross section SEM Picture
35	1.75	31	
32	1.81	40	
27	1.86	50	
22	1.98	31	
17	2.26	0	

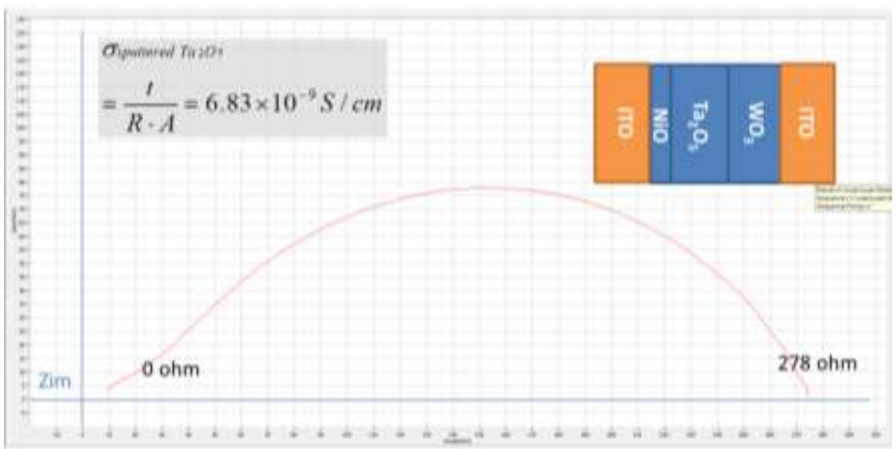
- ✓ The result showed that the refraction index (n) < 2 is corresponding to the film with more porous material structure, which is also considered the good property for ion conductor layer.

Ion Conductivity and Cross section SEM Picture of the Ta_2O_5 films deposited with different process

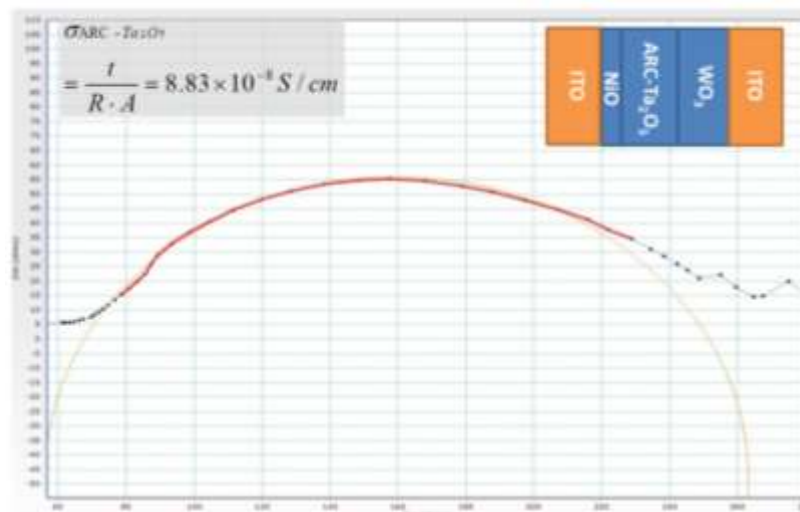




Sputtered Ta_2O_5 ion Conductivity

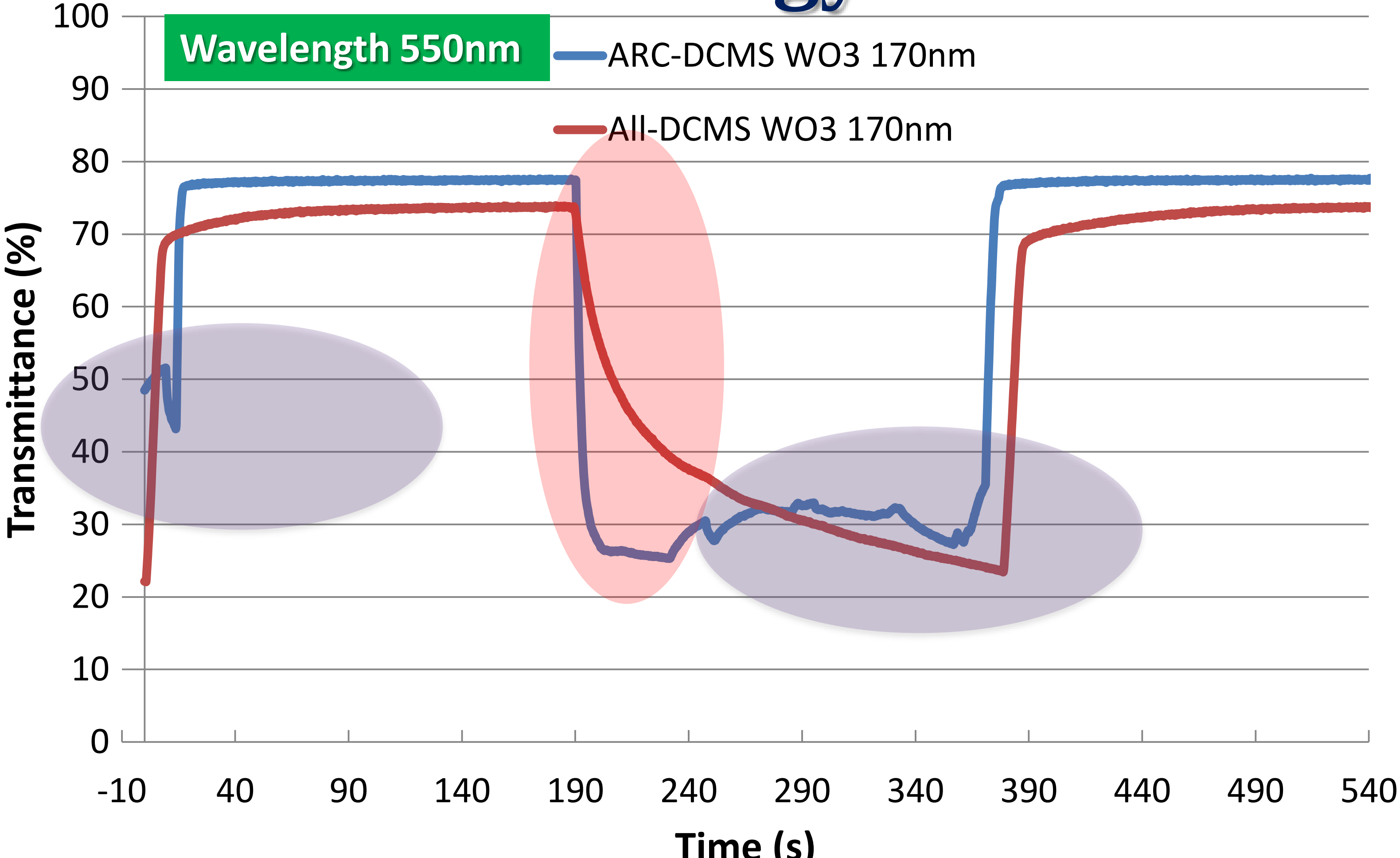


ARC Ta_2O_5 ion Conductivity



The ion conductivity of the ARC plasma technology is one order larger than the sputtering technology.

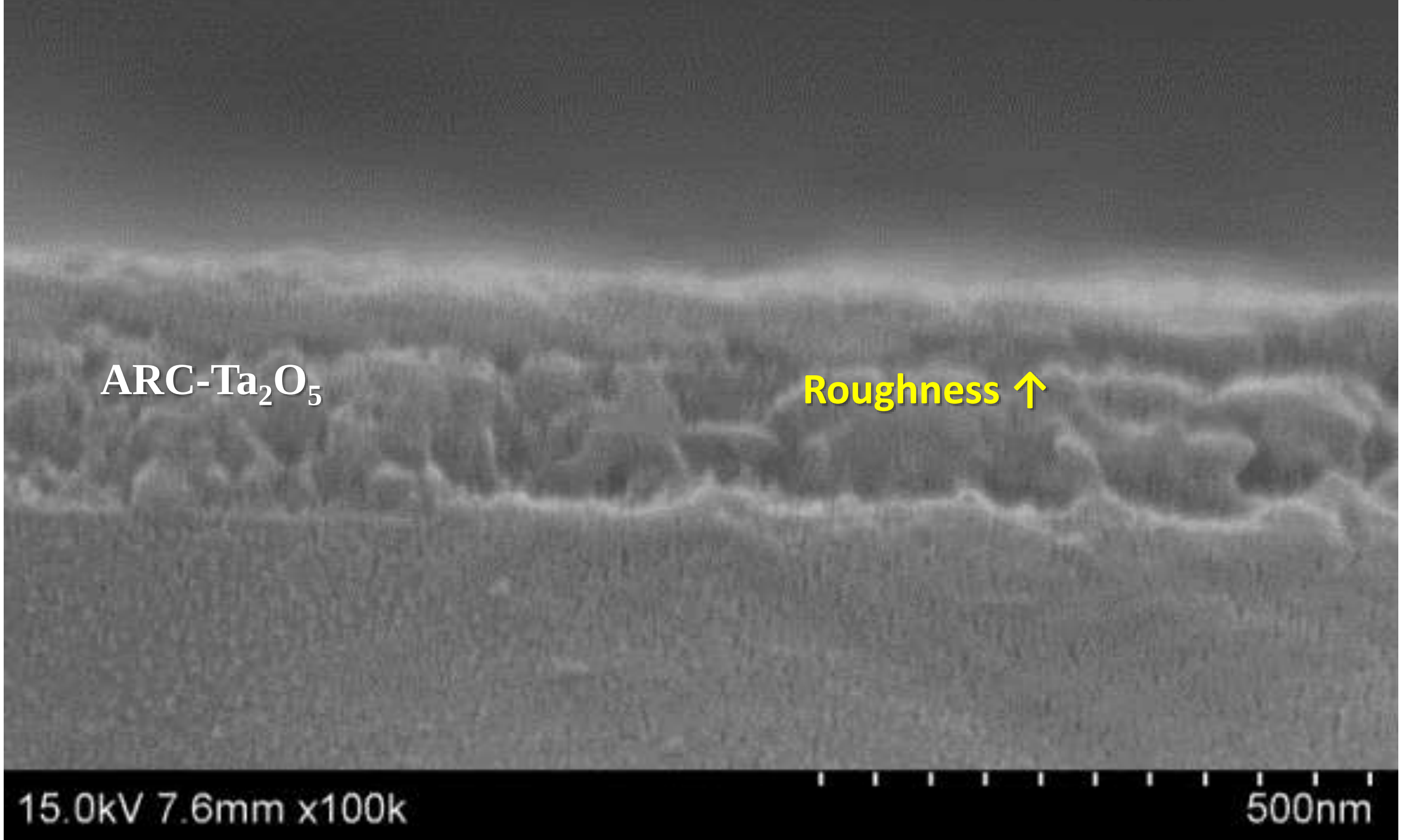
Ta_2O_5 Deposited by DCMS or ARC Plasma Technology for EC Device



