

110 年報

財團法人金屬工業研究發展中心

Metal Industries Research & Development Centre

ANNUAL REPORT

► MIRDCC

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董事長序

發揮跨域量能 促動產業發展

面對全球經濟變局及疫情肆虐影響，創造臺灣出口及生產有利條件，我國經濟不僅未因衝擊而下滑，反而是全球少數經濟正成長的國家。為積極掌握疫後全球復甦契機，政府以既有 5+2 產業創新基礎上，推動「六大核心戰略產業」，提高臺灣關鍵地位和經濟韌性。尤其循環經濟和在地產業轉型升級，更是重中之重的關鍵發展議題。金屬中心作為政府轄下之研究法人機構，配合政府政策推動，藉由整合產學研鏈結，強化跨界 / 跨領域合作，深化創新利基量能，提供產業多元化解決方案，進而提升產業整體競爭力，加速台灣經濟蓬勃發展。

在永續發展的循環經濟議題上，行政院以高雄市為核心示範場域，打造「循環技術暨材料創新研發專區」，作為循環經濟示範場域與推動中心，規劃引進金屬中心等多家研究單位進駐，提供未來再生料源的技術開發及認證，高值應用於化合物半導體材料產業。其中金屬中心主力負責循環鋁材相關技術建置，由於鋁金屬是綠色節能材料，近年來因新興市場崛起及回收鋁料製造趨勢成長，致使鋁材的需求快速大幅成長。因此金屬中心在經濟部科專計畫支持下，結合國內標竿廠開發低廢高值循環鋁材創新製程技術，帶動上中下游應用生產技術提升，促進產業轉型整合，形成新的金屬循環產業鏈，落實綠色製品永續循環高值化應用。後續將相關創新技術擴散至電動車、綠建築、高階設備、智慧機械等高值市場，進而成為推動臺灣循環經濟成長的新能量。



在地產業轉型升級議題上，積極與在地產業鏈結，導入創新科技和跨域整合，驅動在地產業邁向高值化及特色化發展。中心藉由執行 AI 計畫，協助科技部在南科園區打造國際旗艦型的「智慧機器人創新自造基地」，將原本製造生產區域，建置開放式創新平台的自造者基地，孵育下世代新科技產業人才，透過地域、產業與人才的多元結合，成為運用 AI 機器人技術提供解決方案的專業平台，營造南台灣創新自造生態。另外中心更協助政府規劃高雄興達漁港轉型升級為海洋科技基地，設立「高雄海洋科技產業創新專區」，使得該專區將成為台灣離岸風電海事工程、海洋科技人才、海洋科技研發等培育基地與示範場域。同時鍵結丹麥 Maersk、荷蘭 Marin 等公司進行海事人才與工程國際合作，更分別聯合中鋼、台船等 20 多家公司成立 O-team、W-team、M-team 等聯盟，協助建構風力機產業在地化供應鏈體系，將興達漁港蛻變成為亞太地區離岸風電的重要基地，進而帶動地區產業經濟永續經營。

金屬中心成立半個世紀以來，一直以金屬科技為核心，面對內在環境改變與全球產業快速變遷，精進前瞻創新的研發能量，並與產業界及學界共同攜手，同時結合 AI、大數據、雲端等數位應用，協助中小企業智慧應用，促進傳產數位升級轉型，為台灣產業注入更多創新動能。110 年在全體同仁通力合作下，多項重要業務仍得以順利推動，真的要感謝中心每一位同仁的付出！期許中心整體部門精益求精，並一秉初衷地持續肩負官產學研橋樑，將政府研發資源有效轉化成提升產業價值的應用成果，讓身處在全球化浪潮中的台灣產業快速掌握新局、開創契機、永續發展。

董事長

林仁益

The background is a vibrant green with a subtle pattern of stylized, overlapping waves. A large, semi-transparent green arrow points from the bottom left towards the top right, passing behind the main title. In the bottom left corner, there is a circular graphic with a green center and radiating lines, surrounded by concentric yellow and orange arcs. In the bottom right corner, there are several interlocking gear shapes in a lighter green shade. The main title is centered in the upper half of the page.

願景、使命 與技術深耕

ANNUAL REPORT



開闢

「開創先機，闢建未來」鏈結產學研資源，創新材料應用、開創智慧製造、高值醫材及高階精微產業，深入節能與儲能研發領域，展現國際領航力。

金屬中心願景、定位與使命

金屬中心是隸屬於經濟部的財團法人中，唯一將總部設在高雄的研究單位。本中心定位為「以提供金屬科技為主的跨領域整體解決方案之研發與應用服務機構」，肩負著「發揮價值創造之關鍵角色，協助金屬為主的跨領域產業提升附加價值及國際競爭力」之使命，朝「成為以金屬科技領航及跨領域創造產業價值的國際級研究發展機構」之願景邁進。

本中心成立半世紀以來，一直肩負隨著國家產業政策發展及環境變動，協助產業升級與轉型之大任，中心不斷透過組織創新、前瞻技術研發及服務推廣方向的調整，除持續協助傳統「金屬材料及製品產業」升級外，也將核心技術能量

對焦深化，延伸應用至「高值設備產業」、「醫療器材及照護產業」、「高值精微製品產業」及「綠能產業」等具潛力之重點產業；為協助重點產業之科技發展與高值化應用，中心透過新興產業與跨領域加值平台，整合本中心AI、Big data、創新服務等相關能量，積極配合政府所力推的「五加二」產業創新政策，持續扮演推動產業轉型升級角色。

此外，中心將形塑成為「Hub」角色，鏈結國內外技術研發、人才、資源的平台，加強產業與學研的鏈結、中央與地方政府的鏈結、我國與國際的鏈結，並以建立跨域研發生態系統為目標，建立多方位的跨領域研究發展機構。

成為以金屬科技領航及跨領域創造產業價值的國際級研究發展機構

一、核心技術量能對焦深化

策略
主軸



Taiwan

MIRDC
成為「Hub」
鏈結國內外資源



二、形塑成為「Hub」角色

鏈結國內外技術研發、
人才、資源的平台



技術深耕 /

先進材料與製程研發中心

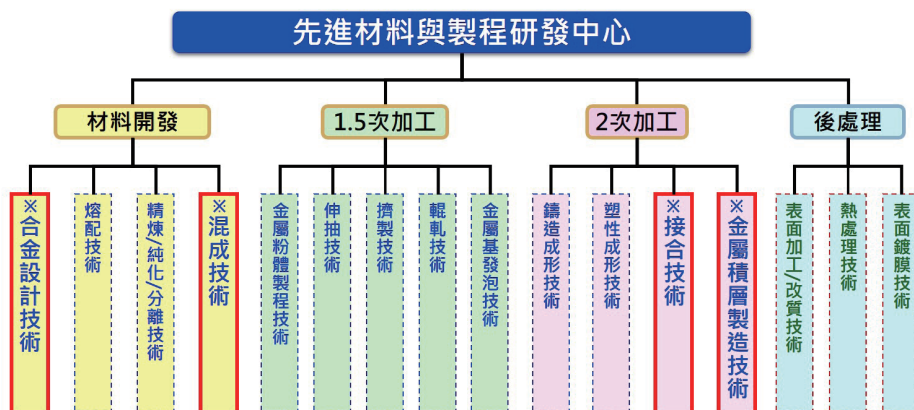
一、願景及價值定位

金屬中心先進材料與製程研發中心以「成為國際級跨領域材料開發及智慧製程整合研發中心」為發展願景，整合既有製程技術(合金熔配/製程模擬/2次加工/表面處理)，結合數位合金設計、材料製

程數值模擬分析、1.5/2次成形加工技術、後處理製程及檢測驗證等，提供創新材料開發與高值應用之全製程數位化跨領域開放式研發平台。

二、技術範疇

新核心技術建置在「材料研發主軸」方面，以快速精準材料設計，透過機器學習與材料模擬縮短材料研發時程，以及高比強度多功能混成材料，整合異質材料特性開發高功能新材料；「製程研發主軸」以多層道數位自動化銲接技術，建置銲接製程數據資料庫，同時整合ROBOT與銲機通訊控制運動軌跡，以及大尺度積層製造，建置積層介面均質控制及整合數位化分析技術，達到快速高品質產品開發。



三、推動策略

結合國家政策與產業發展趨勢為導向，掌握新興市場發展機會，整合產/學/研創新技術研發能力，鏈結標竿廠提升技術應用加值，完善國際交流機制促動交流合作，提升國際創新研發影響力。



四、亮點案例

串聯「金屬與石化產業鏈」及「材料國際學院」能量，強化國內通訊及消費性電子產品關聯產業之國際競爭力，開發兼具金屬機械性能、質感及熱塑複材質輕、可回收利用特性的混成材料，以解決產品數位功能化(如5G通訊)無線傳輸時金屬訊號屏蔽(Signal Shielding)問題。

料，以解決產品數位功能化(如5G通訊)無線傳輸時金屬訊號屏蔽(Signal Shielding)問題。

技術成果

- 挑戰全球筆電年出貨量>2億台的市場，台灣廠商出貨量>1.3億台
- 可回收輕量化殼件附加價值率提升2倍以上(由750元/組提升到1,500元/組)
- 完成3項共7件(含台、美、中國)專利申請、已通過1件台灣專利(複合積層板、殼體及行動通訊裝置)

執行前現況

- 行動裝置產業目前大部分使用高強度鋁合金材料製作殼件，遇到厚度薄時(<0.8mm)的強度及剛度瓶頸，產業需要創新的輕量與薄型化新方案
- 5G世代的MIMO陣列天線設計，迫使行動裝置考慮淘汰會屏蔽電磁波的金屬殼件

鋁合金筆電殼件

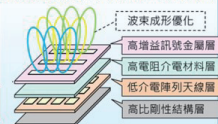


執行後情形

- 完成不使用膠合劑接合(易拆解可回收)，厚度0.8mm的金屬與熱塑複合材料異質混成板材，強度與5系列鋁合金相似，輕量化30%以上
- 完成28GHz毫米波陣列天線內嵌於混成板材中並證實具金屬質感還具有信號的殼件結構可行性



異質混合板材



完成與仁寶電腦(股)公司簽署MOU，共同研發5G筆電殼件新材料，媒體露出共38處，包含3處平面報紙與35處網路新聞。



左：仁寶公司 李盛宏資深副總經理、
右：金屬中心 林秋豐執行長

技術深耕 /

金屬智慧製造技術中心

一、願景及價值定位

金屬中心金屬智慧製造技術中心是產學研創新製程設備與客製化系統合作開發的夥伴，2021年主要協助扣件產業發展，提升認證型高品級及特殊件產品占比，並幫助提升其接單打樣試做能力為目標。2021年扣件產業受到台灣防疫有成的有利因素影響，成為全球少數不斷鏈可穩定供應的國家，因此恢復迅速，自2020年第三季末起至2021

第四季，幾乎所有廠商皆反映接單盛況，惟因匯率、運費、材料與熱處理費用提高及缺工等影響而侵蝕毛利率。於價值定位中，中心以智慧模具調教技術、產品品質建模及製程優化技術、線上品質監測與肇因分析技術、模具健康狀態與壽命監診等技術來補足產業缺口與技術瓶頸。

二、技術範疇

協助扣件產業從接單到成品，為扣件成形製造建立系統性智慧製造解決方案，以快速回應及彈性生產需求，解決扣件生產傳統依賴人工巡檢、缺乏即時資訊等問題，為製造業提供客製化智慧製造解決方案。技術主軸分為彈性製造與預測生產，彈性製造是以機器人結合3D視覺取代人工撿取、塗膠；預測生產是以設備/模具預知保養、製程智慧化決策導引為主軸，前者以全自動製程設備線上感測設

備生產狀況與提早保養預知，後者則應用在設計與試作端，結合CPS效能分析、設計模擬，縮短試作打樣時程可達50%以上。技術含數據擷取、品質監測與統計分析能力及製程方案/模具設計決策導引技術，智慧模具調教技術、產品品質建模及製程優化技術、線上品質監測與肇因分析技術、模具健康狀態與壽命監診等。

三、推動策略

1. 提升傳統產業創新加值園區扣件智慧製造類生產線，強化數位戰情與AI建模精準預測功能之示範推廣。
2. 雲平台推廣
 - 鑄造/鍛造模具設計專家系統為例，採用Solidworks開發工具開發軟體，並開放雲端平台付費會員使用。
 - 機械雲/扣件雲：快速設計、換模調校、生產可視、設備感知、品質預診等App。
3. 整合模具設計與扣件智慧製造類生產線，跨處合作籌建快速打樣支援中心，提升產業界特殊扣件打樣與接單能力。

四、亮點案例

春雨工廠

◎ 公司簡介：

1965年成立，位於高雄市岡山區，員工數約664人，主要業務：磨光線材、球化線材、螺絲、螺帽、螺栓等，六角頭高扭矩控制螺栓為軌道用途。

◎ 產業問題：

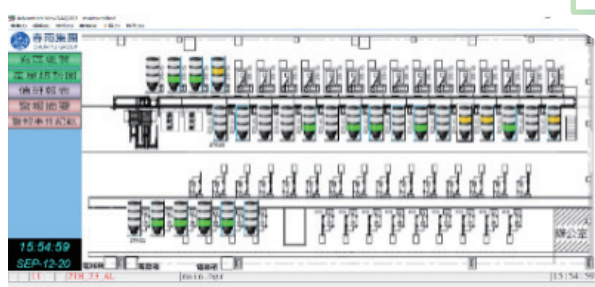
過往設備停機未被巡檢人員即時察覺，停機最長4小時才發現，生產狀況記錄加重管理人員負擔。

◎ 解決方案：

- 建立完整機聯網系統(41台設備)
- 建立戰情系統、三色燈管理
- 安裝馬波斯(義大利系統)鍛力感測

◎ 成果效益：

導入計量資訊可視化，減少設備故障未通報情事，產量有明顯提升，如打頭設備8月至9月總產量提升約27%；軋牙機總產量提升約22%。



機聯網系統 (41台設備)



廠內 41 台設備

技術深耕 /

高階精微製造系統開發中心

一、願景及價值定位

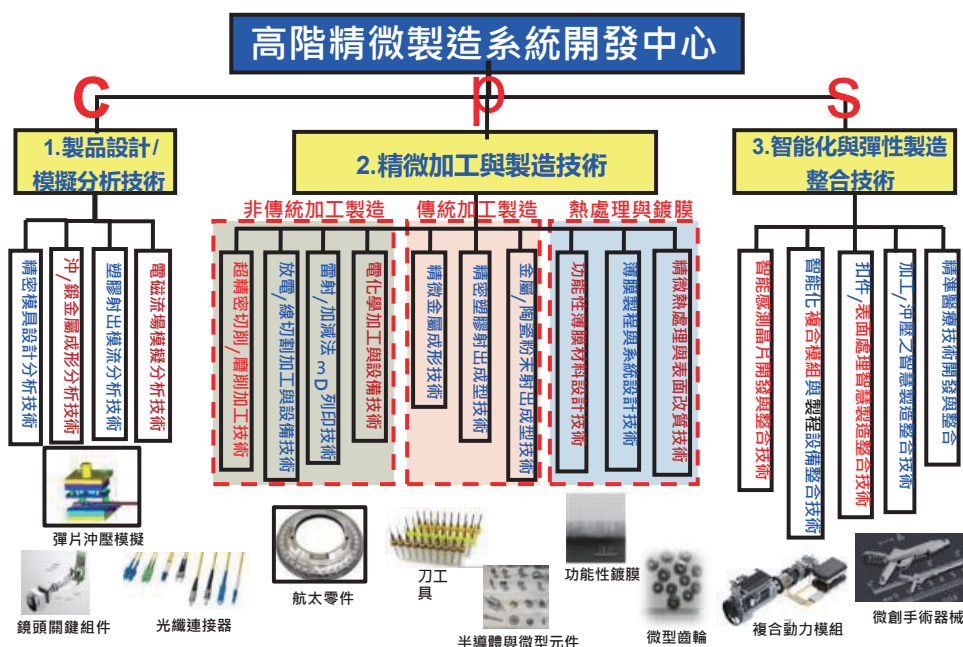
金屬中心高階精微製造系統開發中心以引領台灣成為高值精微製造之研發重鎮為願景，接軌「亞洲高階製造中心」國家產業政策，致力建構精微製造整合平台，發展國內以金屬領域為主之高階精密製造與整合技術，發展高值精微製品關鍵研發基地

與平台，並提供高階製造完整服務，如精密/微型高值製品之快速開發、試作、試量產需求之一站式服務能量，期望成為亞洲高階製造之領航者。

二、技術範疇

高階精微製造系統開發中心，涵蓋三項技術主軸—(1)製品設計/模擬分析技術：沖鍛金屬成形分析、塑膠射出成型等模具設計及電磁流場模擬分析技術等。(2)精微加工與製造技術：超精密加工、放電/線切割/電化學加工、雷射加減法3D列印技術、金屬成形、射出成型、功能性薄膜鍍膜、精微熱處理與表面改質技術。(3)智能化與彈性製造整合技術：智能感測晶片開發與整合、智能化複合模組與製程設備整合技術、扣件/加工/沖壓/表面處理之智慧製造、精準醫療技術開發與整合技術等，詳如下方技術範疇與架構圖。

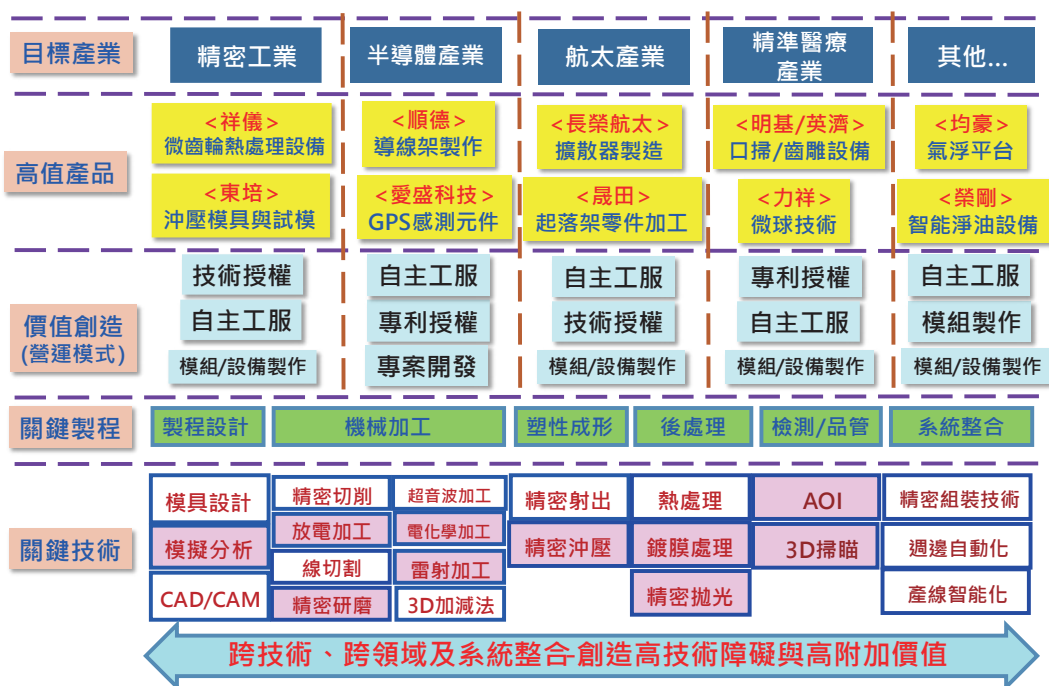
理與表面改質技術。(3)智能化與彈性製造整合技術：智能感測晶片開發與整合、智能化複合模組與製程設備整合技術、扣件/加工/沖壓/表面處理之智慧製造、精準醫療技術開發與整合技術等，詳如下方技術範疇與架構圖。



三、推動策略

高階精微製造系統開發中心之推動策略，以跨技術、跨領域及系統整合，創造高技術障礙與高附

加價值，包含以產、官、學、研合作，促成技術授權、專利授權、自主工服、模組/設備製作等。



四、亮點案例

「連續式微型元件熱處理系統設備」，為全國法人唯一於2021年度同時榮獲創新界奧斯卡-Edison Awards及科技界奧斯卡-R&D100大獎兩項國際大獎。該技術針對微型元件(直徑2mm以下)所開發專屬熱處理製程與系統設備，整合「自動進料系統、自動監測與即時調控主加熱爐、創新油槽與收料模組與智慧化雲端服務」等系統功能，並已成功應用於智慧手機微小螺絲、微齒輪調質等熱處理，可快速找到最佳化熱處理製程條件及最適化生產排程，大幅縮短交貨期程，亦可維持高品質良率及高收料率。

另一方面，精微熱處理後產品已獲得國際大廠，如：特斯拉公司認證，並成功打入特斯拉供應鏈。熱處理是機械工業之母，精密熱處理更是台灣精密產業之關鍵能力，精微熱處理不僅產品無熱變形且硬度提升，品質更由A提升為A+，實測後顯示具備優異的尺寸精度及耐磨耗特性，超越目前國產品質並達國際水準。淬火油槽採取

特殊工件捕集機構設計更是核心技術，可完全捕集漂散於油槽的微小工件，收料率高達100%。後續可持續運用於如3C、醫療機械、電動汽機車、光電半導體、航太等領域。



精微金屬零組件熱處理設備

技術深耕 /

先進微創醫材研發中心

一、願景及價值定位

金屬中心在微創醫材領域持續推動「智慧手術輔助系統」相關技術開發，著重於「空間定位技術」、「醫學影像導航」與「手術機械臂」三項關鍵技術發展，2021年完成全球第一套可於手術中即時更新手術椎節影像空間資訊之「多椎節導航系

統」之開發與整合，並進行大體測試。後續為加速技術實際應用，2022年將完成系統最終測試並於高榮執行臨床試驗。

二、技術範疇

先進微創醫材研發中心除了手術輔助系統開發外，同時也結合相關治療要件，包含「創新微創器械」、「新型植入物」、「無創治療設備」等，皆為先進微創中心開發技術範疇，同時跟隨世界科技發展腳步，先進微創醫材中心積極導入AI技術於醫療上應用之產品開發。



手術輔助系統

三、推動策略

先進微創醫材研發中心著重解決當前臨床遇到的困難與台灣業者欠缺的產品與技術進行投入研發，骨科手術輔助系統為中心第一個推出的大型研發項目與產品，透過分析現有市售產品臨床使用限制與問題，研發全新定位技術，以達到在手術中即時修正手術椎節空間資訊，透過新的技術應用，成為市場上有力的挑戰者。



可即時修正手術椎節資訊

四、亮點案例

2021年研發團隊完成全球第一套「多椎節影像導航系統」之開發，並落實於臨床大體試驗，取得優秀的測試成績，連續施打六節，過程中完全無採用X光進行修正，正確率可達九成以上，同時結合台灣廠商植體，完成完整的脊椎手術流程，對於後續系統進入實際臨床應用都帶來正面的佐證。



多椎節導航系統臨床大體試驗

技術深耕 /

高溫燃燒減碳淨零與儲能研發中心

一、願景及價值定位

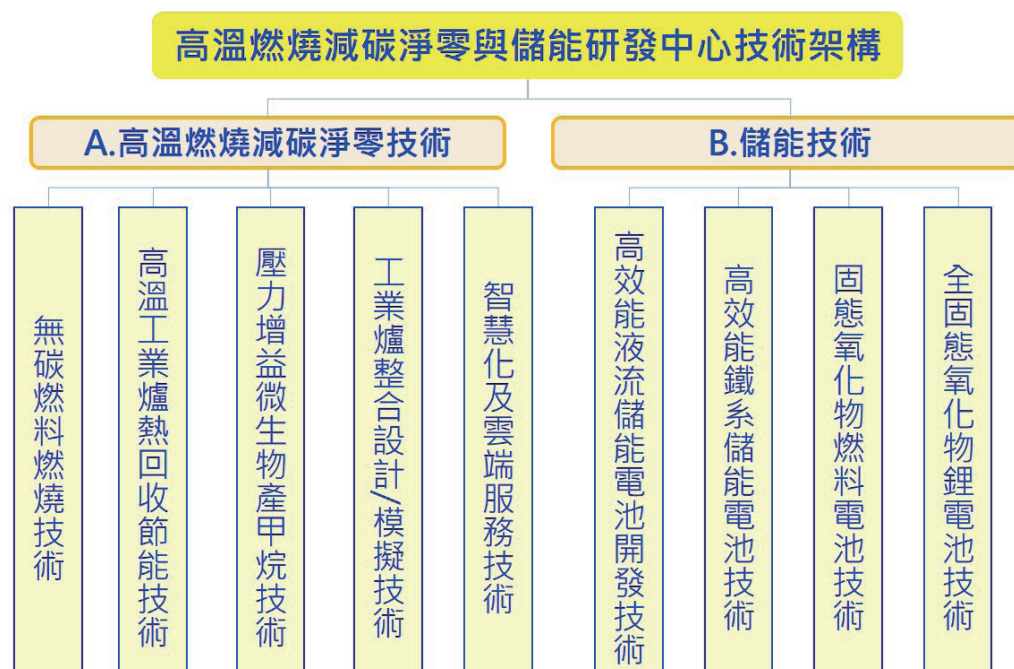
金屬中心高溫燃燒減碳淨零與儲能研發中心因應全球化減碳淨零產業趨勢，以及為解決金屬相關產業高溫製程高碳排放問題，發展蓄熱式、自預熱式、純氫燃燒等高溫燃燒減碳淨零技術，及高比容儲能載具、電解液、電池管理系統等液流電池儲能

技術，將建立國際級研發中心，提供產業高效、安全與符合經濟效益的能源解決方案，協助達成台灣2050減碳淨零目標，並引領產業拓展全球市場。

二、技術範疇

技術主軸包含「高溫燃燒減碳淨零」技術：蓄熱式、自預熱式燃燒等高溫廢熱回收技術、生質能與氢能等無碳燃料燃燒技術、燃燒工業爐整合設計與智慧化技術，協助產業燃燒製程減碳。「儲能技術」：關鍵組件與材料開發、電解質優化與製程開發、高比容儲能系統開發、電池檢測與監測系統開發、儲能電池之能源管理等先進電池技術，提供產業儲能需求。

- 短期技術範疇：聚焦製程溫度550°C以上燃燒式工業爐減碳淨零技術，以及MW液流電池開發其相對應之儲能電池維運管理技術。
- 中期技術範疇：擴大高溫燃燒減碳淨零技術及儲能應用領域。
- 長期技術範疇：發展創能及系統整合技術，發展最適化能資源應用。



三、推動策略

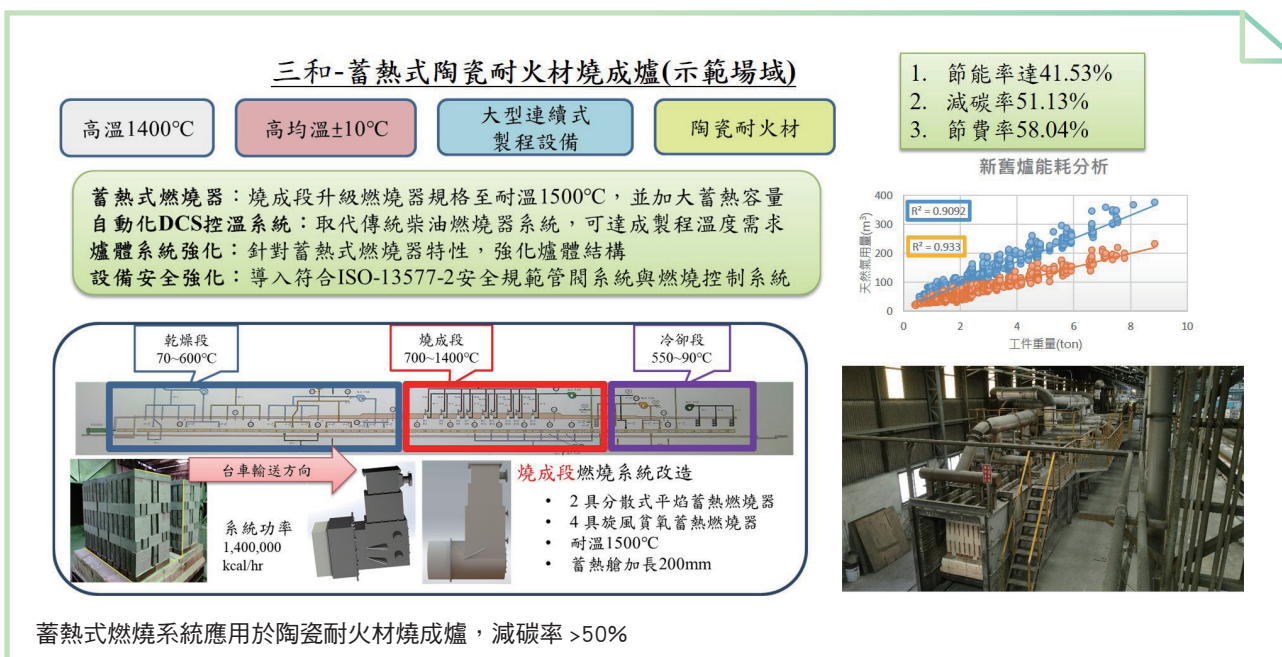
1. 結合國內外團隊，發展創新技術。(掌握技術 know why)
2. 建立測試驗證場域，確認技術效益。(掌握關鍵建置與驗證技術)
3. 技轉相關業者，建立國內服務能量。(培植技術擴展根基)
4. 協助服務團隊透過產業公、學會推廣。(針對目標產業推廣)



