出國報告（出國類別：開會）

赴美參加2022 年全球百大科技研發獎頒獎典禮及參訪加州知名大學出國報告

服務機關： 核能研究所
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派赴國家/地區：美國/加州聖地牙哥與洛杉磯
出國期間：**111**年**11**月**14**日~**111**年**11**月**21**日
報告日期： **112** 年 **2** 月 **21** 日

摘　要

本次出國目的為參加 2022 年全球百大科技獎頒獎典禮，蒐集第一手本屆各國獲獎參賽作品及分析各作品相關技術發展之趨勢，並能提供本所未來參與競賽之依據及提高來年獲獎之機會。藉此次赴美出席頒獎典禮，另安排參訪與國際知名專家學者進行學術交流，瞭解先進國家量子相關技術發展趨勢。與國際頂尖研究單位將建立長期交流及合作溝通管道，掌握世界先進研究機構之研發方向，作為本所未來政策擬訂之研議參考。

本所 111(本)年參加全球百大科技研發獎(2022 R&D 100 Awards)競賽，以「低碳生產、低成本之創新電致變色玻璃量產技術」(英文參賽名稱為 Innovative, low-cost and low-carbon technology for mass-producing electrochromic glass)為題，本所提報一項作品參賽，依據主辦單位於 111 年 8 月 15 日公布入圍決選(R&D 100 Finalists)名單，並於 8 月 22 日公布最終獲獎名單(R&D 100 Award Winners)，本項作品榮獲本屆百大獲獎名單之一。主辦單位公告於 11 月 17 日在聖地牙哥 Coronado Island Marriott Resort & Spa 所舉辦頒獎典禮，本所受邀參加頒獎典禮並奉派物理組陳柏聞副研究員代表出席及現場上台領獎。同時，進行現場蒐集各國得獎作品最新資訊，提供本所後續規畫參賽策略之依據。

為強化研發成果與國際專家學者進行學術交流，於 11 月 15 日及 18 日參訪 UCLA(加州洛杉磯大學)電機系 Prof. Kang-Lung Wang 及 UCSD(加州聖地牙哥大學)電機系 Prof. Tse Nga Ng，瞭解先進國家於量子與綠色能源領域相關發展與應用趨勢。強化本所本所在原子能衍生應用之量子科技整體研發進展，與國際知名大學進行技術交流與意見分享，並掌握國際上最新技術發展趨勢。

關鍵字: 全球百大科技研發獎、低成本之創新電致變色玻璃量產技術、量子科技發展

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一、目　的

核能研究所(以下簡稱:本所)受政府挹注經費下賦予相關研發任務，自民國 57 年成立以來，為國內原子能與輻射應用的專責研究機構，已累積多項技術研發能量，包含核能安全、放射性廢料處理、核醫藥物及生醫技術、太陽電池、生質酒精、環保電漿應用、燃料電池、風力發電與能源管理及微電網等技術。本所近年來致力於獨特創新研發，搭配既有之系統整合能量，已累積多件可交易專利與技術，透過簽訂技術授權案、技術服務案、協助國內企業進行產品開發與創新製程，輔導國內業者技術轉型及升級。

未來配合行政院組織改造，本所將轉型為行政法人「國家原子能科技研究院」，本所刻面對法人組織轉型過程，將聚焦原子能民生應用、以及 2050 淨零碳排等議題上，並以發展成為世界一流研究機構為目標，持續邁進及實現低碳社會及增進民生福祉。爰為本所積極參與國外競賽，以利提升本所國際知名度。本次出國目的除應邀參加全球百大科技研發獎頒獎典禮，取得最新資訊，提供本所日後參賽依據之方針。藉由此次出國之機會與國際專家學者進行學術交流，於 11 月 15 日及 18 日安排參訪行程，瞭解先進國家於量子科技與綠色能源領域相關發展與應用趨勢。

故包含兩項予以說明:

(一) 出席 2022 年全球百大科技研發獎(R&D 100 Awards) 頒獎典禮:

蒞臨典禮現場取得第一手最新發展之趨勢，提供本所未來參與競賽佐證資料，提高未來參與競賽之獲獎機會。

(二) 參訪國際知名學術單位與專家學者進行學術交流:

建立與世界頂尖研究者之溝通管道，掌握世界各先進研究機構研發方向，作為本所未來政策擬訂之研議參考。

二、過　程

本次公差時間含去程及回程共計 8 天，其目的係出席 2022 全球百大科技研發獎(R&D 100 Awards)頒獎典禮及參訪國際知名學術單位與專家學者進行學術交流，其行程表詳如表 1 所示。

表 1 出國期程表

當地日期	地點	工作內容
11 月 14 日(一)	台灣桃園往美國加州洛杉磯	去程
11 月 15 日(二)~ 11 月 16 日(三)~	加州洛杉磯大學	參訪加州洛杉磯大學進行量子材料/元件及量子科技學術交流與資料匯整
11 月 17 日(四)	加州聖地牙哥 Coronado Island Marriott Resort & Spa	參加全球百大頒獎典禮及蒐集現場最新資料
11 月 18 日(五)~	加州聖地牙哥大學	參訪加州聖地牙哥大學進行綠色能源技術交流
11 月 19 日(六)~ 11 月 21 日(一)	美國加州洛杉磯往台北	回程

(一) 出席 2022 年全球百大科技研發獎(R&D 100 Awards) 頒獎典禮

2022 年全球百大科技研發獎(R&D 100 Awards)頒獎典禮係假聖地牙城市內哥科羅納多島-萬豪度假酒店(Coronado Island Marriott Resort & Spa hotel)舉辦，其中頒獎典禮於當地時間 17 日晚間正式舉行，主辦單位規定須著正式服裝出席。為完整了解全球百大科技研發獎獲獎機制及其運作流程暨推廣本所研發成果，本次不僅參加現場頒獎典禮流程，如表 2，俾利了解整體頒獎運作機制並獲得得獎作品相關新知，作為來年申請報名技術篩選、撰寫內容修正及推廣說明參考。

表 2 2022 年全球百大科技研發獎頒獎典禮流程

Thursday, NOVEMBER 17, 2022		
2:00PM–10:00PM	Broad Room	Open Time
5:30PM–7:00PM	Poolside Lawn	R&D 100 Awards Registration
7:00PM – 7:45PM	Coronado Ballroom Foyer	R&D 100 Awards Plated dinner
7:40PM – 10:30PM	Floridian Ballroom G-L	Awards presentation hosted by the R&D World editorial staff

報到處

主辦單位當天頒獎典禮會場

外圍會場餐飲地點

全球百大科技研發獎海報文宣

圖 1 2022 年全球百大科技研發獎報到地點及頒獎典禮周遭環境

此次頒獎程序，延續過往幾屆模式，參賽作品二階段方式公布，第一階段公布入圍(R&D 100 Finalists)以及第二階段公告最終優勝獎(R&D 100 Award Winners)。其中，入圍名單援例於當年 8 月至 10 月中旬公佈於官方網頁上，惟最終得獎名單依慣例於當年 11 月中旬擇美國特定地點進行現場舉辦頒獎典禮。觀察上屆獲獎情形，因疫情關係，最終優勝獎頒獎典禮僅進行線上視訊頒獎，並無舉辦現場儀式。因今年疫情舒緩，於 8 月 24 日公告最終優勝獎得獎作品之研發單位，主辦單位邀請得獎人參加 11 月 17 日假聖地牙;哥科羅納多島-萬豪度假酒店(Coronado Island Marriott Resort & Spa hotel)舉辦頒獎典禮現場上台領獎，如圖 1。

(二) 參訪國際知名學術單位與專家學者進行學術交流

為強化本所研發成果推廣及參與國際專家學者進行學術交流，建立與世界頂尖研究者之溝通管道，作為本所未來政策擬訂之研議參考。於 11 月 15 日及 18 日受邀至 UCLA(加州洛杉磯大學)電機系 Prof. Kang-Lung Wang 及 UCSD(加州聖地牙哥大學)電機系 Prof. Tse Nga Ng，瞭解先進國家於量子科技技術與綠能發展之趨勢。

於 11 月 15 日於拜訪王康隆院士，現為美國加州大學洛杉磯分校電機系雷神講座教授。大學畢業後赴美國麻省理工學院深造，之後在美國投身於學術界與業界，專長為自旋電子、半導體電子學以及奈米技術，其相關的研究對於促成積體電路製程持續微縮貢獻卓著。從事自旋電子的研究，引領自旋電子學的研究方向。也曾領導美國主要奈米材料聯盟（FENA）的半導體電子研究中心，證實了量子反常霍爾效應與拓樸絕緣體，為拓樸量子電腦發展推進一大步。並於 2017 年與加州大學爾灣分校夏晶教授領導的研究團隊，在反常霍爾效應平台系統中，首次發現並以實驗證明馬約拉納費米子的存在。王康隆院士在 40 年的教學生涯中桃李滿天下，學生遍及產學研界，都相當傑出。從過去傳統電腦到量子電腦，量子電腦的技術發展備受重視，如圖 2，其強大的運算潛能，成為科學界與產業界關注焦點。

本次參訪過程中與王院士討論中: 量子電腦（Quantum Computer）到底這個運算架構是否會取代傳統電腦? 王院士認為，以目前技術發展來看，其實並不會，而是各有各的任務，他舉例就如同手機沒辦法取代電腦，記憶體沒有取代硬碟的情況，而量子電腦特色，主要是針對解決特定的古典電腦之問題具有優勢，並非無所不能。發展到現在，所謂量子霸權（Quantum Supremacy）的階段，如圖 3，也就是證明可真正運用量子電腦來進行一個運算任務是指用量子電腦解決古典電腦難以解決的問題，問題本身未必需要有實際應用。不過，現階段的量子電腦運算力其實還非常小，Google 在 Nature 期刊發表研究成果，宣布他們打造了 54 量子位元（qubit）的處理器 Sycamore，引發全球關注。

具體而言，具有 53 個量子位元的量子電腦，因為有 1 個量子位元是壞掉的，在 Google 特定實驗設計下，讓電腦進行 20 次指定的量子操作，實驗重複一百萬次，僅耗時 200 秒就能完成。對於這樣的成果，量子電腦發展來看，現在已經可以實際運用量子電腦進行一個運算任務，這展示了古典電腦做不到的事情，是科學發展上非常重要的里程碑。量子電腦的下一個里程碑，是要實現有用的運算任務，來達到真正具價值的量子霸權階段，目前科學家還在尋找短期內能實現的量子電腦實際應用。

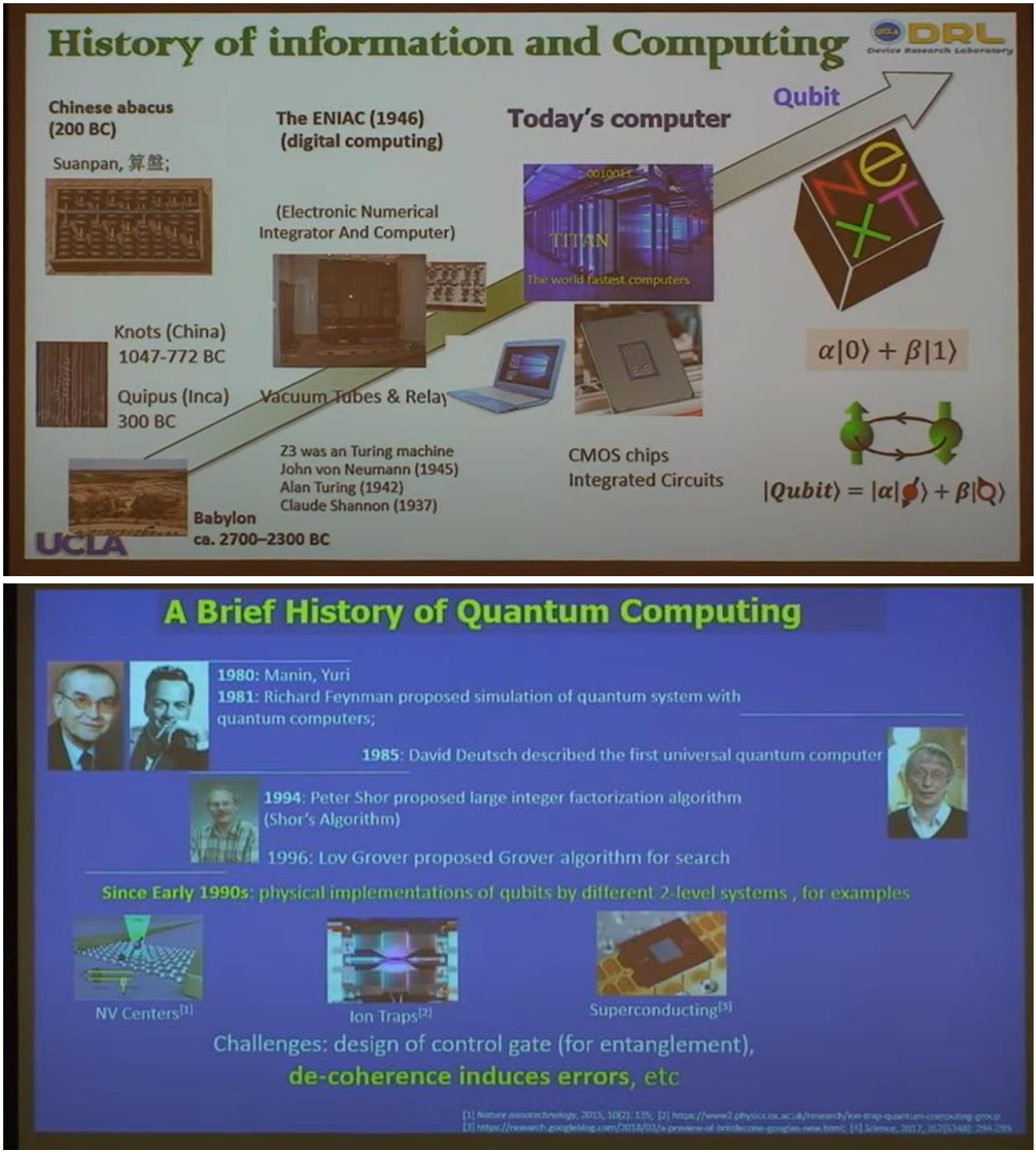


圖 2 量子電腦與量子資訊的發展歷史

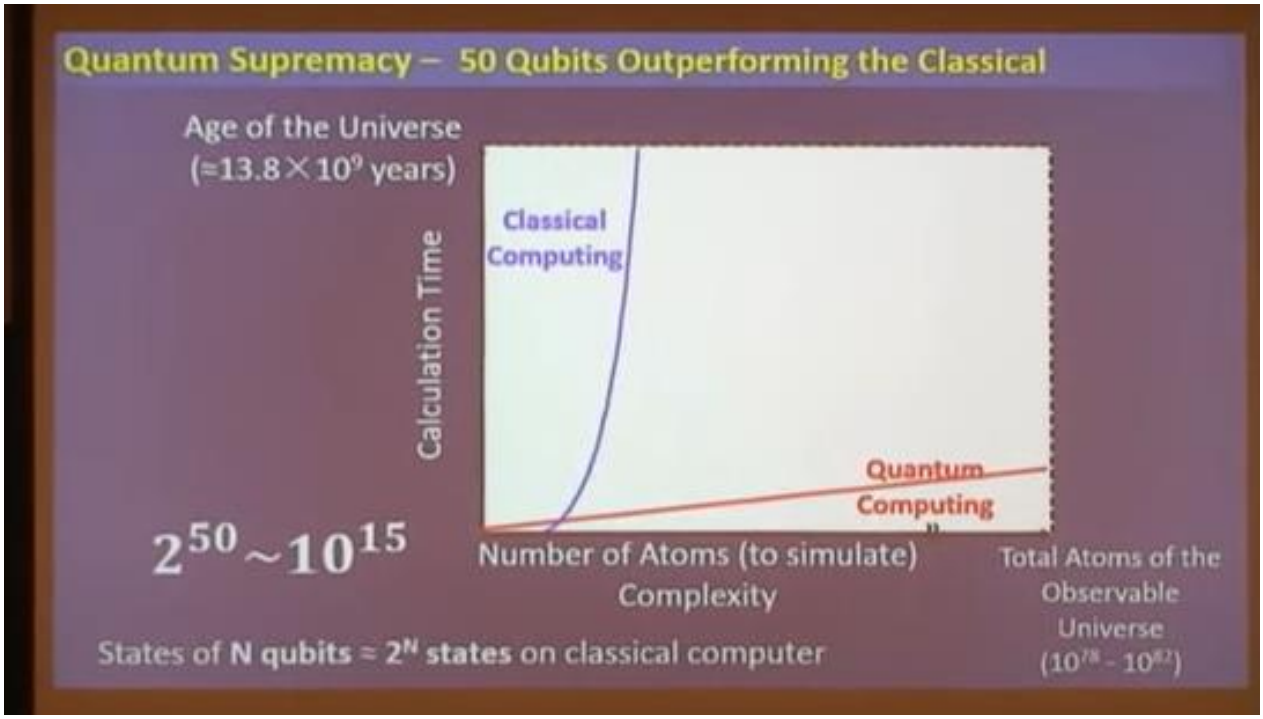


圖 3 Google 打造的 53 量子位元處理器；宣稱量子霸權(量子優勢) Sycamore 古典電腦無法達到境界

於在與王院士討論中，有提到拓樸絕緣體(topological insulator)銻化鉍(BiSb)可以用來做為 SOT MRAM 的磁化翻轉機制導線材料，數量級的大幅降低所需電流與功耗、提昇寫入速度。拓樸絕緣體 (Topological insulator) 因為具有許多獨特的性質因此在近幾年引起大家的關注。拓樸絕緣體的主要特性是它的內部具有絕緣體的性質，但它的表面態卻是呈現金屬的特性的特性。拓樸絕緣體材料對於電子傳輸的能力具有去相位長 (phase coherent length)等優勢，如圖 4。