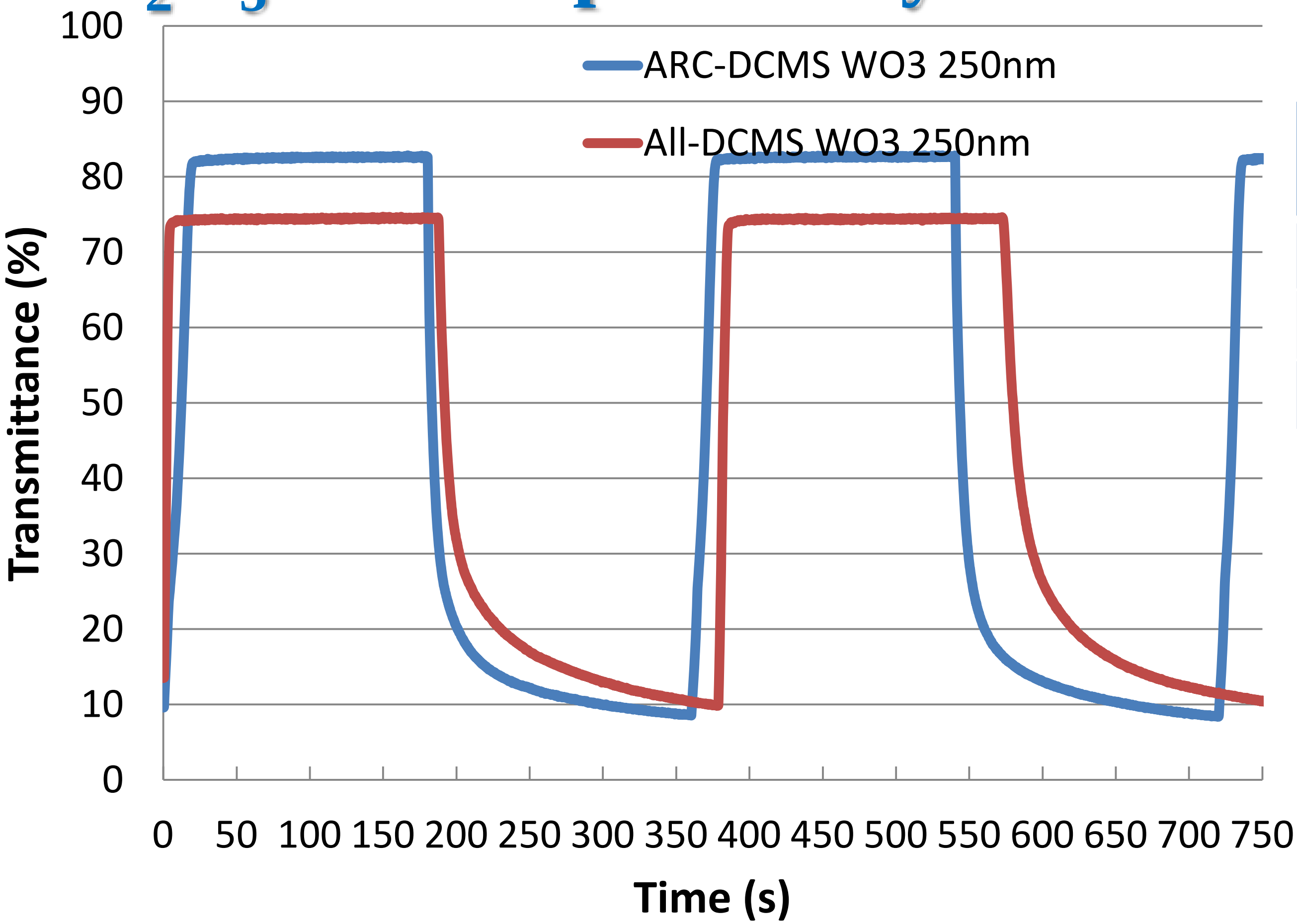
- ✓ The response time of the EC device with the Ta_2O_5 film deposited by ARC plasma coating process is faster than DCMS process.
- ✓ **The EC device with the ARC-Ta_2O_5 process has showed the poor color retention characteristic with the 170nm WO_3 capping.**

Cross section SEM Picture of the Ta_2O_5 film deposited with ARC Plasma coating process

- ✓ The Ta_2O_5 film deposited by the ARC technology has demonstrated the more porous material structure, and it also increases the surface roughness.



EC Device Characteristic with the ion conductor Ta_2O_5 films deposited by ARC and DCMS process



ARC-Ta_2O_5

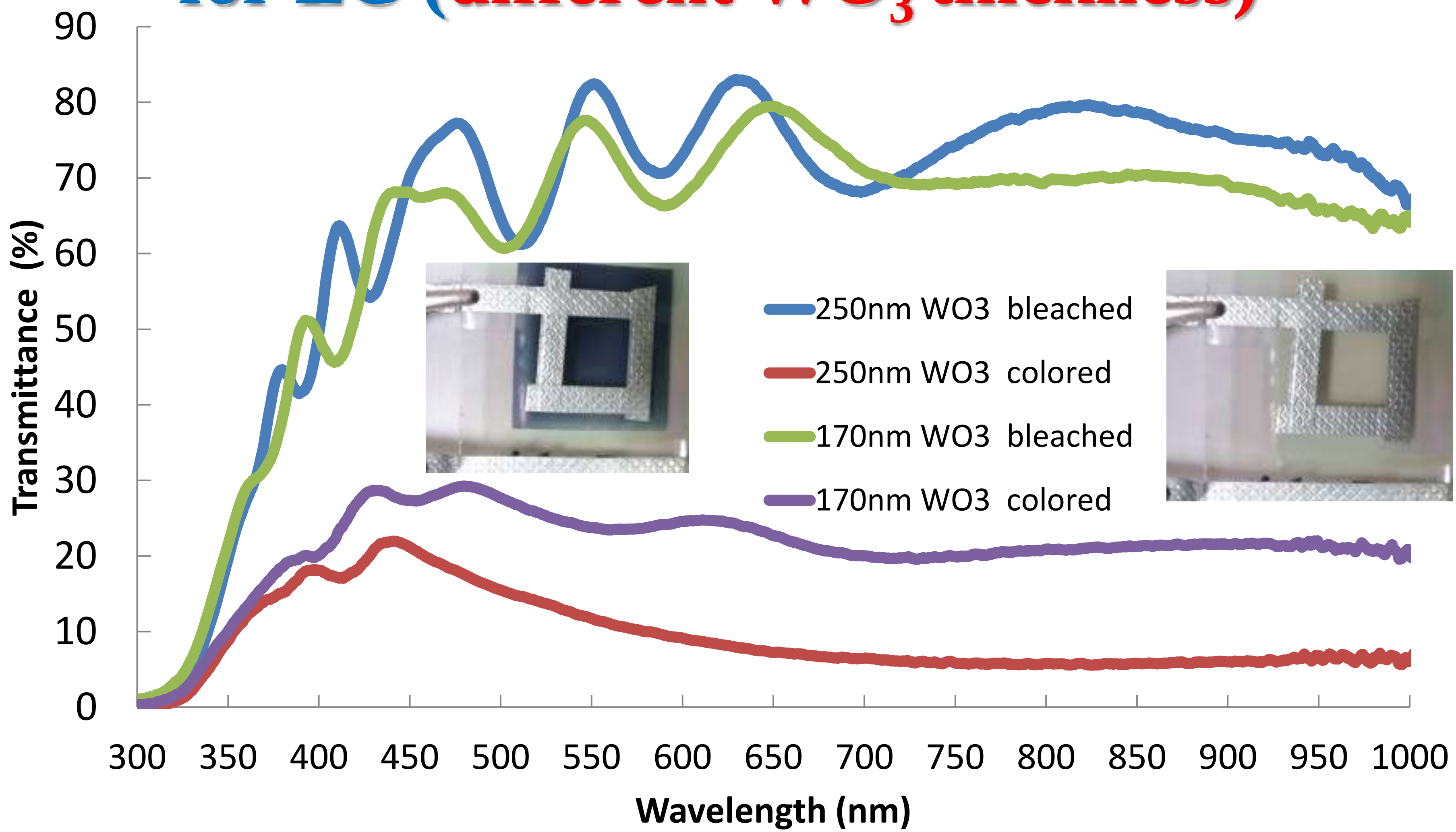
Time (sec)	$Range_{colored}$ (@550nm)	$\Delta T_{colored}$ (@550nm)
1	82%→55%	27%
5	82%→35%	47%
10	82%→26%	56%

DCMS-Ta_2O_5

Time (sec)	$Range_{colored}$ (@550nm)	$\Delta T_{colored}$ (@550nm)
1	74%→69%	5%
5	74%→52%	22%
10	74%→40%	34%

- ✓ **With the 250nm WO_3 capping ,the EC device with the Ta_2O_5 deposited by ARC plasma coating process has demonstrated the good color retention characteristic.**
- ✓ **With the suitable material structure ,the response time of the EC device also improved.**

Ta_2O_5 Deposited with ARC Plasma Technology for EC (different WO_3 thickness)

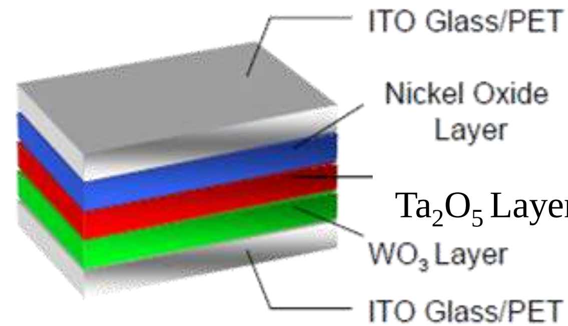


- ✓ The colored characteristic of the EC device has been also improved ($T_{colored}$<10%) with the increase of WO_3 thickness.
- ✓ The best transmittance variation (△T) is 75% @ 550 nm with the 250 nm WO_3 layer.