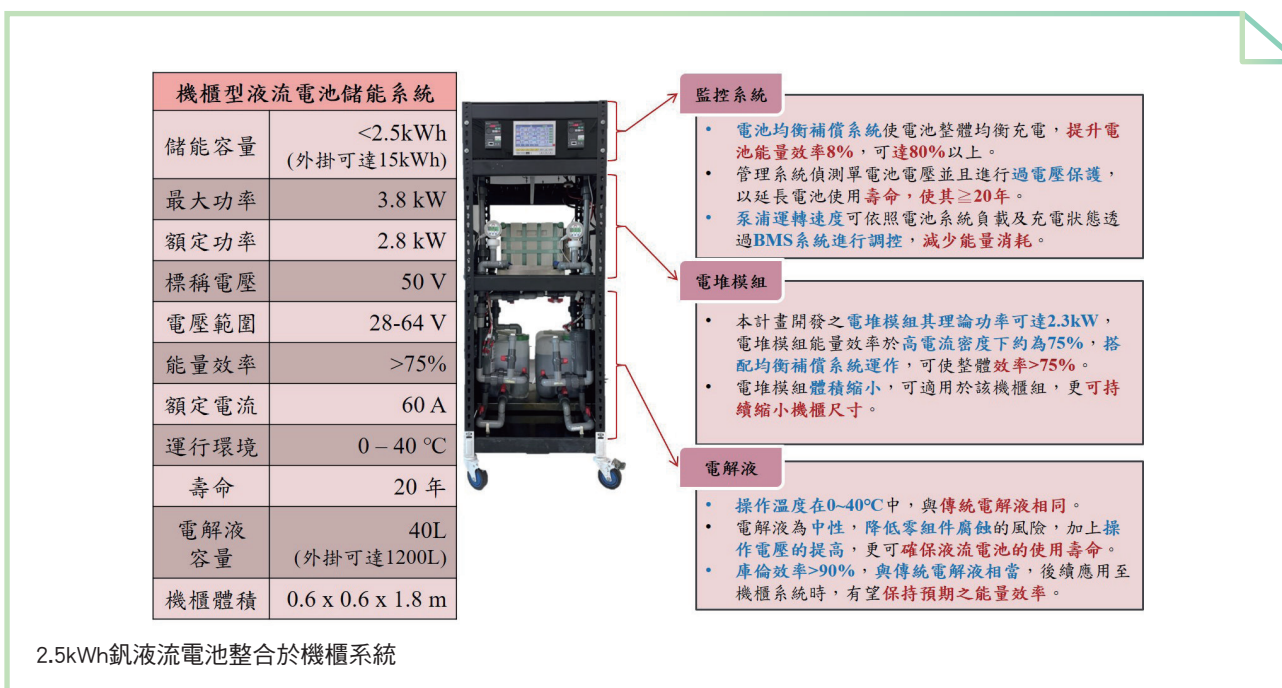
四、亮點案例

高溫燃燒減碳淨零技術：建立平焰式蓄熱燃燒技術，與蓄熱式燃燒工業爐前饋控制系統，提供爐內加熱空間提升並有效解決高溫感知器遲滯問題，提高爐內均溫控制能力。並將應用範疇擴展至高溫1400°C隧道型陶瓷耐火材料燒成設備，協助改建設備最高溫之燒成段，提供40%以上節能效益，同時透過燃料由柴油轉換為天然氣，減碳率可達到50%。

蓄熱式燃燒系統應用於陶瓷耐火材燒成爐，減碳率>50%。



儲能技術：鈎電池為主的電化學儲能扮演關鍵的角色，具有安全性高、可擴充性等特性，因此本技術朝建立高比容儲能載具技術、高效低耗損電解液技術，智慧型電位補償電池管理系統，提供高比容產業級儲能系統關鍵技術，滿足國內小型儲能需求(kW級)。電堆模組其理論功率可達2.3kW，搭配均衡補償系統運作，可使整體效率>75%。電解液庫倫效率 ≥ 90%。



The background is a solid green color. In the upper half, there are faint, stylized white wave patterns. A large, semi-transparent green triangle points downwards from the top center. In the lower-left quadrant, there is a circular graphic with concentric arcs and a starburst effect. In the bottom right, there are faint, stylized white gear patterns. The text "營運概況" is centered in the upper half, and "ANNUAL REPORT" is curved along the bottom left.

營運概況

ANNUAL REPORT



拓展

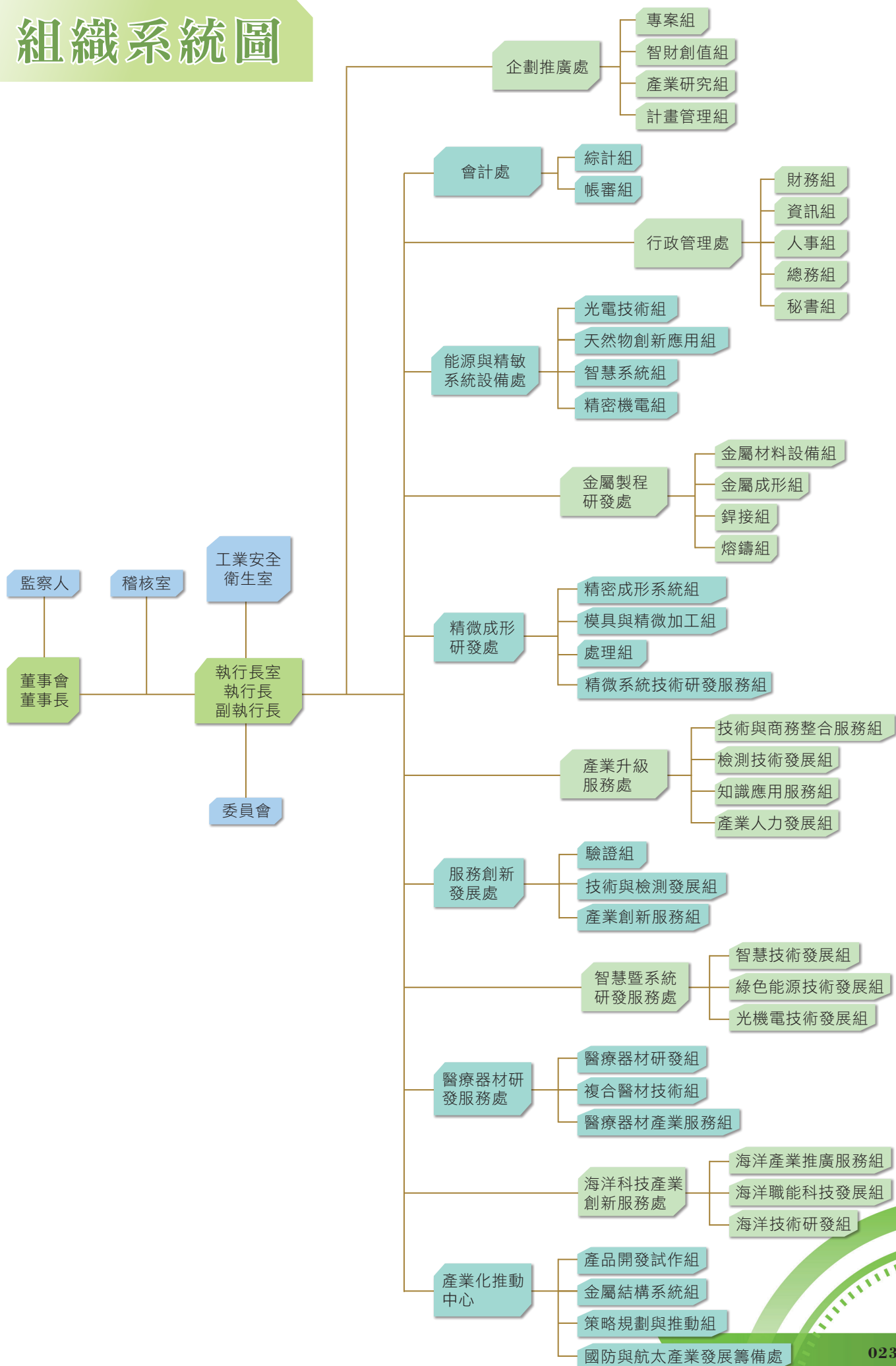
「拓集資源、展現非凡」以創新服務與革新營運組織為目標，匯集國際研發人才與專業技術量能，為產業導入活水與成功契機，協同業者永續發展。



董事及監察人名冊

職別	姓名	代表機構及職稱
董事長	林仁益	金屬工業研究發展中心董事長
常務董事	林德生	經濟部技術處副處長
常務董事	謝翰璋	經濟部標準檢驗局副局長
常務董事	林華宇	經濟部工業局金屬機電組組長
常務董事	李君禮	經濟部能源局副局長
董事	陳瓊華	國家發展委員會產業發展處副處長
董事	謝戎峰	經濟部中小企業處主任秘書
董事	王錫欽	中國鋼鐵公司總經理
董事	馬萬鈞	漢翔航空工業公司總經理
董事	馮展華	國立中正大學校長
董事	覺文郁	國立台灣大學教授
董事	鄭英耀	國立中山大學校長
董事	陳月端	國立高雄大學校長
監察人	楊慶煜	國立高雄科技大學校長
監察人	鄭宛青	經濟部會計處科長
監察人	楊伯耕	經濟部加工出口區管理處處長

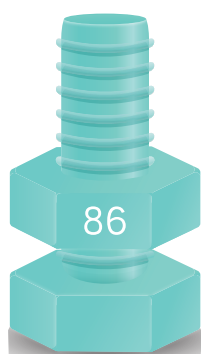
組織系統圖



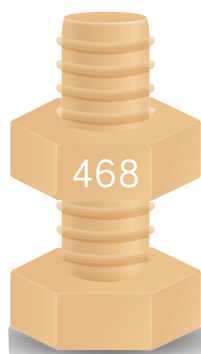
人力

員工人數：736 人 | 平均年齡：43 歲

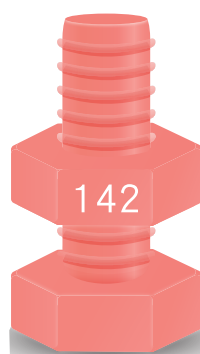
學歷 (人數)



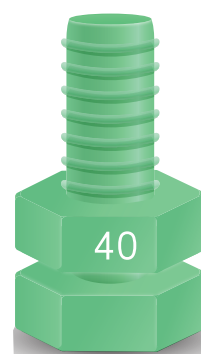
博士



碩士

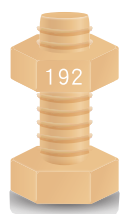


學士



專科及其它

服務年資 (人數)



1-5年



6-10年



11-15年

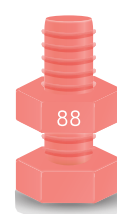
專長 (人數)



機械/自動化/模具



材料/化工/化學



電機/資訊/光電



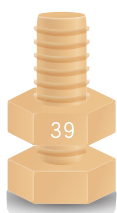
16-20年



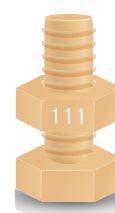
21-25年



26-30年



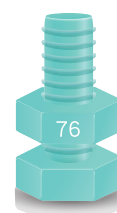
31年以上



醫療/生技/其他工程



管理/行銷/會統



其他

備註：資料基準日為 2021 年 12 月 30 日

財務報表

收支餘絀表

單位：新台幣元

項目	上年度決算		本年度決算		比較增減	
	金額	%	金額	%	金額	%
業務收入	3,173,249,579	103.35	3,070,397,910	100.00	(102,851,669)	-3.24
業務支出	3,094,026,923	100.77	3,038,770,442	98.97	(55,256,481)	-1.79
業務賸餘	79,222,656	2.58	31,627,468	1.03	(47,595,188)	-60.08
業務外賸餘	52,562,546	1.71	18,863,003	0.61	(33,699,543)	-64.11
稅前餘絀	131,785,202	4.29	50,490,471	1.64	(81,294,731)	-61.69
所得稅費用	26,114,418	0.85	8,981,676	0.29	(17,132,742)	-65.61
年度餘絀	105,670,784	3.44	41,508,795	1.35	(64,161,989)	-60.72

資產負債表

單位：新台幣元

項目	本年度決算	%	項目	本年度決算	%
流動資產	1,430,967,661	63.65	流動負債	699,390,987	31.11
基金及長投	84,828,935	3.77	長期負債	-	0.00
不動產、廠房及設備	596,173,038	26.52	其他負債	133,856,159	5.95
無形資產	78,177,468	3.48	負債合計	833,247,146	37.06
其他資產	58,147,893	2.59	淨值	1,415,047,849	62.94
資產總計	2,248,294,995	100.00	負債及淨值合計	2,248,294,995	100.00

The background is a warm golden-yellow color. It features several decorative elements: a large, semi-transparent yellow triangle pointing downwards from the top center; a series of stylized, overlapping wavy lines in a lighter yellow shade across the upper half; a circular sunburst or fan-like pattern on the left side with radiating lines; and several interlocking gears of different sizes in the bottom right corner. A thick, curved white line with an orange segment sweeps across the bottom left. A small, bright white starburst is located near the center of the sunburst pattern.

榮耀成果

ANNUAL REPORT



創新

「創造科技、新秀輩出」孕育精英人才，建立聯盟合作及跨域合作平台，落實高端研究與應用；突破障礙、注入活水，在國際競賽及展場樹立卓越典範。



獲膺榮耀

2021 年

4 月、10 月、11 月

得獎團隊 / 單位：黃家宏、葉庭魁、吳政諺、鍾育霖、陳其禕、劉俊呈 / 精微處

頒獎單位：WTWH Media LLC、美國愛迪生、R&D 100、The Globee Awards

中心首創開發的「連續式微型元件熱處理系統設備」，可改善微型元件（肉厚 2mm 以下之，如手機中的碳鋼螺絲或風扇中小馬達軸心及小齒輪等）在傳統大型熱處理設備進行滲碳、淬火時，因量體小易導致品質不均，容易脆化斷裂，同時收料率不佳，造成原料浪費、瑕疵混料等問題，並成功整合「自動進料系統、自動監測與即時調控主加熱爐、創新油槽暨收料模組與智慧化雲端服務」等四大創新功能，使整體收料率達 100%，良率達 99%，而產出之產品無變形且硬度提升，具備優異的尺寸精度及耐磨耗特性，超越目前國產品質並達國際水準，同時大幅降低交期時程與成本，並可依產品或功能需求，快速替換製程模組，目前該系統設備已於特斯拉、BOSCH 等國際大廠供應鏈生產應用，同時與國內祥儀、興光工業等公司進行產業合作，期許共同建構完善的精微生產鏈，帶動精微元件之加工製造及熱處理相關產業發展，獲得 2021 R&D 100 Awards、2021 美國愛迪生獎銅牌及 2021 CEO World Awards 榮耀。

2021 年 5 月

得獎團隊 / 單位：吳鎮宇、林建佑、鄭勝元、施博錕 / 製程處

頒獎單位：德國 iF

「發泡鋁充氣救生具」採用泡沫鋁技術，不僅在水中有浮力，更兼具耐候性及抗衝擊性，體積只有傳統救生浮標的 1/19，不僅攜帶方便，浮力更足夠讓大人在水中漂浮，榮獲 2021 德國 iF 產品設計獎榮譽。

2021 年 10 月

得獎團隊 / 單位：曾俊傑、蔡東霖、陳俊銘、翁麗雯、王珮驊 / 醫材處

許家豪 / 製程處

頒獎單位：The Globee Awards

「可控水反應鎂合金」，可應用在農業科技、生活健康與醫療等產業。在農業的應用上，鎂合金的水反應現象可以在特定時間內營造出植物生長所需的氫氣及鎂鋅鈣營養成份，並藉由氫氣改變植物的生理激素反應，提升其抵禦逆境的能力，能夠生長的更好；在醫療器材發展上，可應用在骨釘、止血夾、或血管支架等植入物，讓這些植入物在組織或骨骼再生修復過程中，達到均勻且緩慢的降解，被人體完全吸收，不用再透過二次手術取出，降低病患的痛苦，獲得 2021 CEO World Awards 榮耀。

2021 年 10 月

得獎團隊 / 單位：楊光勳、許昭傑、戴聖儒、蘇炳華 / 海科處

頒獎單位：The Globee Awards

「無停轉風機無人機巡檢系統技術」，可以在風機運轉中進行檢測，不需要停機，大幅縮短檢測時間，5 分鐘就可以完成單座風機的檢測，即使連微小到 4mm 的葉片裂縫缺陷都可以檢測出來，足足節省風機檢測成本 40% 以上。也可以組成多台無人機通訊聯隊，同時進行大規模風場巡檢，提高整座風場檢測效率，獲得 2021 CEO World Awards 榮耀。

2021 年 10 月

得獎團隊 / 單位：曾俊傑、蔡東霖、陳俊銘、翁麗雯、王珮驊 / 醫材處

許家豪 / 製程處

頒獎單位：經濟部

「可控制醫用鎂合金降解速率技術」榮獲 110 年度法人科專成果表揚績優技轉獎。

2021 年 10 月

得獎團隊 / 單位：胡博期、簡國諭、王祥賓、林治中 / 精微處

頒獎單位：中華民國對外貿易發展協會

「雷射雕刻機」獲得台灣創新技術博覽會金牌獎。

2021 年 10 月

得獎團隊 / 單位：胡博期、陳彥廷 / 精微處
林治中、黃文輝 / 系統處
頒獎單位：中華民國對外貿易發展協會

「骨科手術之三維即時定位方法」獲得台灣創新技術博覽會金牌獎。

2021 年 10 月

得獎團隊 / 單位：楊光勳、許昭傑、蘇炳華、藍聰義 / 海科處
頒獎單位：中華民國對外貿易發展協會

「固定翼垂直起降飛行器及其自動控制方法」獲得台灣創新技術博覽會銀牌獎。

2021 年 10 月

得獎團隊 / 單位：王俊傑 / 副執行長室
汪立德、陳彥儒、黃彥霖、蔡佩蓉、莊志宇 / 製程處
頒獎單位：中華民國對外貿易發展協會

「複合積層板、殼體及行動通訊裝置」獲得台灣創新技術博覽會銅牌獎。

2021 年 9 月

得獎人員 / 單位：吳文傑 / 智發處
頒獎單位：中國工程師學會台中分會

獲得「110 年度傑出工程師獎」。

2021 年 11 月

得獎人員 / 單位：黃苑筠 / 製程處
頒獎單位：台灣鑄造學會

獲得「110 年度青年鑄造工程師獎」。

2021 年 12 月

得獎人員 / 單位：林秋豐 / 執行長室
頒獎單位：中國機械工程學會

獲得「110 年度機械工程獎章」。

2021 年 12 月

得獎人員 / 單位：徐愷呈 / 升級處
頒獎單位：中國機械工程學會

獲得「110 年度優秀青年工程師獎」。

產業研發聯盟

1. 天然植物藥用與保健產品研發聯盟

由金屬中心、義守大學、長利等單位共同組成，協助推動精準健康，進行植物新藥及功能性健康食品之創新研發及產品化發展，藉由關鍵與創新技術實際運用，創跨域創新里程碑。

2. 汽車與風電零組件熔鑄減碳關鍵技術開發聯盟

由光隆、台灣應達、三惟等單位共同組成，將現有鑄造生產線之一投入高效率設備與創新製程優化，以高熔解效率、自動化澆注、鑄件減碳快速驗證、IOT 減碳管理等四大策略，達到熔鑄減碳關鍵技術開發之建置。

3. 創新口罩及其優化設備整案輸出聯盟

由金屬中心、華新、銘機、萬泰等單位共同組成，建置整廠輸出之智慧製造系統，建置一條生產線進行研究與整合，期將產線良率提升至 98% 以上。另為符合歐美日先進國家要求，金屬中心亦成立口罩鏈高階諮詢顧問團，結合專家群輔導協助。

4. 工業閥產品數位升級暨履歷溯源整合開發聯盟

由金屬中心、巨全、英鼎、聯合大學等單位共同組成，對於閥門產品、機械組件等材質資訊、驗證證書，發展數位匯流、品保作業數位化，建立正確、快速產品資料識別、生產履歷、品管控制、檢驗報告與證書等，作為客戶審查與 MTR 報表產出資訊雲端共享。

5. 壓鑄智慧製造聯盟

由金屬中心、DITSA、鑽全、統仁等單位共同組成，協助廠商掌握製程關鍵參數，優化設計與成型參數，實現線上品質預測，達到線上全檢 & 適化調控，以及即時輔助品質判定，製程要因改善系統化，分析結果有效回饋，利於製程改善。鑽全公司目前建置智慧製造示範場域，並整合設備廠及協力廠共同籌組聯盟。

6. 航太研發維修菁英暨發動機產修聯盟

由金屬中心、聯合動力、南亞技術學院、漢翔航空、駐龍精等單位共同組成，建立國機國造產修技術與零組件開發能量，短期以軍機發動機維修備品為載具，帶領高雄廠商快速切入發動機產修市場，打造高雄成為航太零組件之都。

7. 跨域數位轉型交流平台

由河見、凌誠、佳凌等單位共同組成，針對園區產業轉型示範推動輔導，期能促使園區產業加值創新，協助產業之升級轉型、更新活化等發揮更大綜效，進而強化營運效率，提升園區產業之競爭力。

8. 海扶刀 AI 輔助定位辨識系統開發聯盟

由金屬中心、仰德儀器、波音醫學設備等單位共同組成，促進我國建立製作海扶刀 AI 手術輔助，空間定位、整機系統的研發團隊，解決 100% 仰賴國外進口與設備昂貴等問題。

9. 工具機工作台鑄件聯盟

由源潤豐、傑晃、新穎等單位共同組成，整合工具機零組件等上中下游業者，建立技術自主之產業鏈，促進國外工具機發展趨勢及熱處理關鍵技術，建立自主應用之新材料、新技術、新產品。

10. 國產高階微米網版印刷技術研發聯盟

由鈺鎧、金鼎、台特等單位組成，整合不銹鋼材料、伸線及熱處理、織布製造及 5G 被動元件製造相關技術，協助鈺鎧公司應用高階微米級網版印刷技術製造 5G 關鍵被動元件，以提升全球市佔率。

11. 離岸風電水下基礎結構法蘭 / 管端之智慧化銑平設備研發聯盟

由盈昶精工、俊鼎機械等單位共同組成，大型鋼構件的成形加工和製造設備機具，目前國內都沒有廠商自行研發，卻又是離岸結構件生產製造所必要之設備，開發之離岸風電水下基礎結構法蘭 / 管端之智慧化銑平設備，可符合台灣的產業和市場需求。

產學研互動

結盟對象：長榮航太科技股份有限公司

時間：2021年1月1日 / 代表人：林執行長秋豐

簽約內容：與長榮航太股份有限公司，為促進產研合作發展進行航空發動機零組件加工技術等相關合作，簽訂合作備忘錄。

結盟對象：光陽工業股份有限公司

時間：2021年1月1日 / 代表人：林董事長仁益

簽約內容：與光陽工業股份有限公司，為有效運用雙方人才交流及知識互惠，共同推動科技發展及知識應用以提升產業競爭優勢。

結盟對象：哈瑪星科技股份有限公司

時間：2021年4月1日 / 代表人：林董事長仁益

簽約內容：與哈瑪星科技股份有限公司，為推廣 SAF Business ByDesign 市場，期望透過雙方策略聯盟，提供完整解決方案。

結盟對象：國立高雄大學

時間：2021年4月29日 / 代表人：林董事長仁益

簽約內容：與國立高雄大學，為積極推動產學合作與促進金屬中心產業發展，有效運用雙方資源，建立政府與學術研究機構及智庫之合作關係機制，以增進雙方實務與學術經驗交流，特議定本協議書以為雙方加強合作之依據。

結盟對象：中華民國儀器商業同業公會全國聯合會

時間：2021年5月14日 / 代表人：林董事長仁益

簽約內容：與中華民國儀器商業同業公會全國聯合會簽訂本合作備忘錄，為借助金屬中心長期於協助產業人力發展能量，共同推動儀器產業人才的發展。



結盟對象：Fraunhofer IPA

時間：2021年6月1日 / 代表人：林董事長仁益

簽約內容：與 Fraunhofer IPA 針對 AI 相關技術進行交流，故簽訂合作意向書。

結盟對象：四季洋園生物機電股份有限公司

時間：2021年9月1日 / 代表人：林董事長仁益

簽約內容：與四季洋園生物機電股份有限公司執行水素產業研發中心計畫，並進行海水分離系統之合作研發。

結盟對象：中華牙醫學會及緬甸牙科協會

時間：2021年10月30日 / 代表人：林執行長秋豐

簽約內容：與中華牙醫學會及緬甸牙科協會，以牙科植體相關產品應用與牙科產業領域交流進行合作。

**結盟對象：中華民國牙醫師公會全國聯合會及 St. Frances Cabrini Medical Center Inc.**

時間：2021年11月10日 / 代表人：林董事長仁益

簽約內容：與中華民國牙醫師公會全國聯合會及 St. Frances Cabrini Medical Center Inc. 以牙科植體相關產品應用與牙科產業領域交流進行合作。

結盟對象：和成欣業股份有限公司

時間：2021年12月23日 / 代表人：林董事長仁益

簽約內容：與和成欣業股份有限公司為促進國內廚衛浴家電產業發展及長期檢測合作，特議定本合作備忘錄作為雙方加強合作之依據。

**結盟對象：中華牙醫學會及越南胡志明醫藥大學**

時間：2021年10月30日 / 代表人：林執行長秋豐

簽約內容：與中華牙醫學會及越南胡志明醫藥大學，以牙科植體相關產品應用與牙科產業領域交流進行合作。



發展見證



時間：2021 年 1 月 11 日

海洋科技產業創新專區開幕典禮

活動內容：

「海洋科技產業創新專區」開幕典禮由經濟部王美花部長、經濟部能源局游振偉局長、高雄市陳其邁市長與金屬中心林仁益董事長、林秋豐執行長等貴賓一同參與。為完備國內水下基礎製造、海事工程技術、人才與產業發展能量，「海洋科技產業創新專區」，以「海洋工程」、「海洋科技工程人才培訓及認證」、「海洋科技產業創新」為主軸，建立我國離岸風電水下基礎製造能量，培育國內離岸風電相關人才，並建立海洋科技產業自主研發能量。「海洋科技產業創新專區」可促成離岸風電海事工程科技產業在地化，創造在地就業機會。同時，也促進興達漁港轉型升級，蛻變成為亞太地區離岸風電的重要基地之一。



時間：2021 年 4 月 27 日

海洋科技產業創新專區離岸工程中心動工典禮

活動內容：

由經濟部陳怡鈴主任秘書擔任主祭，與高雄市政府陳其邁市長及能源局游振偉局長等貴賓，一同於海洋科技產業創新專區內舉行「離岸工程中心」動工典禮，共同見證首座國家級模擬實海域場域建置之啟動。未來「離岸工程中心」可以提供多元產業服務，除了縮尺模型之實海域模擬測試外，亦可提供潛水員訓練、水下載具駕駛員訓練、水下儀器設備測試或校正、水下結構檢測或維修模擬訓練等，並將結合國內外學研能量，持續擴大深水池之潛力應用領域，包含再生能源、海事工程、海洋儀器、離岸結構物、安全防禦與學術研究等，發揮此國家級研發設施之效益，加速國內產業發展之目標。