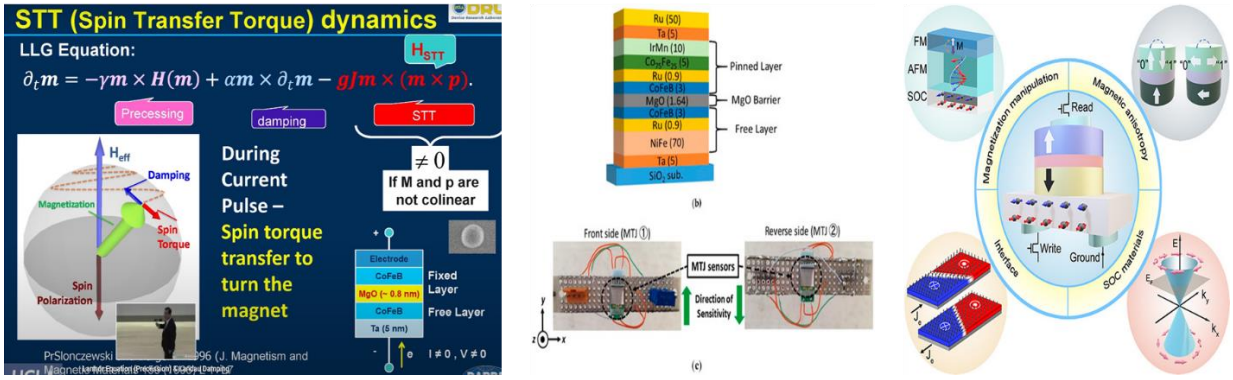


圖 4 自旋轉移矩(Spin-transfer torque)是一種利用自旋極化電流來改變磁性隧道磁阻值

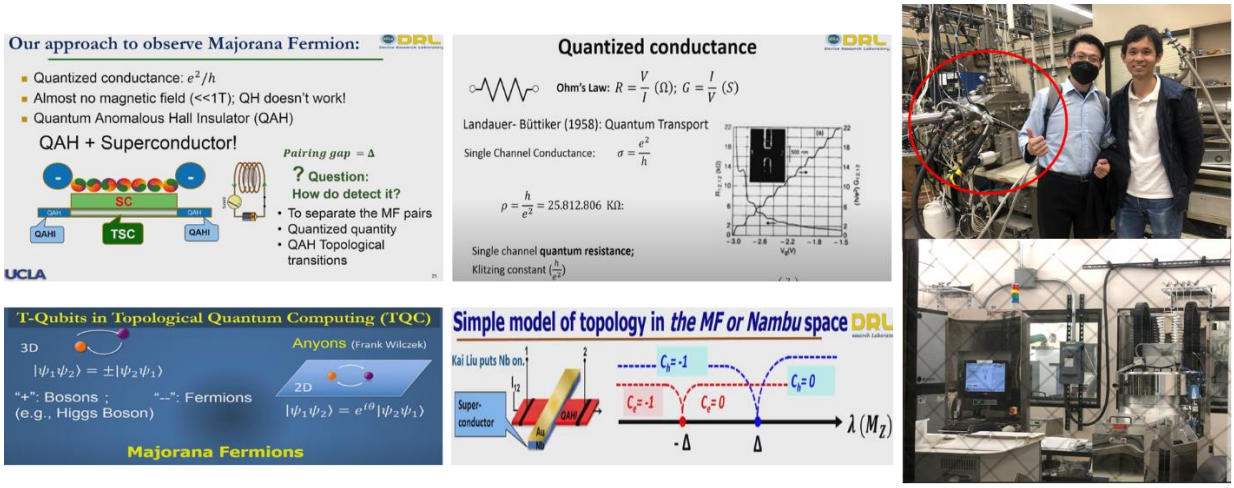


圖 5 拓樸量子位元在量子能量傳輸的應用

王康隆院士領軍的 UCLA 研究團隊，以 Molecular beam epitaxy, MBE 製程，偵測到了馬約拉納費米子（Majorana Fermion）。利用 Dirac formula 成功解釋了費米子的性質，並預測有反物質的存在，如圖 5。在宇宙之中物質—反物質會一對對存在且物質和反物質的特性是一模一樣唯一的差別只有電荷是相反的。比如說：電子是物質，帶有一個負電荷；那麼它的反物質就帶一個正電荷。

以分子束磊晶系統成長磁性拓樸絕緣體三層(Trilayer)異質結構，希望利用本實驗室先前最好的參數來得到晶向與結構良好的樣品，並進行磁電性的分析。拓樸絕緣體特殊的能帶結構導致此種材料在內部絕緣而在邊緣或表面導電，若是將磁性摻雜於拓樸絕緣體，則會破壞時間反衍對稱性(time reversal symmetry)，此時便會出現量子異常霍爾效應(Quantum Anomalous Hall Effect, QAHE)、拓樸軸子態(topological axion states)和馬約拉納費米子(Majonara fermion)這些特殊的量子態，因此磁性拓樸絕緣體為日後研究量子拓樸、電子自旋學以及其應用的重要載體，成長反鐵磁性拓樸絕緣體薄膜，調整成長樣品時的參數得到結構晶向良好的樣品。

另一參訪行程，於 11 月 18 日於拜訪加州聖地牙哥電機系 Prof. Tse Nga Ng。在此次會談中，主要針對兩個議題進行交流，(1)中寬帶紅外光偵測器研究，由於在異質材料界面中，存在特殊 P-N Junction，對於中寬帶紅外響應貢獻，以及(2)具有超級電容器之電致變色元件等議題進行交流。

Prof. Tse Nga Ng 表示加入異質小分子材料，可大幅提升元件的外部量子效率，最大可從 50%提升至 60%，有利於近紅外光的感光物質於光偵測器靈敏度。透過摻雜技術之進展，摻雜物後提高低能階亞激態躍遷之特性，可提高光偵測器元件在加上負向偏壓時，暗電流會明顯的增加，如圖 6，而我們團隊研究加入一層電荷阻擋層後，可有效地降低漏電流。並且增加 mobility 特性，因此提升靈敏度功能及提高長波長應用反應範圍。

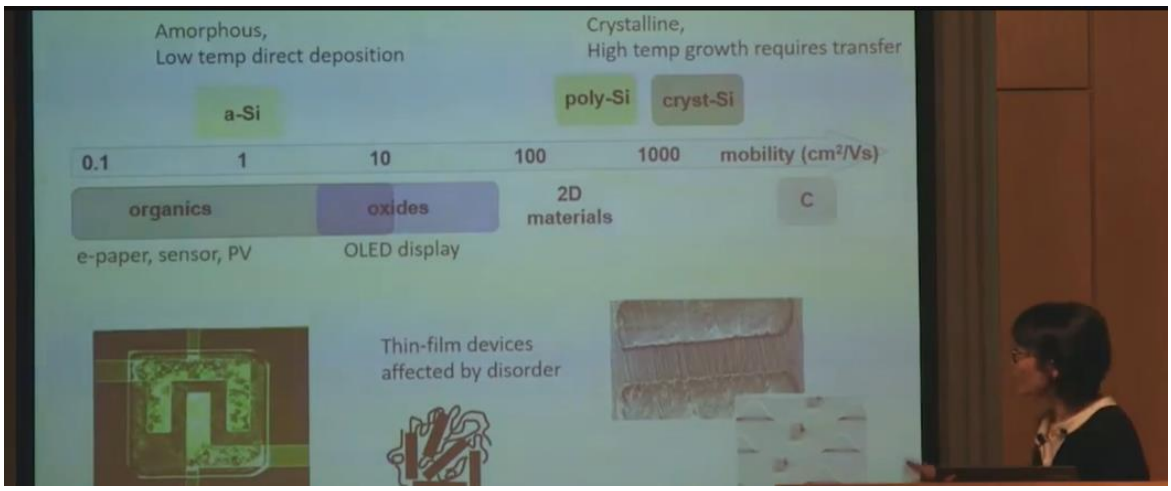
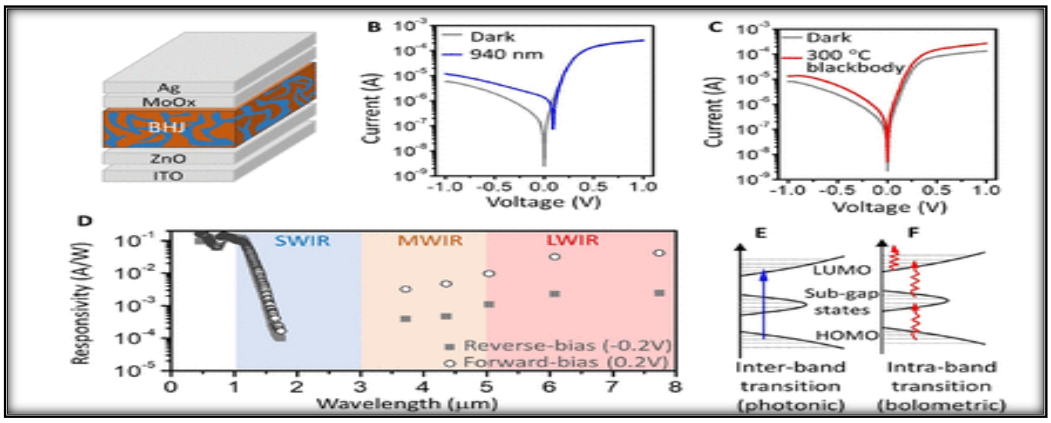


圖 6 在不同有機分子、氧化物及二維材料上的軟性光偵測器應用



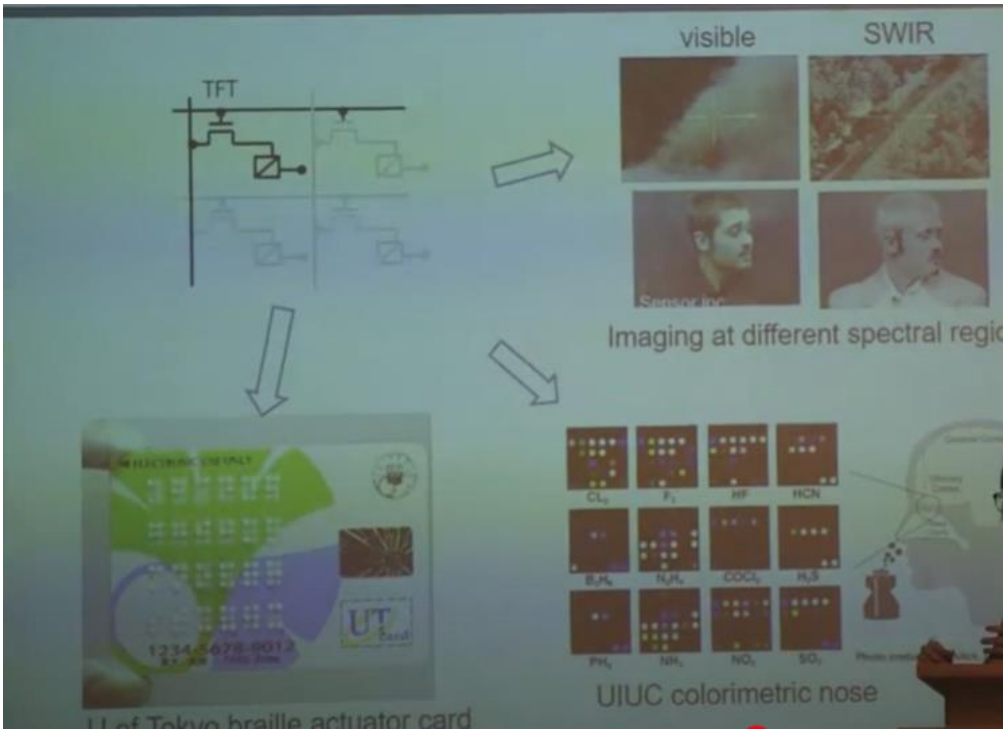


圖 7 有機光偵測器元件在可見光及短波長紅外線波段之簡易成像示意圖

Prof. Tse Nga Ng 表示由於紅外線偵測器的進步發展，使得紅外線應用得以實現並在近二十年迅速發展。例如:軍事夜視系統、醫學醫療儀器、通訊系統、天文觀測、民生保全系統、氣象、太空遙測系統等領域，其重要性不言可喻。其中，短波長紅外線 (SWIR, IR-B DIN)：1.4～3 微米，水的吸收在 1,450 奈米顯著的增加。1,530 至 1,560 奈米是主導遠距離通信的主要光譜區域，如圖 6。

Prof. Tse Nga Ng 也介紹光偵測器可吸收光能轉並轉換成電訊號，利用電訊號即可偵測光源訊號的強弱。傳統的半導體光偵測器多數使用矽或化合物無機半導體為主動材料。而近來已有越來越多的研究投入於有機光偵測器。相較於無機材料，多數有機材料有較低的折射率(refraction index)，因此容易導入(coupling)光子於元件之中；有機材料也有可撓性，且其重量輕、容易攜帶，並且製程溫度低，如圖 7，可製作於可撓性塑膠基板上，因此易於與其它的有機電子光電元件整合，例如有機光學積體電路(organic photonic integrated circuit)等。

三、心　得

本次出國目的為參加 2022 年全球百大科技獎頒獎典禮，全球百大科技研發獎素有研發界奧斯卡之稱的 R&D 100 Awards，今年邁入 60 周年。是研發領域極為推崇的科技研發國際大獎，每年從全球上千件創新技術中，挑選出 100 項年度具重大創新意義及對人類生活影響深遠的商品化技術，已成為市場上鑑定新技術革命性地位之重要指標，如圖 8。

圖 8 全球百大科技研發獎簡介

迄 2022 年已賡續辦理 60 屆，惟自 2015 年起變更作品評選機制，改採 2 階段進行評選，於當年度 8 月間公布第 1 階段入圍名單，並於 11 月間進行第 2 階段頒獎典禮以公布獲獎作品名稱，且將申請類別區分成 5 大類，分別為 Analytical/Test(分析/測試)、IT/Electrical(資訊/電子)、Mechanical Devices/Materials(機械裝置/材料)、Process/Prototyping(程序/原型)及 Software/Services(軟體/服務)，至 2017 年更增列第 6 類 other Innovations(其他革新獎)，詳如表 3。另主辦單位同年度亦新增 Special Recognition Awards(特別獎項)，該獎項係由主辦單位特別頒發，而非由參獎者自行申請之類別。

表 3 全球百大科技研發獎申請類別之分類

類別	細項	舉例
Analytical/Test (分析/測試)	Analytical Instrumentation (分析儀器)	chromatography, spectroscopy, analyzers, etc. (層析計、光譜儀及量熱器等)
	Electronic Instrumentation (電子測試裝備)	oscilloscopes, VOMs, spectrum analyzers, digital multimeters, probes, etc. (示波器、頻譜分析儀、數位萬用電表、探頭等)
	Imaging Systems/Devices (影像系統/裝置)	microscopes, cameras, telescopes, binoculars, optics, etc.

		(顯微鏡、照相機、筒式光學放大鏡、雙筒望遠鏡、光學儀器之各組成部分等)
	Testing Systems (測試系統)	hardness, materials, tensile, physical, etc. (硬度、材料、張力、物質等)
	Laboratory Equipment (實驗室設備)	fume hoods, cabinets, casework, lab animals, lab automation, balances/scales, centrifuges, tubing/valves, mixers, etc. (通風櫥、陳列櫥、台柜、實驗室動物、實驗室自動化、天秤/磅秤、離心機、管道系統/閥門、混合機等)
	Life Sciences (生命科學)	biopharmaceuticals, DNA/RNA systems, food & beverage, genomics, proteomics, GMO, medical devices, medicine, medical implants, etc. (生物製藥、去氧核糖核酸/核糖核酸系統、食物&飲料、基因組學、蛋白組學、基因改良生物、醫療設備、醫學、醫療植入物等)
IT/Electrical (資訊/電子)	Electrical Devices (電力裝置)	motors, switches, lighting systems, power systems and components, etc. (馬達、開關、照明系統、電力系統及元件等)
	Information Technologies (資訊技術)	computers, cell phones, printers, storage systems, supercomputers, computer hardware, operating systems, cloud computing, big data, data mining, data security, etc. (電腦、手機、列表機、儲存系統、超級電腦、電腦硬體、作業系統、雲端運算、大數據、資料探勘、資料保全等)
	Communication Systems/Devices (通訊系統/裝置)	wireless, broadband, networking systems, routers, wearables, lidar/radar, space communications, etc. (無線電、寬頻、網路系統、路由器、穿戴式設備、雷達、太空通訊等)
	Safety & Security (安全性及保密性)	sensing, detecting, monitoring, alarm systems, access point/portals, isolation systems, barriers, etc. (測知、偵測、監控、警報系統、切入點/入口、隔離系統、屏障等)
	Beam Instrumentation (電磁儀器)	x-ray, neutron, proton, gamma ray, etc. (X 光線機、中子產生器、質子產生器、伽馬射線產生器)
	Lasers & Photonics (雷射及光子學)	CO2 lasers, solid-state lasers, LEDs, synchrotron items, etc. (二氧化碳雷射、固態雷射、發光二極體、同步項目等)
Mechanical	Mechanical Systems	pumps, gears, transmissions, robotics,

Devices/Materials (機械裝置/材料)	(機械系統)	structural components, air-handling systems, thermal devices, heating and cooling systems, etc. (幫浦、齒輪、變速器、機器人、結構元件、空氣調節系統、過熱保護設備、加熱及冷卻系統等)
	Chemical & Gases (化學及氣體材料)	chemicals, reagents, powders, rare gases, etc. (化學製品、試劑、粉末、稀有氣體等)
	Materials (材料)	metals, alloys, polymers, plastics, paints, ceramics , composites, adhesives (金屬、合金、聚合物、塑膠、油漆、陶瓷、複合材料、粘合劑)
	Thin Film & Vacuum (薄膜以及真空技術)	deposition systems, vacuum pumps/chambers, vacuum valves, lithography, semiconductor processing, etc. (沉積系統、真空幫浦/室、真空閥、微影製程、半導體處理等)
	Energy Systems/Components (能源系統/零組件)	PV, fuel cells, nuclear, IC engines, hybrid systems, energy modeling software, etc. (光電、燃料電池、核能、積體電路引擎、混合系統、能源建模軟體等)
	Environmental Systems/Instruments (環境系統/儀器)	pH meters, filtering systems, precipitators, carbon capture, mercury capture, etc. (酸鹼度計、過濾系統、除塵器、碳捕獲、汞捕獲等)
Process/Prototyping (程序/原型)	Process Systems (程序系統)	mixing, formulating, distilling, baking, coating, etc. (混合、制定、蒸餾、烘、塗層)
	Additive Manufacturing (積層製造)	3-D printing, rapid prototyping (3-D 列印、快速成型)
	Supply Chain (供應鏈)	management, operations, etc. (管理、操作等)
	Process Improvement (流程改善)	design, production, distribution strategies (設計、生產、分配策略)
Software/Services (軟體/服務)	Software (軟體程序)	reporting, simulation, visualization, process and analysis, and chemistry (報告、模擬、可視化、過程和分析、化學)
	Safety & Security (安全性及保密性)	sensing, detecting, monitoring, alarm systems, access point/portals, isolation systems, barriers, etc. (測知、偵測、監控、警報系統、切入點/入口、隔離系統、屏障等)
	Military/Aerospace/Law Enforcement Devices (軍事/太空科學研究/執法裝置)	forensic tools, weapons, drones, de-icing solutions, flight simulators, air traffic control tech, etc. (法庭工具、武器、無人駕駛飛機、除冰解決方案、飛行模擬、空中交通管制技術)

本次出席 2022 年百大科技研發獎之頒獎典禮，本所以「綠色製造」的觀點，創新匯流，沿 2050 淨零碳排軌跡前進，打造可實際量產之低碳生產技術，引領台灣製造業作為淨零排之先驅。參賽主題「低碳生產、低成本之創新電致變色玻璃量產技術」(英文參賽名稱為 Innovative, low-cost and low-carbon technology for mass-producing electrochromic glass)為題，是台灣獲獎項目內唯一符合 2050 淨零碳排趨勢。

為因應歐盟世界各國及我國「2050 年淨零排放」趨勢，本所落實能源轉型，以具有前瞻且可量產之綠色製造低碳生產方式，研發「獨創全球之高密度電弧電漿源及其量產製程設備」，開發出新穎奈米級多孔性薄膜，取代目前採用的濺鍍(sputtering)製程，並應用於快速電致變色節能窗產品，如圖 9。就淨零排放路徑而言，在「製造端」此技術可大幅減少設備能耗 75%；在「應用端」此產品符合綠建築規範具隔熱效果，可減少室內溫度 3 ˚C 以上，降低室內冷氣空調所需之能耗，引領我國製造業邁向淨零碳排先驅。為提升綠色循環經濟價值，已成功技轉給全球市佔率第三大之力○興(LICON)製造商，授權生產。未來透過雙方合作開發低碳生產、低成本之電致變色節能窗，更有利於企業、環境、與消費者創造出「三贏局面」(Win-Win-Win situation)。