AIP ADVANCES **6**, 115009 (2016)

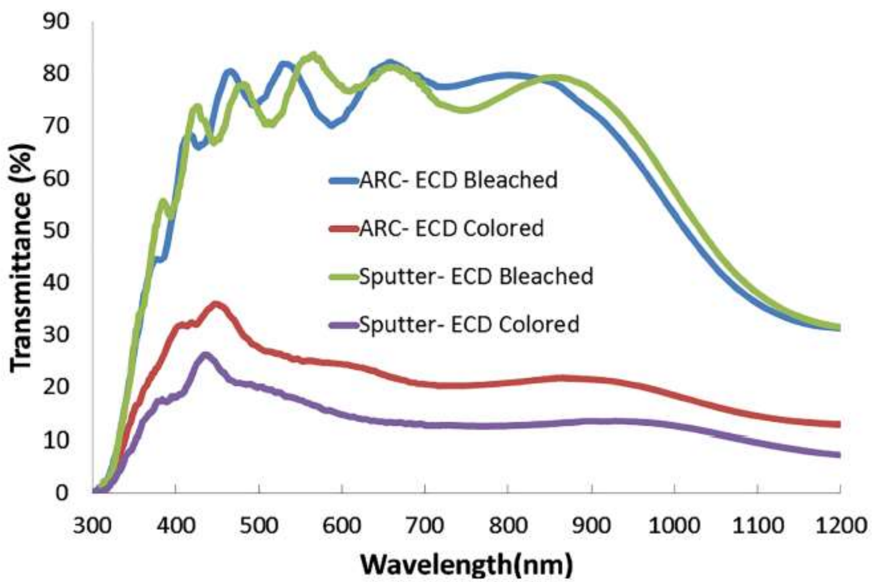
The improvement of all-solid-state electrochromic devices fabricated with the reactive sputter and cathodic arc technology

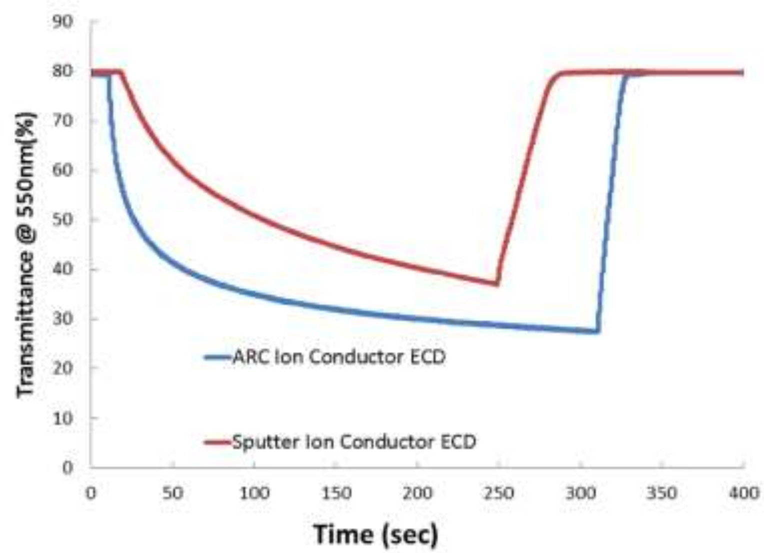
Min-Chuan Wang,[a] Yung-Chih Chen, Ming-Hao Hsieh, Yu-Chen Li, Jen-Yuan Wang, Jin-Yu Wu, Wen-Fa Tsai, and Der-Jun Jan
Physics Division, Institute of Nuclear Energy Research, Taoyuan City 32546, Taiwan



Multilayered Device

(Received 22 August 2016; accepted 24 October 2016; published online 2 November 2016)





Conclusion

- ✓ **The benefits of the ion injection from the top of the Ta_2O_5 film are the activation of the ion path in Ta_2O_5 and the NiO electrochromic characteristic.**
- ✓ **The 400 cm^2 EC window with all-DCMS process without any lamination has passed the reliability test and the SHGC value can be dynamically controlled from 0.2 to 0.65.**
- ✓ **The NIR-blocking TCO with the low sheet resistance and high transparency characteristics provides the lower power consumption for large area applications and it is possible to directly apply the device onto energy-saving glass with the NIR rejection function even in the bleached state. (Spectral selectivity and Low sheet resistance and high transparency TCO)**
- ✓ **The ARC plasma coating process has demonstrated the higher deposition rate for low-cost production and good material structure for device characteristics. (Switching speed, Low cost and high deposition rate)**

Thank You!

CCMR 2017 PROGRAM

Collaborative Conference on Materials Research

26 – 30 June 2017

International Convention Center Jeju

Jeju island, South Korea

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Collaborative Conference on Materials Research
Kwangwoon University, South Korea

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Welcome to the CCMR 2017

It is our great pleasure to have you all for the Collaborative Conference on Materials Research 2017 (CCMR 2017) at the ICC jeju, Jeju island, South Korea during the 26th - 30th June 2017.

On behalf of the Organizing Committees of CCMR 2017, we would like to express our sincere welcome to all the participants of this international meeting on diverse research fields. Especially, we are very grateful to those distinguished invited, oral and poster speakers for joining from over 35 countries including Australia, Austria, Canada, Chile, China, Denmark, Egypt, France, Germany, India, Indonesia, Iran, Ireland, Israel, Japan, Malaysia, Lithuania, Netherlands, Norway, Oman, Philippines, Poland, Romania, Russia, Singapore, South Africa, Spain, Sweden, Switzerland, Taiwan, Thailand, United Kingdom, United State of America and South Korea.

This international conference of ‘CCMR’ series was first organized in 2011 and has been annually hosted by the CCMR and Kwangwoon University. The aim of this conference is collaboratively and internationally to discuss the worldwide state-of-the-art of Materials science and technologies. For this purpose, over 300 distinguished experts on materials research are invited all over the world. The ‘CCMR’ has been already grown up to be the renowned global meeting on Materials research both in name and reality judging from the numbers of speakers and attending countries as well as the quality of the presented talks and papers.

For all of us, it is an invaluable chance to share and exchange opinions and discuss future directions and strategies for further development of materials science and technology together with internationally renowned experts. We believe that this international meeting of ‘CCMR 2017’ will be a very precious opportunity in sharing and exchanging the recent development on the material research as well as discussing the future trend. We are also confident that this meeting will be most rewarding and will be a good success.

Welcome to the CCMR 2017

Lastly, we would like to extend our sincere regards to the internationally renowned invited speakers, participants of this collaborative meeting and all the related personals for preparing this momentous meeting. Especially, we would like to express our deep appreciation to Prof. Jihoon Lee of Kwangwoon University for his continuing volunteer-ship, endeavors and sacrifices for organizing this wonderful international meeting.

Once again, thank you all for your supports and dedications!

Prof. Gregory Salamo
Conference Chair of the CCMR 2017
University of Arkansas, Fayetteville, AR, USA

Prof. Milko van der Boom
Conference Co-chair of the CCMR 2017
Weizmann Institute of Science, Israel

CCMR 2017 Conference Schedule (tentative)

25 June Sunday	**On-site Registration** in the Venue, 2:00 - 5:00PM (Carried on during the conference)
26 June Monday	Full day oral presentations, 9.00 - 5:00PM **Poster Session** from 5:30PM Conference **Reception** from 6:00PM - (Buffet & wine with live music)
27 June Tuesday	Full day oral presentations, 9.00 - 5:00PM **Evening Activity**, from 7:00PM -10.30PM (Transportation and tickets covered)
28 June Wednesday	Full day oral presentations, 9.00 - 5:00PM **Conference Banquet** from 6:00PM – Welcoming & congratulatory addresses Live music show, etc.
29 June Thursday	Full day oral presentations, 9.00 - 5:00PM
30 June Friday	**All Day Tour**, 9.00 - 5:00PM (Transportation, tickets & lunch covered)

Collaborative Conference on Materials Research (CCMR) 2017
26 – 30 June 2017
International Convention Center (ICC) Jeju, Jeju island, South Korea

DAY 1 (Monday 26 June)