卓越典範 /

熱處理模組智慧化 精微零組件再升級

「連續式微型元件熱處理系統設備」勇奪 2021 愛迪生獎及 R&D 100 全球百大發明獎

獲獎團隊：黃家宏、葉庭魁、吳政諺、鍾育霖、陳其禕、劉俊呈 / 精微處

金屬中心精微處處理組自主研發「連續式微型元件熱處理系統設備」，以模組化及智慧化設計，創新熱處理之進料系統、加熱爐、油槽及收料裝置，使整體收料率達100%、良率達99%，勇奪愛迪生銅獎及R&D 100全球百大科技發明獎。



微型零件需求上漲 熱處理技術成痛點

近年來3C產品朝向輕薄、短小、可攜式的趨勢發展，帶動各項微型元件需求上漲，舉凡手機中的碳鋼螺絲、風扇中小馬達軸心或小齒輪，甚至是微創手術、醫療檢測的精密轉軸、探針等，都是熱門的微型零組件。而當零件沖壓成形後，會進入熱處理階段，以均勻加熱材料的方式提升金屬韌性及強度；一般熱處理過程包括加熱、淬火、收料、清洗、回火等步驟，但微型零件小又輕，若用傳統設備進行熱處理，需要包覆細鋼網才不會四處飄散，且要累積足夠數量再處理才符合成本，導致材料堆疊在一起熱處理，容易有材料受熱不均、變形、脆化、交期延宕等問題，形成長期以來的產業痛點。





切入國際高值市場 帶領產業加速轉型

過去業界普遍委外執行熱處理程序，隨著國產設備系統的問世，業者就能內建自主管理系統，加速作業排程，大幅提升整體生產效率和競爭力。目前金屬中心已將相關技術與設備分別移轉給專門進行熱處理的興光工業，以及從事專業微小精密馬達齒輪箱的祥儀企業，並協助多家企業改善微型零組件的熱處理品質，使其快速切入精密零件國際供應鏈，例如：特斯拉(Tesla)的電動車門把、軸承及變速箱零組件；博世(Bosch)、牧田(Makita)齒輪箱。未來還可應用於醫療機械、光電半導體、機械手臂、電動汽機車、航太等，使技術切入國際高值化產品市場，並加快台灣產業數位化及智慧化的轉型腳步。

自主研發模組設計 四大創新提升良率

微型零件使用傳統熱處理製程，不只容易使零件脆化斷裂，還同時有品質不均、收料率不佳、造成原料浪費及瑕疵混料等問題，加上傳統熱處理系統設備的大型油槽箱不適用於微型零件，經常導致零件四處漂浮、不易收集，促使金屬中心加快腳步，自主研發出「連續式微型元件熱處理系統設備」。該設備針對高複雜結構或直徑2mm以下的零件進行開發，採用模組化系統，整合「自動進料系統」、「自動監測與即時調控主加熱爐」、「螺旋式漏斗油槽」、「改良式收料裝置」四大創新設計，並將油槽與輸送帶整併合一，使收料率可從傳統設備的50~60%提升至100%；品質良率則從50~65%提升至99%。

創新5G與AI導入 客製無人智慧產線

無論傳統的製造工業，還是高科技半導體、電動車與無人機產業，熱處理程序都在生產過程中扮演著關鍵角色。為滿足業者多元需求，金屬中心也在連續式微型元件熱處理系統設備中導入最新5G通訊與AI人工智慧技術，讓業者能夠依產品或功能客製化專用製程、快速替換模組，將傳統熱處理經驗轉為數據決策，快速準確分析出溫度、時間等最佳熱處理製程參數，管控及預測零組件熱處理加工品質，不僅能帶來彈性運用與高效率，也能降低人為經驗的依賴與摸索，並有利於建立產業專屬IoT方案、為後續無人智慧化產線鋪路，協助業者建構完善的微型元件生產鏈，推動產業開拓新商機。



廢棄鋁打造救生神器 循環經濟創商機

「發泡鋁充氣救生浮具」榮獲 2021 德國 iF 設計獎

獲獎團隊：吳鎮宇、林建佑、鄭勝元、
施博鋁 / 製程處

金屬中心製程處熔鑄組開發「發泡鋁充氣救生浮具」，以循環再利用的概念，重新塑造廢棄鋁金屬的價值與使用性，將再生鋁材結合專利發泡技術，設計出體積小、輕量化、便於多種海上活動攜帶的救生浮具，獲得德國iF設計獎殊榮。



呼應綠色環保議題 創新循環再生資源

因應環保趨勢，眾多國際大廠如汽車、民生、消費性電子、建築等產業已訂定永續發展目標，其中回收再利用是快速有效的措施，但如何運用廢棄資源再創高值效益，考驗著產業的創新技術。在金屬工業中，鋁是應用最廣泛的材料之一，在各道加工程序時會產生廢料及廢品，而再生鋁、發泡鋁的應用又有無限潛力，因此金屬中心在經濟部技術處的支持下，投入「低壓鑄造回收鋁材發泡成形與製造技術」，致力打造輕量、可吸收撞擊能量及防音特性的多孔金屬，研發成果不僅改善了傳統製程成本過高問題，亦將廢棄金屬轉化為創新綠色材料，為產業帶來高值循環經濟。



回收鋁材創造效益 打造充氣救生浮具

如何運用創新綠色材料開發產品？金屬中心看準發泡鋁具輕量、耐候、可浮於水，以及抗衝撞的特色，開發出「發泡鋁充氣救生浮具」。這款浮具只有傳統救生圈體積的1/19，不只輕巧、易於攜帶，圓潤的外型亦方便手掌抓握，只需將保險環拉開並投擲到水中，入水後就能自動充氣讓落水者抓住，增加落水者在水上等待救援或自救的時間；衝浪、橡皮艇、滑水等運動人員都能輕鬆攜帶，還可增加船艇攜帶救生浮具量，提供乘客更多安全保障。以水上救援為例，一台載重15公斤的無人機原本只能搭載3至5個傳統救生浮具，如今卻能搭載10至15個發泡鋁充氣救生浮具。

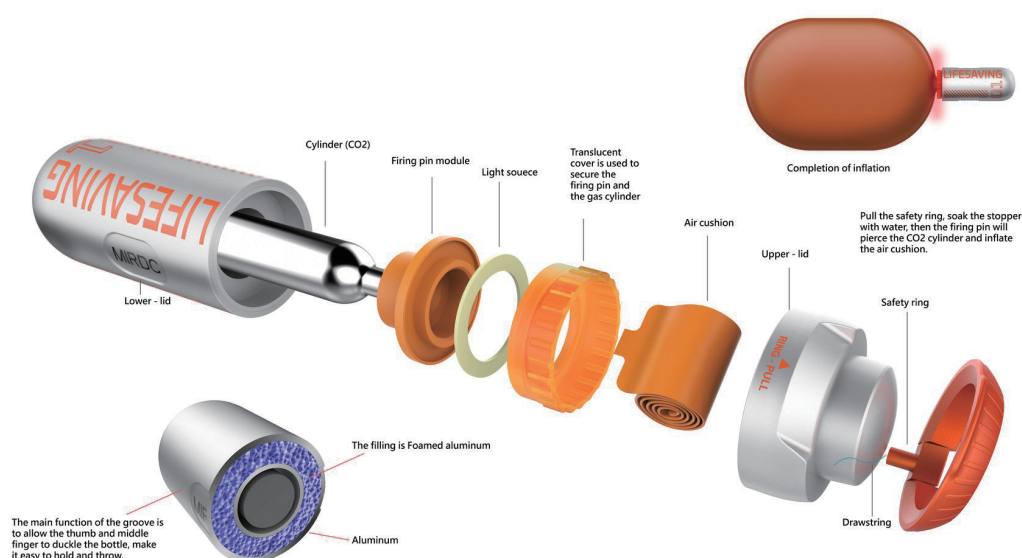
擁發泡鋁製造專利 首創國內製程設備

以往想要製造發泡鋁，必須從粉末冶金製程取得，以添加分子化合物的發泡劑輔助，需多次生產、成品結構控制不易，致使原料成本高、市場接受度低。如今透過金屬中心的製造發泡鋁專利方法，採低壓鑄造方式進行注氣發泡，用鋁渣/鎂廢料搭配調壓及壓重裝置完成模內充填成形，不僅成本更低，還可增加發泡率、使發泡更均勻，同時解決鋁及鎂的廢料處理問題。另一方面，中心亦匯聚技術量能，建置國內首套循環鋁材低壓鑄造發泡成形製程設備，並使用全回收鋁(工業廢鋁料與民生廢鋁瓶罐)進行發泡製造，不僅降低鋁渣生成量，還能創造循環鋁材高值應用。



功能材料多元應用 力促產業永續發展

因不少業者已具備壓鑄設備的基礎，未來推廣應用可減輕業者負擔，促進循環鋁材廣泛應用，例如應用於高值防撞部件，發泡鋁的吸能作用可低撞擊車輛本身的反作用力，提升產品防撞擊破壞係數15%以上，提高駕駛者安全生命保護；或是應用於高值抗振電動車元件，在電動車動力模組支架內部充填發泡鋁鑄芯塊，可提升24%減振效果。未來亦可生產大面積產品，善用發泡鋁多孔性結構，作為吸音、減振、隔熱及電磁屏蔽的功能材料，例如建築隔音材料、建築耐燃材料、建築防電磁波材料、工具機抗振板等，使材料提升附加價值5-10倍，以高值化發展促進產業邁向永續未來。



卓越典範 /

3D列印浮雕藝術 開創跨域視障輔具

「3D 列印砂模鑄造技術 - 浮雕視障輔具應用」斬獲 2021 時代雜誌最佳發明特別獎

獲獎團隊：

王俊傑 / 副執行長室

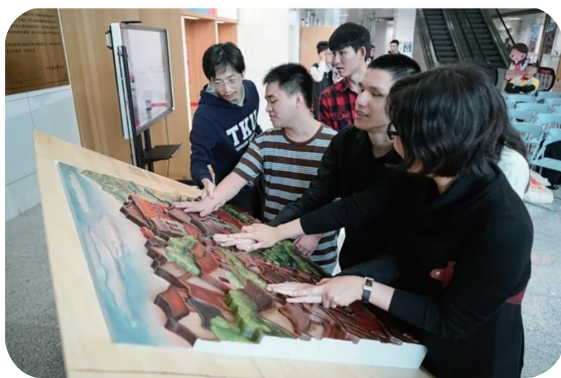
鄭炳國、郭信宏、蔡和霖、吳承柏、陸致偉 / 製程處

將「3D列印砂模鑄造技術」應用於視障輔具開發，將平面版畫複製為立體浮雕，幫助視障者藉由觸覺認識藝術作品；該技術具備工序簡化、可複製、低成本、高效率、高品質等特色，斬獲時代雜誌最佳發明特別獎。



首座3D列印機台 成立營運服務中心

過去，傳統金屬產品製造工法需要開模具、砂模製作、試作、修模、鑄造等工序，且金屬模僅能以實體方式成形，模具重量達幾百公斤，不僅程序繁瑣、耗時費力，若遇大型工件或複雜形狀設計也容易受限。金屬中心在2016年即引進台灣第一座3D列印鑄造用砂模機，先進技術可直接「列印」出鑄造用砂模，大幅縮減模具製作時間，並克服複雜形狀工件加工困難及模具重複修改等問題。同時也成立「3D列印鑄造砂模營運服務中心」，協助鑄造、機械、航太、汽車、工具機、水五金、船舶等重點產業，應用3D列印技術提升國內業者自主開發能力，切入全球零組件產業供應鏈。



促進視障文化平權 建置輔具開發程序

金屬中心除了運用3D列印砂模鑄造技術協助產業開發金屬製品，亦致力以創新科技響應視障文化平權與社會公益。為協助視障朋友擁有更佳的藝術欣賞體驗，中心建置化繁為簡、高效及低成本的視障輔具開發程序，運用大型3D列印砂模系統結合翻模工法，將台灣代表畫家之一的陳澄波作品《淡水風景》重製為大小相同的立體浮雕作品，使視障者得以用雙手感受原畫作的構圖和布局，盡情探索畫中房屋造型和遠近空間感。其中，為了加強砂模浮雕原型強度與細緻度，中心也重新設置砂材比例與黏著劑控制技術，並導入砂模底座支撐設計，開創工業跨域藝術的全新風貌。

一體成形快速造模 解決複雜形狀缺口

鑄造產業為國家重要基礎工業之一，台灣鑄造產業發展已超過40年，造就了工具機、水五金、閥體等多項金屬製品之興盛；透過3D列印這類積層製造技術，能促進鑄造原型、模型與模具開發，在黏著劑噴塗成型製程與鑄造產業中應用廣泛，業者可以快速打樣、創新提案、設計複雜形狀，並運用一體成形的快速造模優勢降低產品開發中用的鑄造模具成本，不需考慮拔模角、不需開立木模等，能有效縮短產品開發週期與減少成本約35%，解決技術應用之缺口。以汽缸頭為例，傳統砂模開發約23天，導入3D列印砂模製程後，創新砂模開發只要約15天即可完成，大幅降低開發時間。

提供開發試作場域 創新科技研發應用

有鑒於3D列印砂模鑄造技術可多元輔助新產品自主開發，縮短首件提樣時程、爭取訂單，因此金屬中心提供業者少量多樣、客製化的開發與試作場域，目前已陸續協助成大精機工業、河見電機工業、萬事興實業、嘉鋼精密工業、怡欣達金屬等公司，應用先進3D列印鑄造砂模技術，解決新型工業零組件大尺寸與形狀複雜問題，滿足新產品開發及縮短期程需求。此外，中心也自行開發輕量化沖壓模具，運用拓撲分析與結構輕量化設計，整合3D列印砂模無形狀限制的優勢，建立國內首創鈹金沖壓模具技術，搭配可回收鋅合金模材，使模具減重40%以上、成本與時程降低25%以上，偕產業共同開創鑄造競爭力。



3D PRINTING SAND CASTING TECHNOLOGY

MIRDC'S 3D RELIEF ART WORK IS SELECTED AS A
SPECIAL MENTION IN TIME'S BEST INVENTIONS OF 2021!





金屬工業研究發展中心
METAL INDUSTRIES RESEARCH & DEVELOPMENT CENTRE



技術與 研發創新

ANNUAL REPORT



精耕

「精煉技術、耕耘不懈」深耕在地技術、推展國際視野，同時凝聚研發能量、鎖定世界趨勢，創新金屬應用促進產業多元化發展，打造全球頂尖競爭力。

熔鑄技術

2021年延續過去研究，專注於耐蝕易切削不銹鋼材料開發，針對產業對不銹鋼材料的高強度、耐蝕性、以及加工性能需求，建立成份合金設計及產品製程。透過硫、鈣、鉍等強化元素添加，優化材料切削性、機械強度與加工性能，使品質媲美國際大廠，並可應用於3C精密扣件及車用等扣件，強化國產競爭力。

未來將著重於高強度鑄鐵材料開發，協助提升業者鏈結二次加工及量產技術，並且優化材料機械性質與切削加工性能，發展自動控制設備的機器人手臂關鍵精密零組件，以補足國內機器人產業缺口，降低關鍵零組件成本，提高國內機器人及自動化產業的優勢。

研發現況

1. 耐蝕易切削不銹鋼材料開發

- 耐蝕易切削不銹鋼材料開發可有效提升不銹鋼耐蝕性能與機械強度，可延長材料壽命(Reuse)，為產業迫切需求。
- 透過耐蝕易切削不銹鋼熔鑄與熱鍛成形製程，進行機械性質分析，硬度達176Hv、抗拉強度為538MPa、耐蝕性達550hr無銹蝕及加工性能提升30%。
- 耐蝕易切削不銹鋼材料可媲美國際大廠(新日鐵住金)之材料性質，如取代進口材料，可降低材料成本達10%以上。
- 我國車用螺絲出口產值高達新台幣2億元/年。



車用扣件

未來研究

1. 高強度鑄鐵材料開發

- 建立易切削高強度沃斯回火球墨鑄鐵合金配方及熱處理製程，鏈結二次加工及使用端等業者量產技術能量，開發自動控制設備用機器人手臂關鍵精密零組件，協助業者轉型，並提升產業競爭優勢。
- 建立易切削高強度沃斯回火熱處理製程技術開發，提升材料機械性質與切削加工性能，機械強度可達900MPa以上、衝擊值達100J以上。
- 預期易切削雙相區間沃斯回火球墨鑄鐵應用於機器手臂用齒輪，可超越國際大廠(Harmonic Drive)之減速機性能，扭轉剛性>64,000Nm/rad，耐久壽命>10,000hrs。
- 補足國內機器人產業缺口，降低關鍵零組件成本，提高國內機器人及自動化產業的競爭力，創造產值達2億元以上。



車用曲柄軸

鐸接技術

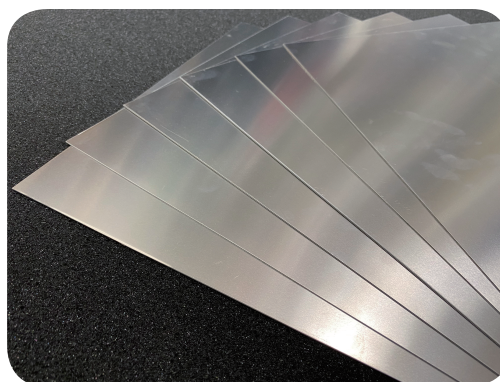
今年鐸接技術上因應市場對於金屬板材高強化、輕量化，以及快速鐸接等需求，透過鋁合金與熱塑複材接合界面處理技術及真空熱壓製造技術面上，突破鋁合金輕量化瓶頸，完成兼具金屬質感、高強度、輕量及可循環回收等優異特性之混成板材，並藉由大面積鋁板高速度摩擦攪拌鐸接技術開發，大幅提升鐸接速度，同時使鐸道品質符合ISO國際規範，使鋁材得以高值化發展。

本中心致力於數位轉型，未來將匯聚既有技術量能，發展及建立數位化鐸接製程，整合雷射視覺、運動控制、鐸接模擬、入熱量分析及鐸接程序規劃技術，建立數位化鐸接程序資料庫，實現鐸接製程可視化及自動化，達成智慧化鐸接與品質控管。此外，亦會針對複合材料、異厚板開發高階鐸接技術，推動金屬材料朝向多元應用發展，提升產業競爭力。

研發現況

1. 金屬基混成板材開發

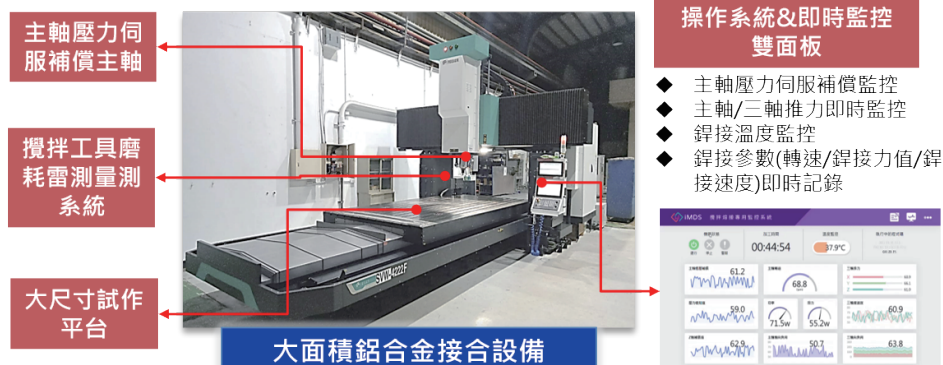
- 因應高強度輕量化得以減碳的需求趨勢，進行異質混成板材開發。
- 新開發鋁合金與GFRTTP混成板材具備較鋁合金輕量化20%以上且板材彈性模數 $\geq 60\text{GPa}$ 。
- 預期新開發鋁合金與GFRTTP混成板材應用於5C殼件產品，兼具金屬的質感、高強度、輕量及可循環回收等優異特性。



混成板材

2. 大面積鋁板高速度摩擦攪拌鐸接技術開發

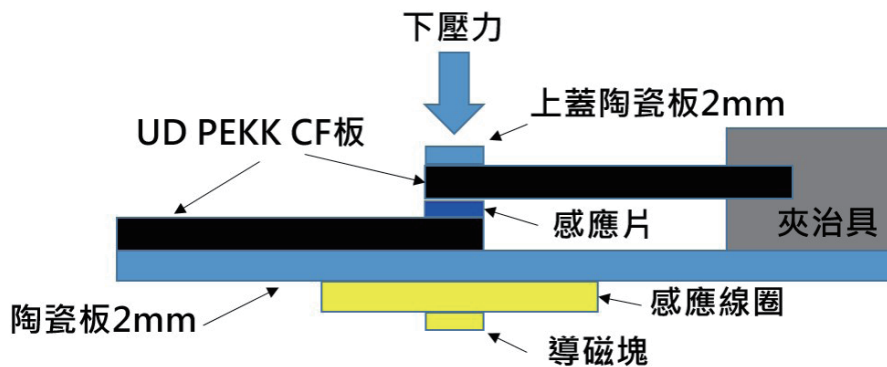
- 對應電動車輕量化鋁材應用趨勢與高品質接合需求，進行大面積鋁板高速度摩擦攪拌鐸接技術開發。
- 本技術可提升大面積鋁材鐸接速度20%，鐸道品質符合ISO 25239國際規範要求，鐸接變異量控制 $<1.0\text{mm/m}$ 以內。
- 本技術可應用於電動車零組件與5G訊號量測裝置產品，並克服鋁合金產品鐸接缺陷與變形問題，促進回收鋁材高值化產品應用。



未來研究

1. 可循環熱塑性複合材料銲接技術

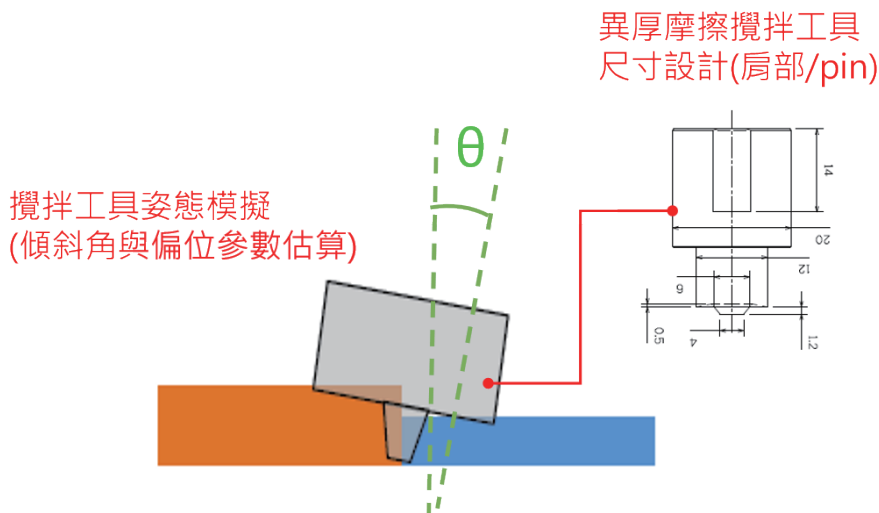
- 因應循環經濟新材料發展，熱塑性複合材料具備可循環回收及可銲接特性，進行熱塑性複合材料銲接技術開發。
- 預計利用電磁線圈對碳纖維複合材料感應加熱，透過感應線圈設計及設備開發，並建立熱塑複材感應銲接製程中之溫度、壓力、時間等參數，使複合材料搭接剪切強度>20MPa以上。



熱塑複材銲接技術

2. 異厚板摩擦攪拌鉚接技術開發

- 因應循環鋁材與鋁合金輕量化應用於國際車廠規模不斷擴大，將進行輕量化異厚板摩擦攪拌銲接技術開發。
- 預計藉由摩擦攪拌銲接熱源分析技術，結合特殊攪拌工具開發，將銲接實測與熱源數值比對調整，建立異厚板件銲接關鍵參數，使異厚板銲後銲接強度達母材強度65%以上。



異厚板摩擦攪拌

成形技術

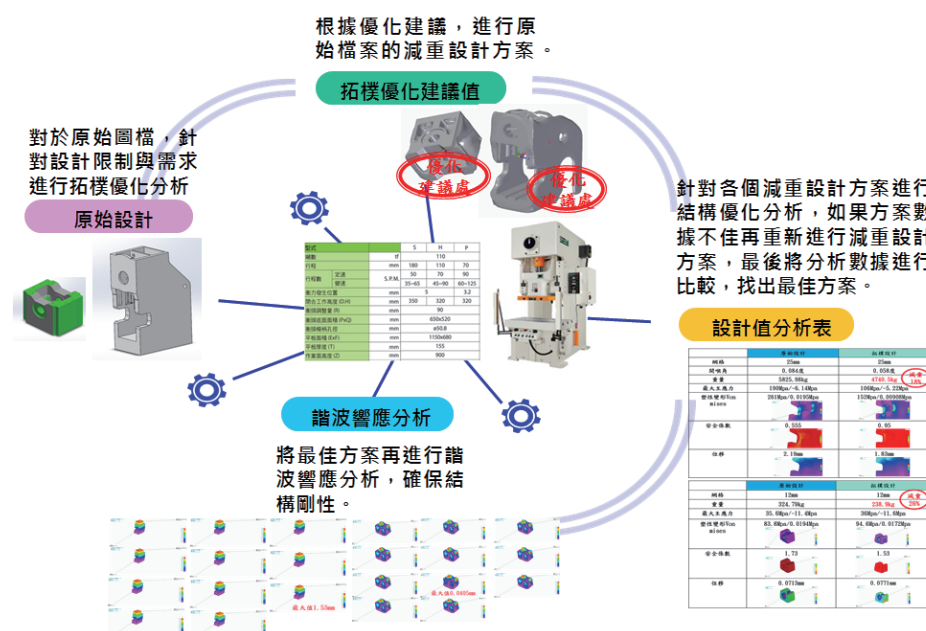
2021年主要針對螺絲、螺帽及鍛造產品製程進行開發，並進行數位化轉型進行相關模組與技術，例如成形機械結構優化、成形機械設計資料自動化生成模組等，今年更研發模具快速設計與快速試作技術、高功能性部品製造技術，克服縮短設計時程、減少製程損耗、提升部品附加價值及功能性，並協助國內成形產業透過數位化與智慧化系統進行升級轉型。

未來研發重點將著重鍛造模具設計、製程控制關鍵技術，同時精進數位化轉型技術發展，優先進行成形機械製造資料自動化生成模組、沖壓數位化設計模組，以及成型虛實整合模組等技術。藉由提供快速設定參數等優勢，提高模組產值、減少生成時間、降低人為經驗之誤判，同時增加產量、效益，以及品質，大幅減低產線成本。

研發現況

1. 成形機械結構優化設計技術

- 導入結構優化技術於成型機械設計，進行單一零部件拓樸優化以及整機拓樸優化，減輕成型機械重量10%以上，藉此達到結構減重與強度兩者兼具的成效。
- 針對C型沖床：滑塊案例減重比達26%、機身案例減重比達18.6%。H型沖床：滑塊案例減重比達15.5%、機身案例減重比達20%。
- 可協助成型機械廠商，節省材料、提升結構效能，設計大型成型機械時兼顧輕量化，可大幅降低製造成本、增加利潤。



2. 智慧虛實整合系統技術

- 本技術智慧虛實整合系統，可針對人員、原料、模具與沖床設備等資訊，由系統整合自動生成沖壓產線排程，從接單至生產，數位化管理，並集中監控產線資訊，即時狀態分析與預測，提升產能效率。
- 本技術可應用於沖壓、電鍍、射出等相關模具產線，進行智慧虛實整合管理，減少人為經驗與誤判，提升管理效益與產量及品質。



數位集中監控管理生產



數位化管理 資訊輔助產鏈效益最大化

3. 成型機械設計資料自動化生成模組

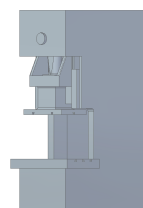
- 協助廠商將沖床經驗程式化與數位化，讓國內沖床設計人員快速學會設計方法。
- 成型機械模組化自動化設計技術導入，對於國產沖床之開發技術，可由3個月縮短為1個月，提高設計人員50%以上產值，增加附加價值10-20%。