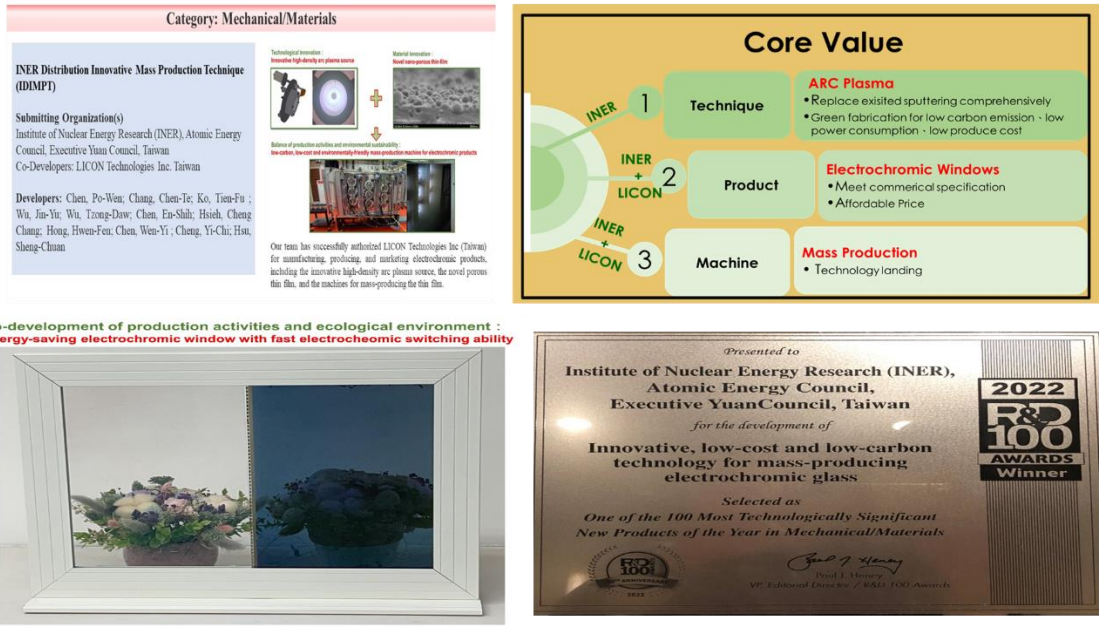


圖 9 左上圖本次參賽作品角逐機械裝置/材料類;右上圖與力○興聯名參賽並歸納出核心技術;左下圖快速電致變色節能窗產品;右下圖本屆獲獎獎牌

發現台灣其他研究單位亦有榮獲該獎項，這次 2022 R&D 100 Awards 全球百大科技研發獎，今年台灣創新科技囊括 12 個獎項，如表 4，高居全球第二亞洲第一，超越歐洲、日本。本屆台灣獲獎包含工研院「高精密陣列之微型 Micro LED 全彩顯示模組」、「眼底病變 AI 輔助診斷與偵測技術」以及與國際材料大廠杜邦微電路及元件材料(Microcircuit Materials；MCM)

公司合作的「9KC GreenTape™ LTCC 於 5G 毫米波通訊技術」；資策會「乳攝品質 AI 輔助評量系統」、「勒索軟體智能獵捕平台」；金屬中心「智慧骨科手術輔助系統-即時動態追跡手術輔助系統」、「不銹鋼耐蝕暨表面硬化系統設備」、「4D(3D+異質)固相式積層製造」；紡織所「Digital M®變形功能樹脂」、「SILVTEA 導電銀墨水」。

表 4　2022 年全球百大科技研發獎之台灣單位獲獎資料

項次	單位	主題
1	核研所	低碳生產、低成本之創新電致變色玻璃量產技術
2	工研院	高精密陣列之微型 Micro LED 全彩顯示模組
3		眼底病變 AI 輔助診斷與偵測技術
4		9KC GreenTape™ LTCC 於 5G 毫米波通訊技術
5	資策會	乳攝品質 AI 輔助評量系統
6		勒索軟體智能獵捕平台
7	金屬中心	智慧骨科手術輔助系統-即時動態追跡手術輔助系統
8		不銹鋼耐蝕暨表面硬化系統設備
9		4D（3D+異質）固相式積層製造
10	紡織所	DigitalM®變形功能樹脂
11		SILVTEA 導電銀墨水
12	台科大	可用於同時產水-產電的黑色魔毯

透過這次全球百大科技研發獎之台灣單位獲獎，獲得各大國際獎項的肯定，更是台灣產業轉型躍升的核心動能，甚至孵育出多家新創公司，是真正以創新科技解決產業問題，帶動產業效益與價值。今年獲得台灣參賽獲得國際大獎外，更呼應全球世界潮流議題，如元宇宙、淨零排放、智慧醫療技術。全球掀起元宇宙熱潮下，追求更快速、更舒適的沉浸體驗，也相關創新科技因運而生。

在通訊方面，5G 的普及讓傳輸技術逐漸從目前的主流頻段走向速度更快的毫米波頻段，工研院與杜邦微電路及元件材料公司合作研發的「9KC GreenTape™ LTCC 於 5G 毫米波通訊技術」，將耐高溫、低損耗的低溫共燒陶瓷(Low-Temperature Cofired Ceramics；LTCC)打造出用於 5G 毫米波的通訊元件，幫助國內產業擴大無線通訊研發領域。在顯示技術方面，Micro LED 市場商機無窮，除常見的 3C 產品與車用曲面顯示器，本次工研院參賽作品以「高精密陣列之微型 Micro LED 全彩顯示模組」獲獎，作品具有超廣色域、高解析、高亮度、高整合、低功耗等特點，更以聯盟的形式帶動台灣 Micro LED 產業。在資訊安全上，資策會「勒索軟體智能獵捕平台」，透過 AI 技術主動分析駭客攻擊軌跡、病毒碼比對與威脅行為軌跡推估，協助國內企業於資安上具有辨識駭客攻擊。

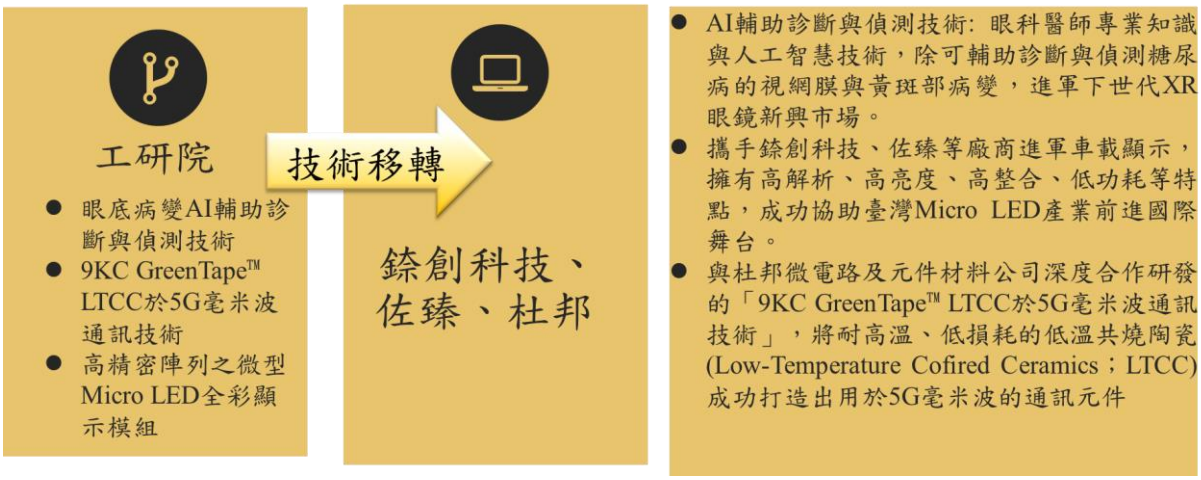


圖 10 國內工研院 2022 年獲獎資訊

另外，因應新冠肺炎疫情及高齡化等因素讓全球智慧醫療應用加速普及。台灣工研院研發「眼底病變 AI 輔助診斷與偵測技術」，整合眼科醫師專業知識與人工智慧技術，除可輔助診斷與偵測視網膜與黃斑部病變，加快醫師看診判讀的速度與準確，以利遠端看診守護偏鄉，如圖 10。

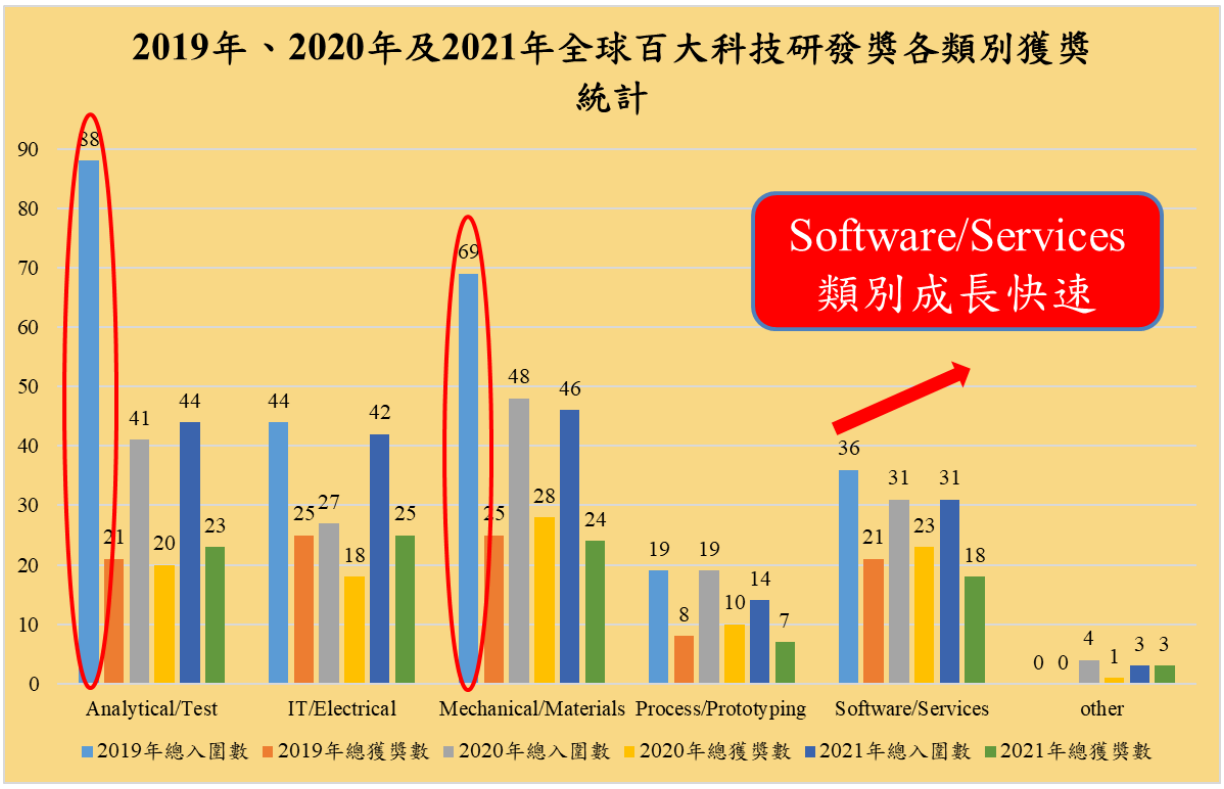


圖 11 各參賽單位近年來各分類入圍及獲獎項數統計

接著對各類別進一步探討，可發現 2020 年之各類別之入圍數比起 2019 及 2021 年較為平均，不像 2019 年 Analytical/Test 及 Mechanical Devices 入圍數明顯較高，主要係落於 Analytical/Test、IT/Electrical 及 Mechanical /Materials 等 3 類中。2021 年與跟過去分類做比較，其 Software/Service 獲獎件數大幅成長(如圖 11)，遠勝過過去紀錄，已逐漸成為全球百大科技研獎項重視之類別，極有可能與近年來之主流趨勢有關聯，例如人工智慧(深度學習)、大數據、雲端平行運算、智慧家庭、智慧城市(包含自駕車)及物聯網等。

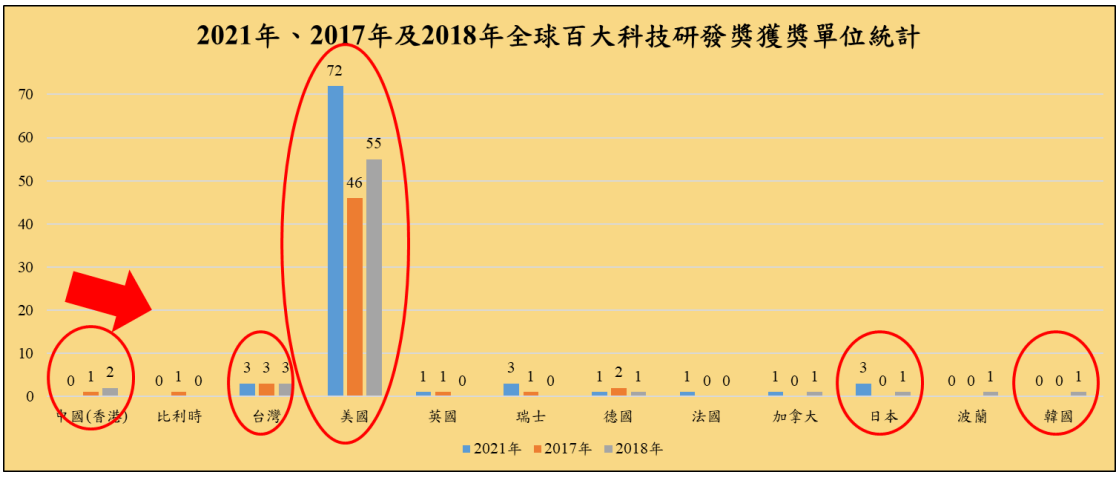


圖 12 各國近年來獲獎項數統計

2021 年獲獎單位仍以美國境內單位為主，且多為知名機構，雖有其他國家獲獎，其名額仍屬偏少(如圖 12)。2021 年總獲獎家數比起 2018 年增加，但仍比 2017 年減少，中國獲得獎項逐年下降，係值得注意之趨勢(主要係以香港為主)，係近年來值得注意之趨勢。經現場觀察，除參賽作品具有創新研發能力重要特質外，如何具體描述技術內容是一件相當重要之事項，獲獎技術經歸納後，發現有些較為不同之特質，其相關結論如下:

係將新技術與過去舊有技術相互比較，就其技術獨特性或突破性特別闡釋。

(1)創新獨特性: 舉例而言，過去傳統製作方式，具有創新獨特性之技術，其申請內容應強調技術質化方面之改變以及所克服之新困難點，至於改善效率高低，並非創新獨特性所重視之點。具有創新獨特性之技術多屬跨領域發展過程中所產生之產物，不見得為發展過程中之主要目標技術，亦有可能係額外產生之副產物。

(2)科技突破性: 新技術係奠基於舊有觀念發展延伸，其技術本質上並未克服任何新困難點，僅就原有技術基礎上，增進改善技術效率，故其申請內容應強調技術量化方面之變動。全球百大科技研發獎對技術有關之科技突破程度，並不以得預測之進步幅度為滿足，例如 1 倍至 2 倍，具有科技突破性性質之技術多屬研發單位之核心技術，係為其重要發展之命脈。

為提高研究單位之創新能力及競爭力，爰需積極發掘主流技術(新興科技)之走向，除經由跨領域、跨單位等方式獲知新興科技外，透過參獎之良性循環圖獲知技術潮流趨勢亦是另一

種管道，尤其係參與高水準之競賽，並適時淘汰落後或偏離市場方向之技術，以提高未來獲獎機率(如圖 13)。

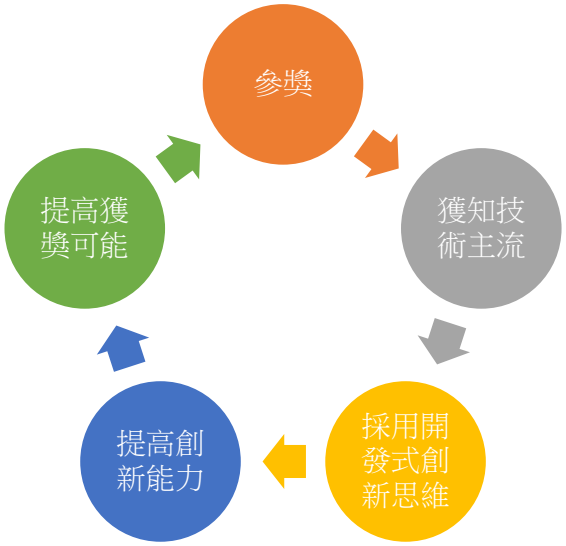


圖 13 參獎之良性循環圖

發展技術之最終目的係為了產生能獲得大眾願意購買之產品，即使新技術擁有創新獨特性或是科技突破性，然最終卻無法符合使用者之需求，則會成為無實質應用效果之技術，對人類福祉並無任何幫助，形成孤芳自賞之窘境。為證明具有市場應用價值，需要實際應用例子，或有合作或技轉廠商開始生產之證明，屬於多面向廣泛應用，而非進入紅海市場中，即可算初步具市場經濟性。

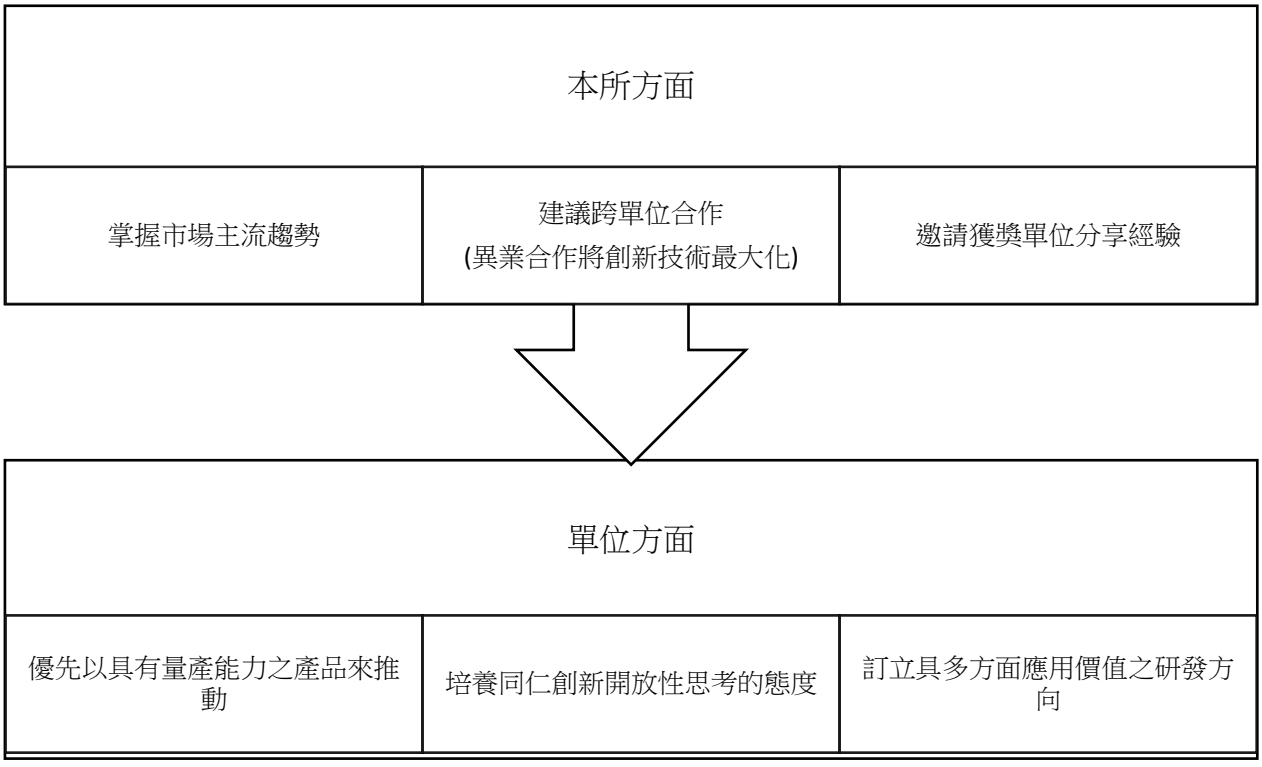
四、建　議　事　項

1.未來參賽作品，與過去舊有技術相互比較，就其技術獨特性或突破性特別闡釋。與過去傳統製作方式進行比較，強調本次參賽作品的獨特性之處，為申請內容之技術亮點，此種申請內容好處係能以新穎觀念克服新困難點(技術獨特性)並其技術改善指標能達到領先群程度即可，即能有獲獎之實力。