Room 301A			
Time	**Page**	**Speaker**	**Talk Title**
Materials Characterization			**Chair: Christian Heyn**
09:00-09:30	1	**Toyo Kazu Yamada**	STM spectroscopy study on single atoms, single molecules, graphene-nanoribbons, and life molecules
09:30-10:00	3	**Young-Sang Yu**	Advanced X-ray microscopy techniques for highly resolved chemical imaging
10:00-10:30	4	**Koji Horiba**	Synchrotron radiation ARPES study of emerging materials
10:30-11:00	***Session Break***		
Epitaxial Materials			**Chair: Toyo Kazu Yamada**
11:00-11:30	6	**Christian Heyn**	Droplet etching of self-assembled nanoholes during semiconductor epitaxy – mechanisms and applications
11:30-12:00	9	**Kohei Yoshimatsu**	Epitaxial growth and physical properties of low-valence titanium oxide films
12:00-12:30	11	**Qixin Guo**	Epitaxial growth of gallium oxide based wide bandgap semiconductors
12:30-12:45	12	**Luna Namazi**	Radial Wurtzite GaSb on InAs Core Template Nanowires
12:45-14:00	***Lunch Break***		
Quantum Matters & Materials			**Chair: Jean-Luc Pelouard**
14:00-14:30	14	**Yves Acremann**	Spin dynamics: From ultra-slow to ultra-fast
14:30-15:00	15	**Yuan Qu**	Electron States, Optical Phonons, and Related Transport Properties in Core-shell Nanowires
15:00-15:30	17	**Robin Tucker**	Entangled Quantum Laser Pulses in Material Media
15:30-16:00	***Session Break***		
Optoelectronic Materials			**Chair: Yves Acremann**
16:00-16:30	18	**Jean-Luc Pelouard**	Infrared photo-detection in the context of sub-wavelength structuration
16:30-17:00	20	**Nikita Bityurin**	Photoinduced nanocomposites
17:00-17:15	21	**Yaohui Zhan**	Light trapping and electrical transport in hot-carrier based photodetectors
17:30-18:00	***Poster Session (Ocean View in ICC Jeju, 5F)***		
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Room 301B			
Time	**Page**	**Speaker**	**Talk Title**
Quantum Matters & Materials			**Chair: Hiroshi Fukuoka**
09:00-09:30	22	**Taichi Goto**	Multi-input spin wave logic circuits based on yttrium iron garnet films
09:30-10:00	23	**Han Dong Sun**	Developing lasers from inorganic perovskite nanocrystals
10:00-10:30	25	**Dai-Sik Kim**	Terahertz Angstrom Dynamics of ALD and CVD grown gaps
10:30-11:00	***Session Break***		
Superconducting Materials			**Chair: Taichi Goto**
11:00-11:30	26	**Hiroshi Fukuoka**	High-Pressure Synthesis and Properties of Rhodium and Cobalt Antimony Skutterudite Compounds
11:30-12:00	28	**Ryusuke Ikeda**	Theory of Field-induced Transformation of Vortex Lattice Structure in Noncentrosymmetric Superconductors
12:00-12:30	30	**Yossi Paltiel**	Probing Molecular-Transport Properties using the Superconducting Proximity Effect
12:30-14:00	***Lunch Break***		
Oxide Materials			**Chair: Masanari Kimura**
14:00-14:30	31	**Kesong Yang**	First-Principles Design of Two-Dimensional Electron Gas in the Perovskite-Oxide-Based Interface Materials
14:30-15:00	33	**Tohru Higuchi**	New Oxide Electrolyte and Electrode Materials with Lattice Distortion for SOFC at Intermediate Temperature Region
15:00-15:30	36	**Jan Seidel**	Topological structures as nanoscale functional elements: Electrical and mechanical properties of phase boundaries in BiFeO3
15:30-16:00	***Session Break***		
Transition Metal Oxides			**Chair: Kesong Yang**
16:00-16:30	37	**Masanari Kimura**	Transition Metal Catalyzed Multi-component Coupling Reactions involving CO_2 Insertion
16:30-17:00	39	**Teruo Kanki**	Electric field-induced hydrogen doping into VO_2 nanowires at room temperature
17:30-18:00	***Poster Session (Ocean View in ICC Jeju, 5F)***		
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Room 303A			
Time	**Page**	**Speaker**	**Talk Title**
Energy Materials			**Chair: Rama Venkatasubramanian**
09:00-09:30	40	**Eunsang Kwon**	Structure of Lithium-Cation Endohedral [C_{60}] Fullerene and Its Application to Energy Storage
09:30-10:00	42	**Michihisa Koyama**	Practical Applications of Computational Chemistry to Functional Materials in Future Energy Devices
10:00-10:30	44	**Seong Chan Jun**	Controllable sulfuration in NiO nanosheets with enhanced capacitance
10:30-11:00	***Session Break***		
Energy Materials			**Chair: Eunsang Kwon**
11:00-11:30	45	**Jae-Hong Lim**	Electrochemical synthesis of high efficient thermoelectric films via embedded nanostructures
11:30-12:00	46	**Yosuke Kurosaki**	Thermoelectric performance in silicide materials: $MnSi_{1.7}$ and Ca_3Si_4
12:00-12:30	49	**Rama Venkatasubramanian**	Nanostructured Thermoelectric Materials and Devices
12:30-14:00	***Lunch Break***		
Magnetism and Magnetic Materials			**Chair: Iriya Muneta**
14:00-14:30	50	**Masato Kotsugi**	Magnetic property of rare-metal-free supermagnet $L1_0$-FeNi(Co)
14:30-15:00	52	**Terumitsu Tanaka**	Micromagntic simulation of microwave-assisted magnetization switching on granular medium
15:00-15:30	54	**Koji Sekiguchi**	Nano-magnonics in cooperation of spin current
15:30-16:00	***Session Break***		
Magnetism and Magnetic Materials			**Chair: Masato Kotsugi**
16:00-16:30	56	**Iriya Muneta**	Band structure and ferromagnetism in ferromagnetic semiconductor GaMnAs
16:30-17:00	59	**Ki-Suk Lee**	Topological Properties of Magnetic Skyrmions
17:00-17:15	61	**Kamila Kollbek**	Magneto-plasmonic properties of nanoparticles obtained by Inert Gas Condensation method
17:30-18:00	***Poster Session (Ocean View in ICC Jeju, 5F)***		
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Room 303B			
Time	**Page**	**Speaker**	**Talk Title**
Oxide Materials			**Chair: Jianqiang Liu**
09:00-09:30	63	**Richeng Yu**	Tuning the magnetism of epitaxial cobalt oxide thin films by electron beam irradiation
09:30-10:00	65	**Adriana Zaleska-Medynska**	TiO2/MxOy ordered nanotubes for photocatalytic purpose
10:00-10:30	67	**Qian Xin**	Metal oxide SnO_x: from n-type, p-type to bipolar conductivity
10:30-11:00	***Session Break***		
Photovoltaics Photocatalysis Materials			**Chair: Richeng Yu**
11:00-11:30	69	**Jianqiang Liu**	Study of the mixed metal oxide photoanode based on layered double hydroxide for solar cells
11:30-12:00	71	**Sanghuyk Wooh**	Stable Hydrophobic Photocatalytic Metal-Oxide Surfaces
12:00-12:30	73	**Xinhui Lu**	Synchrotron X-ray scattering based thin film solar cell studies
12:30-14:00	***Lunch Break***		
2-D Materials			**Chair: Salem Bassem**
14:00-14:30	74	**Jacek Majewski**	Stability and electronic structure of C-B-N hexagonal 2D structures
14:30-15:00	76	**Sung-Kwan Mo**	Electronic structures of two-dimensional transition metal dichalcogenides
15:00-15:30	77	**Jun Nozawa**	Nucleation of two-dimensional islands of colloidal crystals
15:30-16:00	***Session Break***		
Electronic Materials			**Chair: Jacek Majewski**
16:00-16:30	80	**Salem Bassem**	Growth and integration of group IV nanowires for Tunnel FET devices
16:30-17:00	81	**Seonghyun Park**	Low-voltage organic field-effect transistors (OFETs) with water-processed polymer active layers
17:30-18:00	***Poster Session (Ocean View in ICC Jeju, 5F)***		
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Time	**Page**	**Speaker**	**Talk Title**
Biomaterials and Applications			**Chair: Nishimura Takahiro**
09:00-09:30	82	**Chi Hwan Lee**	Advanced Biomedical Devices Enabled by Transfer Printing Techniques
09:30-10:00	83	**Ji Tae Kim**	Manipulation of functional nano-matters in fluids
10:00-10:30	84	**Bing Yan**	Interactions of Nanoparticles with the Aryl Hydrocarbon Receptor (AhR) Pathway
10:30-10:45	85	**Yu-Hsuan Chen**	Silver-containing mesoporous bioactive glass as a novel antibacterial bone material against prosthetic joint infection
10:45-11:00	***Session Break***		
Biomaterials and Applications			**Chair: Chi Hwan Lee**
11:00-11:30	87	**Nishimura Takahiro**	Optical fabrication of patterned DNA hydrogel
11:30-12:00	89	**Josep Nogues**	Multifunctional magneto-plasmonic nanodomes for combined magnetic manipulation, multi-modal imaging and photo-thermal therapies
12:00-12:30	90	**Uyi Sulaeman**	The Improvement of Silver Phosphate Activity for Organic Dye Degradation under Visible Light Irradiation
12:30-14:00	***Lunch Break***		
Polymers and Applications			**Chair: Jhinhwan Lee**
14:00-14:30	93	**Markus Busch**	High-Pressure Polymerization Process Technology: Modeling and Control of Polymeric Micro-Structure together with Safety Considerations
14:30-15:00	96	**Heinz-Bernhard Kraatz**	Self-Assembled Peptide Materials
15:00-15:30	98	**Yousuke Ooyama**	Fluorescence PET (Photo-induced Electron Transfer) Sensors for Water Based on Anthracene-Phenylboronic Acid Ester
15:30-15:45	100	**Frank van Mastrigt**	Viscosity Modification with Thermoresponsive Comb Polymers
15:45-16:00	***Session Break***		
Materials Synthesis Characterization			**Chair: Markus Busch**
16:00-16:30	102	**Jhinhwan Lee**	Spin-polarized STM on underdoped cuprate and various spin lattice systems
16:30-17:00	103	**Young Jae Song**	Synthesis and Characterization of Atomic and Electronic Properties of Graphene-based Heterostructure
17:30-18:00	***Poster Session (Ocean View in ICC Jeju, 5F)***		
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Time	**Page**	**Speaker**	**Talk Title**
Light Emitting Materials			**Chair: Shigeyuki Yagi**
09:00-09:30	105	**Guo-Dong Hao**	Study on radiative efficiency and current injection efficiency under current injection in AlGaN DUV-LEDs
09:30-10:00	107	**Eric Rivard**	Taking Advantage of Heavy Main Group Elements to Achieve Phosphorescence
10:00-10:30	108	**Hendrik Swart**	Rare earths doped zinc oxide nanophosphor powder: A future material for solid state lighting and solar cell applications
10:30-11:00	***Session Break***		
Light Emitting Materials			**Chair: Guo-Dong Hao**
11:00-11:30	110	**Shigeyuki Yagi**	Development of Phosphorescent Organometallic Complexes for Solution-processed OLED
11:30-12:00	112	**Makoto Sakurai**	Structural and electric modification of nano-carbon materials using highly charged ions
12:00-12:30			
12:30-14:00	***Lunch Break***		
Nanostructures & Nanomaterials			**Chair: Xuelun Wang**
14:00-14:30	114	**Seiji Samukawa**	Neutral Beam Technology for Future Nano-materials and nano-devices
14:30-15:00	118	**Micha Polak**	Unique Phenomena Predicted for Phase-Separating Alloy Nanoparticles
15:00-15:30	120	**Nana Zhao**	Polycation functionalized nanoparticles for multifunctional delivery systems
15:30-15:45	121	**Alexander F. Bedilo**	Stabilization of oxide nanoparticles by coating with carbon or silica
15:45-16:00	***Session Break***		
Light Emitting Materials			**Chair: Seiji Samukawa**
16:00-16:30	125	**Tae Geun Kim**	Direct ohmic contact to p-AlGaN and its application to UV A-to-C LEDs
16:30-17:00	126	**Xuelun Wang**	Control the Emission Directionality of LEDs through Evanescent Wave Coupling
17:30-18:00	***Poster Session (Ocean View in ICC Jeju, 5F)***		
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Room 401B			
Time	**Page**	**Speaker**	**Talk Title**
Electronic Materials			**Chair: Huaming Li**
09:00-09:30	129	**Joshua Yang**	Challenges and solutions for memristors used for memory and neuromorphic computing
09:30-10:00	131	**Kyeong-Sik Min**	Memristor-CMOS Hybrid Circuits for Brain-Mimicking Computing
10:00-10:30	132	**Naoka Nagamura**	Photoemission nano-spectromicroscopy analysis of 2D materials based transistors
10:30-11:00	***Session Break***		
Materials Synthesis Characterization			**Chair: Huaming Li**
11:00-11:30	135	**Huaming Li**	Thermodynamic properties by equation of state and from Ab initio molecular dynamics of liquid sodium and potassium under pressure
11:30-12:00	136	**Alex Lugovskoy**	Production of Hydroxyapatite Layers on the Plasma Electrolytically Oxidized Surface of Ti6Al4V Alloy
12:00-12:30	137	**Auezhan Amanov**	Nanoceystallization of Ti-6Al-4V alloy with the high-temperature UNSM treatment
12:30-14:00	***Lunch Break***		
Materials Synthesis Characterization			**Chair: Yuden Teraoka**
14:00-14:30	139	**Shaolong Wu**	Silicon micro/nano-wire arrays prepared by chemical etching for photoelectrochemcial application
14:30-15:00	142	**Takamasa Sagara**	Nano-Regulated Dynamics of Oil Droplets and Organic Monolayers on Au Electrode Surfaces in Aqueous Media
15:00-15:30	146	**Kam Sing Wong**	Imaging restoration for scattered light through random medium using phase retrieval technique
15:30-16:00	***Session Break***		
Materials Synthesis Characterization			**Chair: Shaolong Wu**
16:00-16:30	148	**Yuden Teraoka**	Chemical Reaction Dynamics of Oxide Layer Formation at Ni(001) Surface via Supersonic Oxygen Molecular Beams as Observed by Synchrotron Photoemission Spectroscopy
16:30-17:00	153	**Tetsuya Yamamoto**	Irradiation of electrohegative oxygen ions generated in after arc plasma to achieve 50-nm-thick Ga-doped ZnO polycrystalline films exhibiting fast response to highdrogen gas
17:00-17:15	156	**Linling Qin**	Silicon-Gold Core-Shell Nanowire Array for Optically and Electrically Characterized Refractive Index Sensor Based on Plasmonic Resonance and Schottky Junction
17:30-18:00	***Poster Session (Ocean View in ICC Jeju, 5F)***		
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Room 301A			
Time	**Page**	**Speaker**	**Talk Title**
Light Emitting Materials			**Chair: Florian Wendler**
09:00-09:30	158	**Kensuke Miyajima**	Observation of superfluorescence from biexcitons confined in semiconductor quantum dots
09:30-10:00	160	**Seoung-Hwan Park**	Electronic and optical properties of BN-based quantum well optoelectronic devices
10:00-10:30	162	**Jwo-Huei Jou**	OLED based good light for lighting
10:30-11:00	***Session Break***		
Light Emitting Materials			**Chair: Kensuke Miyajima**
11:00-11:30	164	**Florian Wendler**	Microscopic modeling of graphene-based photoemitting and photodetecting devices
11:30-12:00	165	**Tomasz J. Ochalski**	Optical properties and emission dynamics of groups IV and III-V nanomaterials
12:00-12:30	168	**Samaresh Das**	Efficient High Speed 2D Materials/Silicon Heterojunction Photodetectors
12:30-14:00	***Lunch Break***		
Electronic Materials			**Chair: Min-Chuan Wang**
14:00-14:30	169	**Alois Lugstein**	Room Temperature Quantum Ballistic Transport in Monolithic Al-Ge-Al Nanowire Heterostructures
14:30-15:00	171	**Chadwin D. Young**	Device Performance Evaluation of Critical Interfacesin Few-Layer MoS2 Field Effect Transistors with High-k Dielectrics
15:00-15:30	175	**Yao-Feng Chang**	Resistive Switching Characteristics and Mechanisms in Silicon Oxide and Silicon Nitride Memory Devices
15:30-16:00	***Session Break***		
Optoelectronic Materials			**Chair: Alois Lugstein**
16:00-16:30	177	**Min-Chuan Wang**	All-solid-state metal-oxide thin film devices fabricated with the plasma coating technology
16:30-17:00	180	**Shigeyuki Imura**	Development of a highly sensitive CMOS image sensor overlaid with a crystalline selenium photoconversion layer
18:00-Night	***Beach walk and Chicken & Beer Party (Leodo Plasa in ICC Jeju, 1F)***		