沖床之參數導引介面



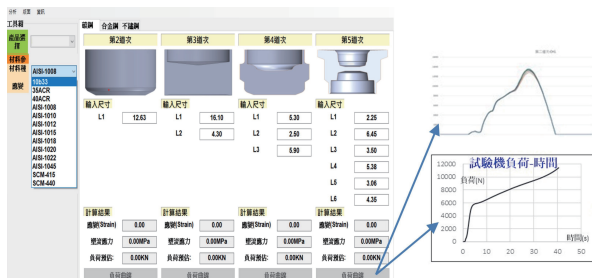
沖床之標準零件庫



完成沖床整機組立

4. 螺絲成形負荷感測技術與螺帽成形上界限分析技術

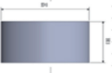
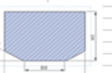
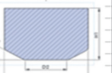
- 協助國內設備業者建立模具材料、幾何與感測器電壓之關係，藉由電壓轉換公式取得負荷曲線，再由負荷推估模具壽命，此項技術可縮短開發時所損耗的時間進而減少成本。
- 由螺帽上界限法建立成形力快速評估模型，可得到輸入產品尺寸、材料性質後便能得到所需負荷，縮短開發時所損耗的時間進而減少成本。



成形力快速評估模型示意圖

5. 鍛造產品製程設計決策導引技術

- 針對目前扣件產業需求，開發螺帽產品之模具數位輔助設計系統，以促進業者建立數位化設計與分析能量，有助於加快切入智慧製造應用領域。
- 透過開發產品分類與製程設計模型，預計可以減少產品開發時程40%，開始設計至完成試模由45工作天縮短為27工作天、節省總開發成本約10%以上（不重複修模）。

螺帽預成形設計系統					
六角螺帽 (ISO 4033-1999)	產品參數				操作步驟 利用下列公式 量取規格
	5邊次	尺寸(mm)			
	規格			M5	
	六角對邊(S)			7.89	
	螺帽高度(H)			4.95	
	螺帽孔徑(D)			4.48	
材料建議直徑 (mm)				至	
各階段尺寸					
原料		第一階段		第二階段	
					
D1	7.1	D1	7.3	D1	7.5
H1	5.9	D2	4.1	D2	4.1
		H1	5.9	H1	5.7
		A1	60	A1	60
表面粗糙度Ra	1.00	表面粗糙度Ra	0.06	表面粗糙度Ra	0.12
表面硬度HRC	1.00	表面硬度HRC	1.00	表面硬度HRC	1.00

標準螺帽尺寸設計輔助系統示意圖

6. 免調質鋼近淨形鍛造技術

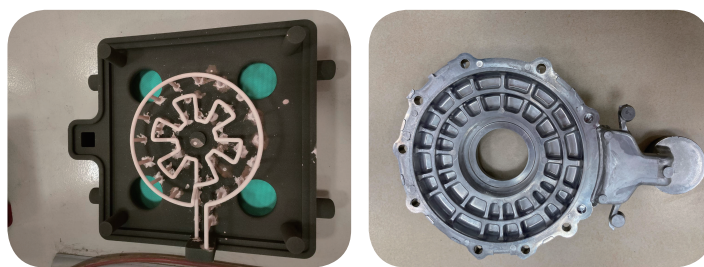
- 開發免經調質熱處理製程之材料及鍛造製程，結合複動化模具進行近淨形鍛造，可達到高得料率約88%效益。以齒輪鍛件為例，冷精整後齒面無需加工可達JIS 4級精度標準、硬度達HRC 28；表面經處理後硬度可達HRC 56。
- 技術成果可應用於傳動齒輪件，也可應用於輪轂或轉向節等車用零件，其材料及製程技術均呼應減碳節能訴求，且能降低成本10%以上。



高硬度齒輪鍛件

7. 異形水路快速模具試作技術

- 藉由噴膠黏粉積層製造技術進行異形水路模具的開發，以達到熱衝壓製程模具製造週期縮短、接單能力提升的需求。
- 陶芯異形水路及可耐1600°C下8MPa的鐵水衝擊，並可製作出細長與彎曲水路。
- 可快速提供小批量生產交樣，成本降低40%以上，時間縮短40%以上（50天至30天以內）。
- 異形水路模具可應用於需要散熱或藉由模內淬火製程而獲得高品質特性的產品，可應用於熱衝壓產業、壓鑄業、塑膠射出業等。



含高細長比內流道之砂模

8. 高強度鋁合金零部件溫成形技術

- 完成7xxx鋁合金溫成形製程開發，並以車門抗撞橫樑部件作為載具進行實際試作驗證。溫成形製程可克服現有冷衝成形無法承製高強度鋁合金鈹件的困境。成形後鈹件經尺寸精度量測比對及機械性質驗證後，尺寸精度可控制在 $\pm 0.6\text{mm}$ 範圍內，抗拉強度可達7075-T6板料原抗拉強度85%以上。
- 新開發之高強度鋁合金零部件（溫/熱成形部件），主要應用於運輸產業輕量化部件，預估可減重30%以上，並具有可回收之循環材料經濟效益。



7xxx鋁合金部件試製成果

9. 混成板材構件成形製程及模擬分析技術

- 運用鋁板及玻纖熱塑複材疊層製造之混成板材完成3C殼件產品試製。藉由熱預成形、邊角精整兩道設計方案進行模具設計、製作及成形測試。試作成品轉角處無破裂缺陷。鋁板及玻纖層無皺褶、轉角處切截面層間接合良好，無剝離現象發生。殼件邊角尺寸 $\leq R 2\text{ mm}$ ，符合筆電產品外型特徵需求。
- 利用LS-DYNA模擬軟體建立混成板材疊層構件之成形模擬模型。針對四層材料、三層界面層之混成板材熱成形製程模擬，各項尺寸誤差準確度可達78.59%以上（厚度減薄、回彈角度等）。



邊角整形(上)、熱預成形(下)圖角比較

圓規2.0量測轉角處

混成板材多道次成形之成品示意圖

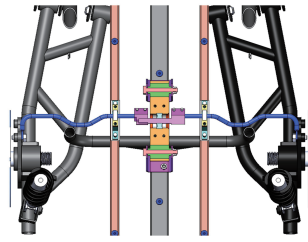
10. 拖曳臂撓性元件研製及驗證

撓性旋轉座設計與研製

- 五點式懸架-撓性旋轉座，垂直入力變為旋轉力矩，可減少側傾角度變化。
- 依ISO 4138試驗，側向加速度極限提升41%。
- 安裝拖曳臂撓性元件：側向加速度最大極限值約 3.99 m/s^2 。

減振貨架平台

- 減振貨架：1. 可撓性載台-吸收側向偏擺 2. 空氣彈簧-吸收垂直振動 3. 同心轉盤-吸收轉動。
- 依據ISO-7401進行負載100公斤驗證，減振值 $\geq 30\%$
- 振幅降低19.1dB。
- 實車五點量測：減振值最低 $\geq 30\%$ ，最高76%。



撓性旋轉座設計與研製

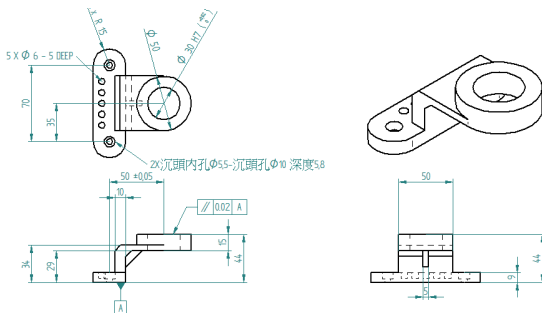


減振貨架平台

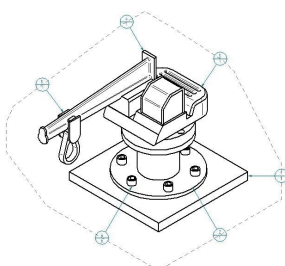
未來研究

1. 成型機械製造資料自動化生成模組

- 協助廠商將沖床經驗程式化與數位化，讓國內沖床設計人員快速學會設計方法。
- 成型機械模組化自動化設計技術導入，對於國產沖床之開發技術，可由4個月縮短為1個月，提高設計人員60%以上產值，增加附加價值10-30%。



工程圖自動繪製

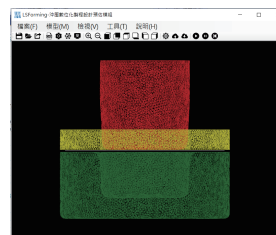


BOM表自動生成

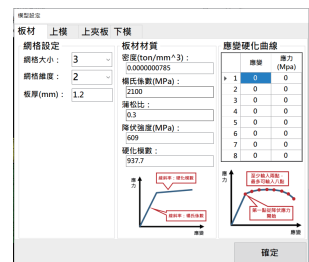
Item Number	File Name (no extension)	Author	Quantity
1	底板		1
2	底座		1
3	吊車座		1
4	吊臂總成		1
5	吊車		1
6	螺絲		6

2. 沖壓數位化製程設計模組開發

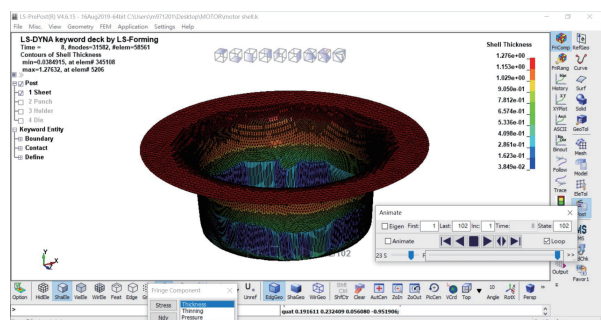
- 國內雖有成型製程CAE技術，但在製程優化部分仍根據人為經驗或是直覺進行設計更改。
- 本模組技術可於模組內設定快速設定CAE模擬條件與參數，如：公母模定義、材質、沖壓速度等）；減少模具工程師學習與調整CAE軟體參數的時間。
- 針對抽引案例使其板厚最大變薄率 $\leq 20\%$ ，針對沖鍛案例使其尺寸精度 $\leq 0.05\text{mm}$ 。模具設計開發效率提升36%(由原先14天至9天)。



模組操作介面 (主畫面)



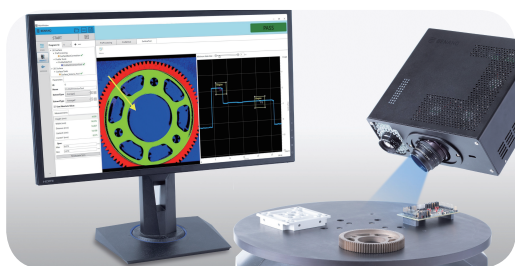
模組操作介面 (模型設定)



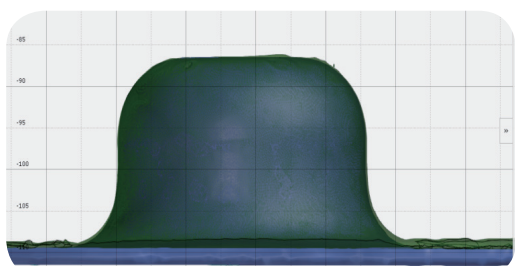
模組設定完後直接匯入 CAE軟體進行分析

3. 成型虛實整合模組

- 目前製造產業上主要的檢測工作大多以接觸式的量測方式進行檢測，有的需製作精密的檢治具，執行都得準備相當複雜的前置工作。
- 本模組可以3D掃描的技術將量測物件逆向掃描成密集的點雲資料，再以操作便捷的比對功能進行自動分析與成果展示，讓檢測人員一目了然及時掌握品質狀態。
- 透過本模組之比對功能可協助工程人員進行模具調整，使最終模具設計與實際加工結果比對誤差 $\leq 10\%$ 。



使用 3D掃描裝置進行成型零件外觀輪廓掃描，取得點雲資料



將虛實結果進行比對，並判斷 OK或 NG
(綠色點雲：實際 3D掃描輪廓／藍色實體：CAE 分析結果)

5. 金屬靶胚晶粒控制關鍵技術

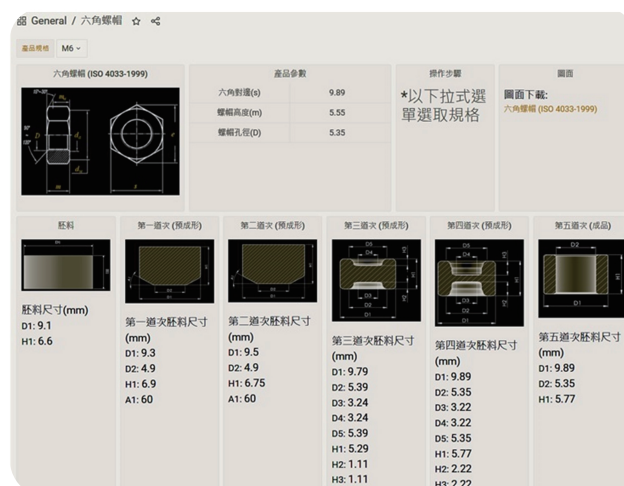
半導體靶材目前均從國外進口，關鍵材料受美日等國箝制，因此擬建立靶材自主生產技術，而靶胚細晶化需求為其中一環。目前規劃以國內業者可提供之金屬棒材，透過CAE模擬分析關鍵製程：徑向鍛造、等通道轉角擠型及熱機再結晶製程等參數條件，再結合實作以驗證所得，最終建立符合業者應用需求之半導體靶胚。



金屬靶胚示意圖

4. 鍛造模具數位輔助設計系統

- 透過建立鍛造模具設計專家系統可協助國內外業者提升研發能量，並切入少量多樣且更彈性化之製造能力，加快切入智慧製造應用領域。
- 降低傳統產業進入高值化產品市場之門檻，以技術導向設計法則提供業界自主研發能力，可針對各家廠商建立各自產品知識庫，藉此提升複雜化、客製化產品生產、製造能力，以促進廠商回流投資意願。



鍛件模具設計專家系統介面示意圖

6. 板金漸進成形技術

因應國內業者目前開發板金產品過程中所面臨的成本過高與時程太長等問題，規劃開發板金漸進成形技術，利用產品外型轉譯的數位路徑控制技術，將產品3D造型轉譯成沖頭路徑資料，並建置成可由CNC加工設備或機械手臂可讀之Code，以逐步完成鈹金零件之成形。

7. 高強度鋁合金零部件溫/熱成形技術

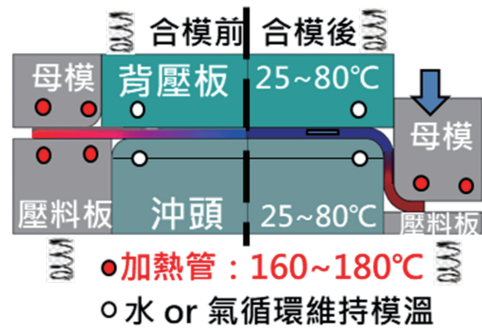
2021年已完成中強度鋁合金溫成形製程研究開發。未來將持續針對熱處理型高強度鋁合金進行溫/熱成形製程研究，同時將成形與後端鈑件熱處理製程結合進行熱處理製程研究。藉由中心建置之熱衝壓製程示範場域，協助業者拓展高強度鋁合金零部件相關之成形技術。



高強度鋁合金溫 / 熱成形示範場域示意圖

8. 混成板材構件成形製程技術

發展內嵌電子元件之混成板材熱成形製程。依據鋁板、玻纖複材板在不同溫度區段之成形性(140°C~200°C)，以及電子元件高溫損傷溫度上限(220°C以下)，定義線外加熱溫度以避免天線基板(PCB)軟化變形。為保持合適成形溫度(160°C~180°C)，設計變模溫輔熱成形模具，減少成形過程混成板材接觸到模面表面導致溫度驟降，以避免鋁板層成形性下降及玻纖層間樹脂固化導致板材破裂及玻纖斷裂。



混成板材變溫輔熱成形製程示意圖

9. 利基車地形適應懸吊系統

針對利基車多地形場域應用需求，進行高操控特性、轉向穩定性與安全性之適應懸吊系統研究，並針對不同車廠不同軸距、不同乘載重量的開發車種，提供完整開發服務，符合特殊消費使用環境。

- 車身側傾角度變化20°~25°（載200kg-空重），低側傾。
- 可調式懸架阻尼器及減振平台。
- 負載150公斤，靜態可承受30kgf側推力。
- 動態依ISO 4138，承受0.1g側向力，行進角度偏移≤10°。



利基車構型示意圖

處理技術

今年處理技術研究核心為捲對捲鍍膜技術，應用範圍包含光電、能源，以及民生工業之包裝材等。同時，突破以往光電應用捲對捲設備，進行功能設計及鍍膜模組變更，預計建立國內自主衛星應用包覆材生產線。

中心亦專注於高壽命模具表面複合處理技術，以沖切/熱鍛/壓鑄為研發重點；精微連續式熱處理設備，可解決微型零件的熱處理問題；沃斯田體不鏽鋼特殊硬化技術，將能應用於防刮、自攻螺絲、高壓氣體接頭等方面。

未來研發著重於建立高速鍍膜GFS技術、高壓氣淬真空滲碳技術，以突破濺鍍速率，解決業者在汽機車齒輪、輪軸、刀工模具等，須預留加工尺寸及熱處理後的修正問題，藉由控制氣體降溫速率，達到低變形量、穩定尺寸、減少後續加工之目標。

研發現況

1. 捲對捲鍍膜系統

- 因應衛星於太空中需面對各種高能粒子與輻射環境的防護需求，乃應用高反射率鍍膜材料於PI薄膜，以作為衛星感測器的包覆材。
- 開發之PI膜係濺鍍鋁高反射材料，光吸收率 α 小於0.44，放射率大於0.71。
- 開發之捲對捲設備具有雙面鍍膜功能。



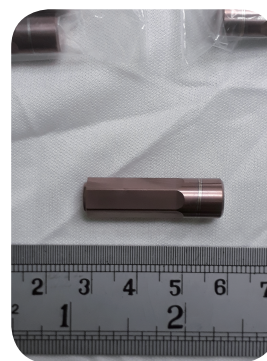
捲對捲鍍膜系統



衛星感測器的包覆材

2. 高壽命模具表面複合處理技術

- 因高強度材料的應用與新材料的開發，模具使用環境愈趨嚴苛，乃開發複合表面處理技術，以提高模具使用壽命。
- 所開發之無白層滲氮複合TiAlSiN高耐性耐磨鍍膜處理技術，應用於沖棒之生產良率較CVD提升16.7%。
- 針對SCM440手工套筒之深沖製程，沖棒壽命提升24.4% (5100沖次)。



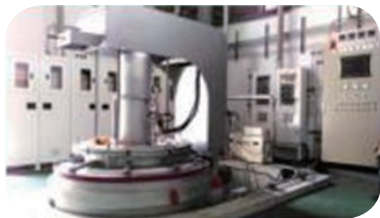
螺絲衝棒



手工套筒衝棒

3. 沃斯田體不銹鋼特殊硬化處理技術

- 因應食品級沃斯田體不銹鋼耐磨抗刮的市場需求，乃進行沃斯田體不銹鋼表面特殊硬化處理技術開發。
- 透過特殊滲氮、滲碳或碳氮共滲技術，得到最佳滲層深度，並維持表面硬度在HV0.1 800~1000。
- 預期應用於裝飾性產品，表面硬度可提升5倍以上。應用於食品加工設備，預估可提高使用壽命2倍以上。



沃斯田體不銹鋼特殊硬化處理設備



高值餐具（澄市設計）

4. 微型元件連續式熱處理系統

- 專利收料機構，精微零件因微小輕量於淬火時工件易飄散於油槽中，本機構設備設計特有技術可將收料率提升到>99%。
- 淬火爐溫度均勻性 $\pm 2^{\circ}\text{C}$ ；回火爐溫度均勻性 $\pm 1^{\circ}\text{C}$ 。
- 不須包網、硬度均勻、變形量低。
- 客製化模組，可依客戶製程需求搭配淬火爐、淬火槽、清洗槽、回火爐建置與可視化模組配置，可視化對接PLC介面，並監控異常製程、警報，即時提醒、修正。
- 製程參數數據庫建立及優化參數，透過智慧化模組從大量製程數據中建立最佳化參數、優化製程。



微型元件連續式熱處理系統



微型齒輪

未來研究

1. 氣流濺鍍技術

- 利用Hollow Cathode Glow Discharge原理，建立高速鍍膜技術。
- 氣流濺鍍技術可應用於多樣化材料系統，以開發各種陶瓷，磁性等耐磨耗、耐蝕、抗氧化等功能性鍍層。



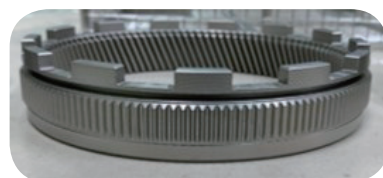
氣流濺鍍技術

2. 高壓氣淬真空滲碳熱處理技術

- 高氣淬壓力20 bar，為無污染綠色氣淬方式，對環境友善。
- 可控式氣體降溫速率，降低工件變形量，並可設計不同階段性降溫速率來符合客製化工件。
- 真空製程技術，阻絕其他氣體影響因素、熱均勻性佳。



高壓氣淬真空滲碳爐



齒輪

模具暨精微加工技術

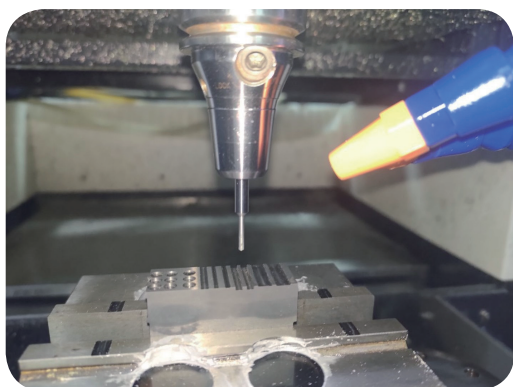
2021年研發針對模具產業、航太零組件製造與醫療產業之需求進行開發，包含：鎢鋼模具高品級製造、加工設備增值服務與雲端智慧模組、手術影像導航定位。另因應高階精微製造、產業智能化趨勢需求，投入先進製造與精準醫療技術開發等重點技術；運用資料庫建構技術降低工序落差、增加雲計算優勢，迎接智慧轉型新世代。

在未來研究方面，本中心繼續朝智慧化、數位化、高值化邁進，針對業者需求，提供傳統及非傳統加工技術之精準製造技術APP，並且建立決策支援系統，使加工模組得以優化及標準化。同時，本中心也致力精進醫療及藥用相關技術，預計透過經顱磁刺激系統技術開發和具高均勻性微球創新製程量產系統開發及藥物緩釋載體之製備系統，顛覆傳統的治療，給予醫療上的新契機。

研發現況

1. 鎢鋼模具高品級製造

- 建立鎢鋼直銑加工技術開發，提升鎢鋼模具加工品質、表面粗糙度 $\leq Ra\ 0.093\ \mu m$ 和特徵加工精度介於 $-1.2\ \mu m \sim +7\ \mu m$ 之間。
- 透過FEM切削模擬分析，完成針對鎢鋼加工優化角度的PCD刀具設計製作，並經實際上機切削測試，結果較市售泛用刀具提昇壽命 $>33\%$ 。



PCD刀具加工狀態



鎢鋼模具加工品質

2. 加工設備增值服務與雲端智慧模組

- 建立切削工序特徵化資料庫建構技術，支援三軸同動之工序辨識，具3大類分類器(工序、公差、路徑規劃權重)，分類準確度 $\geq 90\%$ 。
- 建立加工振動數位模型，可提供機台最大前六組自然頻率與振幅，與實際機台驗證誤差 $<10\%$ ，可避開共振頻率，提高加工品質。



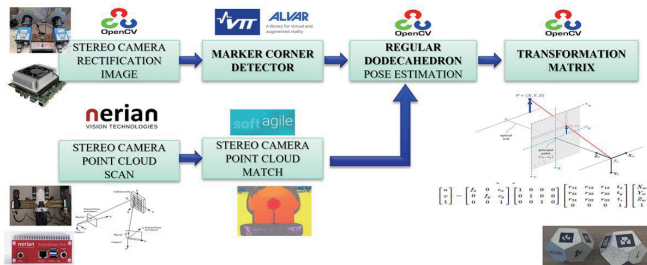
AE Sensor 及夾治具



訊號放大器及 PICO 擷取卡盒

3. 手術影像導航定位

- 6DOF姿態空間技術開發，開發雙眼視覺暨遠近場架構之Mutile-Markers 6DOF模組，並導入SVD矩陣分解演算法及點雲即時識別演算法，優化6DOF姿態空間精度，可同步識別10組幾何球體，精進達到預定位精度RMS≤1mm，更新頻率達成≥40Hz。
- 即時空間定位掃描探頭台車系統開發，整合高速光柵即時掃描探頭、光源系統，適應手術室緊湊空間，探頭體積≤750x200x200 mm，範圍≤1000 x 1000 mm；解析≥12Mpixels、更新率≥60 FPS，投影解析度≥2K。



雙眼視覺之 6DOF姿態演算軟體架構



即時空間定位掃描探頭台車

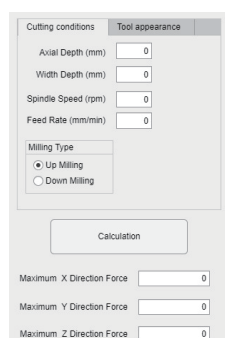
未來研究

1. 難切削模具之微量潤滑加工模組技術

- 針對不同使用目標需求，提供傳統及非傳統加工技術之精準製造APP，建立決策支援系統，同時整合難加工/難成形合金加工製程感測模組，在模具穩健優化精準製造目標上，建立標準化評估程序。
- 建立油霧潤滑輔助切削製程加工技術，降低國內業者進入MQL輔助切削的技術門檻，加速業者生產品質與良率的提升，爭取高附加價值的新訂單。



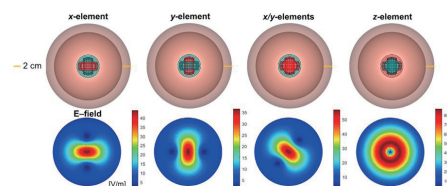
難切削模具之微量潤滑加工模組技術



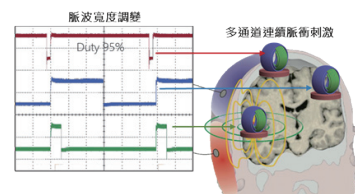
切削力預測分析

2. 經顱磁刺激系統技術開發

- 多通道3軸線圈技術開發，XYZ軸立體線圈與多陣列線圈配置達成小區域精準對焦與高能量輸出。透過3軸互感調變對應多個患部同時治療優勢，具備多通道小尺徑(<50mm)線圈可快速整合腦磁圖OPMs即時量測治療後成效。
- 多重脈衝調變技術開發，多通道治療模式符合i-TBS/c-TBS新世代治療模式，以IGBT高功率技術生成具短脈衝間隔快速脈衝(<10ms脈衝間隔)。



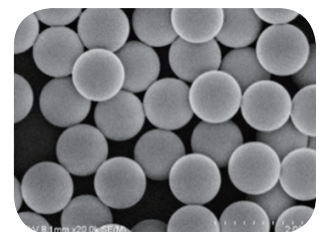
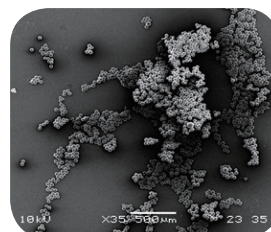
3軸線圈設計構型與 CAE分析模擬



多重脈衝調變技術

3. 具高均勻性微球創新製程量產系統開發

- 開發新世代微球量產製備系統，結合工研院代工GMP廠生產，搭配售後服務方向與生技廠長期合作。
- 目前主要發展微球、藥物緩釋長效載體創新技術及生醫級量產設備開發，經皮下組織注射(載體粒徑25~50 μm)或皮膚傳輸(載體粒徑400nm~1 μm)，可設計為立即釋放或到幾個月的控制釋放輸送系統，此技術主要被應用妝品傳輸產品、醫美顏針…等。



具高均勻性微球創新製程量產系統開發

精密機電及自動化技術

今年研發重點持續專精智慧製造相關設備與技術，包括機器手臂結合3D視覺及記錄現場動作而產生路徑技術、複雜曲面金屬鍛件取放技術、被動元件高速檢測驗證設備技術、石化業AI安全監視、直覺化擷取模組、鞋智慧化打粗塗膠設備技術等，並且協助水五金產業發展智慧製造。

除了運用2D、3D、AI各項科技升級技術，也藉由整合設備智慧感知與訊息聯網，確保製程安全及製品品質、避免人工作業及記錄容易造成的錯誤；針對產業機電整合與智慧製造需求，提供各項精密機電及自動化技術服務，滿足產業智慧化的轉型趨勢。