2.介紹係經由何種動機或想法導致新技術之產生，其思考邏輯脈絡為何。爰此，技術申請文件應著重於動機、想法及原理，主要係考量申請文件是否能具體揭露研發動機或強項，亦即所謂技術亮點之可能性。

3.將新技術之市場經濟性特別點出，如何應用在現有產品上並具體表現出來。原則上提升創新能力係獲獎之主要關鍵，可大幅提升獲獎機會，故依據本次出訪全球百大科技研發獎之心得內容，分別從本所、內部單位提出創新能力改善建議，以提高本所未來得獎機會，其相關事項整理如下。

表 2 未來建議事項



(一) 本所方面

1. 掌握市場主流趨勢:
   適當修正本所研發方向(例如納入雲端應用、平行運算、人工智慧、深度學習、大數據、智慧家庭、智慧城市、物聯網等相關技術)。
2. 跨單位合作(異業合作):
   推動內部單位或外單位，均是強化開創性思考，乃至增強創新能力之途徑之一。觀察本屆獲獎技術，多為跨單位合作所產生之成果，俾利激盪更多新穎之技術亮點。

3. 邀請獲獎單位分享經驗:

   邀請獲獎單位分享經驗，將其他單位果去成功獲獎的研發或納入嶄新技術之相關項目權重，有助提高未來獲獎之機率。

(二) 單位方面

1. 優先以具有量產能力之產品來推動:參獎技術之技術應有實體示範場域或是相關測試紀錄，應屬具量產能量之實體產品，而非仍是原型產品或概念，應有現存之技術移轉合作關係，並能確實了解市場上所遇到之真實問題。
2. 優先以具有量產能力之產品來推動:培養定期關注國際新趨勢，建立同仁之創新態度。
3. 優先以具有量產能力之產品來推動:研發技術應用廣度應儘量極大化，勿僅侷限小眾市場之應用。

五、附　錄

(一) 本次參賽資料申請書

Page: 1) PRODUCT/SERVICE CATEGORIES
1) PRODUCT/SERVICE CATEGORIES
Title of your entry
Innovative, low-cost and low-carbon technology for mass-producing electrochromic glass
Category
Mechanical/Materials ($550 Entry Fee)

Page: 2) R&D 100 PRODUCT/SERVICE DETAILS
2) R&D 100 PRODUCT/SERVICE DETAILS
Name of the primary submitting organization
Institute of Nuclear Energy Research (INER), Atomic Energy Council, Executive Yuan

Name(s) of co-developing organization(s) - if applicable
LICON Technologies Inc.
http://www.alight.com.tw/index.php?lang=en

Product/service brand name
INER and LICON Distribution Low-Carbon Mass Production of Electrochromic Products (LCMPEP)

Product Introduction

Check here to certify that this product/service was introduced to the market between January 1, 2021 and March 31, 2022.
Yes

If your submission is subject to regulatory approval, has this product been approved?
Yes

Price of product/service in U.S. dollars
INER is a research unit under the Atomic Energy Council of the Executive Yuan of Taiwan, the Republic of China. INER does not commercially manufacture products

developed out of its research projects. INER instead licenses technologies to third parties. Price for such licensing, and technology transfer when engaged, depends on contract arrangements.

Short description of the product

Please supply a short description of your product/service. (Please limit your answer to 50 words or less.)

The technology provides an innovative high-density arc plasma source and the machine, for mass production, adopting this arc plasma source. The electrochromic window manufactured by the technology can achieve energy saving and be fully in line with the standards of green building materials. The technology can replace the currently available sputtering processes for producing electrochromic products and the power consumption of the machines for mass production can be significantly reduced in order to achieve the objective of "Green Manufacturing (G.M.). Thus, the technology provides the world with an innovative and optimized solution for mass-producing electrochromic glass by low cost and low carbon emission.

Please indicate the type of institution you represent

Government or independent Lab/Institute

Submitter's relation to entered product/service

Product Developer

Photo(s) of the Product

Our team has successfully authorizes LCMPEP, including the innovative high-density arc plasma source, the novel porous thin film and the machines for mass-producing the thin film, to LICON Technologies Inc (Taiwan) for manufacturing, producing and marketing electrochromic products.

Photo #1 (optional)

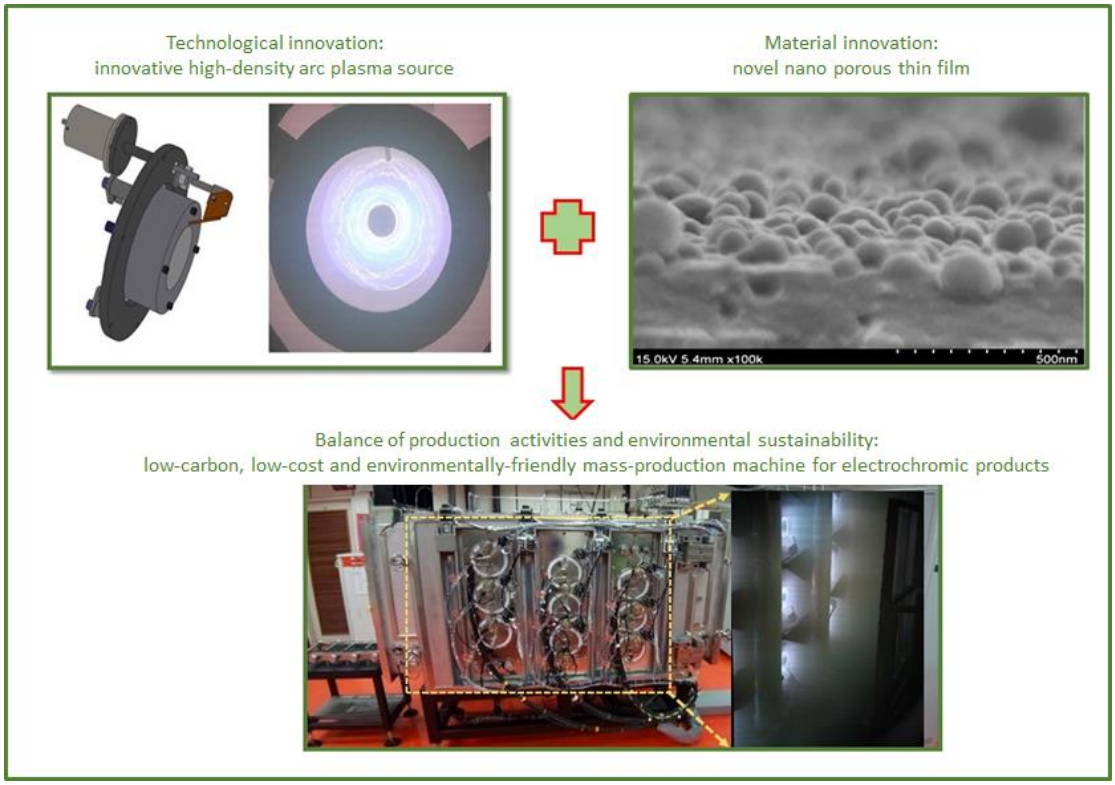


Photo #2 (optional)

LICON Technologies Inc (hereinafter “LICON”) is the only one Asian manufacturer capable of mass-producing electrochromic side mirrors and rearview mirrors. LICON has the third-highest market share of these products and their sales network covers the whole world. The energy-saving, low-cost and low-carbon electrochromic glass developed by the corporation of LICON and INER can solve the problem that the popularization of electrochromic products cannot be achieved because of high unit prices.

Co-development of production activities and ecological environment:
energy-saving electrochromic window with fast electrochromic switching ability and low energy consumption

Page: 3)

3) PRODUCT/SERVICE DESCRIPTION

A. What does the product or technology do?

Describe the principal application(s) of this product.

This core technical feature of this technology is as shown in Fig. 1, which is a novel high-density arc plasma source and the machine, for mass production, adopting this arc plasma source. Currently, the arc plasma technology are mainly applied to producing coatings with high wear resistance, high corrosion resistance or for decorative purpose. Our team successfully overcomes the obstacle of applying the arc plasma plating technology to high-end products. In addition, our team further improves the arc plasma plating process to manufacture nanoscale thin films so as to develop a novel nanoscale porous material. Finally, our team successfully develops an energy-saving electrochromic thin film with fast electrochromic switching ability.

The mass-production type electrochromic thin film high-speed plating machine developed based on this technology has been successfully authorized to LICON for mass-producing electrochromic products. Compared with the currently available sputtering processes, the thin-film plating rate of this technology can be increased by 5-10 times and the power consumption of the plasma source can be reduced to 1/4 of the currently available sputtering processes. Thus, this technology can satisfy the low-carbon production, low energy consumption and low pollution requirements of the “Green Manufacturing (G.M.)”, which can dramatically decrease greenhouse gas emission, alleviate global warming and reduce environmental pollution with a view to promote the balance of production and environmental sustainability. Moreover, this technology can effectively lower the cost of the electrochromic products, which can enhance the competitiveness of the electrochromic product manufacturers in the market, such that the electrochromic products can be more accessible and affordable for most people. In this way, this technology can solve the problem that the popularization of energy-saving electrochromic windows cannot be realized due to their high unit prices.

LICON is the only one Asian manufacturer capable of mass-producing electrochromic side mirrors and rearview mirrors. LICON has the third-highest market share of these products and their sales network covers the whole world. Via the corporation of LICON and INER in the future, the energy-saving thin film with fast electrochromic switching ability developed by this technology will be integrated with the high electrical-conductivity solid electrolyte and the packaging technique developed by LICON in order to develop an energy-saving electrochromic window. This product can be manufactured by a low-carbon manufacturing process and conform to the commercial standards. Furthermore, this product is not only of low power consumption, but also achieves high heat isolation and meets the standards of green building materials. As a result, this product can definitely reduce the power consumption of air conditioners of various buildings and keep the indoor temperature being proper. Therefore, this product can be more environmentally-friendly with an aim of realizing the balance of production and environmental sustainability.

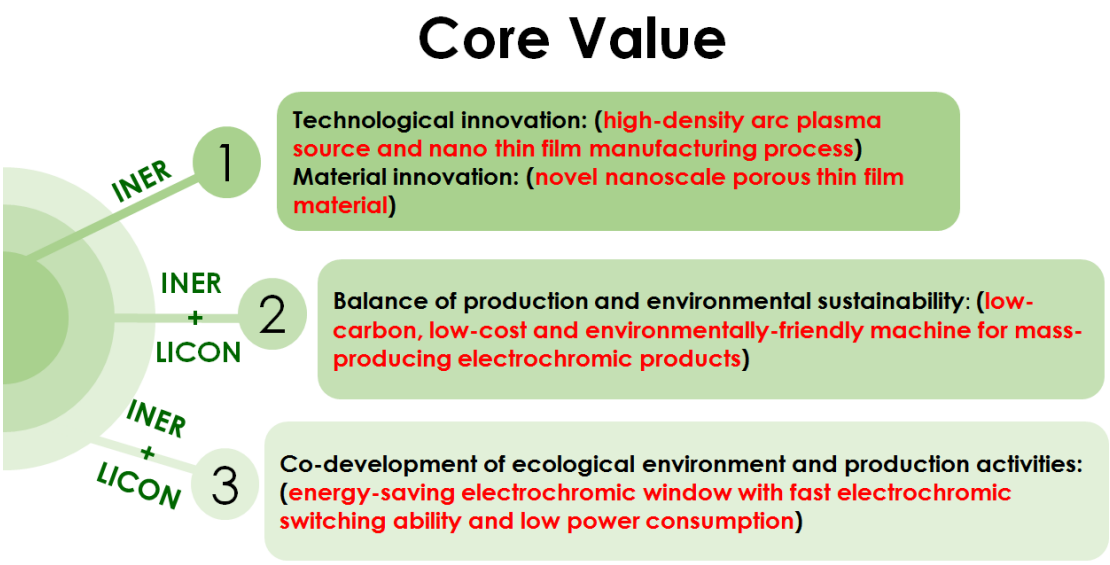


Fig.1. Core technical feature

1. Technology:

1.1Replacement: To Replace Existed Sputtering Process Comprehensively

This technology develops a novel arc plasma source, as the design shown in Fig. 2(a). Our team carefully designs the shading mask, the target and the positions of the magnets in order to optimize the arc plasma source, Via accurately adjusting and controlling the moving speeds and the sizes of the arc points, as shown in Fig. 2(b), the energy density and the ionization rate of the plasma can be further optimized with a view to achieve long-term and stable operation of the plating process. Our team further integrates the above arc plasma source with specially-designed and optimized process parameters: (1) precisely adjust and control the working current of the arc plasma; (2) adjust the working air pressure ratio according to different materials; (3) adjust the magnets to the best positions to effectively manufacture a porous structure applicable to energy-saving electrochromic glass products capable of achieving high transmittance, fast electrochromic switching ability and other excellent characteristics. The plating rate of the novel arc plasma source can be up to about 10~100nm/min in performing the plating process for electrochromic thin films, which is much greater than the plating rate, about 1~10nm/min, of magnetron sputtering. Compared with the conventional magnetron sputtering process for electrochromic thin film, this technology can achieve greater manufacturing efficiency and higher production.

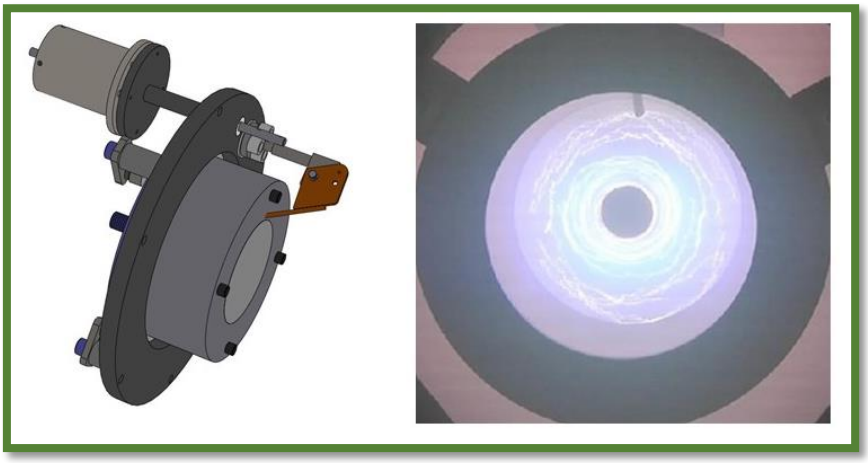


Fig. 2. (a) New Design of Arc Plasma Source (b) Arc Plasma Discharge

Regarding apply this technology to achieve energy saving and carbon reduction, saving energy can be achieved by decreasing the power consumption of the machines when the machines are used to mass-produce products, such that the overall energy consumption of the factories can be effectively decreased. In this way, not only is the expense in electricity reduced, but also the greenhouse gas emission and air pollutant emission, caused by power generation and energy consumption, are decreased. The energy-saving performance assessments and carbon emission assessments of applying this technology to manufacture electrochromic window products are as shown in Fig. 3. Fig. 3 shows the schematic view of the power consumption assessment and the assessment of the carbon emission caused by the power consumption according to the aspect of energy-saving and carbon reduction. In addition, Table 1 shows the assessments made according to 4 perspectives, including “Process”, “Product”, “Power” and “Produce”.

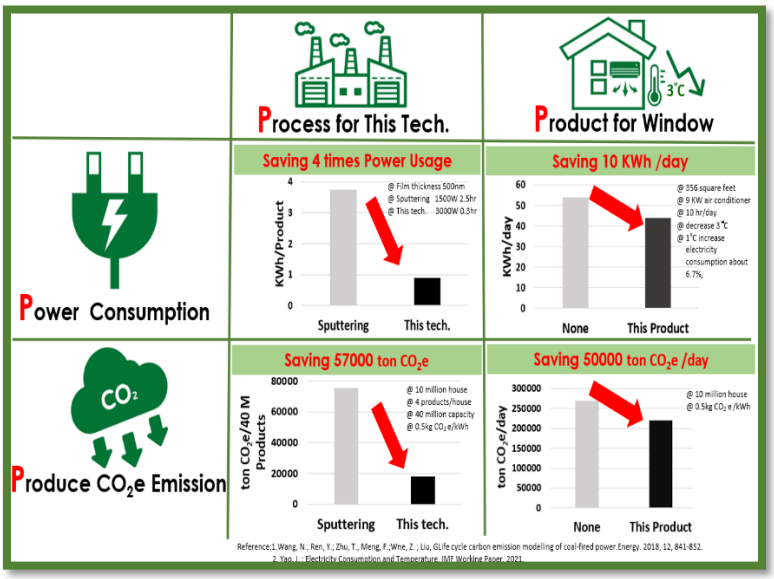


Fig. 3. Schematic view of energy-saving and carbon reduction performance assessment of applying this technology in production

Table 1. Energy-saving and carbon reduction performance assessment of this technology

Direction	Assessment	Cost-effective
Energy Saving	Process/Power The power consumption needed by the manufacturing process of this technology	Saving 4 times power usage (Note 1)
	Product/Power The energy consumption, of the air conditioner, reduced by this product installed in a building	Saving 10kWh/day of power consumption for each household. (Note 2)
Carbon Reduction	Process/Produce The carbon emission generated due to the manufacturing process of this technology	Saving 57,000 ton CO_2 e/day. (Note 3)
	Product/Produce The carbon emission, of the air conditioner of a building, after this product installed in the building	Saving 50,000 ton CO_2 e/day. (Note 4)

Note 1: it is assumed that the default thickness of the thin film is 500nm. The power consumptions (watt) of two manufacturing processes for plating the thin film with the above thickness are assessed. The power of the machine for the sputtering process is 1500W and the manufacturing time is 2.5hr. The power of the machine for this technology is 3000W and the manufacturing time is 0.3hr.

Note 2: it is assumed that the air conditioner is designed, by default, for a room whose size is 365 square feet. Via this technology, the air condition of 8kW can reduce the indoor temperature by 3°C and the average usage time is 10hr, such that the power consumption of the air conditioner can be reduced (when the temperature increases by 1°C, the power consumption may increase by 6.7%).

Note 3: it is assumed that a unit zone includes, by default, 10 million households and the house of each household is installed with four windows manufactured by this technology. The desired production capacity is 4 million windows per month (production capacity=quantity of household×quantity of windows needed by one household). The power consumption, of the sputtering process, for achieving the above production capacity is compared with that of this technology, and the corresponding CO_2 emissions (CO_2 e) are assessed based on 0.5 kg CO_2 e/kWh.

Note 4: the conditions are the same with those of Note 2; it is assumed that a unit zone includes, by default, 10 million households and the CO_2 emissions (CO_2 e) is assessed based on 0.5 kg CO_2 e/kWh.

Reference:

1.Wang, N.; Ren, Y.; Zhu, T., Meng, F.;Wne, Z. ; Liu, GLife cycle carbon emission modelling of coal-fired power.Energy. 2018, 12, 841-852.

2. Yao, J. ; Electricity Consumption and Temperature. IMF Working Paper. 2021.

Fig. 4 shows a low-cost mass-production type electrochromic thin film high-speed plating machine developed based on this technology, which is a first larger high-density arc plasma system for mass production in Taiwan. The picture at the right side of Fig. 4 shows the arc plasma source in operating state. Currently, out team has mastered the conditions of the manufacturing process for electrochromic thin films and the stability conditions so as to develop the energy-saving electrochromic glass for the green building application. Our team will promote the localization of the production utilizing this technology and the popularization of this product, and further promote this product to the multi-billion dollar global market.