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Room 301B			
Time	**Page**	**Speaker**	**Talk Title**
Photovoltaics Photocatalysis Materials			**Chair: Akira Ishibashi**
09:00-09:30	182	**Joe Shapter**	Nanocarbons in Novel Solar Cells
09:30-10:00	184	**Hikaru Kobayashi**	Highly Efficient Black Si Solar Cells Fabricated by Use of Surface Structure Chemical Transfer Method
10:00-10:30	187	**Min-Cherl Jung**	The presence of CH_3NH_2 neutral species in organometal halide perovskite films
10:30-11:00		***Session Break***	
Photovoltaics Photocatalysis Materials			**Chair: Joe Shapter**
11:00-11:30	188	**Akira Ishibashi**	Systems Development in Atom-Bit-Energy/Environment (ABE^2) Space for a New Solar-cell, Medical and Safety Applications Based on Clean Unit System Platform (CUSP)
11:30-12:00	193	**Jorgen Schou**	Pulsed laser deposition (PLD) of the CZTS absorber for thin solar cells with up to 5.2-% -efficiency
12:00-12:30	195	**Peter Christian Kjærgaard Vesborg**	Tandem photoelectrodes for solar fuel synthesis - design considerations for water splitting and CO2 reduction
12:30-14:00		***Lunch Break***	
Nanostructures & Nanomaterials			**Chair: Quanxi Jia**
14:00-14:30	197	**Jai Prakash**	Nanocomposites for Multifunctional Applications
14:30-15:00	198	**Koichi Okamoto**	Plasmonic Nanostructures and Metamaterials for Optoelectronic Applications with Wider Wavelength Range
15:00-15:30	201	**Puran Pandey**	Growth of Various Configuration, Size, and Composition of Bimetallic Pd-Ag Nanostructures on Sapphire (0001)
15:30-16:00		***Session Break***	
Oxide Materials			**Chair: Jai Prakash**
16:00-16:30	203	**Quanxi Jia**	Oxygen Vacancy Induced Changes in Structural, Electronic, and Magnetic Properties of Perovskite Metal-Oxide Films
16:30-17:00	204	**Satoshi Uda**	Thermodynamic view on the oxide melt structure near the growth interface
17:00-17:30	206	**Tomasz Mazur**	Memristive effects in perovskite modified thin films
18:00-Night		***Beach walk and Chicken & Beer Party (Leodo Plasa in ICC Jeju, 1F)***	