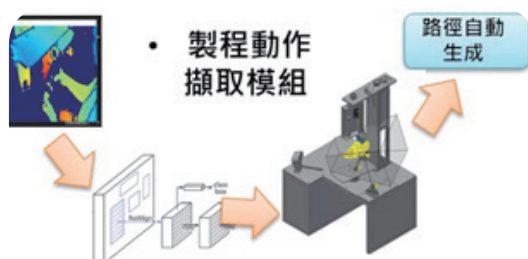
另外，中心也致力於協助國內產業在智慧手臂單元導入傳統產線及電子業元件3D雷射表面段差量測，提供關鍵模組技術補足應用上之缺口，期待提高高值設備國產化自製率，提升傳統產業智慧無人化製造及降低石化業的公安發生頻率。未來研發將著重於智慧機器人與製造應用AI系統、先進觸媒中心AI安全監視系統兩大區塊，同時鑽研智慧系統整合方案。

研發現況

1. 智慧機器人與製造應用AI系統

柔性材料機器人加工系統技術-製鞋製程動作學習技術

- 直覺化製程動作擷取模組，應用3D影像資訊及AI學習技術，實施機械手臂於產線生產。
- 製程動作精度為 $\leq 0.5\text{ mm}$ 。
- 此技術可提昇25%的機器人調機效率。



直覺化製程動作擷取模組



打粗噴膠手臂工作單元

2. 全自動3D雷射AOI尺寸量測設備

高精度2D+3D影像量測技術

- 高精度2D尺寸瞬檢量測技術採用RGB三色光源混光照明檢測技術，量測精度 $\pm 2\mu\text{m}$ 。
- 3D雷射表面段差量測量測技術，量測精度 $\pm 2\mu\text{m}$ 。



全自動 3D雷射 AOI尺寸量測設備

3. 高速晶片料帶檢測設備

高速影像瑕疵檢測技術

- 檢測速度最高1秒50張影像（依檢測項目而有不同）。
- 檢查項目：外觀、缺料、立料、反料、刮傷、斷裂、字碼…等。
- RGB三色光源混光照明檢測技術。



AUTO VC高速檢測設備

4. 重力鑄造智慧化情報站建置

- 面對產業智慧化轉型的趨勢潮流，為協助水五金產業智慧製造能力提升，進行「重力鑄造智慧化情報站建置」。
- 導入產線聯網與生產管理可視化技術，達成機台連網，可以將熔煉爐的銅水溫度、冷卻水的溫度及壓力，澆鑄機生產工件的數量等生產資訊以及異常警報連網上傳，透過電子看板或智慧手機即時顯示，避免人工作業及記錄容易造成的錯誤。
- 情報站的建置促成生產品質良率提升約15%、產值提升約14%，同時也解決缺工與技術傳承的問題，深化鑄造製程相關技術，藉此翻轉水五金產業，接軌國際智慧製造技術潮流。



重力鑄造現場



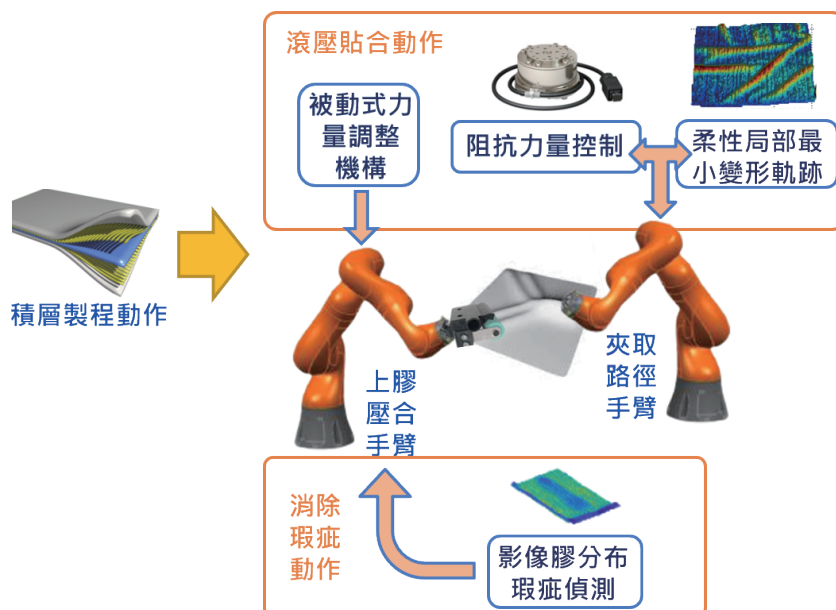
情報站電子看板

未來研究

1. 智慧機器人與製造應用AI系統

柔性材料機器人加工系統技術-積層製程動作擷取整合系統

- 建立柔性物件區塊變形估算技術。
- 夾取與製程手臂的協機技術：多層幾何中心對位 $\leq \pm 10\text{mm}$ @面積 $800\text{mm} \times 600\text{mm}$ 。
- 積層上膠壓合力量控制技術：上膠貼壓合有效面積 $\geq 70\%$ 、重現力量誤差 $\leq 10\%$ 。



積層製程系統實施架構

2. 先進觸媒中心AI安全監視系統

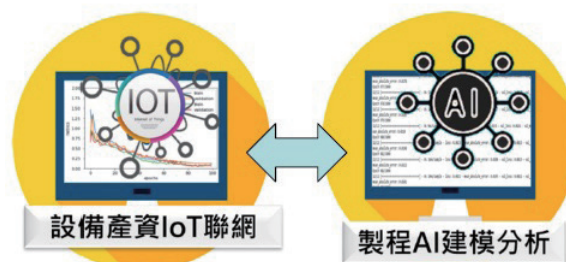
- 透過RFID暨AI智慧影像辨識技術，監視作業場所內人員配帶安全護具狀況，輔助工安管理、降低人員傷害風險。
- 透過將RFID標籤嵌入各項安全設具、包含安全帽、護目鏡、攜帶型氣體偵測器等，偵測人員進出管制區域時的配戴狀況是否符合作業標準。



人員裝備及人員異常行為系統示意圖

3. 水五金零件製程大數據分析智慧系統整合方案

- 因應水五金產業智慧製造發展趨勢，進行零件製程大數據分析智慧系統整合方案開發。
- 擬發展零件製程大數據分析智慧系統整合方案，將具備製程數據可視化及自動化儲存能力。
- 利用製程大數據分析、回饋等智能化技術以取代人工經驗的判別，可以提早發現製程異常徵兆，排除機台可能發生的問題，並建立高品質產品生產調控技術。



製程大數據分析智慧系統整合方案



邊緣運算及雲端管理系統

檢測技術

檢測技術2021年研發範圍包括提升國內壓鑄品質、閥產業設計開發與驗證，以及能源儲能系統檢測技術、離岸風場技術。在壓鑄產品方面，發展模內感測模組及鋼材曲面殘留應力檢測分析技術，協助改善車輛、航太、機械產業製程，未來將透過檢測產業化與製程鏈結技術，促進國內鑄鍛件產業往高值化。

針對閥產業驗證，建立流量控制閥門產品之量測技術，提供球閥、球塞閥、逆止閥、蝶閥、平衡閥及減壓閥等各種產品結構設計之驗證，促進外銷競爭力。未來則會增加伸縮可撓式不銹鋼接頭、管件產品性能測試技術，協助提升新型接頭及接管產品之性能及可容性，推動產業永續發展。

金屬中心亦致力於能源相關檢驗技術，建置儲能系統安全試驗實驗室，提供電動車輛國際標準性能試驗，並建構鋰電池儲能及電動車輛安全環境。另一方面，政府離岸風電政策現已進入實質興建階段，本中心也協助經濟部標準檢驗局建立自主檢測驗證制度，以推動關鍵零組件在地化、提升國內離岸風電產業品質與效率。

研發現況

1. 控制閥產品量測驗證技術

- 因應國內閥產業設計驗證需求，建立流量控制類閥門產品CV量測技術的開發。
- 開發的ISA 75.02控制閥CV量測技術，可提升控制閥產品設計，提供驗證控制類產品結構設計，兩端壓力差為1 psi時，通過的體積流率(加侖/分鐘)。
- 預期新CV試驗量測設備，在球閥產品流量性能驗證效率上可提升20%以上。
- 新CV量測設備未來亦可應用於其他管道流體控制產品，預估可促進產品性能提升15%以上。



控制閥產品開發



CV流量試驗設備

2. 應用於壓鑄之模內感測模組設計開發

將受壓力/溫度轉換為電性訊號，獲得模內成型過程中之狀態變化，並藉由此資訊結合品質標的汽泡及縮孔等，建置AI品質預測模型，以達到產品品質全檢。



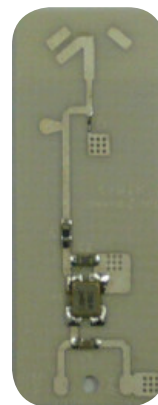
模內感測訊號擷取模組

3. 射頻定位模組

本年度射頻定位模組，投入8雷達射頻定位技術、硬體電路優化以及嵌入式定位演算模組開發。完成10組偶極天線定位標、8雷達電動升降台車、訊號遮蔽修正演算法與嵌入式定位演算軟體。三維空間定位誤差RMS<1.5mm，定位更新率達30Hz。



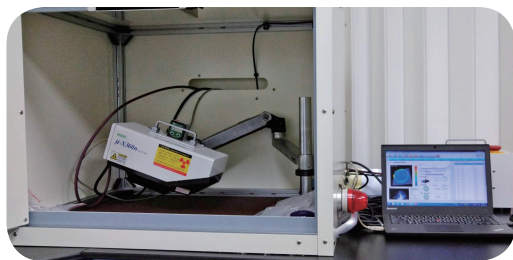
整合微控制器 24GHz雷達



偶極天線定位標

4. 鋼材曲面殘留應力檢測分析技術

以攜帶式殘留應力量測設備搭配曲面分析模型，曲面殘留應力檢測分析模組，其量測曲率半徑介於1.5~25mm、解析度0.1MPa、精度 $\leq \pm 3\%$ 。本技術使殘留應力分析具備曲面與平面分析能力，以確保提高量測精度，並解決鋼材工件因幾何型態無法檢測與誤差過大問題，後續可串聯整合性檢測技術，作為產品異常肇因檢測分析架構之一，並鏈結製程建立品質判斷依據，預計可運用於車輛、航太、機械製造等產業。



鋼材曲面殘留應力檢測

5. 儲能系統檢測技術

- 因應儲能需求與產業政策推動，建置360kW/360kWh儲能檢測實驗室，除作為第三方驗證單位外，也可協助業者於產品設計上缺失改善，以符合法規標準。
- 辦理11場次國家標準草案審查會議，以及協助研擬5案國家標準草案。
- 辦理2案公共工程採購案(統包工程採購案、監造服務採購案)



儲能檢測實驗室

6. 離岸風電檢測驗證設備升級

2021年擴增四項大型扣件檢測設備、高階非破壞檢測系統、影像辨識系統、ANSYS數值分析軟體擴充模組以及SESAM固定式離岸風力機基礎分析軟體計10項資本設備，並建立相對應於標準的作業程序與系統，強化離岸風電自主檢測驗證技術能量。



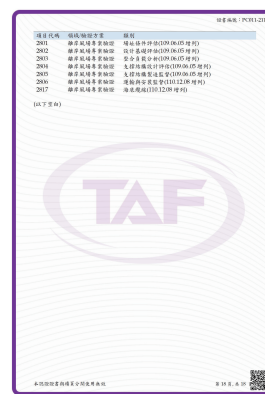
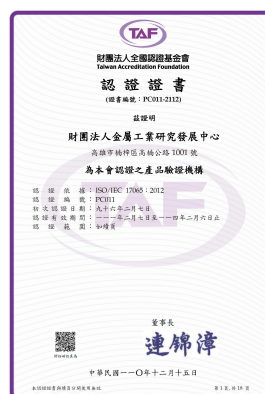
大型扣件檢測設備



高階非破壞檢測系統

7. 離岸風場專案驗證機構增項

專案驗證機構於2020年通過TAF認證5個專案驗證模組(場址條件評估、設計基礎評估、整合負載分析評估、支撐結構設計評估及支撐結構製造監督)，率先成為國內首家離岸風場專案驗證機構，2021年持續投入，於2021/12/15取得風場專案驗證機構「海纜設計評估」、「海纜製造監督」及「運輸與安裝」驗證模組認證證書。



證書 風場驗證模組

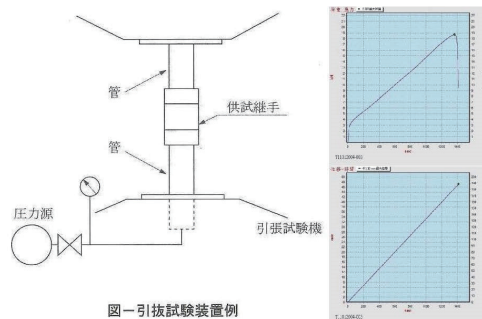
未來研究

1. 伸縮可撓式接頭、管件性能測試技術

- 因應國內產業設計驗證需求，將建立伸縮可撓式不銹鋼接頭、管件產品性能測試技術的增加。
- 開發內壓反覆及拉伸測試等性能測試設備，可提升伸縮可撓式接頭、管件產品設計，提供驗證產品結構在正常壓力狀態下，最大抗脫出性能。
- 預期新可撓式接頭、管產品測試設備，在產品性能驗證效率上可提升25%以上。
- 新可撓式接頭、管產品測試設備未來亦可應用於其他形式接頭、管件、壓力容器，預估可促進產品性能提升15%以上。



伸縮可撓不銹鋼接頭產品開發

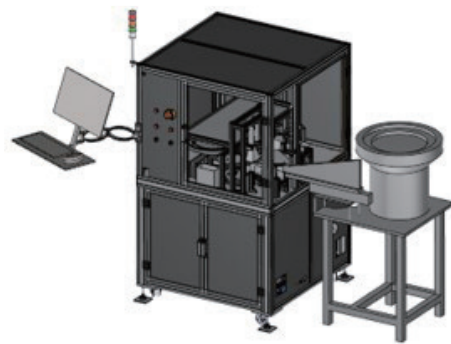


圖一引拔試驗裝置例

可撓接頭性能試驗

2. 應用於外部缺陷檢測與智慧辨識技術

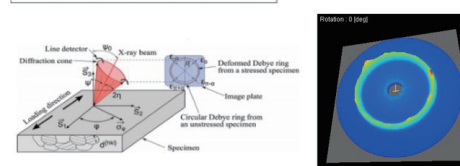
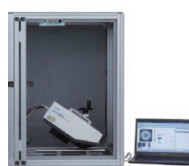
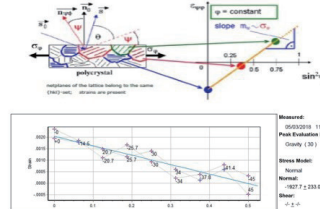
因應扣件製品AI智慧化檢測與高值化發展，對於外部缺陷全檢以及導入智慧化需求日增，將進行影像檢測結合AI判別應用。即時數位影像收集大數據，結合AI自動化辨識缺陷技術，預估AI模組判別率 $\geq 90\%$ 、檢測速度 ≤ 400 pcs/min，可提升檢測效率。



螺絲外觀檢測機

3. 殘留應力檢測產業化與製程鏈結技術

因應國內鑄鍛件產業逐漸往高值化發展需求，發展殘留應力檢測技術並鏈結製程，作為異常特徵要因分析因子。預期量測技術所應用之鑄鍛件產品，可進行表面應力量測並與製程參數整合建立品質標的指標、壽命分析指標，未來亦可應用於車輛、航太、機械製造等產業，預估可發展品質、製程改善等技術。



殘留應力分析示意圖

4. 儲能系統檢測技術

- 提供業界完整與嚴謹的檢測能量包含產品之電性安全、環境安全、機械安全等測試驗證與服務平台。
- 縮短業者產品檢測驗證到上市的時程，加速產業切入國際市場。
- 整合中心之技術能力及人員專業背景，培育儲能產業之技術驗證人才。

5. 離岸風場專案驗證國際合作

中心與驗船中心、船舶中心、大電力中心及國際驗證公司DNV組成離岸風場專案驗證聯盟，並於今年1月與DNV一同向EPC商富崙(FOXWELL)洽商台電二期離岸風場第三方專案驗證業務，藉由DNV經驗指導及交流，以及國內法人團隊在地能量，展開台電二期離岸風場之專案驗證業務，自場址調查開始將一路至風場竣工，國際合作實務案例將持續提升團隊驗證人員實務經驗與能量。



檢測驗證案例

6. 離岸風電關鍵零組件檢測驗證示範案例

離岸風電為國內新興產業，實場檢測技術、驗證施行尚缺乏實際應用案例與契機，尤其國內離岸風場現僅有2座運轉，運維相關檢測實務經驗及長期參數仍不足，仍需尋求多方管道洽商離岸風電營運商，以實務案例進行標準、檢測流程的發展，藉以推展後續離岸風場運維在地生根。



驗證國際合作

管理技術

2021年管理技術專注於優化企業產品、系統驗證技術及創新服務。為優化產品製造，開發設備機台智慧監測技術，達到故障預警及可視化，提高產能、減少不預期故障停機。未來將結合5G、AIoT及AR等應用，完成金屬製品業遠端協作指引，引導新手保養設備及維修，解決傳統製造業設備零組件汰換問題。

在系統驗證技術方面，持續精進ISO及TOSHMS等管理系統驗證服務，並因應衛生福利部醫療器材專法，發展國內醫療器材QMS、國外QSD等查核驗證技術，確保醫療器材之安全及功效。另外亦專注機械安全驗證能量開發與建置活動，藉由國際符合性評鑑程序，保障勞工之安全，後續將發展機械設備風險管理技術。

創新服務則致力於加速產業價值鏈升級轉型，運用智慧製造串連設備、軟體與系統，提供完整的智慧製造工廠工具，促進數位基盤布建，創新商業模式管理(跨域結盟/虛實整合)，使中小企業形成跨廠智慧生產互聯體系，加速台灣企業轉型。未來將開發溫室氣體管理工具，協助企業掌握碳足跡與排放量。

一、創新服務

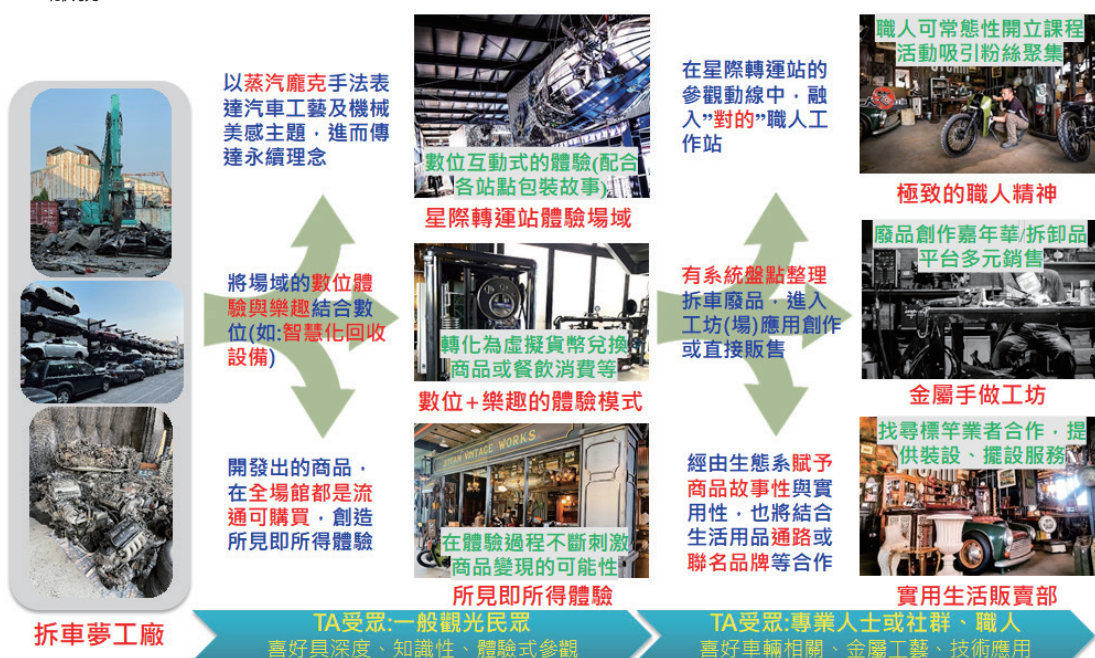
一 研發現況

1. 黑金變黃金體驗生態系

- 將回收場拆解的汽機車零件，經過工匠、職人重製技術，轉譯(藝)為家具、家飾、裝置藝術、活動策展等產品或服務，場域裡同時體現教育、娛樂、美食、手作、客製等服務，合作對象也可由職人慢慢擴大，回收品項也可由車輛逐漸擴散，藉以創造更多元的循環創生商業模式。
- 帶動31家中小企業，邀約15家創作家或相關職人、匯聚五大重點職人，完成場域文案與合作模式，並發展7件極致作品，以及10件黑金轉譯(藝)商品或服務。



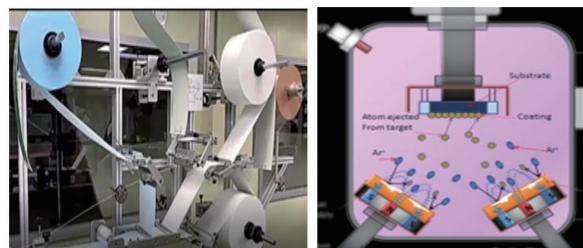
創新產品高值化



拆車夢工廠體驗流程

2. 創新口罩與製造共創潛力生態系

- 新冠肺炎疫情帶動全球醫療級口罩及其他防疫物資的龐大需求，面對全球化競爭的醫材產品生命週期短暫、多樣少量、快速交貨等壓力下，聚焦抗菌抗病毒材料生產口罩。使用二代智慧化生產及線上檢測、自動包裝及戰情監控等系統，並據以VR或戰情室方式呈現數位化成果，創造台灣高值化口罩競爭力與新藍海。
- 帶動16家中小企業，協助媒合護理學會、製造業者與行銷業者合作，設計8項創新口罩防疫商品，提升生活用創新防疫口罩商機，協助防疫趨勢融合生活需求之創新設計，朝向與病毒共存生活型態。



銀銅鈦濺鍍技術

3. 茶飲產業價值體系

- 台灣茶產業老年化嚴重、年青世代不想投入導致數位進程推展緩慢，所有品質都建立在老師傅經驗工藝上，進而影響到面對客戶的精製加工廠。因此本計畫利用原料製程評鑑系統庫存追蹤系統溫溼度監控系統，整合數位化/雲端科技/物聯網/巨量分析，推動數位化茶葉產製品質產業鏈，穩定風味品質，量產優質溯源包裝茶飲原料。
- 數位轉型後，減少貨品盤點時間成本10%，並同時降低原料受潮之品質不良9%，與減少安全庫存及缺料率10%，增加就業人數 23 人包括茶葉檢測人員、數位系統維護人員。未來將以茶葉產業鏈做為示範驗證，複製經驗推廣至咖啡產業鏈。



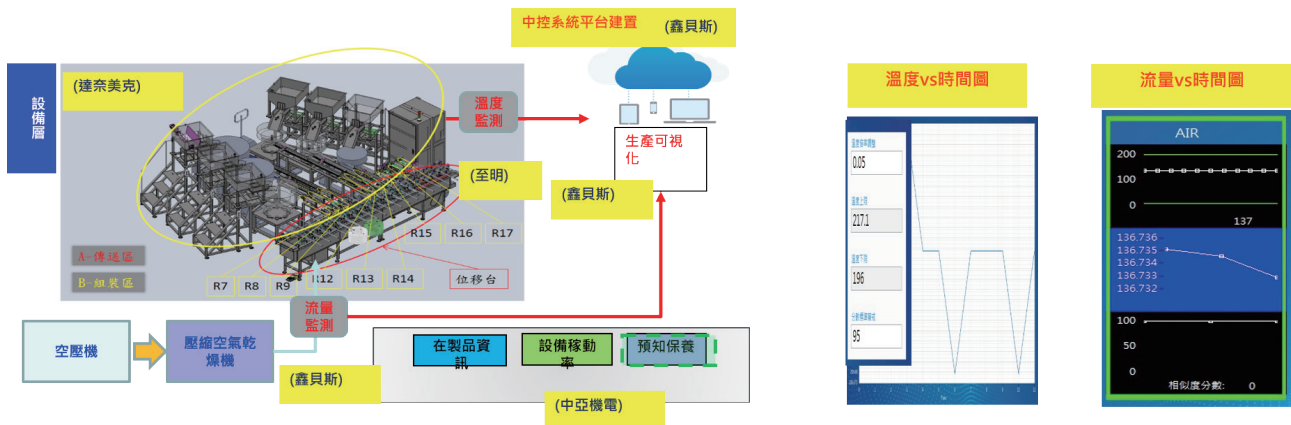
茶飲產業輔導流程



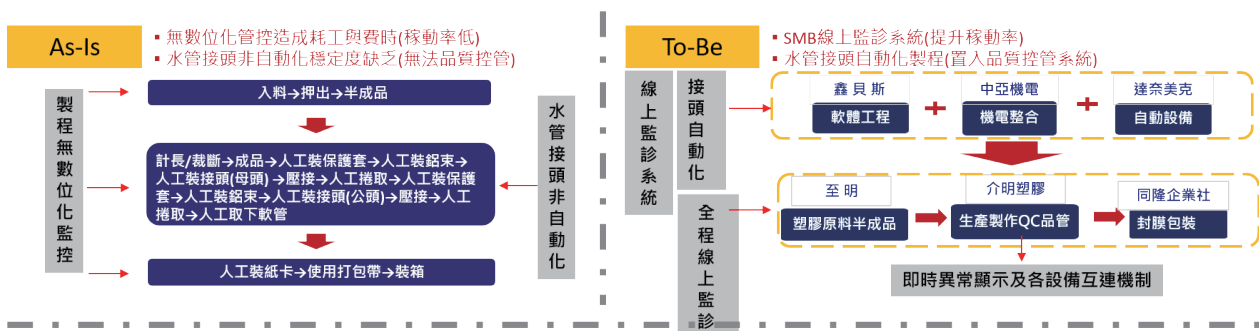
庫存管理系統

4. 塑膠製品產業價值體系

- 塑膠產業之產線設備老舊、產品特性少量多樣、零配件組立透過人工作業品質不穩且產線不能中斷的工廠環境，故體系推動以主導廠介明塑膠之國際訂單生產為組裝驗證平台，藉由導入可視化模組、建立即時異常顯示機制，開發園藝軟管智慧製造組裝產線設備，整合機械與周邊體系廠商進入體系。
- 促成場內自檢驗證率達100%、良率由98%提升至99.5%，衍生國際訂單成長近5千萬元，未來將持續增加鏈結供應鏈系統/設備/加工廠參與，並推動智慧技術導入升級擴充在地智慧產線服務能量。



智慧工廠中控資訊平台



價值體系發展策略

未來研究

1. 溫室氣體管理工具開發

- 為協助中小企業快速執行溫室氣體盤查中類別1~6相關數據資料的計算，此盤查工具的介面設計以簡單欄位供選擇填寫，填寫完畢後可產出排放數據與圖表，讓企業掌握排放量佔比，估算出的排放量也可作為組織建立基準年數據之依據。

排放源基本資料				活動數據	原始單位	溫室氣體	氣體種類	排放係數		排放量			
排放源	原燃料種類	範疇類別	排放型式					排放係數	係數單位	年排放量 (公噸)	GWP (IPCC AR)	年CO ₂ 當量 (公噸CO ₂ e)	總排放量
蒸汽鍋爐(重油)	重油(燃料油)	1	E	20	公秉	CO ₂ :CH ₄ :N ₂ O	CO ₂	3.110959872	KgCO ₂ /L				
							CH ₄	0.00012058	KgCH ₄ /L				
							N ₂ O	2.4116E-05	KgN ₂ O/L				
蒸汽鍋爐(LPG)	液化石油氣	1	E		km ³	CO ₂ :CH ₄ :N ₂ O	CO ₂						
蒸汽鍋爐(NG)	天然氣	1	E		m ³	CO ₂ :CH ₄ :N ₂ O	CH ₄						
發酵製程(啤酒)	麥汁	1	P		公秉	CO ₂	CO ₂						
堆高機	柴油	1	T		tkm	CO ₂ :CH ₄ :N ₂ O							
公務車	專用汽油	1	T		m ³	CO ₂ :CH ₄ :N ₂ O							
化糞池	水肥	1	F		公升	CH ₄							
冷氣機	R134a	1	F		公噸	R134a							
冰箱	R134a	1	F		公秉	R134a							
冰水主機	R134a	1	F		km ³	R134a							
滅火器	CO ₂	1	F		m ³	CO ₂							
無氟斷路器	SF ₆	1	F			SF ₆							