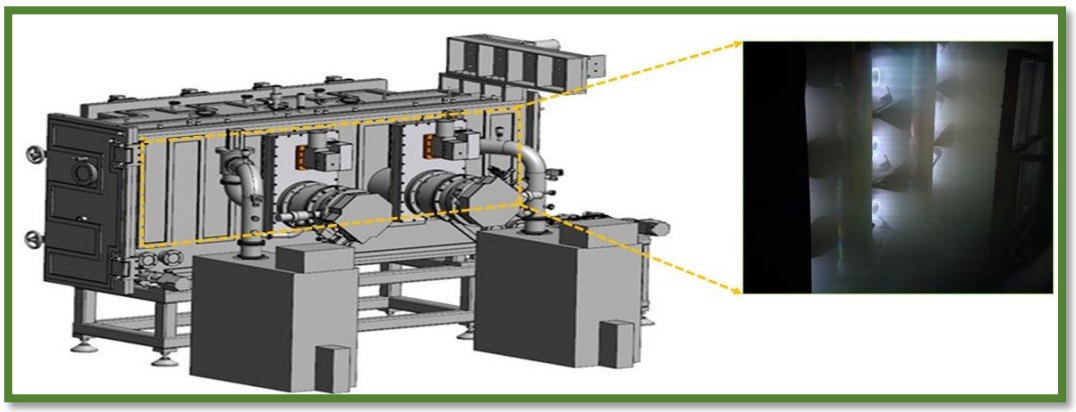


Fig. 4. (a) Mass production machine with arc plasma

The energy-saving electrochromic window (the area of this window is about 400×300 mm^2), manufactured by this technology and conforming to the commercial standards, is as shown in Fig. 5. This window has the excellent characteristics of 4H1L, including (1) High Transmittance Modulation (2) High heat Isolation (3) High Memory Effect (4) High Durability (5) Low power driving. Thus, it is obvious that the characteristics of this window is greater than those of the energy-saving electrochromic window manufactured by SAGE Electrochromic (world top company). In addition, the cost of the machines for this technology is relatively low, which can decrease the manufacturing cost and reduce the unit price of this product in order to achieve the popularization of this product in various applications.

Fig. 5. Performance of Energy-Saving Window (area: about 400× 300 mm^2)

The novel arc plasma source developed by this technology focuses on “Green Manufacturing (G.M.)” That is to say, the manufacturers need to minimize carbon emission and decrease pollutants which may damage the environment during the manufacturing processes of their products. The only way to achieve the goal “Sustainable development” is to make sure that the environmental load never exceeds the environmental carrying capacity. In order to realize green manufacturing and promote green production, our team successfully develops an electrochromic thin film manufacturing technique via this technology, which can dramatically reduce power consumption and lower greenhouse gas emission. Therefore, this technology allows us to be closer to the goal of “Net Zero” with an aim of enhancing the value of green circular economy. In addition, this technology can effectively reduce the energy consumption of the manufacturing process, such that the manufacturing cost can be further decreased. As a result, the products manufactured by the manufacturing process can have higher commercial competitiveness and affordable prices for consumers. On the other hand, as the energy consumed in the manufacturing process decreases, the carbon emission can also decrease, which can create a “Win-Win-Win situation” for the environment, enterprises and consumers, as shown in Fig. 6.

Fig. 6 Win-Win-Win situation

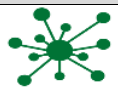
B. How does the product operate?

Describe the mechanism of action, theories, materials, composition or construction.

The core technical feature of this technology is the novel high-density arc plasma source, which can be divided into three major parts. First, our team precisely controls the size of the macro-particles of the plating material to be nanoscale so as to develop a novel arc plasma nanoscale thin film manufacturing process. Second, our team develops a nanoscale porous structure and applies this structure to the electrochromic thin film, which can realize fast electrochromic switching ability. Finally, our team develops a one-step packaging technique, as shown in Table 2.

The electrochromic window developed based on this technology can be manufactured by a low-carbon manufacturing process and conform to the commercial standards. Further, this product has many brilliant characteristics, such as (1) energy-saving (low power driving, great memory effect, etc.); (2) high heat isolation (great infrared insolation ability, active SHGC adjustment, etc.). This product can achieve not only energy saving and carbon reduction, but also can conform to the standards of green building materials, as shown in Table 2.

Table 2. Core technical feature

1. Innovative high-density arc plasma source		
☑		**1-1 Precisely control particle size to be nanoscale**
☑		**1-2 Electrochromic thin film with porous structure and fast electrochromic switching ability**
☑		**1-3 One-stop packaging**
2. Low-carbon electrochromic window conforming to commercial standards		
☑		**2-1 Low power driving**
☑		**2-2 Excellent memory effect**
☑		**2-3 High heat isolation**
☑		**2-4 Adjustable SHGC**

1. Novel high-density arc plasma source

1-1. Precisely control particle size to be nanoscale

This technology can increase the total current of the arc plasma to be at least 400A by reducing the size of the shading mask and properly designing the multi-gun discharge mechanism so as to provide a deposition technique with high production capacity. Our team further provides 3 specially-designed process parameters optimized for the deposition technique: (1) precisely adjust and control the working current of the arc plasma; (2) adjust the working air pressure ratio according to different materials; (3) adjust the magnets to the best positions to accurately control the moving of the arc points, such that the sizes of the micro-particles can be controlled to be 100~200nm, as shown in Fig. 7.

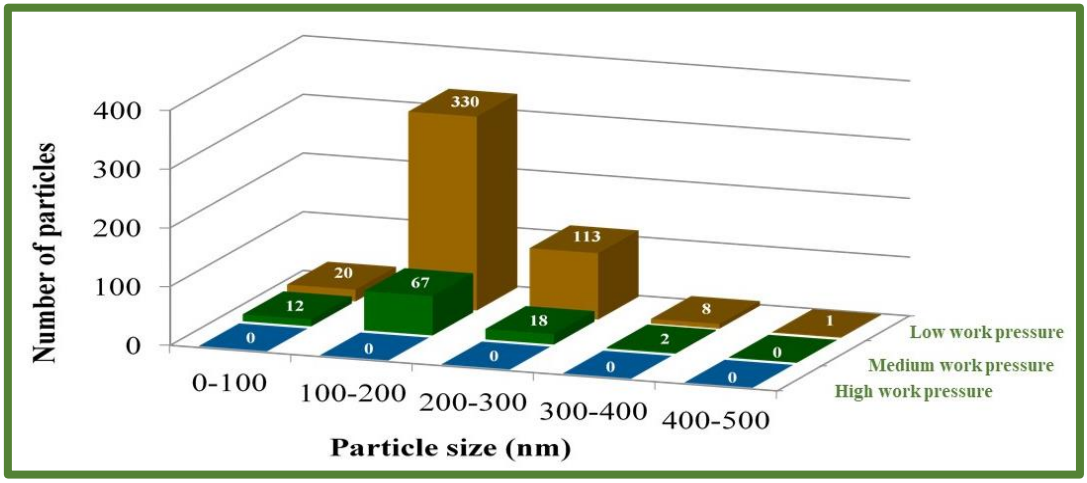


Fig. 7. Control macro-particle size between100~200 nm

1.2 Electrochromic thin film with porous structure and fast electrochromic switching ability

Our team integrates this technology with special-designed process parameters, and successfully manufacture a porous structure applicable to energy-saving electrochromic glass products capable of achieving high transmittance, fast electrochromic switching ability and other excellent characteristics, as shown in Fig. 8.

Step 1: utilize this technology to deposit an electrochromic film and an ion storage film in order to manufacture a large-area electrochromic device.
Step 2: the electrochromic layer and the ion storage layer have porous structures in order to enhance their capacitances and coloring efficiencies.
Step 3: the porous structure of the electrochromic film can shorten the moving paths of the ion and electrons,
Step 4: the energy-saving electrochromic glass has fast and great electrochromic switching ability.

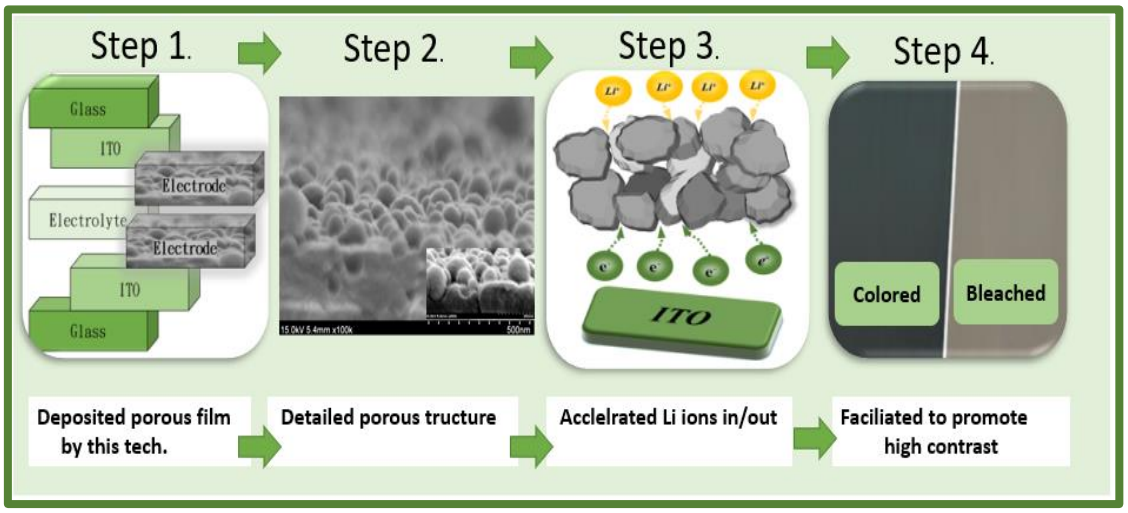


Fig.8. Using nano-porous structure to enhance electrochromic performance.

1.3 One-stop packaging

Our team has successfully developed a large-area electrochromic glass packaging technique by utilizing this technology, as shown in Fig. 9, which includes an automatic glue dispensing device, a glass positioning device, a vacuum injection device, etc. The technique can effectively reduce the outsourcing conditions and expenses of commercializing this product with the purpose of further optimizing this product.

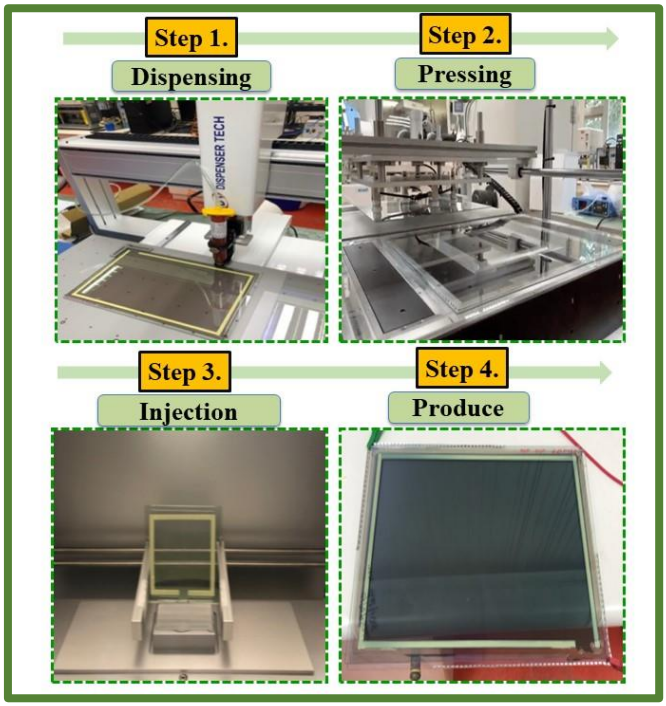


Fig. 9. One-stop packaging for electrochromic glass

2. Low-carbon electrochromic window conforming to commercial standards

2-1. Low Power Driving

This electrochromic product is of low energy consumption and can be driven by low voltage. The operating voltage of this product is less than ±2.5V. In addition, the current density of the charge/discharge current of this product is only 10-100 mA/cm^2, so the maximal power of this product can be merely 2.5W, as shown in Fig. 10.

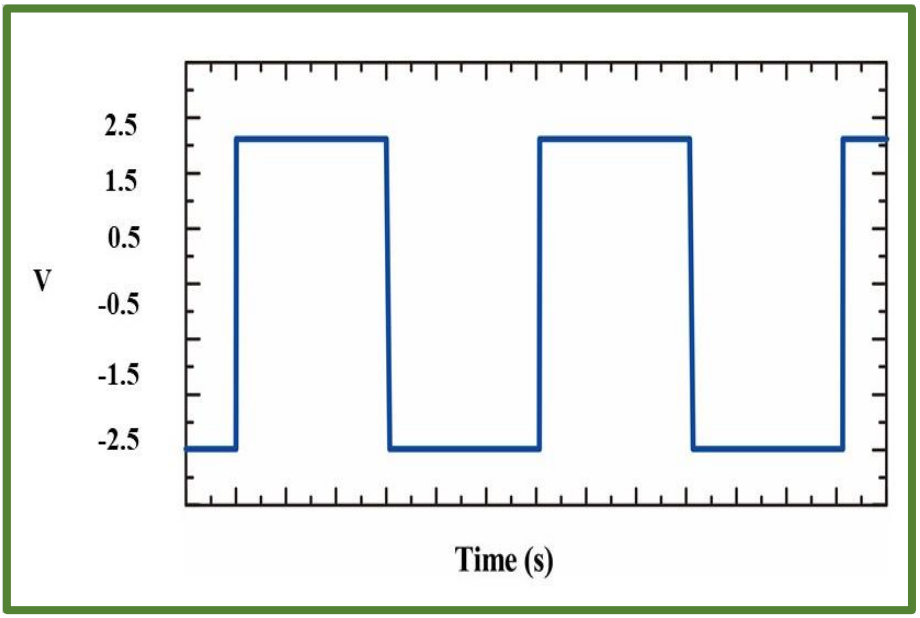


Fig. 10. Product was applied low voltage of -2.5 V for colored state and 2.5 V bleached one.

2-2. Excellent memory effect

After this product is idle for 4 days without connecting to the driving power source and the transmittance spectrum is the wavelength of 633nm, its transmittance is only changed from 22% to 28%. Thus, this product has brilliant memory effect, as shown in Fig. 11. Therefore, the power consumption of the energy-saving electrochromic glass system can be effectively reduced.

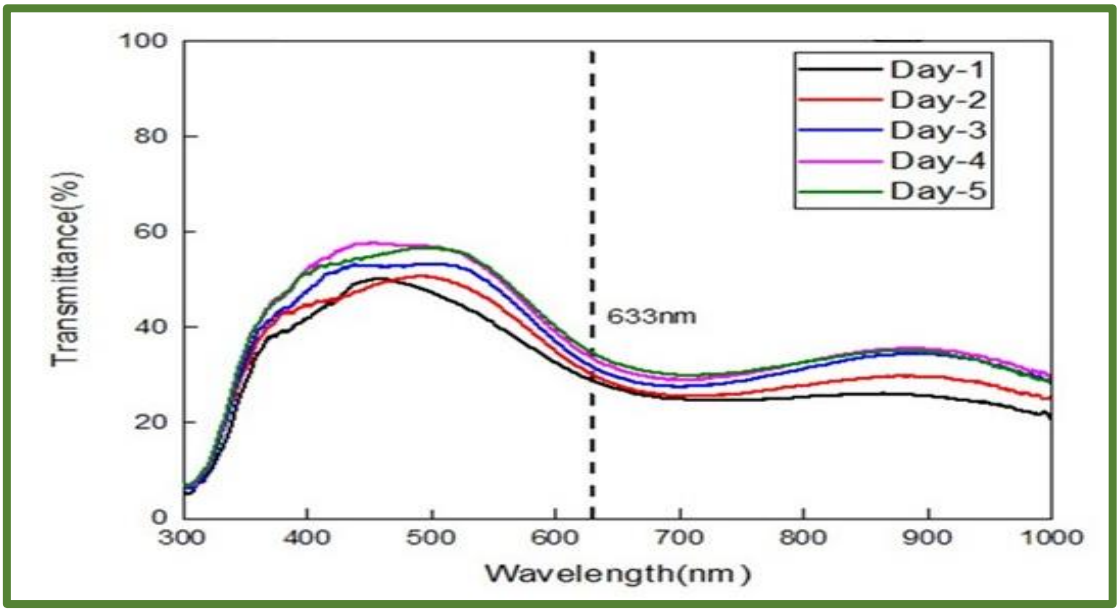


Fig.11. Electrochromic glass with good memory effect

2-3. High heat isolation

This product can effectively isolate the radiate heat and ultraviolet caused by sunlight, and can provide high heat isolation. Accordingly, this product can decrease the power consumption of the indoor air conditioning system. Fig. 12 shows the high heat isolation of this product.

A. When this product is colored, the transmittance of this product is 8% and the heat isolation of this product is 99.1%.

B. When this product is bleached, the transmittance of this product is 60% and the heat isolation of this product is 67.3%.

C. The transmittance change, in the visible light band, of this product is 52% (≥ 50% required by the commercial standards).

IV. PRODUCT COMPARISON

A. Describe how your product/service improves upon competitive products or technologies.

Currently, the most representative energy-saving electrochromic window manufacturer is SAGE Electrochromics (United States). This company manufactures electrochromic thin films by sputtering. However, this technology adopts a revolutionary method to manufacture electrochromic thin films by arc plasma sources. Compared with SAGE Electrochromics, this technology has many advantages, as shown in Table 2.

Table 2. Specification comparison between the product of INER and the product of SAGE Electrochromics[1]

		INER	**SAGE**
Plasma source	Technique	ARC Plasma	Sputtering
	Plasma density	10^{16}~10^{20}	10^{14}~10^{18}
	Plasma ionization rate	65~90%	1~5 %
Electrochromic thin film	Plating rate	10~100 nm/min	1~10 nm/min
	Structure	Porous structure	Dense structure
	Electrochromic switching speed	Fast	Slow
Electrochromic product	Transmittance in colored state	8%	1%
	Transmittance in bleached state	60%	55%
	Transmittance change	52%	54%
	Memory effect	Last for 4 days	Last for 1 days
	Maximal power	2.5 W	3 W

Reference 1: Smart Glass Market by Technology, Application, Control Mode and Geographic Analysis - Global Forecast to 2027

B. **Describe the limitations of your product/service.**

1. Exceed the service life of the product: 10000 cycles:

   The major principle of the product developed by this technology is to activate the reduction/oxidation reactions via the intercalation and de-intercalation of the metal ions in the electrochromic thin film, such that this product can be switched between the colored state and the bleached state. If the number of cycles exceeds the service of this product, the variation between the colored state and the bleached state may gradually decay or ineffective. (e.g., the variation may be decreased to 93% when the number of cycles reaches 2,500; the variation may be decreased to 70% when the number of cycles reaches 10,000).

2. Exceed the working temperature range of this product: -10°C ~ 120°C

   When the user uses this product in a country at high latitudes and the temperature in winter reaches -30°C, this product may malfunction because the metal ions cannot pass through the original channels due to electrolytes.