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Room 303A			
Time	**Page**	**Speaker**	**Talk Title**
Oxide Materials			**Chair: June Seo Kim**
09:00-09:30	208	**Jonathan Bartley**	Metal oxide materials for heterogeneous catalysis
09:30-10:00	211	**Guus Rijnders**	New phenomena in oxide heterostructures
10:00-10:30	212	**Alan Man Ching Ng**	Atomic scale In-situ characterization of the photocatalytic dye degradation of metal nanoclusters supported on an ultrathin metal oxide layer
10:30-11:00	***Session Break***		
Magnetism and Magnetic Materials			**Chair: Jonathan Bartley**
11:00-11:30	213	**June Seo Kim**	Various magnetic behaviors at the interfaces between heavy metals and ferromagnets
11:30-12:00	214	**Rongying Jin**	Non-Trivial Berry Phase in Magnetic BaMnSb2 Semimetal
12:00-12:30	215	**Nerija Zurauskiene**	Nanostructured manganite-cobaltite thin films for pulsed magnetic field sensing: physics and applications
12:30-14:00	***Lunch Break***		
Magnetism and Magnetic Materials			**Chair: Leonardo Lari**
14:00-14:30	217	**Qizhen Li**	Porous Magnesium Composites: Microstructure and Mechanical Characterization
14:30-15:00	218	**Dariusz Wasik**	Effect of pressure on magnetic anisotropy and ferromagnetic-paramagnetic phase transition in (Ga,Mn)As
15:00-15:30	220	**Juan E. Peralta**	Magnetic Exchange Couplings in Transition Metal Complexes and Nanostructures from First-principles
15:30-16:00	***Session Break***		
Magnetism and Magnetic Materials			**Chair: Qizhen Li**
16:00-16:30	222	**Leonardo Lari**	Atomic level control of interfaces for spintronic applications
16:30-17:00	223	**Mi-Young Im**	Study on nontrivial spin phenomena in magnetic vortices using soft X-ray microscopy
17:00-17:15	225	**G. C. Loh**	Doping effects on Heisenberg and Dzyaloshinskii-Moriya exchange interactions in $Fe_{1-x}Mn_xGe$
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Room 303B			
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Polymers and Applications			**Chair: Huanyao Cun**
09:00-09:30	230	**Xiang Gao**	Controllable Preparation of Novel High Performance, Multifunctional Polymer Materials
09:30-10:00	231	**Christian A. Nijhuis**	Control over the Tunneling Rates and Rectification of Molecular Tunneling Junctions via Dielectric Response Engineering
10:00-10:30	232	**Mihail P. Petkov**	Porosity characterization of mesoporous aerogels using positron annihilation spectroscopy, nitrogen adsorption and molecular diffusion
10:30-10:45	234	**Andreea Matei**	Conductive thin films prepared by laser techniques for printed circuits
10:45-11:00	***Session Break***		
2-D Materials			**Chair: Xiang Gao**
11:00-11:30	235	**Huanyao Cun**	2D monolayers: From nanotents to nanoporous membranes
11:30-12:00	236	**Seong-Gon Kim**	Electronic and magnetic properties of strong localization of anionic electrons in the interlayer of two-dimensional Y2C electride
12:00-12:30	240	**Veronica Barone**	Intercalation of layered materials for novel applications
12:30-14:00	***Lunch Break***		
Oxide Materials			**Chair: Frank Henning**
14:00-14:30	241	**Jonghyun Park**	Unveiling the role of CeO2 atomic layer deposition coating layer on LiMn2O4 cathode material: experimental and theoretical study
14:30-15:00	242	**Minseok Choi**	First-principles study on defect and strain in oxides
15:00-15:30	243	**Zhen He**	Electrodeposited Metal Oxides for Efficient Water Oxidation
15:30-16:00	***Session Break***		
Polymers and Applications			**Chair: Jonghyun Park**
16:00-16:30	245	**Frank Henning**	Advanced manufacturing of structural thermoset composites for automotive
16:30-17:00	247	**Hee-Woo Rhee**	How to design nanocompsoite membranes to improve PEMFC performance?
17:00-17:30	248	**Qi Li**	Polymer-based nanocomposites with high energy and power densities toward capacitive energy storage at elevated temperature
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Sensors and Applications			**Chair: Dongseok Suh**
09:00-09:30	249	**Chyuan Haur Kao**	High K Materials as Sensing Membranes in Bio-Sensor Applications
09:30-10:00	252	**Seung Ki Moon**	Applications of 3D printing technologies for customized sensors
10:00-10:30	253	**Kar Seng Teng**	Scaled-up Production of Nanobio sensors
10:30-11:00	***Session Break***		
Sensors and Applications			**Chair: Chyuan Haur Kao**
11:00-11:30	255	**Dongseok Suh**	Application of 2D materials for high performance magnetic Hall sensor
11:30-12:00	256	**Seok Lee**	2 by 8 chemical vapor sensor array for monitoring the air quality of the environment
12:00-12:30	257	**Takeo Hyodo**	Gas-sensing devices for highly sensitive and selective detection
12:30-14:00	***Lunch Break***		
Diamond Materials			**Chair: Yoshifumi Morita**
14:00-14:30	261	**Jiangwei Liu**	Recent developments for our diamond electronic devices
14:30-15:00	262	**Takeshi Kawae**	Diamond Field Effect Transistor with Ferroelectric Gate Structure
15:00-15:30	263	**Kenji Ueda**	Photoconductive characteristics of graphene/diamond heterojunctions
15:30-16:00	***Session Break***		
Graphene and Applications			**Chair: Jiangwei Liu**
16:00-16:30	264	**Yoshifumi Morita**	Quantum Design of CNT/graphene-based Superconducting Devices
16:30-17:00	265	**Iwao Kawayama**	Terahertz Spectroscopy of Graphene
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Room 401A			
Time	**Page**	**Speaker**	**Talk Title**
Electronic Materials			**Chair: Qiang Li**
09:00-09:30	266	**Jeonghoon Yoo**	Dielectric collimator design in a microwave range and its experimental verifications
09:30-10:00	267	**Norio Tagawa**	Wide Band p-MUT for High Frequency Ultrasound Imaging
10:00-10:30	270	**Kotaro Makino**	Terahertz wave detection by multilayered phase change memory material
10:30-11:00	***Session Break***		
Energy Materials			**Chair: Jeonghoon Yoo**
11:00-11:30	271	**Qiang Li**	Control over emissivity of middle infrared thermal emitters with phase changing material
11:30-12:00	273	**Zhimiao Yan**	Optimal Study of Broadband Piezoelectric Energy Harvesters using Inductive-resistive Circuit
12:00-12:30	274	**Ting Tan**	Optimal design for galloping piezoelectric energy harvesters based on analytical solution
12:30-14:00	***Lunch Break***		
Quantum Matters & Materials			**Chair: Vladimir Saveljev**
14:00-14:30	276	**Barbara Pieczyrak**	Spin-split surface states at Tl/Si(111) and Pb/Si(111) and chemical probing with Cl and O atoms
14:30-15:00	277	**Jeff Sonier**	Quantum spin fluctuations in the bulk insulating state of pure and Fe-doped SmB_6
15:00-15:30	278	**Jun Okabayashi**	Tailoring spin and orbital in complexed materials probed by x-ray magnetic spectroscopy
15:30-16:00	***Session Break***		
Materials Theory and Principles			**Chair: Barbara Pieczyrak**
16:00-16:30	279	**Vladimir Saveljev**	Physical model and computer simulation of the moiré effect in nanoparticles
16:30-17:00	282	**YiJing Yan**	Quasi-particle approach to quantum transport and quantum dissipation
17:00-17:30	283	**Masaru Aniya**	Concept and Applications of the Bond Strength-Coordination Number Fluctuation Model of Viscosity
18:00-Night	***Beach walk and Chicken & Beer Party (Leodo Plasa in ICC Jeju, 1F)***		

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Room 401B			
Time	**Page**	**Speaker**	**Talk Title**
Materials Synthesis Characterization			**Chair: Amadeo L. Vazquez de Parga**
09:00-09:30	284	**Juan Rivadeneira H.**	BioCobre® Technology; an improved methodology to leaching mineral concentrates
09:30-10:00	285	**Zhengyong Huang**	Preparation of Boron Nitride Nanodielectric with High Thermal Conductivity and Super Hydrophobicity
10:00-10:30	286	**Yao Shuai**	The Resistive Switching Behavior in Single Crystalline LiNbO3 Thin Films
10:30-10:45	288	**Sundar Kunwar**	Study on Morphological and Optical Property of Ag Nanostrucutres on GaN (0001)
10:45-11:00	***Session Break***		
Graphene and Applications			**Chair: Juan Rivadeneira H.**
11:00-11:30	290	**Inhee Maeng**	Ultrafast Terahertz Dynamics of Graphene Nanostructures
11:30-12:00	292	**Amadeo L. Vazquez de Parga**	Chemical functionalization of epitaxial graphene in ultra-high vacuum
12:00-12:30	293	**Ryota Negishi**	Bandlike-tranport in highly crystalline graphene films from defective graphene oxide
12:30-14:00	***Lunch Break***		
Materials Synthesis Characterization			**Chair: Indranath Dutta**
14:00-14:30	295	**Wen-Hsien Huang**	Low-thermal-budget Semiconductor Thin Film and Laser Annealing for Monolithic 3DIC and Flexible Electronics
14:30-15:00	297	**Qing Hao**	Transport Property Studies of Nanoporous Graphene and Si Thin Films
15:00-15:30	298	**Chuantong Chen**	Bonding technology with the sintered Ag particles and its mechanical properties for high temperature power device applications
15:30-16:00	***Session Break***		
Materials Synthesis Characterization			**Chair: Wen-Hsien Huang**
16:00-16:30	300	**Indranath Dutta**	Diffusional Sliding at Hetero-Interfaces by Thermal-Mechanical-Electrical Impetus and Impact on 3D Electronic Packages
16:30-17:00	301	**Seung Kwon Seol**	Multiple-materials 3D printing with Functional Inks
17:00-17:30	303	**Yuji Kuwahara**	Chemical Analysis of Nanomaterials Studied by Tip-enhanced Raman Scattering Spectroscopy
18:00-Night	***Beach walk and Chicken & Beer Party (Leodo Plasa in ICC Jeju, 1F)***		