溫室氣體盤查工具

二、系統驗證

研發現況

1. 管理系統驗證技術

因應國內產業對於企業永續經營意識之提升，持續提供客戶最佳ISO管理系統驗證解決方案：

- 除了獲得TAF之ISO 45001職安衛管理系統認證外，為國內前2家取得TAF之TOSHMS驗證方案、獲得職安署認可的驗證機構，可協助企業提升其職安衛管理績效。
- ISO 9001、ISO 14001等管理系統驗證技術持續精進，協助企業符合國際標準，深化產業國際競爭力。
- 取得驗證合格廠商數累計580家，共核發893張驗證證書。



管理技術_系統驗證技術 (ISO驗證)

2. 產品驗證技術

規劃並建置ISO17065之產品驗證及ISO17020工廠檢查技術能量，取得TAF認可登錄證書，配合政府法規要求，取得認可機構資格。

1. 勞動部機械安全驗證與檢測能量建置
 - 自動電擊防止裝置產品驗證
 - 堆高機、高空作業車檢測與產品驗證
 - 車床、銑床、刨床等中心加工機及研磨機產品驗證
2. 經濟部標準檢驗局H型鋼、鍍鋅鋼管產品工廠檢查技術建置。

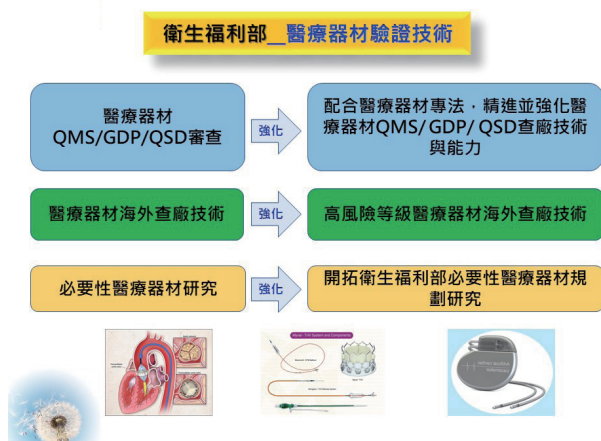


管理技術_系統驗證技術(機械安全驗證)

3. 醫療器材驗證技術開發

因應衛生福利部「醫療器材管理法」，規劃醫療器材產品驗證技術。

- 國產醫療器材QMS驗證技術推展。
- 進口醫療器材QSD審查技術推展。
- 進口高風險醫療器材海外查廠技術建置。
- 醫療器材販售業者申請GDP驗證能量規劃。
- 必要性醫療器材預警系統機制規劃。

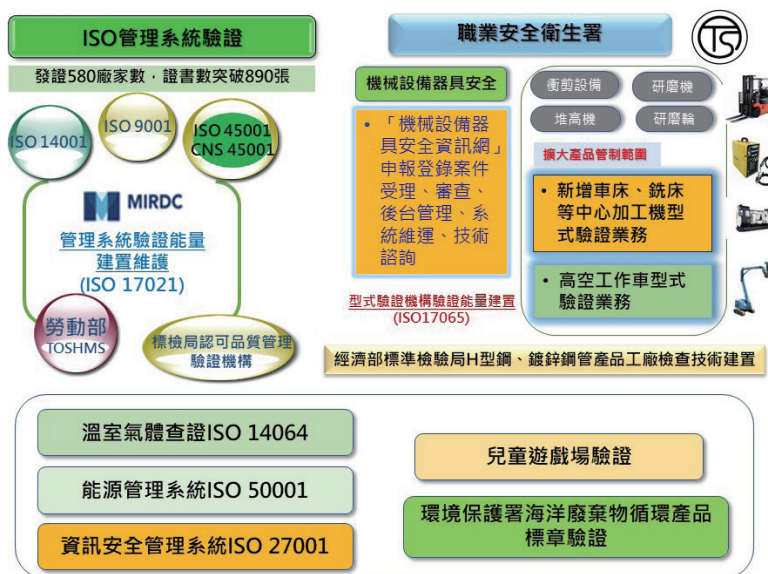


管理技術_系統驗證技術(醫療器材驗證)

未來研究

1. 驗證產業市場開發

- 發展國教署兒童遊戲場驗證業務，以提升兒童遊戲場之安全性。
- 因應氣候變遷加劇，以及後疫情時代企業面臨數位轉型之需求，驗證領域將朝向能源管理系統ISO 50001、溫室氣體查證ISO 14064、資訊安全管理系統ISO 27001等方向發展。



管理技術_系統驗證技術

2. 機械設備風險管理技術

- 依據機械設備產品風險評估國際標準，開發機械設備風險管理評估機制，提升機械設備之安全性，保障勞工安全。
- 研究並導入符合機械安全之國際安全標準，擴展機械設備安全防護觀念與技術，發展風險評估所須之機械安全對策。

三、管理

一 研發現況

1. 企業整體競爭力提昇輔導

- 製造業服務化創新營運輔導
- 經營績效分析及策略規劃(含平衡記分卡)
- 企業卓越經營標竿輔導
- 中堅企業、台灣精品獎，小巨人獎輔導

2. 企業流程管理電子化加值

- BPR (e化企業流程改造)
- 全球運籌管理(GLM)建置
- 協同設計(CDM)建置
- 產品資料管理(PDM)建置
- 廠商關係管理(CRM) 建置
- 供應鏈管理(SCM) 建置
- 金屬加工智慧製造管理系統(Hi-MOSS)建置
- 模具設計知識導引系統(DNS)
- 協同開發管理系統(PPM)



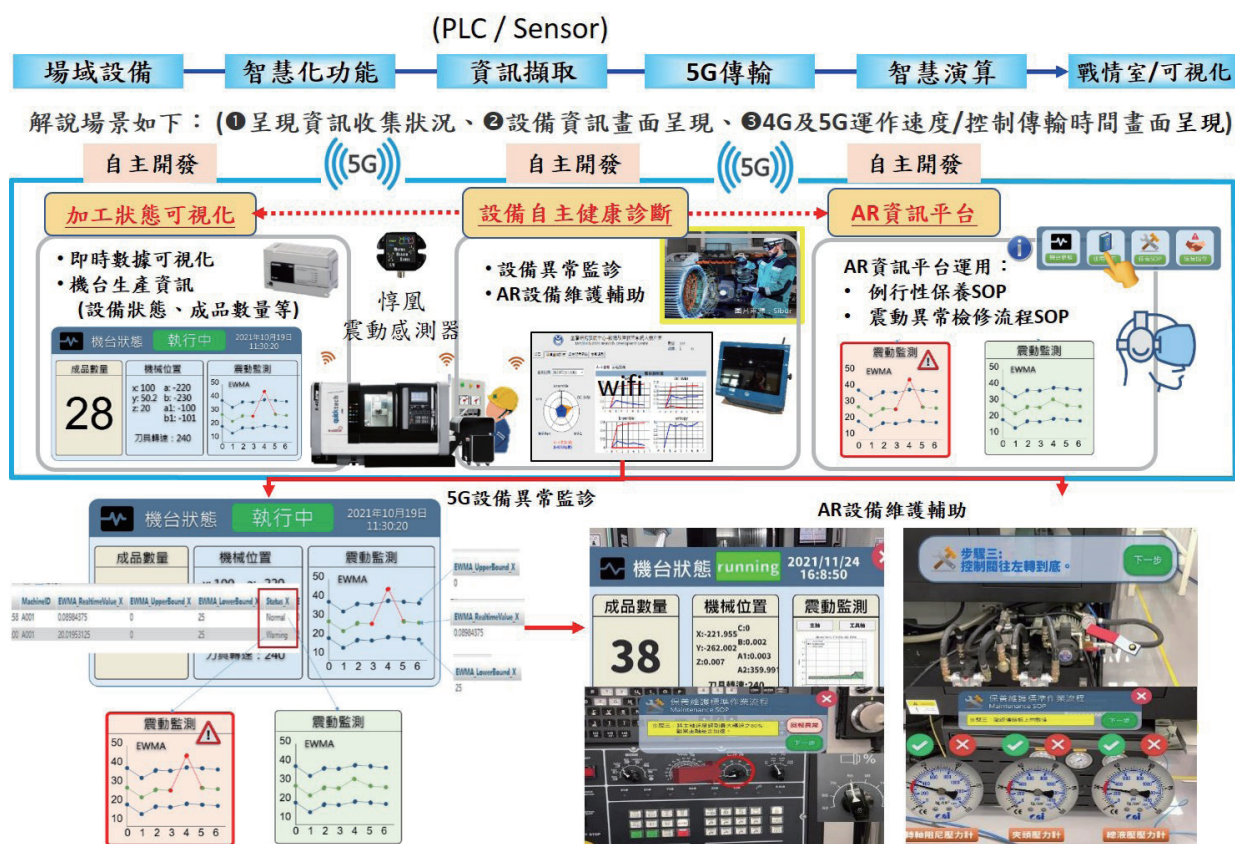
廠商關係管理系統 (CRM)

3. 數據智慧應用

- 營運情資管理平台
- 鍛造力品質預測模型技術
- 機聯網可視化技術
- 預測軸承損耗技術
- 設備預知保養技術
- 5G AR輔助設備精準維護技術



鍛力感測監測平台



5G AR輔助設備精準維護技術

未來研究

1. 運用科技創新協助企業轉型、開創新局，了解產業客戶的期望以及產業創新的作法，建立典範模式及示範場域，協助產業升級轉型

- 運用數據擷取及分析方法、追蹤重點產業及廠商、鑑別產業別新產品新技術、進行輿情分析支援營運決策。
- 提供製程品質預測、設備故障預診、刀具磨耗預測及可視化戰情室等AIoT智慧製造解決方案，達到品質提升及智慧營運。
- 結合5G專網及AR，深化AIoT智慧製造解決方案，延伸5G AR輔助設備精準維護及工廠走動式巡檢管理等加值應用。

食品（生技）設備技術

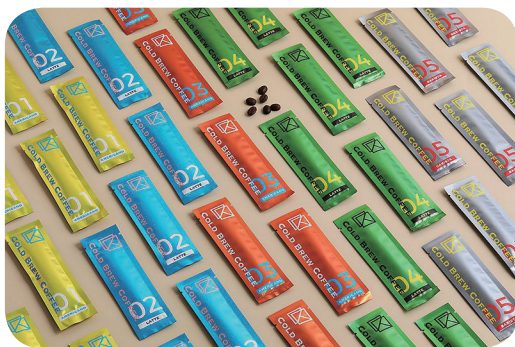
為協助各類農產品多元加工，金屬中心開發真空微波乾燥設備，除應用於乾燥製程以外，亦可協同水產及各式食品生技業者進行相關的推廣與生產測試。另外，在食品加工製程履歷技術方面，掌握製程紀錄不僅可以有效管理製程品質，也可以提出完整製程履歷，有利於出口的商機。今年更與天關公司研發建置咖啡混合攪拌設備，透過低溫精萃製程及設備技術，大幅提升咖啡粉在水中的分佈與溶解性，協助業者研發出有別於傳統咖啡產品型態兼具香氣濃郁之冷萃濃縮咖啡即時飲品，新產品已於募資平台上達到百萬營業額。

本中心未來將針對農產品加工技術及設備進行開發，縮短食品烘烤及均勻受熱之時間，協助廠商建立熟成環境監測系統，監測環境氣體、控制溫度與氣流，以掌握均勻性與上市時間。另一方面，亦將針對健康食品、化妝品及藥物領域開發無縫膠囊成型製程及設備技術。

研發現況

1. 低溫精萃製程及設備

- 以特殊低溫製程，可應用於天然原料、中草藥等物質進行有效成分萃取，完整保留香氣成分。
- 藉由快速濾淨系統使產品達到固液分離，且進行分子震盪，大幅提升產品風味口感，且有效提高萃取液濃度，廣泛應用於食品工業中。



冷萃濃縮咖啡即時飲品

2. 食品加工製程履歷技術

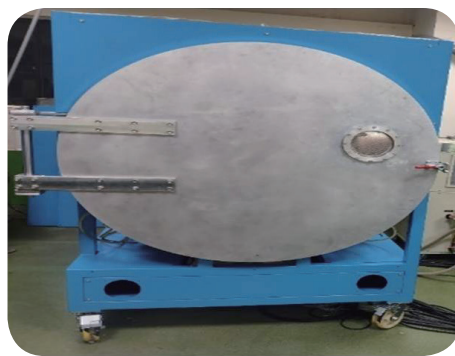
- 面對食品加工的安全與出口的商機，加工製程的紀錄有助於管理生產製程與控制食品安全。
- 協助廠商建立加工製程履歷，自動紀錄各製程的條件與狀態，避免人工抄寫的問題發生。
- 掌握製程紀錄不僅可以有效管理製程品質，也可以提出完整製程履歷，有利於出口的商機。



食品加工製程履歷技術

3. 真空微波乾燥設備及新式產品製程技術

- 真空微波乾燥設備及新式產品製程技術使用真空與微波技術結合所成之真空微波乾燥設備，並透過學研合作進行實際設備製程驗證及新創產品開發，藉此確認設備能效及產品品質。
- 設備透過在真空下水分沸點較低的特性，搭配微波穿透式加熱特性，可達成快速加熱去除水分之能效。在製程開發上除可針對新鮮果物進行乾燥處理外，也將可針對相關加工食品進行乾燥製程，藉此達到新式產品生產技術研發。
- 針對多樣果物完成產品及製程驗證，在製程時間與生產能耗上皆有良好表現。未來除可於各類農產品乾燥製程使用外，也將結合水產及各式食品生技業者進行相關的推廣與生產測試，將研發成果落實於產業應用，有效提高我國農產品等相關食品業者之產品附加價值。

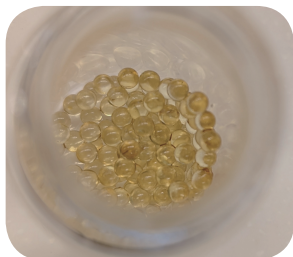


真空微波果乾設備

未來研究

1. 無縫膠囊成型製程及設備技術

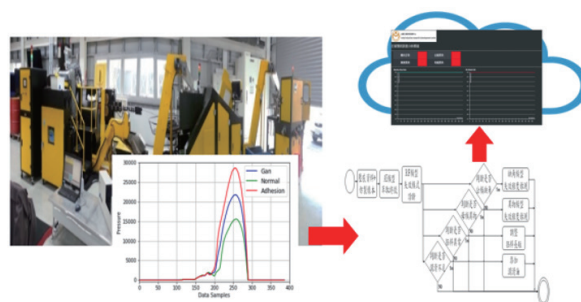
- 以明膠作為殼材材料，包覆油性或水性液體，讓液體形式的材料可以轉變為固體、保護機能活性、防止營養物質損失，以及增加吸收效率等功能。
- 可廣泛應用在健康食品、化妝品及藥物領域。



無縫膠囊產品

2. 農產品熟成控制技術

- 農產品熟成控制的複雜性，將影響農產品熟成的均勻性與上市時間。
- 協助廠商建立熟成環境監測系統，監測農產品熟成環境氣體，並控制溫度與氣流，避免人工經驗判斷，影響熟成時機。
- 掌握熟成紀錄不僅可以有效管理製程品質，也可以完整控制熟成製程，有利於出口的商機。



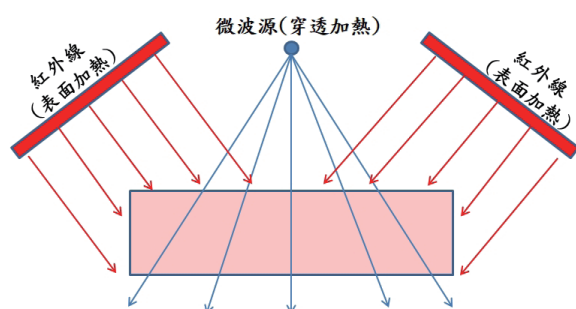
成形設備狀態分析模組使用示意

3. 複合式真空微波乾燥系統

- 複合式真空微波乾燥系統為承接過去真空微波技術的進一步改良，在食品乾燥製程上透過真空微波技術已可有效解決傳統烘烤製程時間及設備佔地過大的問題，乾燥製程時間相較傳統熱風方式可有效大幅縮短25%，然而微波加熱的內熱外冷加熱特性讓部分乾燥產物的外層呈現較為鬆軟潮濕之特性，因此加入複合式烘烤將可解決此問題，使設備技術應用方向朝更多元化發展。
- 過去所開發真空微波乾燥技術雖解決傳統表面熱擴散方式乾燥設備所造成外熱內冷及外部乾燥過度等熱量無法有效傳遞至內部之窘境，但在設備驗證及產品製程研發過程我們發現有許多食品的口感有達

到內軟外酥的需求。有鑑於此，我們將再次結合傳統紅外線烘烤功能，解決相關設備技術複合上的干擾問題，透過內外同步加溫之方式達到最佳的食物口感需求。

- 可使用於各式食品乾燥製程外，針對其他關於塑膠、化工及醫藥等材料製程也具有使用效益。



複合式烘烤真空微波乾燥系統

光電系統技術

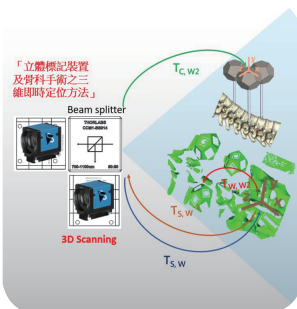
今年研發著重於智慧製造技術，透過設備資料蒐集、狀態監測、製程品質監測、數位定位技術、尺寸量測數位spc、人工智慧技術、網路技術、雲端運算技術、AI優化等技術整合應用，提升產業製程效能、降低產品瑕疵加速產業化應用。

技術面上以數據化為基礎，建構智慧化生產、設備與管理製程，串聯設計、生產到服務，進而達到降低成本、提高效率、優化品質及體驗，促使工業環境進步。未來將針對光學定位技術與軟體工程、農產品熟成控制技術、地雲端產業標準支援工具、ALD/ALE於光電半導體的製程應用作研發，以控制製程時間、提高精準度並減少誤差。

研發現況

1. 骨科手術之三維即時定位暨補償方法開發

- 為了改善骨科手術切口大、輻射量高、操作不穩定等問題，骨科手術機器人開始進入手術室。而醫療用精準定位技術產品目前國內主要依賴國外系統進行自主產品整合開發，主要以加拿大NDI系統商，其產品之重要技術特徵為光學式探頭、嵌入反光球之參考框架所構成之紅外線定位模組。龐大的耗材成本與系統整合上的限制大幅度限縮自主開發空間。本技術將為國內醫療定位系統業主建立自主完整化光學射頻複合式定位系統取代加拿大NDI系統，提升自主化定位系統市佔率。
- 本技術透過自主開發精準定位技術，整合多面向標記圖案識別演算法，利用轉置矩陣進行影像座標與WCS世界座標之間的轉換，計算出6DOF具有方向性的姿態空間座標（XYZ軸向、座標），完成轉至矩陣演算建立與座標融合方法。於立體標中導入主標及副標概念，當主標遮擋時透過周圍副標即時推算出主標的空間座標。透過空間曲面四角副標偵測技術即時計算出主標的姿態空間座標。
- 建立3D點雲立體視覺定位技術，包含(1)即時影像定位系統GUI暨結合6DOF姿態演算法之空間標記盲點姿態偵測模組，導入主、副標即時識別演算法。(2)3D點雲掃描暨分割模組、嵌入式點雲前處理模組與姿態轉換模組，整合自主開發之6DOF無盲點姿態計算，最終達到定位精度 $RMS \leq 2mm$ 。



骨科手術之三維即時定位暨補償方法

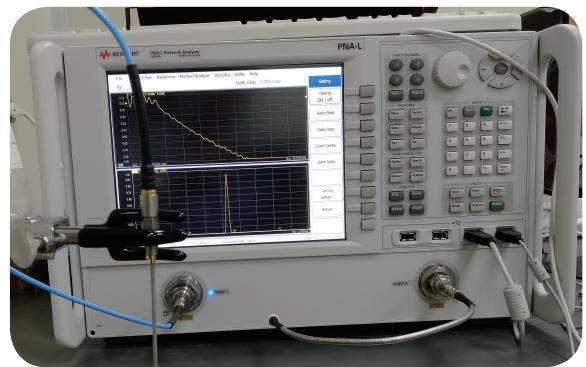


即時定位系統暨 GUI介面

2. 非接觸式超薄金屬射頻檢測技術

- 創新非接觸式超薄金屬射頻檢測技術，自主開發高頻感測天線探頭，頻率範圍：1~10GHz、反應響應： $>-30dB$ 。
- 本技術可應用於金屬薄膜特性檢測，如5G用的印刷電路板、5G銀漿、扣件表面特性的檢知以及熱處理深度檢知。
- 運用此技術可於產線上即時獲得產品金屬表面特性與熱處理解析度，不需要離線檢查可大幅提高良品率，若搭配控制系統可提升製程可控制性。

本射頻檢測技術可應用在扣件產業、鋼鐵產業、汽車零組件產業等，對於我國金屬相關產業智慧化製造有明顯幫助。

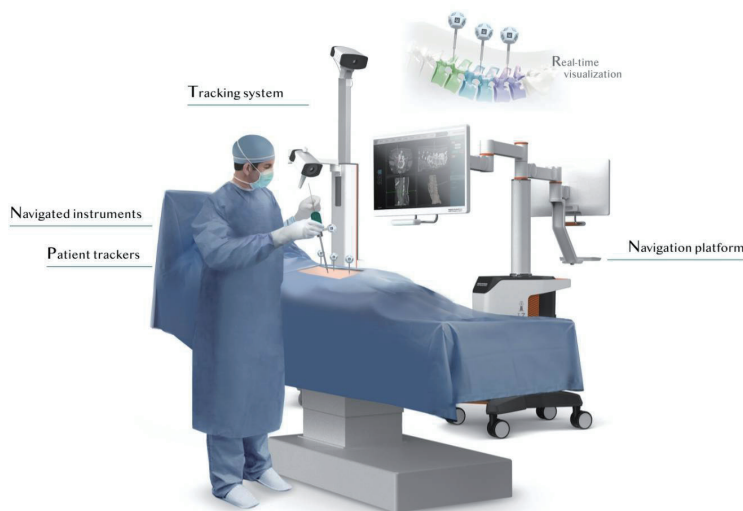


非接觸式超薄金屬檢測技術開發

未來研究

1. 光學定位技術與軟體工程

- 精進3D複合定位之多標記定位模組技術，開發雙眼視覺架構之Mutile-Markers 6DOF模組，並導入SVD矩陣分解演算法及點雲即時識別演算法，達成空間標記盲點姿態偵測。整合嵌入式3D點雲前處理模組與優化點雲分割及分類之最佳演算法，回饋予導航系統，實現最終定位機制，精進達到定位精度 $RMS \leq 1mm$ 。



手術導航用定位系統

2. 農產品熟成控制技術

- 農產品熟成控制的複雜性，將影響農產品熟成的均勻性與上市時間。協助廠商建立熟成環境監測系統，監測農產品熟成環境氣體，並控制溫度與氣流，避免人工經驗判斷，影響熟成時機。
- 掌握熟成紀錄不僅可以有效管理製程品質，也可以完整控制熟成製程，有利於出口的商機。

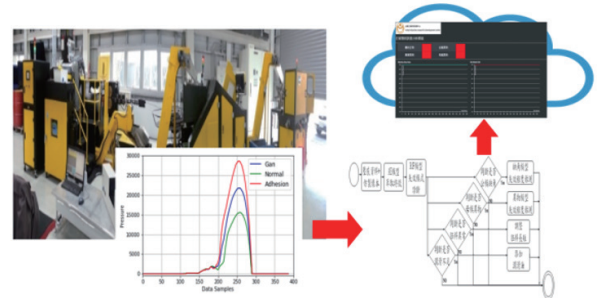


農產品熟成控制技術

3. 地雲端產業標準支援工具

異質雲整合系統（金屬扣件雲與智慧機械雲）：將針對下列三款金屬扣件雲SaaS模組依智慧機械雲規範上架串接至智慧機械雲店中店（金屬中心專區），並提供橫幅看板於智慧機械雲上廣告輪播：

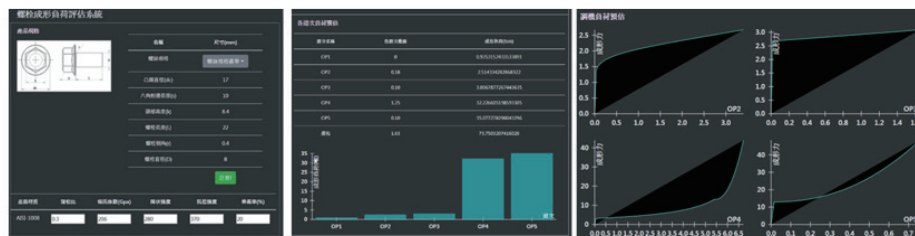
- 智慧調模導引模組：以光學輔助並透過固定流程與少量樣本數據，經WebUI介面操作引導使用者完成模具調校程序，降低人員操作誤差並有效縮短調模時間至少50%以上。
- 成形設備狀態分析模組：可搭配雲端運算進行模型開發、訓練及派送，並應用於地端進行資料蒐集、模型分析判別異常事件，以達到成形製程線上即時感知全監測目標。
- 模具快速設計評估模組：可透過Web介面輸入道次設計所需之規格、材料、各道次尺寸等可調控參數，並產出各道次模具成形負荷與模具應力應變以供使用者評估參考，可縮減扣件模具試模時間約50%。



成形設備狀態分析模組使用示意



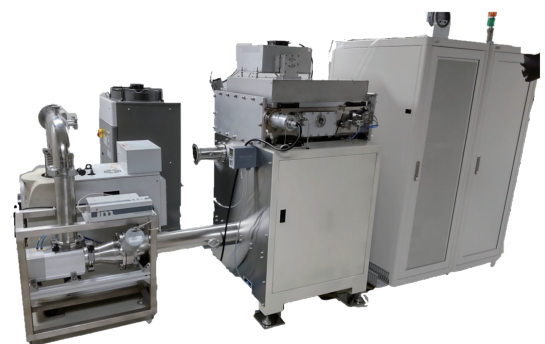
智慧調模導引模組使用示意



模具快速設計評估模組使用示意

4. ALD/ALE於光電半導體的製程應用

- 開發創新原子層沉積技術設備，具有的方形腔體設計能夠乘載不同形貌的基板，並將原子層沉積ALD和原子層蝕刻ALE兩項功能創新結合在同一腔體內，再加上擁有常溫鍍膜的技術，可將其應用在化合物半導體、電子元件、微發光二極體等產品的表面改質、表面蝕刻（粗糙度改善）、表面保護的關鍵製程，而此三種技術在同一設備製造完成，更能有效減低產品污染，進而提升可靠度和良率。
- 未來將與台灣化合物半導體廠商共同合作開發表面缺陷處理與修復技術、新穎前驅物材料以及產品驗證平台。也同步布局半導體和Micro LED的設備與代工市場，並且將可應用在第三代半導體GaN和SiC材料上，同時應用在散熱材料，新型封裝技術上，藉以有效改善可靠度。



原子層沉積 (ALD)與蝕刻技術 (ALE)單腔雙製程設備

醫療器材及照護技術

醫療器材及照護技術2021年針對智慧骨科手術、群體生理監護裝置，以及骨缺損修復產品進行開發。透過輔助技術整合定位及影像導航與機械臂應用，滿足精準手術需求，提高位移準度、縮短影像對位時間。後續將進一步整合機械手臂，提供完整且穩定的手術輔助系統供醫師於臨床使用。

在群體生理監護裝置技術方面，金屬中心開發穿戴式裝置，整合生理監測手環與通訊模組，以健康物聯網HIOT為應用，滿足各種環境下的生理量測需求。同時開發親民的手機APP軟體，方便民眾自主健康管理，可應用於養生村、養護機構、馬拉松等場域。

本中心亦重點開發骨缺損修復產品，透過冷凍乾燥成型技術製作出具可撓性的膠原蛋白/陶瓷複合材。搭配液劑使用，可達到任意塑形效果，並在填補後自硬化，適用於填補多種骨缺損型態，未來則會針對注射式骨再生材料及多層複合式軟骨修復材技進行研發。