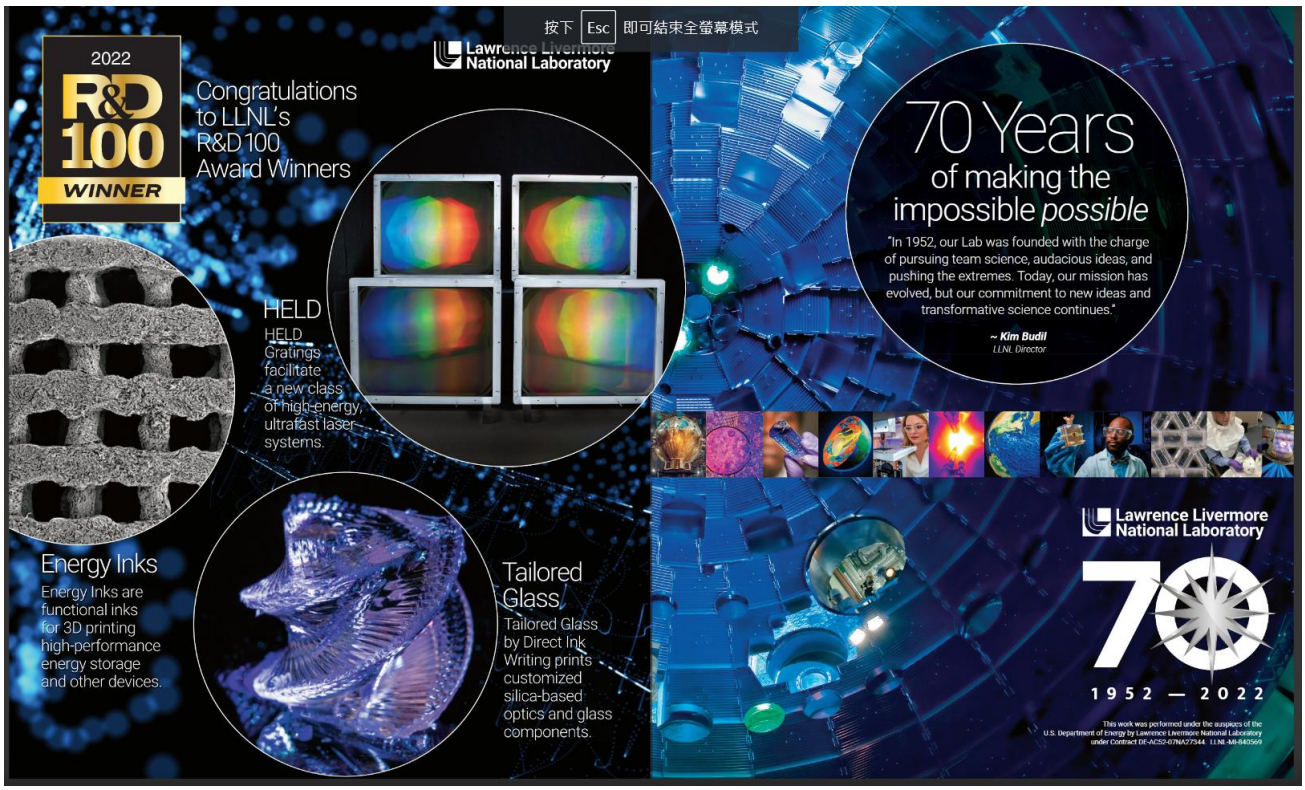
C. Summary

This technology focuses on developing a novel arc plasma source and our team successfully realizes the plating process for large-area electrochromic thin films. This thin film developed by this technology is integrated with the high electrical-conductivity solid electrolyte and the packaging technique developed by LICON in order to develop an energy-saving electrochromic window conforming to the commercial standards. Our team also successfully develops a mass-production type electrochromic thin film high-speed plating machine based on the integration of the above technologies and the technology authorization of the above machine is now in progress.

The novel arc plasma have many competitive advantages, such as low carbon production, low energy consumption, low cost, etc. The energy-saving electrochromic glass developed based on this technology also has many marvelous characteristics, such as low power driving, high transmittance variation, great thermal isolation, great memory effect, high stability, etc. The high-quality electrochromic glass can be applicable to the windows of houses and moving carriers (such as car sunroofs, yacht windows, airplane windows, etc.) so as to balance daylighting and energy saving.

Moreover, this unique technology can further significantly reduce the manufacturing cost and increase the production efficiency of the electrochromic glass. In this way, this product can be accessible and affordable for most people to use this product in their daily lives instead of being only applicable to a few high-end products, such as Boeing 787 Dreamliner. Therefore, people can not only enjoy great daylighting and beautiful view via this product, but also reduce the energy consumption of the air conditioners in order to achieve carbon reduction for the earth. This technology can be helpful, from the low-carbon manufacturing processes for manufacturers to the energy-saving applications for consumers, for the improvement of global warming, can create a “Win-Win-Win situation” for the environment, enterprises and consumers.

(二) 大會會議提供各參賽作品資料及各領域專題介紹



FROM THE EDITOR

An R&D 100 history lesson

This has been a big year for the R&D 100 Awards. The program, often referred to as "The Oscars of Innovation," is celebrating its 60th year — truly an incredible accomplishment. Each year, this renowned program celebrates the technology that is poised to change the world for the better. Submissions come from across the globe in six different categories and five special recognition areas.

In this issue, you'll learn about the 100 winners, along with 13 special recognition medalists. These products and technologies originated in corporate, academic, and government laboratories, although many winners come from collaborations between organizations in these three groups.

Neil Ruzic was the founder of both Industrial Research Magazine (now R&D World) and the R&D 100 Awards program. According to Brian E. Joseph, President & CEO of Touchstone Research Laboratory, Ruzic was frustrated that the Nobel Prizes were given out for just a handful of fields — such as medicine, physics, literature, and peace — but if you were outside those fields, there were no awards of any significance.

"Also, the Nobel Prizes didn't necessarily have an impact on the production of goods and services. He felt there was this need, and that's the genesis of the R&D 100 Awards," said Joseph.

Ruzic was quite a fascinating fellow, and I wish I could have met him before his passing in 2004. He was a pilot, co-founder of the National Space Society, and even wrote a dozen books. Joseph recalled that he had the dream of setting up an "Island for Science" in the Bahamas and even purchased a home there. Today, that island is Norwegian Cruise Line's "private island" called CocoCay.

But back to this year's winners … now that the COVID-19 pandemic is somewhat under control, we're excited to celebrate these brilliant scientists and engineers in person. Our black-tie gala awards dinner is returning for the first time since 2019. I hope you'll be able to join us on November 17 at the Coronado Island Marriott Resort & Spa near San Diego. This event is always such an amazing night of networking and celebration with some of the greatest luminaries in the world of research. We're looking forward to honoring the 2022 winners.

It's also time to start thinking about the 2023 program and what accomplishments you should submit for next year's awards. The 61st iteration of the R&D 100 Awards will open for nominations on March 1, 2023. We look forward to seeing what your team has been working on — and celebrating your innovations — thanks to the foresight of Neil Ruzic. &

Paul J. Heney | VP, Editorial Director
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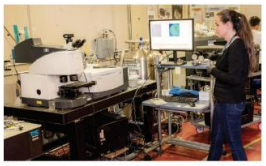
Quanta Image Sensor (QIS) Camera

Gigajot Technology, Inc.

In fields such as life science, quantum physics, and astronomy, the ability to image in ultra-low light is critical — so scientists and engineers can detect and count individual photons. Until now, photon-counting sensor options have had problematic limitations of higher noise, stochastic noise associated with avalanche gain, require deep cooling, cannot count multiple photons, and have low resolution. Gigajot's Quanta Image Sensor (QIS) Camera solves these problems and provides a powerful new imaging platform to advance scientific research and enable new discoveries. Because the deep sub-electron read noise is achieved with tiny pixels, magnifying lenses are not required, and life science samples can be studied without expensive optics. In the long run, the small pixel performance of the QIS Camera will migrate from high-end scientific applications to other markets where low light performance is valued, such as cell phones, surveillance, professional video, industrial, and automotive cameras.

Spectral Phenotyping with MirroRx

Lawrence Berkeley National Laboratory



MirroRx is a biomarker technology that accurately predicts disease status. The disease phenotype is analyzed by measuring how the patient's endogenous molecules vibrate upon exposure to infrared light. The difference between the vibrational profiles of disease and control samples is so visible that the spectral process is like "cellular fingerprinting." Aggressive cancers such as ovarian and gliomas have low survival rates, but the disease cells have little to distinguish them from non-disease cells. Neither the presence of disease nor its prognosis is predictable. New biomarkers are needed if we are to improve the outcome of clinical trials or to develop more effective therapies. Towards that goal, early results with MirroRx on a handful of samples from presymptomatic patients — who later developed Alzheimer's — indicate that the technology can spot Alzheimer's before symptoms develop. If this holds true in future validation trials, spectral phenotyping by MirroRx may, at long last, provide a window of time for patients to try experimental medicines that could delay or even stop disease progression.

UniTOM HR Dynamic Micro-CT System

Tescan Orsay Holding, a.s.

TESCAN's UniTOM HR Dynamic Micro-CT System solution brings fast dynamic CT imaging from the cutting-edge synchrotron to the mainstream laboratory. UniTOM brings together the most sought-after micro-CT capabilities, giving researchers a versatile solution that covers a broad range of 3D imaging and in-situ applications, handles a variety of sample shapes and sizes, and enables 4D time-resolved dynamic experiments. UniTOM HR can characterize newly developed materials at the highest possible micro-CT spatial resolution, a requirement for sub-micron scale static 3D imaging. It can also provide researchers with a better understanding of how these new materials — and functional components created from these materials — will behave under changing conditions through real-time, not time-lapse, visualizations. This dynamic capability sets UniTOM HR apart from other micro-CT instruments on the market. Many time-dependent processes are unpredictable and capturing the most important aspects of the process may not be possible in an interrupted or time-lapse collection scheme. TESCAN has resolved this issue with its dynamic CT technology that collects data throughout the entire process.

Continuous Tracking Surgical Assistance System (CTSAS)

Metal Industries Research & Development Centre (MIRDC)

Continuous Tracking Surgical Assistance System (CTSAS) is the first-ever dodecahedral marker, combined with real-time images of independent vertebra and dynamic correction navigation, that can track and truly present the posture changes of each vertebra. In the process of surgical navigation, only a single registration is required, and intraoperative real-time images can be provided for reference. It can make detailed corrections to the fine posture of each vertebra so that the navigation image is closer to the real spinal topography. It also solves the issue of the traditional tracker being too large and easily causing mutual interference. CTSAS subverts the ecology of the current tracking system and uses the logic of dodecahedral marker design to create a new technology where each operated vertebra can be positioned and tracked at one time. This brings a new model of thinking into multilevel spinal surgery navigation. Furthermore, CTSAS can be combined with a robotic arm to assist surgeons in finding surgical sites more easily through AI path planning.

Full Field of View Atom Probe Microscope – The Invizo 6000

CAMECA Instruments Inc.

The Invizo 6000 is a high efficiency, symmetric dual-illumination, deep ultraviolet laser atom probe tomography (APT) microscope providing 3D subnanometer spatial resolution information for all elements. It provides the widest field of view and the fastest data collection rate of any APT system to solve the most challenging material's problems. Nanotechnology is playing an ever-increasing role in the development of a long list of compelling new technologies that will improve our lives including faster, energy-saving computer chips; more fuel-efficient automobiles and airplanes; safer next-generation nuclear reactors; brighter and cheaper LED lights; improved energy conversion and storage devices; and stronger, lighter, and longer-lasting metal alloys. Advances in these areas depend critically on the capability to characterize in 3-D at the atomic scale. The unique capabilities of the Invizo 6000 enable researchers in commercial, academic, and institutional environments to gain new insights into the materials and processes that will be used in to make the world safer, more energy-efficient, and at a lower cost.

cryoRaman – Cryogenic Raman Microscope

WITec GmbH
Co-Developer: Attocube Systems AG

The cryoRaman microscopy system integrates confocal Raman imaging within a cryogenic sample chamber. It was developed to bring the sensitivity and spatial resolution of Raman-based chemical characterization to researchers working at the edge of absolute zero. Inherently modular, cryoRaman offers VIS to NIR excitation lasers, 1.8 K to 300 K operating temperatures and high magnetic fields up to 12T. Features that enhance the system's flexibility and convenience include automated alignment and calibration, automated laser output adjustment, and motorized switching between different excitation lasers and white light microscopy. Options include precise software-controlled laser power adjustment, automated switching between optical microscopy and spectroscopic imaging, multi-wavelength excitation capabilities, an automated spectrometer calibration light source, time-correlated single photon counting (TCSPC) modes, low-wavenumber Raman peak detection, and full polarization control in excitation and detection. The modularity and freedom provided by the extensive upgrade possibilities will be of great utility in various fields of application.

Keyence 3D Optical Profiler with Rotational Unit

Keyence Corporation of America

Unlike traditional optical profiling systems that are hard to use and have material restrictions due to low dynamic range, the VR-6000 offers a simple place-and-press interface partnered with HDR scanning to capture highly accurate data — even on glossy or matte surfaces. The HDR algorithm automatically determines optimum lighting conditions, adjusting brightness and focus, to offer a dynamic range that is one thousand times greater than conventional systems. Now any user, regardless of experience level, can obtain accurate and repeatable data on any type of material. In addition, entire surfaces can be scanned in as little as one second, leading to quicker turnaround times and overall improvements in prototype development and inspections. Users can quickly perform pass/fail inspections and can accurately compare data to a CAD file or other part scans. This system leads the way in this market with its ability to solve measurement applications in nearly all industries from small medical devices to larger electronics and aerospace components.

NuSense Technology – High Spatial Resolution Optical Sensors for Harsh Environments

University of Pittsburgh
Co-developer: National Energy Technology Lab

NuSense is a disruptive optical fiber sensor technology that provides unprecedented measurement capabilities in environments previously thought impossible to probe. It is a distributed optical fiber sensor for real-time, high spatial resolution (3-cm), and multi-parameter measurements for energy and industry applications. The sensors perform distributed temperature, hydrogen, and dynamic strain measurements up to 850° C, with fast neutron flux up to 1x10^13 n/s^2/cm^2, and H2 concentrations (0.05% to 20%). NuSense technology provides vital sensing tools to harness valuable data in real-time with high spatial resolution in the most challenging environments previously thought impossible to probe. This tool enables us to understand vital chemistry related to key industrial processes, to optimize energy production processe, to safeguard critical infrastructures, and to build realistic digital twin models. NuSense technology will benefit a wide array of industry sectors and support carbon-free energy productions, advanced manufacturing, hydrogen economy, environmentally friendly recycling, and other industrial processes taking place in harsh environments.

Park FX40 Atomic Force Microscope

Park Systems

AFM is often cited as being challenging to learn and to operate by many engineers and scientists. To overcome this reputation, Park Systems has introduced The Park FX40, a next-generation, research-grade, automated AFM platform with fully automated probe exchange and beam alignment — and uses machine-learning technology to overcome these challenges. With simplified sample navigation and an intelligent scan algorithm, the Park FX40 makes enhanced performance and productivity accessible to everyone, new and experienced users alike. Park FX40 is an industry disrupter as it pushes the boundaries of what AFM can accomplish. The development of Park's FX40 is a great contribution to science in both academic and industrial applications and should be considered for an R&D 100 award this year.

VK-X3000 3D Surface Profiler

Keyence Corporation of America

The VK-X3000 allows users to capture 3D measurements with sub-nanometer resolution, even on materials that are transparent, matte, or have curved/steep slopes. By incorporating three different measurement methods: focus variation, laser confocal scanning, and white light interferometry, the system enables high-accuracy measurement and analysis to be performed on any target. Because the system was designed to be easy-to-use, anyone can capture accurate surface data at the click of a button. The VK Series can automatically adjust to the optimum settings and accurately measure profiles, roughness, and film thickness of an entire surface. With versatility at the forefront of the design, the VK-X3000 tackles quality control and research and development applications across a wide-variety of industries, including aerospace, automotive, electronics, medical devices, wafer processing, and university research. The VK-X3000 is truly an all-in-one device capable of capturing high-magnification images and performing 2D/3D profile measurements, surface roughness, film thickness, and volumetric measurements.

Thermo Scientific Orbitrap Exploris MX Mass Detector

Thermo Fisher Scientific

The Thermo Scientific Orbitrap Exploris MX mass detector is a built-for-purpose system designed to deliver high-confidence results for biomolecule attribute monitoring, also offering compliance readiness when used with Chromeleon CDS software. The system is part of a multi-attribute method (MAM) workflow that offers reduced downtime and maintenance and provides seamless method transfers from biopharmaceutical development to QC. Offering HRAM data for intact analysis of monoclonal antibodies (mAbs), oligonucleotide mass determination and peptide mapping, the Orbitrap Exploris MX mass detector is suitable for biopharma process confirmation. This enables accelerated drug characterization processes in QC and productivity improvements by fully integrating the Orbitrap Exploris MX into the MAM workflow, thereby replacing multiple assays into one information-rich mass spectrometric assay. The detector is based on the proven hardware and instrument control software of the next generation Orbitrap platform. It offers operational simplicity, compliance-readiness, reliability and seamless method transfer from lab to lab, overcoming the challenges with other systems of long downtime, high maintenance, non-compliance, high cost of ownership and high system-to-system variability.

proteoCHIP

BICO
Co-developer: Cellenion
Vienna Biocenter - Institute of Molecular Pathology (IMP) - Karl Mechtler's Lab

proteoCHIP is an innovative microchip made of Teflon and pre-filled with a thin oil layer to avoid evaporation of precious peptides during the sample preparation process. It enables the first commercially available automated workflow for single cell proteomics sample preparation (before Mass Spectrometry analysis) on the cellenONE single cell dispenser, including image-based cell selection and isolation, nanoliter reagent dispensing, and on-deck incubation. proteoCHIP 12*16 is the version dedicated to multiplex MS-based workflows. proteoCHIP revolutionizes the field of single cell proteomics by enabling an end-to-end sample preparation workflow for single cell proteomics before MS analysis, from cell isolation and lysis to peptide fragmentation and labelling to sample pooling and introduction to the LC-MS/MS autosampler. It showed outstanding results with quantification of up to 1500 proteins per run with no sample carrier and outstanding signal to noise. It is already used by most key opinion leaders in the field of single cell proteomics.

2022 R&D 100 WINNERS

Analytical / Test

Thermo Scientific Gallery Enzyme Master Enzyme Analyzer

Thermo Fisher Scientific

As the first and only system to fully automate all critical aspects of enzyme analysis across multiple enzymes and methods, the Thermo Scientific Gallery Enzyme Master Enzyme Analyzer marks a profound leap forward for how enzyme assays are conducted. Through this new system, the most critical pain-points and bottlenecks plaguing traditional spectrophotometric enzyme analysis have been simultaneously addressed — from edge effects and temperature stabilization issues to cumbersome method development and transfer. All the while, new levels of operational simplicity, efficiency, and traceability have been made possible. The system serves to streamline and democratize enzyme analysis. By lowering barriers to enzyme adoption in various sectors — spanning both research and industry — the analyzer will enable development of more innovative and better-quality products, created via less hazardous processes and with reduced waste and optimized product yields. Ultimately, through the broader adoption of enzymes made possible by the Gallery Enzyme Master, food taste can be enhanced, animal feed can be made more nutritious and more promising medicines can be created and brought to patients at pace.

Evusheld: A long-acting antibody combination for the prevention of COVID-19 in high-risk individuals

Vanderbilt University
Co-developer: Vanderbilt University Medical Center; AstraZeneca

Although many immunocompromised people received a COVID-19 vaccine early on, their immune systems often failed to generate proper antibodies in response to the vaccination, leaving this large sub-population of people exposed to infection. Evusheld is an FDA EUA-approved antibody medicine for COVID-19 that is delivered via intramuscular injection and provides lifesaving protection to this highly vulnerable group. Evusheld is currently authorized for people who are not infected with COVID-19 and who are immunocompromised because of medical conditions or treatment, disorders including cancer, or who have a history of a severe adverse reaction to COVID-19 vaccines. The preventative medicine is administered via two intramuscular injections of the neutralizing antibodies that comprise Evusheld and has been shown to provide at least six months of protection from symptomatic COVID-19. Additional laboratory data from the NIH demonstrate that Evusheld neutralizes all variants of concern, including Omicron BA.2, which is currently the dominant variant throughout much of the world. In addition, Evusheld showed up to an 88% reduction in severe COVID-19 or death in symptomatic outpatients.