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Graphene and Applications			**Chair: Yohta Sata**
09:00-09:30	304	**Kengo Takashima**	Influence of edge disorder on device characteristics of graphene-ribbon FETs
09:30-10:00	306	**Nam-Jung Kim**	Graphene-based hybrid nanomaterials for advanced SERS applications
10:00-10:30	307	**Takeharu Haino**	Chemically Functionalized Graphene Quantum Dots
10:30-11:00	***Session Break***		
Graphene and Applications			**Chair: Kengo Takashima**
11:00-11:30	309	**Yohta Sata**	Electric field effect in van der Waals heterostructures based on graphene and TMD materials
11:30-12:00	311	**Monica F. Craciun**	Graphene materials for Nano Electronics, Photonics and Optoelectronics
12:00-12:30	312	**Zinetula Insepov**	Graphene Deformation Properties and Charge Transport by Surface Acoustic Waves in an External DC Field
12:30-14:00	***Lunch Break***		
2-D Materials			**Chair: Yuki Shiomi**
14:00-14:30	314	**Masashi Hasegawa**	High Pressure Synthesis and Characterization of Metal Nitrides
14:30-15:00	316	**Mi Jung**	Ultrathin nanoporous alumina mask as a versatile template for two-dimensional plasmonic nanodot array
15:00-15:30	318	**Mikito Koshino**	Physics of moiré superlattices
15:30-16:00	***Session Break***		
Magnetism and Magnetic Materials			**Chair: Yuki Shiomi**
16:00-16:30	320	**Yuki Shiomi**	Spin-charge interconversion in topological materials
16:30-17:00	322	**Shinya Yamada**	Low-temperature molecular beam epitaxy of nonmagnetic full-Heusler alloy Fe_2VAl films
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Superconducting Materials			**Chair: Jeffrey J. Urban**
09:00-09:30	323	**Atsutaka Maeda**	Superconductivity fluctuation and other properties of Fe chalcogenide epitaxial films and its superlattice
09:30-10:00	324	**Akiyasu Yamamoto**	Modeling the supercurrent flow in high temperature superconducting materials
10:00-10:30	325	**Akinobu Kanda**	Search for unusual Andreev reflection in a graphene/superconductor interface
10:30-11:00	***Session Break***		
Energy Materials			**Chair: Atsutaka Maeda**
11:00-11:30	328	**Jeffrey J. Urban**	Engineering Synergy: Energy and Mass Transport in Hybrid Nanomaterials
11:30-12:00	329	**Kenichi Kawaguchi**	III-V Nanowires for Ambient RF Energy Harvesting
12:00-12:30	331	**Yong Soo Cho**	Advances in In Situ Processing for Piezoelectric Energy Harvesting and Sensing Applications
12:30-14:00	***Lunch Break***		
Energy Materials			**Chair: Manfred Kohl**
14:00-14:30	332	**Jinkyoung Yoo**	Multi-dimensional semiconductor heterostructures for basic energy sciences
14:30-15:00	333	**Kung-Hsuan Lin**	Ultrafast optical and acoustic spectroscopy of GaN for green energy
15:00-15:30	335	**Zhaoyang Fan**	Graphene and Carbon Fiber Based Nanostructures for Kilohertz Ultrafast Supercapacitors
15:30-16:00	***Session Break***		
Energy Materials			**Chair: Zhaoyang Fan**
16:00-16:30	337	**Manfred Kohl**	Magnetic Shape Memory Films for Thermomagnetic Energy Generation
16:30-17:00	339	**Hiromasa Tamaki**	Desigining Mg3Sb2-based Zintl compounds with high thermoelectric performance
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Polymers and Applications			**Chair: Kensuke Naka**
09:00-09:30	341	**Hitoshi Takagi**	Experimental Investigation of Effects of Mechanical Extension on Performance of PVA/CNF Nanocomposites
09:30-10:00	344	**Alexander Brown**	New Phosphorescent Molecules: Insights from time-dependent density functional theory computations
10:00-10:30	346	**Shinsuke Inagi**	Electrosynthesis of Functional Polymeric Materials
10:30-11:00	***Session Break***		
Polymers and Applications			**Chair: Hitoshi Takagi**
11:00-11:30	348	**Kensuke Naka**	Synthesis of Element Block Polymers Based on Fluorinated T8-caged Silsesquioxanes
11:30-12:00	351	**Francesco Picchioni**	Nanocmposites based on thermally reversible networks
12:00-12:30	353	**Marco Lattuada**	Design of nanocomposite materials from self-assembly of nanoparticles
12:30-14:00	***Lunch Break***		
Energy Materials			**Chair: Takashige Omatsu**
14:00-14:30	354	**Meicheng Li**	Novel Hybrid Solar Cells: From Materials to Devices
14:30-15:00	357	**Junghyun Cho**	Nanostructured Ceramic Coatings for Photocatalytic and Antimicrobial Surfaces
15:00-15:30	360	**Rak-Hyun Song**	Durability study of solid oxide fuel cell materials
15:30-16:00	***Session Break***		
Optical Materials			**Chair: Meicheng Li**
16:00-16:30	362	**Takashige Omatsu**	Optical vortex sources for materials processing
16:30-17:00	364	**Chang-Hee Cho**	Resonant optical absorption in periodically structure-modulated semiconductors
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Quantum Matters & Materials			**Chair: Xiaohui Yu**
09:00-09:30	365	**Kun Yang**	Interplay of Topology and Geometry in Fractional Quantum Hall Liquids
09:30-10:00	366	**Masahiko Hada**	Quantum-Chemical Calculations on NMR chemical shifts of Molecules Containing Lead
10:30-11:00	***Session Break***		
Materials Synthesis Characterization			**Chair: Kun Yang**
11:00-11:30	367	**Xiaohui Yu**	ZrB12 Discovered as a "Metallic Diamond"
11:30-12:00	368	**Yusuke Shimada**	Multi-scale interstructure of Mg2Cu addition MgB2 policrystalline wire
12:00-12:30	371	**Katarzyna Hnida**	Nanostructured materials for magnetic, sensing and thermoelectric applications
12:30-14:00	***Lunch Break***		
Biomaterials and Applications			**Chair: Wonhee Lee**
14:00-14:30	374	**Hyo-Jick Choi**	Targeted Oral Vaccine Delivery System
14:30-15:00	376	**Kang Liang**	Biomineralization of Metal-organic Frameworks
15:00-15:30	378	**Theo Lohmuller**	Plasmonic Nanoagents for controlling chemical reactions and biological systems with light
15:30-16:00	***Session Break***		
Electronic Materials			**Chair: Hyo-Jick Choi**
16:00-16:30	379	**Wonhee Lee**	Flexible parylene microfluidics for adjustable functionality
16:30-17:00	380	**Jayati Sarkar**	Miniaturized pattern formation at soft interfaces
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Magnetism and Magnetic Materials			**Chair: Jak Chakhalian**
09:00-09:30	381	**Kuntal Roy**	Recent developments on ultra-low-energy, area-efficient, and fast spin-devices and spin-circuits
09:30-10:00	383	**Shintaro Yasui**	Development of lead-free Bi-based perovskite ferroelectric thin films
10:00-10:30	385	**Yonggang Zhao**	Electric-field control of magnetism in ferromagnetic/ferroelectric multiferroic heterostructures
10:30-11:00	***Session Break***		
Oxide Materials			**Chair: Kuntal Roy**
11:00-11:30	387	**Jak Chakhalian**	When three is better than two: designer polar metals and magnetic 2D electron liquid
11:30-12:00	389	**Keisuke Shibuya**	Impact of electron doping on electronic phases of vanadium dioxide
12:00-12:30	391	**Clemens Ulrich**	Multiferroics: from bulk to thin films: a comprehensive neutron and Raman light scattering investigation
12:30-14:00	***Lunch Break***		
Oxide Materials			**Chair: Ding-Shyue Yang**
14:00-14:30	392	**Siddhartha Ghosh**	Exotic Phenomena in Rare Earth Oxide Films and Interfaces
14:30-15:00	394	**Yanjun Li**	The investigation of local dipole moment on TiO2(110) surface by electrostatic force microscopy
15:00-15:30	396	**Nataliia Tarasova**	The novel halogen-substituted (F-, Cl-) perovskite-related complex oxides: structure, electrical conductivity and chemical stability
15:30-16:00	***Session Break***		
Oxide Materials			**Chair: Siddhartha Ghosh**
16:00-16:30	397	**Ding-Shyue Yang**	Photoinduced Structural Phase-Transition Dynamics of Strained Ultrathin Vanadium Dioxide
16:30-17:00	399	**Yasuhiro Sugawara**	Simultaneous Characterization of Tunneling Current and Local Contact Potential Difference on Rutile TiO_2(110) surface
17:00-17:15	400	**Jinmin Wang**	Hydrothermal Synthesis and Electrochromic Properties of Oxide Nanostructures
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Nanostructures & Nanomaterials			**Chair: Roie Yerushalmi**
09:00-09:30	402	**Klaus Muller-Buschbaum**	Multifunctional MOF Composites – From Thin Films to Core/Shell Structures
09:30-10:00	404	**Sharmila M. Mukhopadhyay**	Next Generation Nanomaterials: Hierarchical Hybrid Architectures for Robust & Reusable Devices
10:00-10:30	407	**Aleksandra Szkudlarek**	Granular metals nanostructures and thin films fabricated with Focused-Electron-Beam-Induced-Deposition and Magnetron Sputtering
10:30-11:00	***Session Break***		
Nanostructures & Nanomaterials			**Chair: Klaus Muller-Buschbaum**
11:00-11:30	410	**Roie Yerushalmi**	Designing Asymmetry at the Nano Scale by Post-synthesis Modifications; Self-processing Synthesis and ex-situ Doping
11:30-12:00	412	**Rafael Taboryski**	Nanotextured surfaces with spectacular anti-reflective and water-repellent properties fabricated by a maskless reactive ion etching method
12:00-12:30	414	**Mao Sui**	Evolution of Pd Nanostructures on c-plane Sapphire by the Control of Annealing Temperature and Duration
12:30-14:00	***Lunch Break***		
Materials Synthesis Characterization			**Chair: Rafael Taboryski**
14:00-14:30	416	**Hiroyuki Saitoh**	High-pressure syntheses of novel hydrides with the aid of in situ synchrotron radiation X-ray diffraction measurement
14:30-15:00	417	**Ida Westermann**	Seeing the big picture through low-scale experiments
15:00-15:30	419	**Hirokazu Sakamoto**	Analysis of STM Images of Organic Crystals and DNA
15:30-16:00	***Session Break***		
18:00-Night	***Conference Banquet (Grand Ballroom in Booyoung hotel, B2F)***		