研發現況

1. 多椎節影像導航技術

- 因應高階醫材與高齡化社會之市場需求，進行多椎節影像導航技術之開發。
- 開發之導航技術其自動椎節分割與虛實影像對位誤差 $<0.5\text{mm}$ ，且收斂時間 $<120\text{ sec}$ 。
- 預期新導航技術所應用之手術導航產品，在手術效率上可縮短50%以上醫師進行影像對位註冊時間，同時減少80%以上穿透式輻射影像拍攝量。
- 新辨識技術未來亦可應用於創傷復位與腦神經外科手術市場需求，預估可達到手術準確率95%以上。



多椎節影像導航手術輔助系統

2. 手術輔助機械臂系統開發

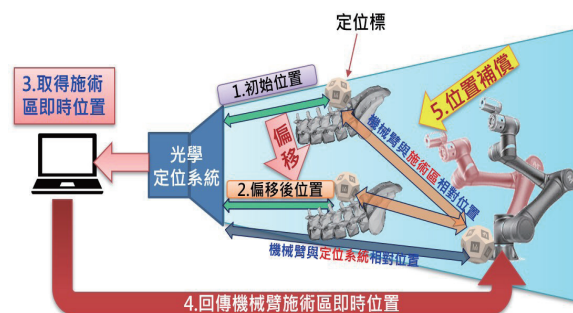
- 精準手術輔助系統於臨床需求日增，令醫材廠商紛紛尋求導航定位與手術機械臂等系統支援。
- 術中適應性位置補償演算法利用輔助機械臂基座和患者間的相互距離及姿態求得相對應的轉換矩陣，驅動機械臂達到目標位置，演算速度 0.036s ，系統直線定位精度 $\text{RMS} = 0.75\text{mm}$ 。
- 開發虛實手術環境搬遷離型轉換技術，累積訓練後的損失函數 0.018 ，累積訓練次數約為250次，手術輔助機械臂夾爪末端位移平均達成率維持在100%，平均位移時間為16秒到達施術位置。



真實環境之機械臂智慧路徑



可即時修正手術椎節資訊



補償機制

3. 群體生理監護裝置技術

LoRa 穿戴裝置開發

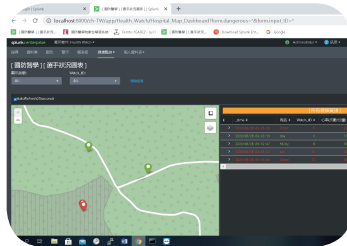
基本規格包含LoRa通訊及資訊傳輸功能、手機APP藍芽連線、時間顯示、電量符號顯示、電量百分比提示...等功能。生理量測包含體表溫度、步數、即時心率(PPG)等。

群體生理監護系統開發

完成群體生理監護系統後台開發，包含主系統程式及系統操作手冊一式，可接收各LoRa gateway閘道器所上傳之LoRa手環量測資料，透過後台進行管理群體生理量測資訊及位置資訊，並建立資料庫系統，以達到人員安全管制及健康管理的目的。



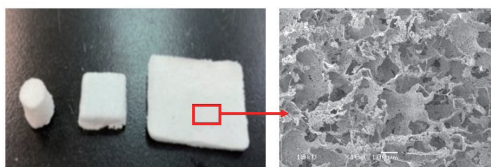
LoRa閘道器群體健康數據收集



群體生理監護系統

5. 膠原蛋白/陶瓷複合支架成型技術開發

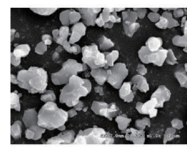
- 為使骨填補材具有可塑、可撓等特性，使醫師在操作時能任意塑形以填補骨缺損，將進行膠原蛋白/陶瓷複合支架成型技術之開發。
- 所開發之複合技術能縮短陶瓷分散與膠原蛋白交聯的時間約50%，透過攪拌剪切力變動率<5%確保混合均勻性。
- 膠原蛋白/陶瓷超音波交聯分散技術，能提升陶瓷顆粒在膠原蛋白溶液內之分散效率20%。
- 此技術未來亦可應用於漿料混合及化學反應，預估可節省10%以上之操作時間。



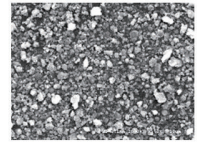
膠原蛋白 / 陶瓷複合材成型後之表面呈現多孔結構

4. 陶瓷次微米化技術開發

- 為提升臨床骨填補物吸收效率、骨生長效率差等問題，透過調控陶瓷顆粒大小以獲得具有生物活性之次微米陶瓷粉末。
- 次微米化後之陶瓷平均粒徑可下降至 $0.556\ \mu\text{m}$ ， $D_{50}=0.445\ \mu\text{m}$ 。
- 次微米化陶瓷粉末之骨分化與礦化能力相較大顆粒材料分別提升約40%與30%。於動物實驗中植入三個月，新生骨比例高於傳統骨粉約20%。
- 次微米化技術未來可廣泛用於食品工業與化妝品業，可提升粉末細化效率約15%。

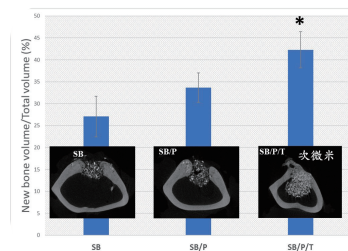


次微米化前 ($> 3\ \mu\text{m}$)



次微米化後 ($< 1\ \mu\text{m}$)

陶瓷顆粒粉末次微米化前後之表面形貌



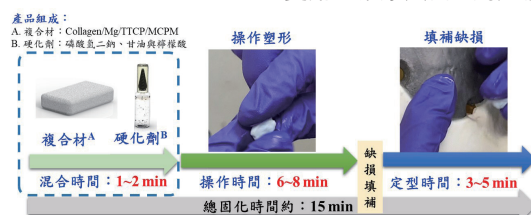
動物實驗植入 3個月後之新骨生長體積

6. 膠原蛋白/陶瓷複合材水合固化技術開發

- 為了改善骨科臨床骨塊填補物因形狀固定，需裁切且質脆易碎，不易填充於複雜缺損，以及骨粉填補後沒有附著點容易散等問題，將開發一骨填補物達到初始固化功能。
- 膠原蛋白/陶瓷複合材之A複合材與B劑混合後，可於15分鐘內硬化且能維持孔隙率介於50~70%，另外其固化抗壓強度 $> 3\ \text{MPa}$ 。
- 預期膠原蛋白/陶瓷複合材在特性方面符合臨床骨填補材之要求，且同時增加醫師的手術效率。
- 未來可應用牙科、整形外科等與骨相關生長相關之應用，例如植入物、填補材。



雙劑型膠原蛋白 / 陶瓷複合材水合固化系統



雙劑型膠原蛋白 / 陶瓷複合材水合固化系統操作流程

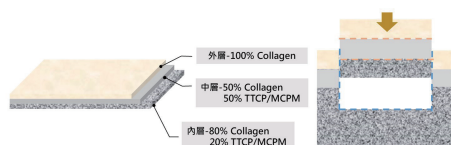
未來研究

1. 手術輔助機械臂系統開發

- 精準手術輔助系統於臨床需求日增，令醫材廠商紛紛尋求導航定位與手術機械臂等系統支援。
- 開發人機協作鑽削末端效應器系統，提供骨科手術輔助機械臂進行破骨、鑽削與攻牙等功能。透過仿骨測試機械臂協作鑽削，其鑽削深度偏差量 $RMS \leq 1mm$ 。
- 運用強化學習與虛實訓練，修補虛實環境周圍差異及增加脊突探棒的物件特徵可辨識性，手術輔助機械臂在真實手術實驗室環境訓練次數達1,000次，測試脊椎假體L1-L5椎節之智慧施打脊突釘成功率達98%。

3. 多層複合式軟骨修復材技術

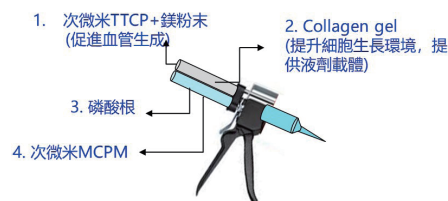
- 由於目前臨床進行軟骨修補常有分離脫落的問題。為此將設計一多層複合材料結構，下層使用較高陶瓷比例與膠原蛋白混合，用於固定於軟骨下方之硬骨；上層利用高膠原蛋白含量作為軟骨組織攀附。
- 多層式複合軟骨填補物之抗拉強度: $>1 \text{ MPa}$ 、孔隙大小: $>100 \mu m$ 與孔隙率: $>50\%$
- 預期多層式複合軟骨填補物能在底層與硬組織結合，並透過生物基質誘導並促進軟組織之修復率，組織生長率相較於膠原蛋白膜可提升約20%
- 未來亦可適用於牙科補骨、整形外科等，並達到良好之硬、軟組織生長效率。



多層式複合軟骨填補物示意圖

2. 注射式骨再生材料技術

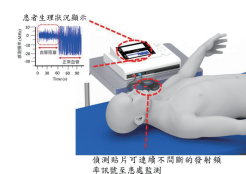
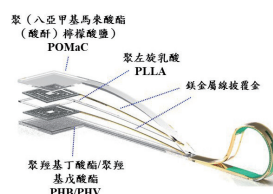
- 目前臨床上傳統注射式骨泥因為吸收速度過慢及不具有生物活性引導，使骨組織不易長入。因此進行注射式骨再生材料技術的開發。
- 新開發之注射式骨再生材料透過AB劑出料比達成可注射時間：4 min、硬化速率可控制在15 min內、固化機械強度 $>5 \text{ MPa}$ 。另外在分化與礦化能力能提升約20%以上。
- 預期注射式骨再生材料於體內應用時，其骨生長效率可提升15%以上。
- 本技術再搭配不同之生物基質，未來亦可應用於整形外科、微創補骨手術等，預估可達提升臨床效果約15%以上。



注射式骨再生材料示意圖

4. 侵入式無線可吸收血流量測系統

- 因應目前臨床上血管吻合修復手術容易產生血栓，導致血管內堵塞灌流不足。為了良好的監測術後血流異常和血栓狀況，開發一款可連續監測、術後無須拆線拔除、操作難度降低與準確度高的血流量測系統。
- 侵入式無線可吸收血流量測系統之皮下組織可偵測深度: 0.5~1.5 cm、血管偵測壓力: 2~5 kPa。
- 預期侵入式無線可吸收血流量測系統可進行連續式偵測，且相較於傳統有線式於術後無需拔除。
- 微小可降解植入式醫材之開發未來亦可應用於精密設備、軟體開發、資通訊和智慧自動化技術，例如醫療電子、軟/硬性印刷電路板等。



無線射頻辨識設備操作環境

侵入式無線可吸收血流量測裝置示意圖

綠能技術

綠能技術2021年研究範圍包含風力發電技術、太陽電池關鍵鍍膜製程設備技術，以及產業燃燒加熱設備相關技術。針對風力發電產業，除了輔導國內業者研發中小型風力機，亦協助工業局推動離岸風電在地化輔導、標檢局第三方驗證能力建置，以及能源局離岸風電運維技術開發。另發展智能檢測系統，大幅提升維運效率，未來將專注於製造流程數位化，為國內業者提供物聯網與產線設備互動之技術。

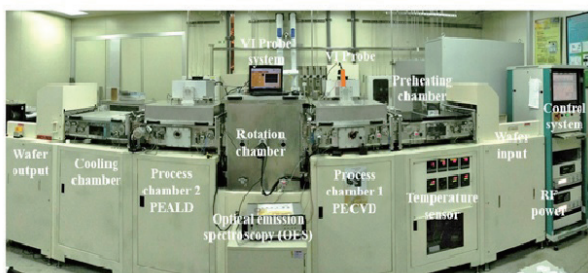
在太陽電池關鍵鍍膜製程設備技術方面，過去金屬中心針對高效能太陽電池製程設備技術，成功開發超高頻真空鍍膜設備，而今年再升級新一代鈍化型太陽電池關鍵鍍膜製程設備，大幅提升製程設備自製率，並將延續技術量能，開發關鍵試量產製程設備，期盼建構高效能太陽電池設備產業鏈。

另一方面，在產業燃燒加熱設備相關研發部分，由於業界工業爐加熱製程有高能耗及均溫性不佳之問題，因此透過分散式平火焰蓄熱燃燒技術、節能智慧控制技術提供示範場域，並協助產業發展重組設計技術，後續將研發自預熱式燃燒、脈衝控制技術，提升製造效率與競爭力。

研發現況

1. 新一代鈍化型太陽電池關鍵鍍膜製程設備開發

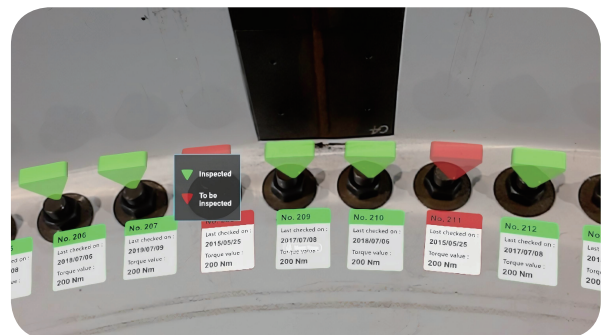
- 國內首次完成本土化TOPCon太陽電池關鍵鈍化製程設備與驗證平台，達成太陽光電自主研發關鍵設備系統的目標，解決產業缺乏關鍵製程設備導致的高開發成本問題。
- 突破國外在高效鈍化型矽晶太陽電池的專利佈局，並在關鍵穿隧鈍化製程設備上達成全面國產化。
- PEALD/VHF Plasma/PECVD 製程設備自製率>70%，建構高效能太陽電池設備產業鏈。
- 整合TOPCon 太陽電池關鍵製程，包含鈍化膜poly-Si、 Al_2O_3 、 SiO_2 、 SiN_x ，建構TOPCon設備組件供應鏈，提升國際競爭力。



新一代鈍化型太陽電池關鍵鍍膜製程設備開發

2. 穿戴式輔助系統開發

- 因應風力發電製造流程及運維作業可追溯，開發穿戴式輔助系統協助數位化追溯作業。
- 運用人工智慧影像辨識、視覺定位及增強實境技術達成塔架檢修輔助。
- 穿戴式輔助系統為運維人員提供流程提示及運維作業數位記錄，減少人為錯誤。
- 穿戴式輔助系統尚可運用於無人飛行載具操作輔助或支撐結構生產。



穿戴式輔助系統開發

3. 智慧型可重組蓄熱燃燒系統開發

- 高溫(800℃以上)燃燒加熱製程設備減少能耗30%以上。

分散式平火焰蓄熱燃燒技術

- 蓄熱式平焰燃燒器
- 外循環煙氣混合參燒技術

工業爐蓄熱燃燒系統節能智慧控制技術

- 分區前饋控制技術
- 換向閥監診技術
- 多燃燒器節能控制優化模型

平焰式燃燒可重組設計技術

- 平焰蓄熱燃燒器操作數據方程式化
- 模組化模擬快速設定技術
- 智慧平焰蓄熱燃燒系統快速輸入人機介面
- 國內首例平焰式智慧型可重組蓄熱燃燒耐火材料燒成製程設備之示範場域。

分散式平火焰蓄熱燃燒技術



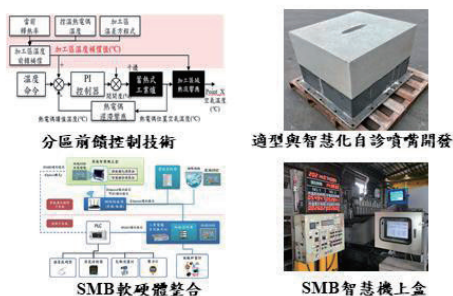
蓄熱式平焰燃燒器

平焰式燃燒可重組設計技術

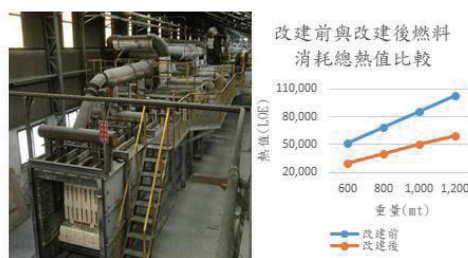


智慧平焰蓄熱燃燒系統快速輸入人機介面

工業爐蓄熱燃燒系統節能智慧控制技術



平焰式蓄熱燃燒高均溫爐節能示範場域

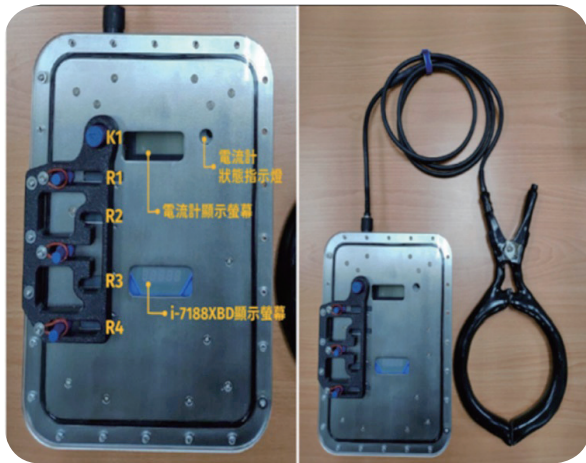


國內首例耐火材料燒成製程設備平焰式智慧型可重組蓄熱系統改建

智慧型自預熱式暨間接燃燒節能技術

4. 陰極保護電化學檢測模組

- 因應水下基礎以人力目視檢查陰極保護耗時長及風險高而開發。
- 電流量測記錄防蝕腐系統運作狀態，準確率70%。
- 本模組使犧牲陽極檢測時間小於30分鐘。
- 可延伸應用至監察外加電流法之有效性。

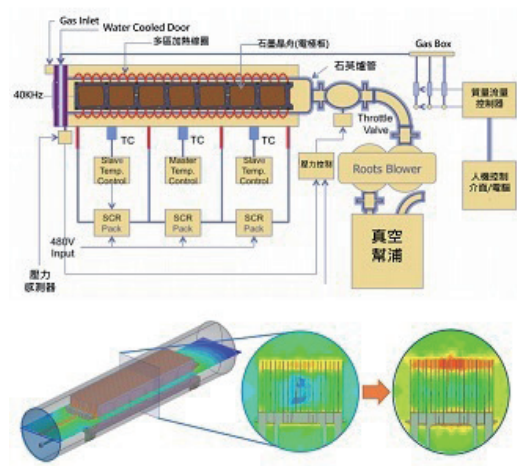


陰極保護電化學檢測模組

未來研究

1. 新一代鈍化型太陽電池關鍵試量產製程設備開發

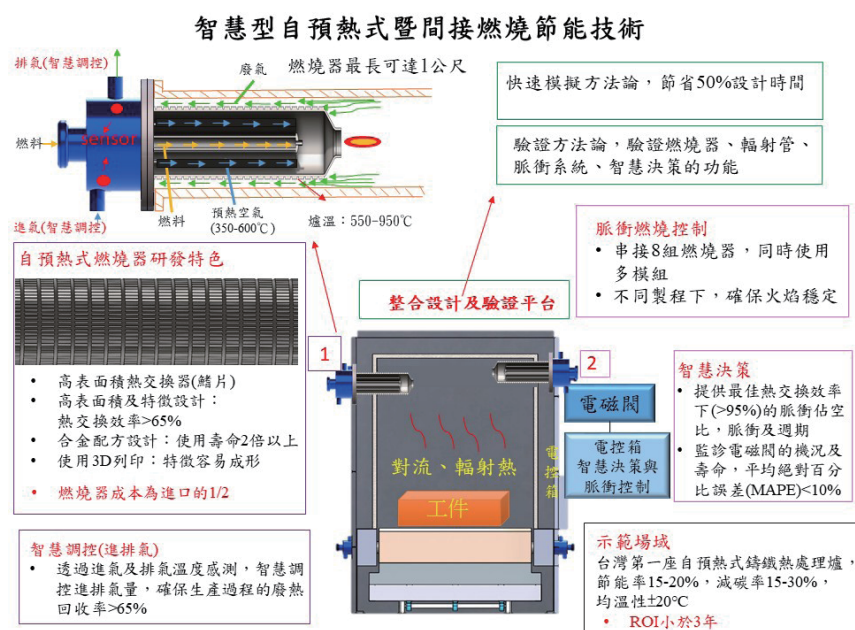
- 開發TOPCon太陽電池試量產設備，進行產品的設備驗證，藉由國產製程設備大量投產，有效提升高效太陽電池產品的市場競爭。
- 預期開發TOPCon關鍵製程設備設備產能達單次製程240片(M6)，可支援超薄穿隧氧化層(厚度 $\leq 2\text{nm}$)與多晶矽層製程。
- 預期開發之試量產型設備產能，可支援產線產能50MW，可生產TOPCon太陽電池產品，在能源效率上較傳統PERC太陽電池提升10%以上。



TOPCon電池量產型鈍化製程設備

2. 智慧型自預熱式暨間接燃燒節能技術

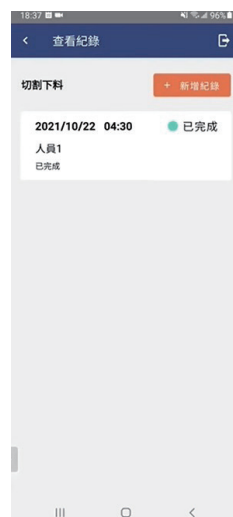
發展自預熱式燃燒器與輻射管、智慧決策與脈衝式燃燒控制技術、自預熱式工業爐整合設計與建立示範場域。可提供金屬相關產業從傳統加工到高階製造的國產化中高溫用熱製程設備廢熱回收技術，達到節能15-20%，減碳15-30%的目標。



智慧型自預熱式暨間接燃燒節能技術發展

3. 製造流程可追溯數位化

- 因應製造流程品質管理要求可追溯，投入建置製造流程可追溯數位化技術。
- 運用增強實境技術結合行動裝置或智慧眼鏡提供解決方案。
- 數位化製造流程可追溯為國內業者提供快速建置數位化品質管理方案。
- 相關技術未來可結合物聯網強化與產線設備互動。



製造流程可追溯數位化

電化學加工技術

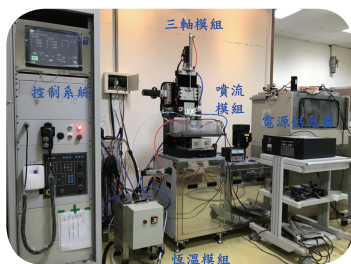
電化學加工技術2021年研發專注於製程決策參數快速建模技術，針對目前國內模具製造廠商在放電加工時遭遇問題提供解決之道，例如表面粗糙度不佳、排渣積碳、電極消耗與放電時間較長等，進而提出快速建模技術，並以特斯拉車用扣件模具花瓣輪廓為標的物，成功提升粗糙度、縮短加工時間。

本中心開發之電化學加工模組，可搭配自行建置之震動模組進行排渣、降低電極工件生成物阻塞等，從而縮短加工時間，提升表面粗糙度需求。未來將持續研發電化學複合加工研磨技術，針對執行模具類的加工提高效率，並解決難加工金屬材料刀具損耗大的產業痛點。

研發現況

1. 製程參數決策快速建模

- 因應模具製造業於放電加工時間長、電極消耗等需求，提出快速建模電化學加工技術開發。
- 車用扣件模具花瓣輪廓加工時間由2Hrs縮短為10mins，表面粗糙度提升50%以上。
- 新技術未來亦可應用於航太產業，估計可減少30%以上的製程成本。



噴流電漿電解表面加工系統

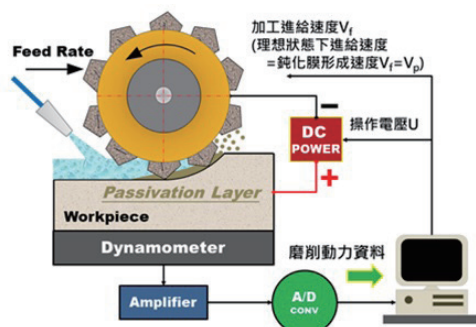


類神經加工預測模組

未來研究

1. 鎢鋼模具電化學複合研磨技術

- 因應模具製造業磨削加工鎢鋼模具有磨輪消耗、加工效率不佳問題，提出電化學複合研磨技術開發。
- 刀具壽命提升25%以上，加工效率提升30%以上。
- 新技術未來亦可應用於精密機械，估計可減少30%以上的製程成本。



電解複合研磨模組

海洋科技產業技術

海洋科技產業技術2021年配合行政院推動離岸風電人才培訓，全力打造台灣成為亞洲離岸風電技術產業聚落，目前已規劃2025年再生能源發電占比20%之政策目標，其中離岸風電預計於2025年累計設置量達5.5 GW。據經濟部公布第三區塊開發政策，正式定案從2026年到2035年共釋出容量達15 GW，藉此促進能源多元化及自主供應，帶動內需與就業，建構風力發電友善發展環境。

為維持風場穩定發電，技術人才培訓需求亦隨新設風場逐年增加，從基礎到進階培訓項目需全面建置。2021年新增國際風能組織(GWO)葉片修復培訓，為因應風機開始運作之人力需求，投入自動化葉片檢查技術與維修所需之必要培訓，未來預期拓展葉片修復進階與客製化培訓內容，協助國內風機運維產業完整建置。

研發現況

1. 葉片修復培訓技術

國際風能組織葉片修復培訓技術開發

- 因應再生能源政策推動，離岸風場運維作業技術人員培訓需求，進行葉片修復培訓技術開發。
- 依照國際風能組織培訓標準，開發培訓項目包含葉片前後緣修復、層狀材料置換、核心材料修復與表面塗層修復等。
- 預期每年提供50人次進階培訓需求。
- 提升風機葉片修復技術人力自主供給率達50%。



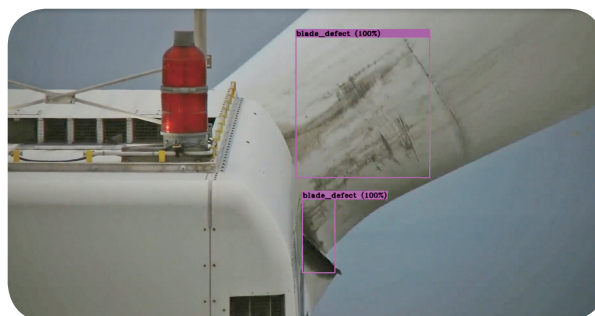
葉片修復培訓技術



2. 自動化風機葉片檢測技術

全球葉片維修每年約187,399天，換算下來超過500年的停機時間；傳統人工檢查方法往往是昂貴、耗時危險，因此透過無人機技術開發更安全、高效和更可靠的替代人工方案有助於使風能運維產業更具競爭力。

- 自動化載具檢測技術可檢測到10mm以下的葉片瑕疵。
- 透過AI影像分析技術可即時對拍攝的影像進行分析並進行15種瑕疵類別分類。
- 可於10分鐘即可完成葉片檢測並且無需停機，相較傳統人工檢測可提升30%以上檢測效能。



自動化風機葉片檢測技術

未來研究

1. 基本安全數位回訓培訓技術

國際風能組織基本安全數位回訓培訓技術開發

- 因應基本安全培訓每2年回訓需求，國內2019至2021年已培訓超過1,000人，回訓需求顯著，進行數位回訓技術開發。
- 依照國際風能組織培訓標準，開發數位教學模式包含視訊教學、標準影片與線上教學介面等。
- 預期每年提供150人次培訓需求。



基本安全數位回訓培訓技術

2. 塔架升降梯操作培訓技術

國際風能組織塔架升降梯操作培訓技術開發

- 因應再生能源政策推動，離岸風場運維作業技術人員培訓需求，進行塔架升降梯操作培訓技術開發。
- 依照國際風能組織培訓標準，開發多種形式之升降梯使用前檢查、操作模式與使用後安全檢查等。
- 預期每年提供150人次培訓需求。



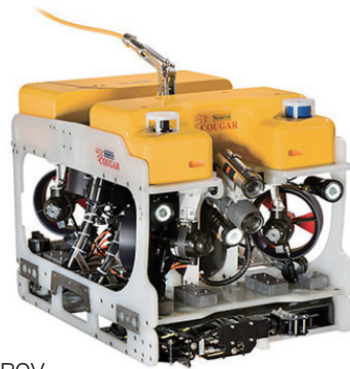
成形設備狀態分析模組使用示意

3. 多載具協同檢測作業技術

建立協作自動化運維檢測技術

隨著海上再生能源的發展和維護任將變的龐大與繁瑣，載體（機器人）協同作業技術將成為重要的發展趨勢，透過協同作業技術除可自主作業外亦可與海上技術人員一起工作。

- ROV為海底電纜壽命監測，例如：海底形態建模，優化海底電纜鋪設設計、最佳安裝地形和路線、用於監測海底位移、溫度和埋深等的分佈式溫度傳感（DTS）系統並應用於防腐蝕檢測等。
- ASV為國內海上風電運維行業實施水下維護提供聲吶探測技術和圖像處理技術。協作自動化運維檢測技術開發未來將使工人從海上危險環境轉移到陸上整合控制室中心除了提升安全性並可將能源成本降低 10%（包括運營費用降低27%）。