2022 R&D 100 WINNERS

IT / Electrical

SOFIA: Spectrometer Optimized for Facility Integrated Applications

Los Alamos National Laboratory
Co-developers: National Institute of Standards and Technology (NIST), University of Colorado - Boulder

Nuclear technology, such as carbon-free nuclear power generation and nuclear medicine, is an essential part of modern life and is widespread around the world. Correspondingly, nuclear safeguards are essential to deter the spread of nuclear weapons. As an example of the magnitude of this challenge, the International Atomic Energy Agency is responsible for safeguarding 212,814 significant quantities of nuclear material in 1,314 facilities across the world as of 2018. SOFIA (Spectrometer Optimized for Facility Integrated Applications) is the first ultra-high-resolution gamma spectrometer based on low-temperature microcalorimeter technology designed for and demonstrated in nuclear facilities. SOFIA provides a magnitude of 10x better resolution than standard high-purity germanium detectors in a compact instrument that can be operated in nearly any facility. This technology provides a path to completely nondestructive analysis with precision and accuracy approaching what is possible in a destructive analysis laboratory. It will find application in nuclear fuel cycle facilities, medical isotope production facilities, environmental monitoring laboratories and other locations that require analysis of nuclear and radioactive materials.

K-Modules: Capacitive Energy Modules for Pulsed Power Applications

Los Alamos National Laboratory

Febetron (energetic X-ray and electron beam-generating devices) users face a threat to their critical missions due to lack of new, reliable pulsed power components. Both the government and private sectors are experiencing this dilemma because existing units that power Febetrons are manufactured by a single vendor. The design has not been upgraded in more than 40 years, raising serious technical concerns about their continued use. To address this, Los Alamos National Laboratory used sophisticated modeling and simulation software and COTS components to design new Febetron-compatible pulsed power units known as K-Modules. K-Modules' performance enhancements include higher X-ray dose and extended X-ray spectra. When used to generate electron beams, K-Modules increase the electron flux. This technology is serviceable and uses reusable and recyclable components. K-Modules are adaptable and allow for potential uses beyond Febetrons such as powering X-ray devices in the medical industry, and fracture detection devices in the petrochemical and gas industry, and for sterilizing food and pharmaceuticals. K-Modules can power E-beam devices used for material properties research as well as nuclear susceptibility testing of military electronic equipment.

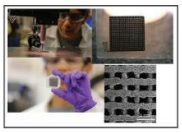
LightSlingers: Antennas that generate radio waves from faster-than-light currents

Los Alamos National Laboratory

Every antenna since the discovery of radio has used, in one form or another, the current density of free electrons as their radiative mechanism. For years, this approach was sufficient, though not without drawbacks. As connectivity came to define modern life, frequency bands became overloaded, and as devices grew in complexity, manufacture of their fragile parts moved overseas. Only a new paradigm in antenna technology can keep pace with the endless proliferation of wireless devices. Researchers at Los Alamos National Laboratory have developed LightSlingers, a leap forward in antenna design that promises to simultaneously declutter and secure the airwaves. LightSlingers uses the "other" radiative mechanism — the polarization current — creating, in effect, an entirely new class of antenna with myriad benefits. LightSlingers offer better coverage, efficiency, bandwidth, and security than traditional antennas or phased arrays, all in a sturdier package with far fewer components. Further, they have no geometry requirements — a LightSlinger antenna can be any shape and molded into any device. On 5G local neighborhood networks or the battlefield, LightSlingers are ready to make waves.

Multifunctional, 3D-Printable Inks for Energy Products (Energy Inks)

Lawrence Livermore National Laboratory
Co-developer: MilliporeSigma, a division of Merck KGaA



Energy Inks, 3D-printing feedstock inks developed by Lawrence Livermore National Laboratory (LLNL) and introduced to the market in three formulations by partner MilliporeSigma, offer functional properties, enabling next-generation, high-performance, 3D-printed devices for energy storage, catalysis, filtration, sensors, and more. Further, these devices can be 3D-printed faster, at a lower cost and exhibit higher performance than competitive technologies. Energy Inks meet 3D printing material flow conditions while optimizing functional properties of the extruded material, requirements difficult to obtain simultaneously. Such functional inks enable the design of customizable, easily integrated components, and, therefore, next-generation high-performance energy devices including those not possible to produce using current methods. Making use of the design flexibility afforded by direct ink writing, customizable storage components can be produced, lowering the costs associated with production. For commercial products, the technology relieves cost and time limitations to speed up marketplace introduction.

More sustainable Collation Shrink Film enabled by REVOLOOP and DOWLEX GM AX01

Dow Packaging and Specialty Plastics, a business unit of Dow Inc.
Co-developer: Polyrafia SA de CV

Using its unique materials science capabilities and appropriately connecting two different technologies, REVOLOOP and DOWLEX GMAX01, Dow developed a secondary packaging with an enhanced sustainability approach, exceptional overall performance, and suitable shrinkage, making the mechanical properties so outstanding that the film gauge can be reduced, improving seal properties, and keeping the processability during film extrusion. Up to 49% of carbon footprint savings can be achieved by the incorporation of PCR REVOLOOP in the film composition. In combination with DOWLEX GM AX01, improved mechanical properties were achieved, allowing downgauging, optimal shrink ability, and processability. This solution also brings exceptional optics — important to expand the marketability of the product. The high-clarity and gloss obtained allow the package to showcase the internal product, without printing, saving costs and delivering a cleaner waste stream for future recycling process. This innovation that includes 40% recycled content and outperforms the incumbent 100% virgin polyethylene, is easy to be implemented in the packaging chain, and addresses the use of waste into a new and perfectly usable packaging.

SABIC's LNP ELCRIN iQ Upcycled Product Portfolio Contributing to Net-Zero Carbon Goals In Multiple Industries

SABIC

SABIC's LNP ELCRIN iQ portfolio helps address a real waste problem by creating a market for recycled plastics by upcycling commodity single-use PET into high value compounds that are used in demanding durable goods applications. Compared to other mechanical recycling technologies, the LNP ELCRIN iQ portfolio can offer consistent quality, a wide range of colors, and compliance with regulatory standards for food contact, medical devices, and smart chemistry. SABIC's LNP ELCRIN iQ portfolio also includes sustainability attributes to the product offerings to provide circular economy transparency through the entire value chain. Responsible source verified by third party and PCR content certificate for each commercial grade are available publicly. Life cycle analysis (LCA) of ELCRIN iQ resins through critical review could provide a baseline benefit of carbon and energy footprint for the portfolio. The certificates and cradle-to-gate LCA information help customers to make a better decision toward carbon neutral goals.

Digital M functional resin material: Drops on where functionality is needed upon fabric

Taiwan Textile Research Institute
Co-developer: Sabrina Fashion Industrial Corp., Fu Hsun Fiber Industries Co., Ltd.

Digital M is a polyol polyurethane resin material with the function of moisture swelling and shrinking. When this material encounters moisture, it will produce a moisture swelling shrinkage effect, to create an "airflow channel" on the fabric surface. The channel can increase the surface volume between the skin and the air to help the skin remain dry. The heights of the airflow channels depend on the humidity of the body. This material can be dripped on the area of the cloth that needs airflow channel function, enabling the cloth to go from normal to functional. In summer, the material reduces stickiness by more than 45%; in winter, it maintains the temperature. It is suitable for digital jetting use. Digital M technology is working with Sabrina and Fuhsun, the fabric suppliers of international major sport brands such as Nike and Adidas, to develop one directional moisture-conducting structured deformation apparel.

PPG COPPER ARMOR Anti-Viral and Anti-Bacterial Paint

Corning

PPG COPPER ARMOR is an antimicrobial paint that uses Corning Guardiant copper technology, a biocide comprised of copper glass ceramic particles, to continuously kill viruses and bacteria on the painted surface, including Staph, MRSA, E Coli, and COVID-19, within two hours of exposure for up to five years. The product is low-odor and has zero volatile organic compounds — and provides mold and mildew resistance to surfaces. Available in eggshell and semi-gloss, Copper Armor can be tinted to more than 600 colors from the PPG paint palette. Protecting our surroundings from harmful viruses and bacteria is a challenge that unfortunately will be ever-present. Introduced in 2021, COPPER ARMOR, is the first virus-killing paint available in the U.S. The product eliminates 99.9% of viruses and bacteria on the painted surface. As a relatively cost-effective solution that's easy-to-apply and readily available across the country, PPG is providing an extra barrier of protection on surroundings and interior surfaces — benefitting property managers and the everyday consumer alike — with this new breakthrough technology.

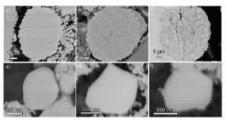
Low GWP Froth-Pak Spray Foam

DuPont

DuPont's Froth-Pak Spray Foam products are used to air seal and insulate various spaces within the building envelope. These products historically use hydrofluorocarbons as blowing agents which are being phased out of use in spray foam products because of their high global warming potential (GWP). Hydrofluoroolefin (HFO) blowing agents have been proposed as acceptable alternatives. However, critical compatibility challenges remain between desired catalyst systems and some HFOs, specifically 1,3,3,3-tetrafluoropropene. This results in loss of catalytic activity over time and degradation of product properties. DuPont seized this noteworthy challenge to invent a solution that delivers a significant reduction in greenhouse gas (GHG) emissions while maintaining product performance, based on a novel approach using carbon dioxide in addition to the liquid 1-chloro-3,3,3-trifluoropropene (HFO-1233zd) as the blowing agent package. The innovation team solved challenges in formulating, manufacturing, and application technology. The resulting sealant and insulation products are shelf stable, maintain all performance attributes, and boast a blowing agent package GWP reduction of more than 99%.

Stable and High-Performing Single-Crystal LiNixMnyCo1-x-y02 Cathode Materials (SC-NMC)

Lawrence Berkeley National Laboratory



To meet the burgeoning international need for high-performance lithium-ion batteries (LIBs), next-generation LIBs must have higher energy density and power density at a lower cost, with better safety and longer lifespans. Lawrence Berkeley National Laboratory's Single-Crystal NMC Cathode Materials (SC-NMC) advances the technology in every category. Other efforts to produce nickel-rich cathode materials have fallen short, resulting in lithium nickel manganese cobalt oxides that fracture and produce side reactions on the particle surface, degrading cathode performance. This cost-effective, scalable method enables production of SC-NMC cathode materials that eliminate the fracturing and reduce the side reactions on the particle surface. Cathodes using the resulting product remain mechanically intact. In fact, SC-NMC is expected to exceed competitors' life cycles by three times or more. The method's processes can be adopted into existing production lines, and SC-NMCs made with our method deliver significantly improved performance and stability compared to commercial polycrystalline materials. No other methods for developing SC-NMC cathode materials come close to developing a product that checks all the boxes necessary to meet the needs of next-generation LIB cathodes.

Brine Concentration with FilmTec Fortilife XC120 membranes

DuPont Water Solutions

Systems using the new innovative FilmTec Fortilife XC120, a spiral-wound reverse osmosis element, achieve water concentrations beyond 80,000 ppm to ~120,000 ppm of total dissolved solids while operating within the pressure limits of standard available reverse osmosis equipment. Reaching these concentrations pushes the overall water recovery up from 90% to 93.5%, reducing the amount of water needing thermal treatment by 35%. This provides an additional ~$0.08/m3 of wastewater treatment savings. Unlike treating wastewater to discharge, MLD-ZLD hybrid systems have the benefit of wastewater valorization. The treated wastewater from a textile mill in India has ~$1.06/m3 of circular economy benefits from the recovered fresh water and salts that can be reused in the dyeing process. These benefits together with the reduced cost of MLD-ZLD operation, and the overall textile wastewater management becomes competitive with the standard treat-for-discharge type operations practiced in other parts of the world. Moreover, the process provides the environmental benefits of lowering the water and salt footprint of the textile factory.

KapFlo: Clear Polyimides without compromising High Temperature Stability for Next Generation OLED Smartphone Displays

DuPont Electronics & Industrial

DuPont has developed and engineered novel families of films and coatings to address design and performance requirements for AMOLED substrates that have enabled display manufacturers to develop next-generation edge-to-edge flexible smartphone displays. These materials have been engineered to provide optical clarity while maintaining mechanical and thermal reliability. A team of DuPont scientists was able to break through the holy grail of thermal versus optical tradeoff and developed clear polyimides (KapFlo) using novel monomers. Engineers on the team were able to quickly scale up the production of the monomers and polymers to get them to customers for trial runs at an exemplary speed of 8-10 months. Commercialization of this novel product was possible because of the richness and diversity of small-molecule, polymer, and process chemistry knowledge within the team. Partnering with customers to understand product and process issues, developing novel solutions for an extremely challenging problem, scaling up the chemistry at record speed and iterative customer sampling using minimum viable products were some of the key factors for a successful product commercialization.

Drain-on-Demand Lithium Battery for Long-life IoT Devices

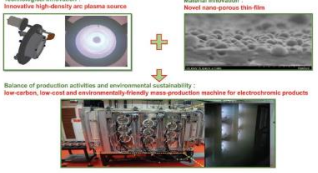
Nano and Advanced Materials Institute
Co-developer: Long Sing Technology Group (Hong Kong) Ltd.

With the emerging IoT technologies to ensure uninterrupted and high-quality signal transmission without loss under 5G, IoT devices require portable power supplies that are high energy-dense, high power, and long lasting in all-weather conditions. Drain-on-Demand Long-life ER14250 employs lithium thionyl chloride chemistry that has the highest energy density, and which has been engineered to overcome the shortcomings of conventional lithium thionyl chloride batteries. The optimized structure of the porous carbon catholyte host by the multifunctional pore-manipulating agent provides a better discharge efficiency at high current drain. The innovative "drain-on demand" coating layer applied on the lithium anode results in a lag-free high discharge performance. Moreover, the corrosion-resistant coating material significantly reduces self-discharge of the battery even under severe conditions. Thus, the battery is highly responsive toward discharge upon demand and provides close-to-design power output to ensure a long service life of the IoT devices. With these features specifically designed to overcome the pain points of current IoT devices, Drain-on-Demand Long-life ER14250 will empower a durable connection in 5G-IoT era.

Innovative, low-cost, and low-carbon technology for mass-producing electrochromic glass

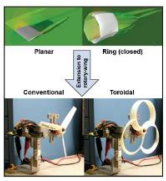
Institute of Nuclear Energy Research (INER), Atomic Energy Council, Executive YuanCouncil, Taiwan
Co-developer: LICON Technologies Inc.

The technology provides an innovative high-density arc plasma source and the machine for mass production, adopting this arc plasma source. The novel arc plasma has many competitive advantages, such as low carbon production, low energy consumption, and low cost. The energy-saving electrochromic glass developed based on this technology also has many excellent characteristics, such as low power driving, high transmittance variation, great thermal isolation, great memory effect, and high stability. The high-quality electrochromic glass can be applicable to the windows of houses and moving carriers (such as car sunroofs, yacht windows, and airplane windows) to balance daylighting and energy saving. Moreover, this unique technology can further significantly reduce the manufacturing cost and increase the production efficiency of the electrochromic glass. In this way, this product can be accessible and affordable for most people to use in their daily lives instead of being only applicable to a few high-end products, such as Boeing's 787 Dreamliner aircraft.



Toroidal Propeller

MIT Lincoln Laboratory



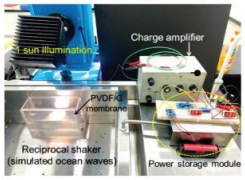
Multirotor air vehicles have matured significantly from their recreational roots, with major aerospace companies and technology giants pouring significant resources into developing vertical takeoff and landing (VTOL) platforms for delivery, transport, inspection, and a host of other missions and markets. However, public opposition to the wide-scale deployment of these low altitude aerial platforms will be fierce and significant if the platforms are loud. The Toroidal Propeller is significantly quieter — notably in the sound frequency most sensitive to humans — than current VTOL propellers, while generating similar thrust for similar power requirements. Its closed-form design is customizable for a wide range of platforms, is easy to manufacture, and is less likely than conventional propellers to catch on or cut objects, improving the safety and resilience of these platforms. These features make the toroidal propeller suitable for drop-in replacement on current systems, and offer a new approach for developing new, acoustically quiet platforms in the future.

2022 R&D 100 WINNERS

Process / Prototyping

Black Magic Carpet for Water and Power Production (BMC-WP)

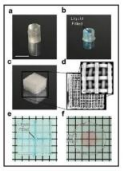
Advanced Membrane Materials Research Center (AMMRC), National Taiwan University of Science and Technology
Co-Developer: King Membrane Energy Technology Inc.



The Black Magic Carpet for Water and Power Production is the first innovation that combines simultaneous steam and power generation using an intelligent membrane with dual capabilities. PVDF/graphene membrane is used in the application of this BMC-WP. This product uses PVDF/graphene solar evaporation membranes to achieve sun-driven freshwater production and wave-driven power generation. The membrane can convert mechanical wave energy into electrical energy. The PVDF/graphene membrane produced a voltage of 2.6 V (±1.3 V) and a power density of 2.11 W m−2 in 1-Hz waves. In addition, under one sun illumination (1 kW m−2), stacked graphene and PVDF developed a hydrophobic interface water channel structure with a water production rate of 1.2 kg m−2 h−1 and a solar-thermal energy conversion efficiency of 84%. The water sampled was within WHO drinking water quality criteria. The developers constructed a product using a single solar evaporator to acquire fresh water and create power simultaneously.

Tailored Glass Using Direct Ink Writing Technology

Lawrence Livermore National Laboratory



Tailored Glass by DIW enables 3D printing of silica-based glass with gradient mechanical and optical properties in unlimited, customized, structural forms of high complexity. By controlling the concentration of multiple specially formulated glass inks throughout the extrusion process, the resulting glass product benefits from the free-form capabilities of 3D printing — while allowing for continuous changes in refractive index or other material properties. Following extrusion, a series of heat treatments solidifies the glass structure with the desired material or optical properties in addition to achieving high density and a range of geometries. This technology is applicable to research, consumer, and industrial markets seeking to harness tailored glass structures through rapid prototyping capabilities that cut down on the time and cost of conventional methods. This reduces expenses for customers seeking low-volume glass manufacturing. Given design flexibility and manufacturing precision, products ranging from laser system components to microfluidics can be tested and brought to market in a fraction of the time with, potentially, reduced energy requirements and less material waste.

RapidCure: High-Speed Electron Beam Processing of Battery Electrodes

Oak Ridge National Laboratory

High-Speed Electron Beam Processing is a low-cost, environmentally benign, and low-carbon-footprint process for producing thick Li-ion battery electrodes. This novel manufacturing approach eliminates the use of the solvent, a toxic volatile organic compound and the high-molecular-weight material used in the traditional PVFD/NMP manufacturing method. The NMP solvent is expensive and toxic and requires a costly solvent recovery process. In this technology, the electron beam serves as the energy source to chemically polymerize and crosslink small molecules into high-molecular-weight polymers. This technology can further decrease the battery cost and thus make them more affordable to consumers. This will improve economic, social, and environmental sustainability of the lithium-ion battery use in electric vehicles, power tools, and consumer electronics. Ateios Systems has licensed the technology from ORNL for solvent-free battery component production using radiation curing.

2022 R&D 100 WINNERS

Software / Services

Siemens Healthineers Intelligent Emergency Imaging

Siemens Healthineers AG

Patient-centered innovation has been and always will be at the core of Siemens Healthineers, whose employees constantly bring breakthrough innovations to market to help healthcare professionals deliver high-quality care and achieve the best possible outcome for patients worldwide. The Siemens Healthineers Intelligent Emergency Imaging workflow powered by myExam Companion helps speed up the care pathway of emergency patients with its comprehensive set of AI-based applications integrating state-of-the-art technology. The workflow helps to standardize and intelligently orchestrate the diagnostic process of emergency patients by guiding technologists through the acquisition of low-dose quality images — while enabling clinicians to read prioritized hemorrhagic cases directly at the scanner. The direct integration of the applications in the scanner speeds up access to data for reading flagged brain hemorrhagic cases and depicting skull fractures and hematomas, allowing multi-disciplinary teams to discuss and plan treatment faster. This dedicated end-to-end workflow, unique to Siemens Healthineers, aspires to create better outcomes and experiences for patients, further improving their lives and families.