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Light Emitting Materials			**Chair: Masashi Kato**
09:00-09:30	422	**Shiro Sakai**	Multi-wavelength AlGaInN-LEDs
09:30-10:00	423	**T. Keith Hollis**	Materials for Photophysical Applications: Organometallic Complexes for Light Emitting Applications: OLEDs
10:00-10:30	424	**Wan Ki Bae**	Structurally Engineered Nanocrystal Quantum Dots for Light-Emitting Applications
10:30-11:00			***Session Break***
Optoelectronic Materials			**Chair: T. Keith Hollis**
11:00-11:30	425	**Masashi Kato**	SiC photocathode for a solar to hydrogen conversion technology
11:30-12:00	428	**Jonathan Major**	Analysis of deep level defects in thin film solar cells
12:00-12:15	429	**O.M. Ntwaeaborwa**	Tunable emission and surface characterization of powders and pulsed laser deposited mixed rare-earths oxyorthosilicate phosphors
12:15-12:30	430	**Yujin Cho**	Cathodoluminescence study of pn junctions and heterointefaces in GaN
12:30-14:00			***Lunch Break***
Electronic Materials			**Chair: Jun Zhang**
14:00-14:30	431	**Shinya Aikawa**	Incorporation of high bond-dissociation energy dopants for low-temperature processable stable InOx-based thin-film transistors
14:30-15:00	433	**Ozdal Boyraz**	Plasmonics for Material Characterization and Thermo Optomechanical Oscillators
15:00-15:30	435	**Yong Hyub Won**	A fabrication of an vari-focal electrowetting lenticular lens for 2D/3D display conversion
15:30-16:00			***Session Break***
Semiconducting Materials			**Chair: Shinya Aikawa**
16:00-16:30	436	**Jun Zhang**	Sideband Raman cooling of Lattice Phonons in Semiconductors
16:30-17:00	437	**Sayed Abboudy**	Influence of the energy overlap integral on the hopping activation energy and metal-insulator transition in doped semiconductors

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Materials Synthesis			**Chair: Min Chen**
09:00-09:30	438	**Atsushi Nakajima**	Superatom Chemistry of Caged Silicon Nanoclusters
09:30-10:00	440	**Julien Madeo**	Exploring the ultrafast dynamics of 2D materials with high spatial resolution
10:00-10:30	441	**Masayoshi Higuchi**	Cuttable Electrochromic Display Sheets Using Metallo-Supramolecular Polymer
10:30-11:00	***Session Break***		
Materials Synthesis Characterization			**Chair: Atsushi Nakajima**
11:00-11:30	442	**Min Chen**	Relationship Between the Sliding Property of a Surface and its Icephobicity
11:30-12:00	443	**Kazuhiro Kanda**	Erosion process of fluorinated diamond-like carbon films by exposure to soft X-rays
12:00-12:30	446	**Hiroshi Okamoto**	Bi-mediated formation of Ge nanodots: A new method for fabricating crystalline nanodots at low temperature
12:30-14:00	***Lunch Break***		
Graphene and Applications			**Chair: Wataru Norimatsu**
14:00-14:30	448	**Masao Nagase**	Epitaxial graphene on SiC for new functional devices
14:30-15:00	450	**Hikari Tomori**	Strain effect in graphene electron transport
15:00-15:30	453	**PingHeng Tan**	Identifying stacking configuration of multilayer graphenes by Raman spectroscopy
15:30-16:00	***Session Break***		
Graphene and Applications			**Chair: Masao Nagase**
16:00-16:30	454	**Wataru Norimatsu**	Interface engineering of epitaxial graphene on SiC
16:30-17:00	455	**Tae-Youl Choi**	Measurement of interfacial thermal resistance between the graphene and Cu film

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Optical Materials			**Chair: Takshi Kimura**
09:00-09:30	456	**Yan Sheng**	Ultrafast-laser-inscribed nonlinear photonic crystals for frequency conversion
09:30-10:00	459	**Ping Zhu**	The complete spatiotemporal measurement of complex ultrashort pulses
10:00-10:30	460	**Masahiko Kondow**	Single mode lasing operation of Photonic Crystal Circular Defect (CirD) Laser
10:30-11:00	***Session Break***		
Magnetism and Magnetic Materials			**Chair: Yan Sheng**
11:00-11:30	462	**Takshi Kimura**	Efficient thermal spin injection and spin signal modulation in metallic hybrid nanostructures
11:30-12:00	463	**Tomohiro Nozaki**	Electric manipulation of perpendicular exchange bias using magnetoelectric Cr2O3 thin films
12:00-12:30	465	**Hongbin Zhang**	DFT+DMFT study of the interplay between spin-orbit coupling and electronic coorelations in 5d insulators
12:30-14:00	***Lunch Break***		
Magnetism and Magnetic Materials			**Chair: You-Quan Li**
14:00-14:30	466	**Le Duc Anh**	Fe-based narrow-gap ferromagnetic semiconductor: New materials for high-performance spintronic devices
14:30-15:00	468	**Helene Bea**	Electric-field control of magnetic skyrmion bubbles nucleation at room temperature
15:00-15:30	471	**Masaki Nakano**	Properties of PLD-fabricated rare-earth permanent film magnets applied for micro-machining
15:30-16:00	472	**You-Quan Li**	Electrically control of electromagnon motion and its applications
15:30-16:00	***Session Break***		

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Oxide Materials			**Chair: John D. Baniecki**
09:00-09:30	473	**Tetsuo Tsuchiya**	Flexible RuO_2 Film for High Heat-Resistant Resistor by ELAMOD using Photo-Reaction of Hybrid Solution (PRHS)
09:30-10:00	475	**Jun Chen**	EBIC/CL Study of $SrTiO_3$
10:00-10:30	477	**Mitsuru Itoh**	Phase control of metastable ABO_3 oxides by PLD
10:30-11:00	481	**Noriyuki Miyata**	A New Memory Device based on Interface Dipole Modulation in HfO_2-based Gate Stack Structure
Oxide Materials			**Chair: Tetsuo Tsuchiya**
11:00-11:30	482	**John D. Baniecki**	Atomic structure properties, interface energetics, and oxygen evolution electrocatalysis activity of perovskite structure oxide electrodes with nanoscopic active layers
11:30-12:00	484	**Iddo Pinkas**	Determining Alloy Composition in $Mo_xW_{(1-x)}S_2$ from Low Wavenumber Raman Spectroscopy
12:00-12:30	485	**Junxia (Lucy) Shi**	Strain Effects on the Interaction between NO_2 and the Mo-edge of the MoS_2 Nanoribbon
12:30-14:00	***Lunch Break***		
Biomaterials and Applications			**Chair: Takuo Tanaka**
14:00-14:30	486	**Xi Qiu Liu**	Control of Cell Behaviors by Delivering Chemokines in Layer-by-Layer Films: Underlying Molecular Mechanisms
14:30-15:00	487	**Zhang Leilei**	Bioactive coatings for carbon/carbon composites
15:00-15:30	488	**Gupta Kailash Chandra**	Chitosan Nano Carriers for Controlled and Sustained Drug Delivery
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09:30-10:00	494	**Piotr Roztocki**	Integrated frequency combs for quantum state generation
10:00-10:30	497	**Katsushi Hashimoto**	Scanning-probe imagning of nuclear/electron spin polarization in a quantum Hall system
Materials Theory and Principles			**Chair: Ermin Malic**
11:00-11:30	498	**David Ehre**	Induced Ice Nucleation by Polar Crystals: The Role of Pyroelectricity and Water Alignment
11:30-12:00	499	**Chee Kwan Gan**	Efficient and direct first-principles determination of thermal properties of metal chalcogenides and transition metal dichalcogenides
12:00-12:30	500	**Erika Birgit Kaufmann**	Theory of Materials Formed as Complements of Triply Periodic CMC Surfaces
12:30-14:00	***Lunch Break***		
Materials Theory and Principles			**Chair: Keisuke Ishizeki**
14:00-14:30	501	**Hideo Ando**	Resonating Hartree-Fock Theory beyond Adiabatic Approximation and Its Application to Strongly-Correlated Systems
14:30-15:00	503	**Yuan Songmei**	High Pressure Waterjet Peening: An Effective Approach for Surface Modification
15:00-15:30	504	**Yoshiro Hirayama**	New aspects of compound semiconductor quantum-point-contact
15:30-16:00	***Session Break***		
Materials Theory and Principles			**Chair: Yuan Songmei**
16:00-16:30	505	**Kenji Shiraishi**	First Principles and Statistical Mechanical Studies on MOVPE Growth of Nitride Semiconductors
16:30-17:00	506	**Keisuke Ishizeki**	Million-Atom Simulation on Inelastic Electronic Transport in Carbon Nanotubes

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