Gremlin: Discovering Weaknesses in Artificial Intelligence

Oak Ridge National Laboratory

Gremlin is an adversarial evolutionary algorithm that finds input data values or simulation scenarios that causes a neural network model to perform the worst, usually by inverting the metrics used to train the model. For example, if the neural network is trained for driving a virtual autonomous vehicle, then training may seek to maximize how far the model can drive before crashing, whereas Gremlin will find scenarios to minimize that distance. The notion is to then retrain the models for those pathological scenarios to improve the model performance for those specific situations. For example, Gremlin might learn that the autonomous vehicle driving model struggles with stop signs at T-intersections at night in heavy rain, so the training data set may be extended to include more instances of that specific scenario, and then the model would continue training with those updated training data. The technology can be used to discover regions of poor performance for neural network models — and then use that information to guide subsequent model changes or retraining or both to concentrate on those areas.

City Buildings, Energy, and Sustainability (CityBES) Web Tool for Climate Change Strategies

Lawrence Berkeley National Laboratory

Buildings generate 39% of global CO2 emissions. Decarbonizing the building sector and improving climate resilience of buildings are essential to the global clean economy. However, evaluating and prioritizing cost-effective technical solutions for individual buildings at city scale poses a significant challenge for city stakeholders. City Buildings, Energy and Sustainability (CityBES) is a powerful tool that helps users address this challenge. This innovative, easy, and free-to-use powerful modeling and analysis tool enables quick and quantitative assessments of actionable recommendations for decarbonizing buildings and improving their thermal resilience against extreme weather at the urban scale. CityBES builds upon open city datasets, international data standards, the powerful EnergyPlus engine, a library of 104 mitigation measures, and 3D-GIS visualization to inform decision making on city buildings, energy, and sustainability. It also can be integrated with other urban analysis tools through its API. Its potential for carbon reductions is substantial — in U.S. cities alone, it can provide energy efficiency and decarbonization pathways to save 3.994 quads of annual primary energy and reduce 591 million metric tons of CO2 emissions.

2022 R&D 100 WINNERS

Software / Services

Certara's Secondary Intelligence Software Predicts Likelihood of New Drug Candidates Causing Safety Concerns

Certara

Certara's Secondary Intelligence is the first software that uses off-target screening data to quantitatively predict safety outcomes for new drug candidates in vivo and in the clinic. It assembles, curates, and visualizes secondary pharmacology analyses, replacing manual, time-consuming work and enabling the risk of new drug candidates provoking off-target safety issues and potentially adverse events to be evaluated and compared. It rates each compound with a 'low', 'intermediate', or 'high' likelihood of causing adverse events at the off-target receptor in clinical use — based on quantitative analysis of clinically used drugs that specifically target that receptor, and on its predicted maximum plasma concentration. Secondary Intelligence software identifies key safety information about each receptor, allowing drug developers to focus on how a test compound interacts with that receptor. It ranks the likelihood of each off-target interaction during clinical use, color-coding it red, amber, or green. Secondary Intelligence also prioritizes "receptor interactions of concern" in a variety of data representations — and ranks compounds against each other enabling drug developers to make informed decisions about which compounds to progress.

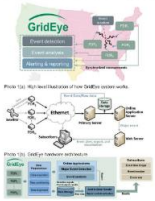
On-Chip Neuromorphic Backpropagation Algorithm

Los Alamos National Laboratory

The On-Chip Neuromorphic Backpropagation Algorithm is the first implementation of the industry standard for machine learning on a neuromorphic computer, consisting of computing elements that act like neurons in the brain. Inference and learning are performed entirely on-chip, drawing 100 times less power than the equivalent algorithm on a GPU/CPU. Using massively parallel, low-power neuromorphic hardware, LANL researchers have developed the first implementation of a neuromorphic backpropagation algorithm, the workhorse of modern ML and artificial intelligence frameworks. The utility of standard ML infrastructure is limited by its power requirements, but the On-Chip Neuromorphic Backpropagation Algorithm (ONBA) enables a wide variety of possible energy-efficient neuromorphic ML architectures. This on-chip low-power learning algorithm brings power usage closer to that of the human brain, which consumes only about 20 W of power. Thus, ONBA serves as a model to reduce the carbon footprint of ML infrastructure, extend battery lifetimes, and reduce system size, enabling autonomous agents of great benefit to society.

GridEye: A Wide-Area Power Grid Real-Time Situational Awareness System

University of Tennessee at Knoxville
Co-developer: Oak Ridge National Laboratory



The integration of renewable energy and power electronics devices has led to an increased number of severe and complex events in power grids, such as generation trips and load shedding. GridEye is a wide-area GPS-synchronized power-grid monitoring and analysis system that provides real-time situational awareness and post-event analytical capabilities for power industries, governments, and researchers to enable effective preparations and responses in a fast speed. It has been on the market since 2021 for wide-area power grids. GridEye is the only product in the industry that provides situational awareness services for power grids at such a large scale. Also, it has event location and MW loss estimation capabilities. In addition, the system can provide timely alert and analysis report to subscribers. It is a game-changing technology that enables unprecedented visibility and situational awareness capability of large-scale power grids. For example, it provides DOE-NAERM with event reports and raw measurements to support urgent event alerts and fast responses — and it provides NERC with event measurements to support the power grid reliability monitoring and analysis.

2022 R&D 100 WINNERS

Software / Services

Airborne Collision Avoidance System for Small Uncrewed Aircraft Systems

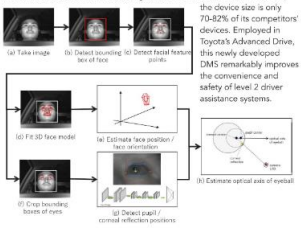
MIT Lincoln Laboratory
Co-developers: Federal Aviation Administration, MITRE, and Johns Hopkins University Applied Physics Laboratory

The Airborne Collision Avoidance System sXu (ACAS sXu) provides an innovative and effective technical solution to provide small uncrewed aircraft systems (sUAS) with the capability to safely avoid other air traffic. This system is the key technology required to allow expanded commercial and public sUAS operations. ACAS sXu is flexible and adaptable, and has incorporated significant advances in dynamic programming, automated tuning, and parallel computing. These advances allow for ACAS sXu to be effective and practical, making it the only mature and demonstrated system to provide this capability for sUAS across all use cases. It provides an interoperable and adaptive capability to meet the needs of not only current sUAS, but also future aircraft, sensors, and procedures that can easily be adapted for the planned UTM system. ACAS sXu has been demonstrated to meet internationally accepted safety targets across the full range of vehicle performances. No other current or proposed system provides this capability.

Driver Monitor System for Advanced Drive

AISIN Corporation
Toyota Central R&D Labs. Inc.; Toyota Motor Corporation; Woven Core Inc.

This is the world's first driver monitor system (DMS) for consumer vehicles that uses coaxial corneal reflection for gaze estimation. Improved robustness of pupil and corneal reflection detection in a vehicle environment and better implementation in an in-vehicle electronic control unit were achieved with an original small deep neural network. Moreover, the coaxial arrangement of the camera and LEDs produced a more compact DMS design. Assessments of vertical separation performance demonstrate that gazing frontward, viewing a navigation system and looking at the horn pad were distinguished correctly in more than 99.7% of cases. Results indicate detection of visual distraction in the frontward direction without any concern of false detection. Moreover, the device size is only 70-82% of its competitors' devices. Employed in Toyota's Advanced Drive, this newly developed DMS remarkably improves the convenience and safety of level 2 driver assistance systems.



Timely Address Space Randomization (TASR)

MIT Lincoln Laboratory

Sophisticated, modern cyberattacks that remotely hijack control of a machine heavily rely on the static and the homogeneous nature of computer systems. TASR is a technology that prevents such attacks in Linux-based applications and servers by automatically and transparently rerandomizing their memory content. The output-based rerandomization technique provides protection against information-leakage attacks — the kind of attacks involved in many of the high-profile breaches in recent years — which attackers often use to bypass one-time randomization techniques like ASLR. TASR is the first technology that mitigates an attacker's ability to leverage information leakage against ASLR, regardless of the mechanism used to leak information. TASR is lightweight, seamless to use, and easy to install on each machine. InfoSifter, a cloud development company, has licensed the technology and is using it to secure cloud-running containers (such as Docker). Because Linux is widely used on servers, cloud platforms and supercomputers, TASR provides memory-corruption protection for a large user base. It can also be implemented on other operating systems and instruction set architectures.

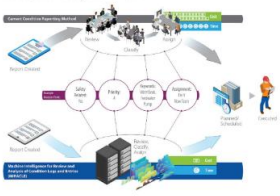
2022 R&D 100 WINNERS

Software / Services

Machine Intelligence for Review and Analysis of Condition Logs and Entries (MIRACLE)

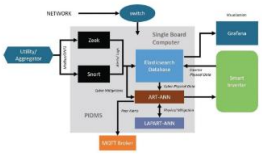
Idaho National Laboratory

Carbon-free nuclear energy is essential in the effort to curtail greenhouse gas emissions and hit the nation's carbon reduction targets. Yet because of financial considerations, some utility operators are choosing to not pursue relicensing, leaving the U.S. more dependent on energy from fossil fuels. Machine Intelligence for Review and Analysis of Condition Logs and Entries (MIRACLE) drastically reduces the hours each human must spend reviewing and discussing every condition report at nuclear plants — and speeds up the time needed to identify and address problems, providing a broader perspective on plant and industry performance. This offers a way for plant owners to improve profitability, efficiency, and safety. On a broader stage, although the system is intended for use in nuclear power plants, the methods developed in its creation should be valuable in any industry that requires massive volumes of documentation reviews. MIRACLE offers savings and efficiencies; this is good not only for the nuclear power industry but the world.



Proactive Intrusion Detection and Mitigation System (PIDMS)

Sandia National Laboratories



The proactive intrusion detection and mitigation system (PIDMS) secures grid-edge photovoltaic smart inverter and other equipment in distributed energy resource systems. It is a distributed, bump-in-the-wire solution; cyber and physical data are automatically processed using network inspection tools and custom machine learning algorithms to detect abnormal events and correlate cyber-physical events. PIDMS software is a suitable cybersecurity solution for DER owners, operators, and aggregators who may have limited resources compared to larger utilities. It can operate on a low-cost, single-board computer either as a bump-in-the-wire solution to DER equipment or co-located within equipment software. It uses machine learning analyses and network intrusion detection system tools to collect and process cyber and physical data. Adversarial activity and/or abnormal behavior is detected using this hybrid analysis approach and mitigative actions are deployed by the PIDMS sensor to eliminate or proactively reduce system impact from the detected disturbance. It also provides proactive response capabilities for stakeholders by selecting an appropriate response after event detection to prevent further risk to the system. It has been tested within a cyber-physical emulation environment and proven to effectively mitigate against various attack scenarios.

CASE STUDY

Ohio grows into a globally recognized R&D hub

A look at how this key Midwestern state pivoted from manufacturing prowess into a unique innovation center.

By Gordon Feller

With top-notch universities, federal research institutes, leading companies from nine major industry sectors, and 14 top-ranked hospital systems, Ohio is a "quiet giant" of innovation in industrial sectors and life science. Ohio has the fifth-highest number of Fortune 500 and Fortune 1000 companies — and is home to more than 120 NYSE/Nasdaq companies with a combined market capitalization exceeding $1 trillion.

Ohio government executives attribute the state's growth to government actions that help businesses succeed and the research and development (R&D) investments that lay the foundation for innovation in the Midwest.

In 2019, government leaders challenged JobsOhio, the state's private economic development corporation, to uncover new opportunities to enhance innovation within the state. JobsOhio saw a need for comprehensive initiatives that advance growth-enabling innovation and bring in companies and highly skilled talent. In collaboration with the state government and healthcare and university partners, JobsOhio launched a three-pronged innovation strategy for Ohio.

ONE: Innovation districts

Through partnerships with leading research institutions, universities, private corporations, and local, regional, and state economic development leaders, Ohio is developing nationally competitive innovation districts in the dense urban settings of Cleveland, Columbus, and Cincinnati. Each location has a priority focus based on the city's existing institutions and expertise.

The world's top people and companies come to these sustainable ecosystems of ideas, infrastructure, and talent to roll up their sleeves, create, and grow. With more than $3 billion in innovation district investments, they anticipate more than 47,500 new STEM graduates, 60,000 new jobs, and up to $9 billion in annual economic impact for the state over the next 10 years.

The Cleveland Innovation District is home to a global center for pathogen research and human health aligned with the $100 billion

CASE STUDY

"So, whether you're sharing photos, video, or reels on Facebook or Instagram, the New Albany data center has a huge impact on bringing the world closer together," said Katie Corner, Meta's manager of the community development team in North America.

Healthcare

A rise in chronic disease, the nation's aging population, and the global pandemic have accelerated the need for medications and triggered an urgency for innovative solutions.

Companies like Amgen, recently named one of the World's 25 Best Workplaces by Fortune, are leading the way and tackling some of healthcare's most complex digital automation technologies. With brands like Enbrel and Otezla and a worldwide presence, Amgen responded to a growing demand for human therapeutics by establishing a 270,000-square foot facility near Columbus and building on the city's collaborative and innovative global healthcare supply chain network.

Military

JobsOhio added the military and federal installations as the No. 10 target sector in 2018. It has positioned Wright-Patterson Air Force Base as a prime beneficiary of federal base closings, relocations, and expansions.

In September 2021, the U.S. Air Force chose the 179th Airlift Wing at Mansfield-Lahm Airport to host the Air National Guard's Information Cyber Warfare Wing. This new mission will bring more than $50 million in capital investments to Richland County and position Ohio on the front lines of the military's fight against cyber threats.

Aware, located in Columbus and one of the leading enterprise-grade collaboration governance platforms specializing in human behavioral data, recently finished a $60 million Series C funding round less than one year after JobsOhio Growth Capital Fund, Ohio Innovation Fund, and other capital venture partners contributed to its Series B equity investment. As one of the many tech startups accelerated by the JobsOhio Growth Capital Fund, Aware expanded its capabilities in addressing data risks and insider threat concerns related to critical online messaging and collaboration tools.

In addition, Ohio continues to play a crucial role in developing Advanced Air Mobility technologies with robust supply chains, test markets, partners, and legislation that both public and private sector entities can rely on. Ohio lawmakers have opened the skies for Unmanned Aircraft Systems Traffic Management (UTM) and Urban Air Mobility (UAM). In August 2022, JobsOhio and 15 other AccelerateOhio partners broke ground on the National Advanced Air Mobility Center of Excellence in Springfield, Ohio, which will serve as the physical space for the collaboration, pushing the speed and depth of the partnership to research, design, and test deployment.

About the R&D Center Grant Program

The R&D Center Grant Program helps support targeted industries, including Advanced Manufacturing, Aerospace & Aviation, Automotive, Healthcare, Financial Services, Food Processing, Information Technology, Logistics & Distribution, and Shale Energy & Petrochemicals.

Project factors that determine grant eligibility include:

- Alignment with JobsOhio sector strategies
- Job creation
- New payroll
- Fixed-asset investment commitments
- Project location
- Applicant's track record in successful R&D commercialization

Eligible uses of funds include:

- Industry-driven, value-added applied research
- Software development
- Developing technologies that a corporation can commercialize

To learn more about the grant program and other JobsOhio initiatives, visit the website: www.jobsohio.com.

INER
Institute of Nuclear Energy Research

https://en.iner.gov.tw

Nuclear safety and nuclear back-end
Radiation applications for people's livelihood
Green energy and system integration

Drying of Agricultural Products Using Solid Desiccant Wheel Dehumidification System

In Taiwan, the diesel burner drying technique is generally employed to dry the garlic and many issues are caused such as time and energy consumption, noise and environmental pollution. The solid desiccant wheel dehumidification system is applied to remove parts of moisture content from garlic for better storage stability, shortening drying time, energy saving, minimizing drying process noise and air pollution contaminant emission. The solid desiccant wheel is manufactured using activated alumina derived from aluminum dross with a three-dimensional random porous structure and applied to adsorb moisture from the garlic. The equilibrium time for the solid desiccant wheels and humidity is determined by observed kinetics in the adsorption kinetic experiment. The adsorption capacity of solid desiccant wheel with different porosity ranging from 20 to 60 pores per inch (PPI) is a function of time at 25°C and 30% relative humidity. The adsorption equilibrium time of desiccant wheel (60 PPI) with 150 mm diameter and 50 mm thickness is twelve minutes. The maximum adsorption capacity is 61.2 g (12 minutes) and per gram of desiccant wheel can adsorb 0.24 g water. The desiccant wheel is divided into two working areas e.g., adsorption and desorption. As the adsorption capability of desiccant wheel is saturated, the wheel is rotated to regeneration area to remove water by heat. The maximum adsorption capacity of desiccant wheel per hour can be reached at 306 g. A trial run of a solid desiccant wheel (diameter 500 mm, height 200 mm) dehumidification system to dry garlic with the capacity of 4,000 kg is executed, 30% of water from the garlics is removed in the period of 14 days and the operation time is 10 days shorter than the traditional diesel burner drying process. The noise and air pollution derived from the diesel burner drying process can be avoided.

Desiccant wheel

Solid desiccant wheel dehumidification system

Operation interface of system

Atmospheric Plasma Sprayed Metal-Supported Solid Oxide Fuel Cell

INER (Institute of Nuclear Energy Research) had devoted to the development and applications of the solid oxide fuel cell (SOFC) power generating technology. A fabrication cluster, named sofciner-MS, for cell unit of solid oxide fuel cell by atmospheric plasma spray-sintering on metallic substrate for high structural durability and fast warm up is developed. From powder to power, we establish a production procedure to manufacture Sofciner-MS cell units by many industry techniques. INER's proprietary atmospheric-plasma-spray-sintering technique allows SOFC to overcome its traditional problems in structural and thermal strengths. Now, at 0.9V and 650, 600 and 550°C, the power outputs of 10x10cm² Sofciner-MS cell unit can reach 34.8, 26.7 and 16.5W, respectively. The maximum power outputs at 0.7V and 650, 600 and 550°C might reach 70.8, 48.8 and 28.8W, respectively. The degradation rate of Sofciner-MS cell unit is less than 3%/khr. INER aims to be a strong technical support to the industry and promote the commercial production of SOFC in Taiwan. SOFC contributes importantly to energy use. Sofciner-MS makes SOFC realistically more practical for real-world applications like transportation.

Plasma-sprayed metal-supported solid oxide fuel cell

Low Thermal Degradation Micro-CPV System

Since 2003, The Institute of Nuclear Energy Research (INER) has developed High-concentration Photovoltaic (HCPV) system technologies, including III-V solar cell epitaxial and processing, concentration module processing, solar tracking device, system integration, control and monitoring, and module qualification. Concentration photovoltaic (CPV) system is a photovoltaic system utilizing an optical system to concentrate sunlight onto a small solar cell to reduce the consumption of expensive solar cells. Now, INER has successfully developed micro-CPV technology with a fully automotive fabrication process. The conversion efficiency of INER's micro-CPV module is 35.5% Field performance test of INER's micro-CPV system and commercial Si-PV system is demonstrated in Taiwan. According to the sunlight exposure test, the micro-CPV system maintained a high energy yield at 97.5% and Si-PV system dramatically decreased to 83% with the increase in solar radiation intensity. The micro-CPV system provide high energy yield, i.e., provides more electric power in a high solar irradiance area.

Micro-CPV module developed by INER with fully automotive fabrication process