ROV



ASV

航太製程技術

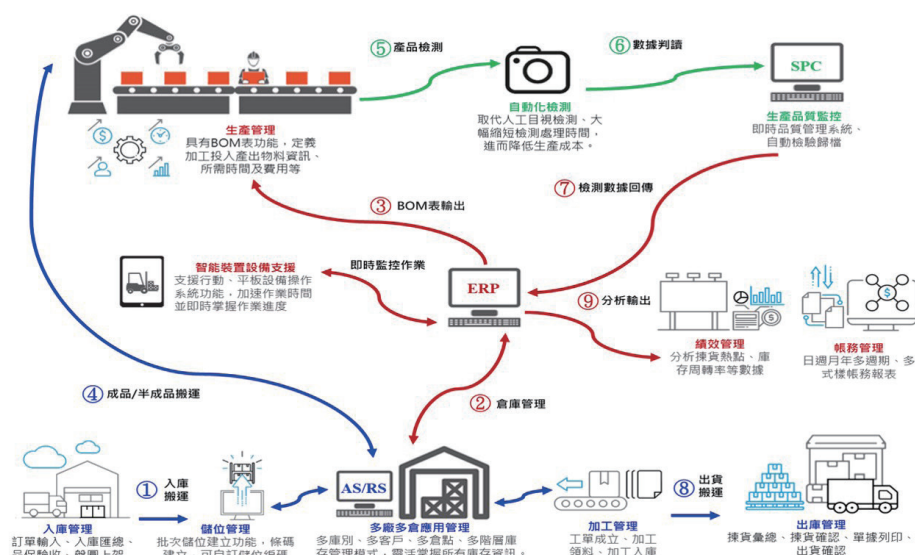
因應全球換機潮及國際貿易需求，2021年本中心協助業者轉型投入航太軍民用領域，同時推動業者通過嚴格航太品質系統認證，提高國內業者在國際航太市場的競爭力，帶動國內業者共同升級轉型。另一方面，中心也鏈結系統整合商及製造商，組織航太供應鏈管理體系，期望在分工及協作的模式下，鏈結國際市場爭取大型訂單。

未來主要研究方向為協助國防產業強化國防自主能量，除了精進現有的鍛造能量，亦建立F16維修體系，以解決機隊高故障、高單價之成本問題。此外，預計建立等溫鍛造、熱模鍛造及環鍛之生產技術，使高階民用發動機躍進國際供應鏈體系，同時導入航太診斷雲平台，帶動國內投資、數位轉型，以及民用商機。

研發現況

1. 轉型投入航太高附加價值產品開發

- 因應中小型製造業數位轉型政策及產業需求，媒合非航太業者與航太系統整合商合作，配合數位管理系統應用，進而轉型航太高附加價值產品生產。
- 因航太產品注重安全及溯源特性，透過數位管理系統及自動生產設備，提高產品生產效率20%，轉型製造航太產品價值提升3倍。



數位化管理系統與應用

2. 發展航太關鍵技術與數位應用

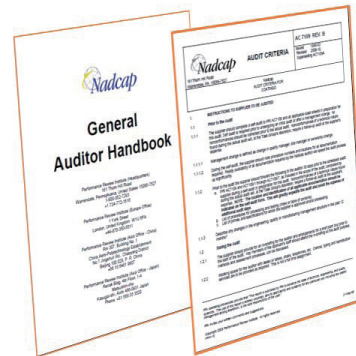
- 媒合航太業者與資服業者合作，由航太業者提供需求與技術應用，並協助資服業者轉型開發航太虛擬實境高值化產品。
- 提高訓練安全與成效，並且降低硬體設備損壞風險及訓練成本，帶動航太產值提升5億元以上。



開發航太虛擬實境產品

3. 建立航太品質系統與供應商認證

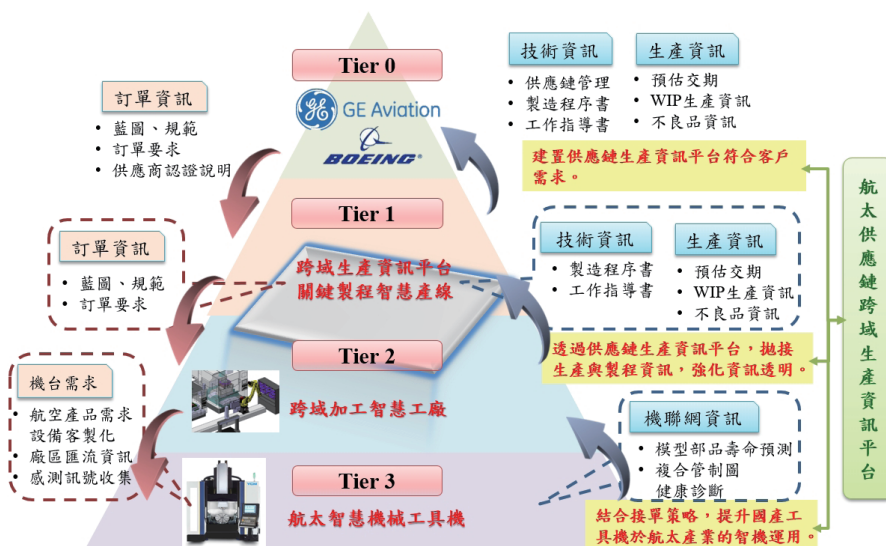
- 推動業者導入航太品質系統，提供專業輔導並協助取得AS9100、Nadcap特殊製程及供應商原廠認證，提高我國業者於國際航太市場能見度。



航太 Nadcap特殊製程認證

4. 組織航太供應鏈管理體系

- 鏈結國內航太系統整合商與機體結構及發動機零組件專業製造商共同合作，導入供應鏈管理系統，進行階層式管理，強化分工及協作模式。
- 供應鏈合作有效爭取國際大型訂單，帶動國內產值提升10億元。

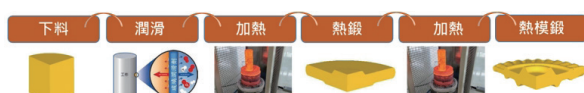


供應鏈管理系統及分工

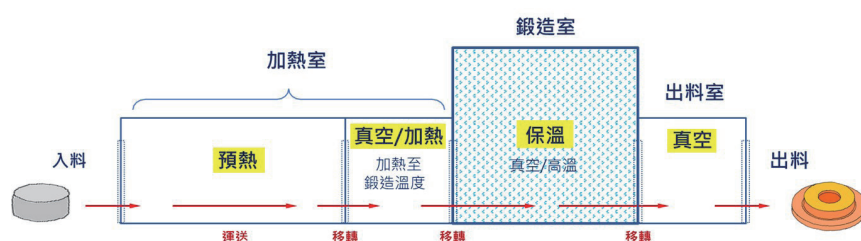
未來研究

1. 推動航空發動機鍛造技術發展與應用

- 藉由國防產業發展方案引領，以軍代民協助國內業者以現有鍛造能量，建立發動機熱段零組件製造技術，進而切入高階民用發動機國際供應鏈體系。
- 透過政策資源補助，建立等溫鍛造、熱模鍛造及環鍛之生產技術，帶動國內投資10億元以上，以強化國防自主帶動民用商機為目標。



航空發動機熱模鍛造關鍵技術



航空發動機恆溫鍛造關鍵技術

2. 推動F16型機維修供應鏈體系

- 因應總統指示與立院附帶決議，籌建F16型機隊之高故障、高單價、長交期品項之自主維修技術，提升機隊妥善率，建立F16維修體系，完善國防自主能量。
- 推動建立F16型機關鍵技術及生產能量，並透過政策資源補助，配合計畫推動時程，預計每年開發F16型機之維修及產製技術至少4項，引領至少3家業者加入F16型機維修供應鏈體系。



推動業者投入 F16型機維修及產製技術開發

3. 航太診斷雲平台開發

- 由於新進業者缺乏連結國內外航太市場管道，對於航太相關認證規範法規資訊及認證流程需尋求輔導，配合政策推動數位轉型，建立航太診斷雲平台，引領新進業者加入航太產業鏈，預計每年可提升產業從業家數至少3%。



航太能量診斷平台

**2021 MIRDC
ANNUAL
REPORT**



Foreword





Message from the Chairman

Exert the Cross-domain Capability Promote Industrial Development

Facing the economic changes and the impact of the raging COVID-19 pandemic, Taiwan's economic performance has not declined due to the shock, but is one of the few countries in the world whose economy is growing. In fact, Taiwan has created favorable conditions for exports and production. In order to actively grasp the opportunities for global recovery after the COVID-19 pandemic, the government has promoted the "Six Core Strategic Industries," building on the foundations of the 5 + 2 Innovative Industries Program, to improve Taiwan's key position and economic resilience. In particular, the circular economy and the transformation and upgrading of local industries are the most important key development topics. As a R&D organization under the government, the Metal Industries Research and Development Centre (MIRDC) cooperates with the promotion of government policies, strengthens cross-border/cross-domain cooperation through integrating industry-university-institute links, to deepen the innovation and niche capacity in providing the industry with diverse solutions and further enhancing the overall competitiveness for the industry, and accelerate the rising and flourishing development of Taiwan's economy.

On the topic of circular economy for sustainable development, the Executive Yuan takes Kaohsiung City as the core demonstration area to create a "Circular Technology and Materials Innovation and R&D District", as a circular economy demonstration area and promotion center, and plans to bring in several research centers including the Metal Industries Research and Development Centre to station, to provide technology development and certification of future renewable material sources and high-value applications in the compound semiconductor material industry. Among them, MIRDC is mainly responsible for the construction of recycling aluminum-related technologies. Since the aluminum metal is a green energy-saving material and due to the rise of emerging markets and the growth trend of recycled aluminum manufacturing in recent years, the demand for aluminum materials has grown rapidly and significantly. Therefore, with the support of the Ministry of Economic Affairs' Technology Development Programs, MIRDC has developed innovative process technologies for low-waste and high-value recycled aluminum materials in combination with domestic benchmark manufacturers, driving the improvement of up-, mid- and down-stream application production technologies, promoting industrial transformation and integration and forming a new metal circular industry chain and



implementing sustainable circular high-value applications of green products. In the future, relevant innovative technologies will be expanded to high-value markets of electric vehicles, green buildings, high-end equipment and smart machinery, which will become the new energy to promote the growth of Taiwan's circular economy.

In terms of the transformation and upgrading of the local industries, MIRDC actively links up with the local industries; introduces innovative technology and cross-domain integration, to drive the local industry towards high-value and characteristic development. With the implementation of the AI program, MIRDC assists the Ministry of Science and Technology to build an international flagship "AI Robot Innovation Maker Base" in the Southern Taiwan Science Park, transforming the original manufacturing production area into a maker base with an open innovation platform, fostering the next generation talents of new technology industry, to becoming a professional platform for providing solutions using AI robotics technology through the diverse combination of regions, industries and talents, to create an innovative maker way of life in southern Taiwan. In addition, MIRDC also assists the government in planning the transformation and upgrading of Kaohsiung Xingda Fishing Port into a marine science and technology base and establishing the "Kaohsiung Maritime Technology Innovation Centre" enabling this Center to become a training base and demonstration field for Taiwan's offshore wind power marine engineering, marine science and technology talents, marine science and technology research and development. At the same time, MIRDC has cooperated with Maersk of Denmark and Marin of Netherlands to conduct international cooperation in maritime talents and engineering and has also established the O-team, W-team, M-team alliances with more than 20 companies including China Steel Corporation and CSBC Corporation, Taiwan to assist in constructing the wind turbines industry localization supply chain system and to transform Xingda Fishing Port into an important base for offshore wind power in the Asia-Pacific region, thereby driving the sustainable operations of the regional industrial economy.

Since its establishment half a century ago, MIRDC has been focusing on metal technology. Facing the changes in the internal environment and the rapid changes in the global industry, MIRDC has improved the forward-looking and innovative research and development capabilities and has joined hands with the industry and academe to combine AI, big data, cloud and other digital applications at the same time to assist small and medium-sized enterprises in smart applications, promote the digital upgrading and transformation of traditional production and inject more innovation momentum into Taiwan's industries. In 2021, with the cooperation of all colleagues, many important businesses have been successfully implemented and personally, I really appreciate the efforts of all colleagues! It is expected that the overall department of the MIRDC will keep improving and will continue serving as the bridge among the government, industry, academe and research institutes with the original intention and effectively transforming government research and development resources into application results that enhance the industrial value, so that Taiwan's industry in the wave of globalization can quickly grasp the new aspects and create new opportunities and sustainable development.

Chairman of
the Board Directors

Ren-Ji Lin

Vision, Mission
and Deep
Cultivation of
Technologies

ANNUAL REPORT



Exploration

“Prospecting for the Future”. MIRDC links with industry-academia-research resources for the applications innovative materials, development of smart manufacturing, high-value medical materials and high-end precision industry. The Centre also cultivates in the research and development of energy conservation as well as energy storage to demonstrate the capacity in international navigation.

Vision, Positioning and Mission of MIRDC

Metal Industries Research & Development Centre (MIRDC) is the only research institute headquartered in Kaohsiung among incorporated institutes affiliated with the Ministry of Economic Affairs. MIRDC positions itself as “the R&D and application service institute providing cross-discipline, total solutions with the focus on metal technology”; it is committed to “playing the key role in value creation and assisting cross-discipline industries centering on metal to enhance their added value, and international competitiveness”, and strides toward realizing the vision of “becoming a premier international metal-technology R&D institute with cross-discipline development leading to value creation for the industry.”

For over half a century since its establishment, MIRDC has been entrusted with the important task of facilitating industrial upgrading and transformation in response to national industrial policy development and environmental changes. By continuous organizational innovation and forward-looking technical R&D / adjustment of service promotion direction, MIRDC not only unceasingly assists the upgrading of the traditional “metal materials & fabricated metal products industries”, but also emphatically extends core capabilities and their applications to potential priority industries, such as “high-value equipment industry”, “automotive industry”, “medical devices & healthcare industries”, “high value-added precision micro manufacturing industries” and “green energy industry”. To facilitate the technical development and high-value applications of the priority, MIRDC builds cross-discipline platforms; integrates related capabilities, such as AI, Big data and innovative services; proactively coordinates in the “5+2 Industrial

Promotion Plan” promoted by the government; and continuously plays the role of promoting industrial transformation and upgrading.

Moreover, MIRDC endeavors to become a “hub” that leverages the platforms of domestic and foreign technology R&D, talents and resources, strengthens the connection between industries and academic/ research sectors, links local governments with the central government and Taiwan with the world, aims to establish a cross-discipline R&D ecosystem, and strides towards realizing a diversified cross-discipline R&D institute.

With the support of the Ministry of Economic Affairs, the Innovation Value-added Center of Traditional Industry, MOEA, constructed and operated by MIRDC, was inaugurated and opened on March 20, 2018. It is located near the Nanzi Headquarters of MIRDC; the Center comprises one innovation building and three workshops (Additive Manufacturing Center, Smart Metal Manufacturing Center and Prototyping Center) which can assist the traditional industry in the south with introducing rapid product development, smart digital manufacturing processes and high-value innovative products development, making it a platform for industry-university-research exchanges and demonstrations, creating diversified industrial development resources and a new dimension for the development of traditional industries in the south.

成為以金屬科技領航及跨領域創造產業價值的國際級研究發展機構

一、核心技術量能對焦深化

策略
主軸



Taiwan

MIRDC
成為「Hub」
鏈結國內外資源



二、形塑成為「Hub」角色

鏈結國內外技術研發、
人才、資源的平台



Center of Excellence /

Advanced Materials and Processing R&D Center

1. Vision and mission

To become an international interdisciplinary R&D center for material development and intelligent process integration is the development vision of the Advanced Materials and Processing R&D Center. By integrating existing process technologies (alloy fusion / process simulation / secondary processing / surface treatment), combining digital alloy design, numerical simulation

and analysis of materials processing, 1.5 / 2nd forming technology, post-treatment process, and inspection and verification, etc., to provide a full process digital cross-domain open R&D platform for innovative material development and high-value applications.

2. Technical scope

The latest core technology is developed for the "material R & D". On the one hand, it aims to develop highly functional new materials and high specific strength multifunctional mixed materials by integrating the characteristics of heterogeneous materials; on the other hand, it shortens the duration of material R&D processes through rapid and accurate material design, machine learning and material simulation. As for the "Processing R&D", a welding process data database is built based on multi-layer digital automatic welding technology. Furthermore, to achieve rapid and high-quality product development, the communication between ROBOT and welding machine is incorporated in the database to control the motion track. Data on large-scale laminated manufacturing and digital analysis technology are also included in the database to build laminated interface homogeneous control, so as to facilitate the development process.

3. Promotion strategy

By aligning itself closely with national policies and industrial development trends, the Center grasps the business opportunities of emerging markets, integrates the innovative and technological R&D capacity of industry university institute and corporates with benchmarking industries to improve the application of value adding technologies, optimizes the international exchange mechanism to promote exchanges and cooperation, and enhances the international influence on innovative R&D.

4. Highlights

By matching the resources of the "metal and petrochemical industry chain" and "International Institute of materials", the international competitiveness of the domestic communication and consumer electronics related industries is strengthened, and the mixed materials with metal mechanical properties and texture, lightweight and recyclability of thermoplastic materials are developed, so that the problem of metal signal shielding during wireless transmission of digital functionalization of products (such as 5G communication) could be solved.

MIRDC signed an MOU with Compal Electronics to jointly develop new materials for 5G laptop casing. The partnering initiative has a total of 38 media coverages, including 3 print newspapers and 35 online media.



Left: Sheng-Hong Li, senior deputy general manager of Compal Electronics
Right: Chiu-Feng Lin, the president of MIRDC

Smart Manufacturing for Metal Industries Technology Center

1. Vision and mission

Smart Manufacturing for Metal Industries Technology Center of MIRDC is the cooperative development partner for the innovative process equipment and customized systems of industry-university-research institute. In 2021, the center's main industry of assistance was the fastener industry, with the goal of increasing its proportion of certified high-grade and special parts products, and assisting in improving its ability to take orders, proofing, and trial production. In 2021, the fastener industry was affected by the favorable factors of Taiwan's successful epidemic prevention, and it has become one of the few countries in the world with a continuous chain and a stable supply. Therefore, it has recovered rapidly. From

the end of the third quarter of 2020 to the fourth quarter of 2021, almost all manufacturers have reported receiving orders. However, due to the impact of exchange rate, freight, material and heat treatment costs and lack of labor, the gross profit margin was eroded. In terms of value positioning, the center uses technologies such as smart mold training technology, product quality modeling and process optimization technology, online quality monitoring and enabled analysis technology, mold health status and life cycle monitoring and other technologies to fill the gaps and bottlenecks in the industry.

2. Technical scope

To assist the fastener industry from order receipt to product finished, the center establishes a systematic intelligent manufacturing solution for fastener forming and manufacturing, and solves the problems of fastener production traditionally relying on manual inspection and lack of real-time information with rapid response and flexible production needs, providing a solid foundation for the manufacturing industry and customized smart manufacturing solutions.

The technical spindle is divided into elastic manufacturing and predictive production. Elastic manufacturing is based on robots combined with 3D vision to replace manual picking and gluing; predictive production is based on equipment/mold predictive maintenance and process intelligent decision-making guidance. The former

features equipment online sensing equipment production status and early maintenance prediction, while the latter is applied to the design and trial production end. Combined with CPS performance analysis and design simulation, the trial production proofing time is shortened by more than 50%.

The technologies include data acquisition, quality monitoring and statistical analysis capabilities, process plan/mold design decision-making technology, smart mold tuning technology, product quality modeling and process optimization technology, online quality monitoring and cause analysis technology, mold health status, life expectancy monitoring, etc.

3. Promotion strategy

1. To improve the intelligent manufacturing production line of fasteners in the Innovation Value-added Center of Traditional Industry, MOEA and strengthen the demonstration and promotion of the accurate prediction function of digital warfare and AI modeling.
2. Cloud platform promotion
 - Take the casting/forging mold design expert system as an example, Solidworks development tools are used to develop software, and open the cloud platform for paid members.
 - Mechanical cloud/fastener cloud: Apps such as rapid design, mold change and adjustment, production visualization, equipment perception, and quality pre-diagnosis.
3. Integrate mold design and fastener intelligent manufacturing production lines, cooperate across locations to build a rapid proofing support center, and improve the ability of special fastener proofing and order taking in the industry.

4. Highlights

CHUN YU WORKS & CO., LTD.

◎ Company Profile:

Established in 1965, the Company is located in Gangshan District, Kaohsiung City. Number of employees: about 664. Main businesses: grinding wire, spheroidizing wire, screws, nuts, bolts, hexagonal head high torque control bolts for rail use, etc.

◎ Issues:

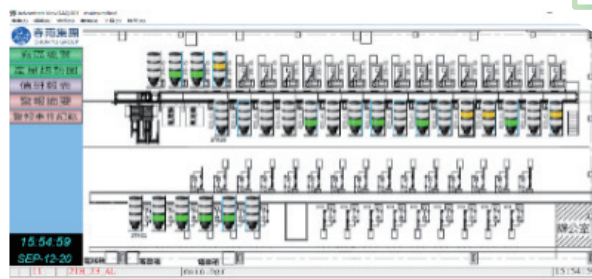
In the past, equipment shutdown was not immediately noticed by the inspection personnel, and it took up to 4 hours to realize the shutdown issue. The production status record increased the burden of the management personnel.

◎ Solution:

- Establish a complete machine networking system (41 devices)
- Establish a war situation system and three-color light management
- Install Marposs (Italian system) forging force sensor

◎ Outcome benefits:

The introduction of visualized measurement information reduces equipment failures and unreported cases; the output has increased significantly. For example, the total output of the head equipment increased by about 27% within one month; the total output of the tooth rolling machine increased by about 22%.



Machine network system (41 devices)



41 devices in the factory

High-end Micro/Meso Manufacturing System Development Center

1. Vision and mission

With the vision of leading Taiwan to become the R&D center of high-value precision micro manufacturing, the High-end Micro/Meso Manufacturing System Development Center of the MIRDC is committed to building an integration platform for precision micro manufacturing to develop the high-end Micro/Meso manufacturing and integration technology in the domestic metal field, develop key R&D bases and

platforms for high-value precision micro products, and provide complete services for high-grade manufacturing, such as one-stop service capacity for rapid development, trial production, and trial mass production of precision/micro high-value products, with the aim of becoming the leader of high-end manufacturing in Asia.

2. Technical scope

The High-end Micro/Meso Manufacturing System Development Center covers three major technologies: (1) Product design/simulation analysis technology: stamped metal forming analysis, mold design for plastic injection molding, electromagnetic flow field simulation analysis technology, etc. (2) Precision processing and manufacturing technologies: ultra-precision processing, electric discharge/wire-cutting/electrochemical processing, laser additive and subtractive 3D printing technology, metal forming, injection molding, functional film coating, precision micro heat treatment and surface

modification technologies. (3) Intelligent and flexible manufacturing integration technology: intelligent sensor chip development and integration, intelligent composite module and process equipment integration technology, fastener/processing/stamping/surface treatment intelligent manufacturing, precision medical technology development and integration technology, etc., as detailed in the following technology scope and framework.

3. Promotion strategy

The promotion strategy of the High-end Micro/Meso Manufacturing System Development Center aims to create high technology barriers and high added value through cross-technology, cross-field and system integration, including collaboration among government-industry-university-institute, facilitating technology licensing, patent licensing, independent industrial development service, module/equipment manufacturing, etc.

4. Highlights

The "Continuous Micro Parts Heat Treatment System Equipment" made it the only non-profit organization in Taiwan to win both the Edison Awards and the R&D 100 Awards 2021. The technology is developed for micro components (less than 2 mm in diameter) with dedicated heat treatment process and system equipment, integrating system functions such as "automatic feeding system, automatic monitoring and real-time control of the main heating furnace, innovative oil bath and collection module, and intelligent cloud service", and has been successfully applied to heat treatment, such as tempering of micro screws and micro-gears for smartphones, which can quickly find the optimal heat treatment process conditions and optimize the production scheduling. In other words, the system significantly shortens the delivery time, and maintaining high quality yield and high collection rate.

On the other hand, products receiving precision micro heat treatment have been certified by leading international manufacturers (e.g., Tesla), and have successfully entered the Tesla supply chain. Heat treatment is the mother of the mechanical industry, and precision heat treatment is the key capability of Taiwan's precision industry. The precision micro heat treatment not only frees products of thermal deformation and increases their hardness, but also has improved the quality from A to A+. The actual test shows that it has excellent dimensional accuracy and wear resistance, surpassing the current quality of domestic products and reaching

international standards. The quenching oil tank is designed with a special workpiece trapping mechanism, which is the core technology, and can completely trap the micro workpieces drifting in the tank, and the material collection rate is as high as 100%. It can be subsequently used in 3C, medical machinery, electric/motor vehicles, optoelectronic semiconductor, aerospace, etc.



Heat Treatment Equipment for Metal Precision Parts

Advanced Minimally Invasive Medical Device R&D Center

1. Vision and mission

In the field of minimally invasive medical materials, MIRDC continues to promote the development of relevant technologies of "intelligent surgical assistance system", with the primary focus on the development of spatial positioning technology, medical image navigation and surgical manipulator, the three key technologies. In 2021, the world's first set of "multi-segment navigation system" that can update the spatial information on

vertebral segment images immediately during surgery was developed and integrated, and its clinical trials on cadaver was also completed. Subsequently, in order to accelerate the practical application of the technology, the final clinical trial of the system will be completed by the end of 2022 and the clinical trial will soon be carried out in Kaohsiung Veterans General Hospital.

2. Technical scope

In addition to the development of surgical auxiliary system, the Advanced Minimally Invasive Medical Device R&D Center has also developed relevant treatment devices, including "innovative minimally invasive instruments", "new implants", and "non-invasive treatment equipment", which are all included in its scope of technical R&D. At the same time, following the scientific and technological trends around the world, the center has actively introduced the application of AI technology in developing medical products.



Surgical assistant system

3. Promotion strategy

The center focuses on seeking solutions to the current clinical difficulties and the lack of products and technologies in Taiwan. The orthopedic surgery assistance system is the first large-scale R&D project and product launched by the center. By analyzing the restrictions on clinical uses and problems of existing commercially available products, it has developed new positioning technology to timely correct the spatial information on surgical vertebral segments during surgery. With the application of new technology, it has made itself a strong competitor in the market.



The information of surgical vertebral segment can be corrected immediately

4. Highlights

In 2021, the R&D team completed the development of the world's first set of "multi-segment image navigation system" and applied it in the clinical trials on cadaver, achieving excellent study results. After applying to six consecutive segments without using the X-ray for correction in the process, it could reach an accuracy rate of more than 90%. At the same time, it has been used to place in the implants made by Taiwan manufacturers, and the whole spinal surgery process was completed successfully, which brought positive evidence for subsequent application on human body in clinical trials.



Clinical trial of multi-segment navigation system on cadaver

Net Zero Industrial Combustion and Energy Storage R&D Center

1. Vision and mission

In response to the global industrial trend of carbon reduction and energy storage and in order to solve the problem of high carbon emissions in the high-temperature processes of metal that is common in related industries, the Net Zero Industrial Combustion and Energy Storage R&D Center of MIRDC has developed high-temperature combustion technology for carbon reduction and energy storage technologies, such as heat storage, self-preheating and pure hydrogen combustion,

as well as flow battery-based energy storage technologies, such as high specific capacity energy storage vehicles, as well as an electrolyte and battery management system. The center is an international R&D center, and has been established to provide industry with efficient, safe and cost-effective energy solutions to help achieve Taiwan's goal of net zero by 2050 and lead the industry to expand into the global market.

2. Technical scope

The core technology is high-temperature combustion technology for carbon reduction and zero carbon emissions: including the application of waste heat recovery technology to high temperature combustion, such as regenerative and self-preheating combustion, zero-emissions technology for burning fuels, such as biomass energy and hydrogen energy, and integrated design and intelligent technology applied to industrial furnaces to reduce carbon emissions arising from industrial combustion processes. "Energy storage technology": to meet the industrial energy storage demand, the center has developed key components, materials, a high-capacity energy storage system, a battery testing and monitoring system, an energy management system for a battery storage system and optimizes electrolyte and manufacturing processes.

- The development technology of short-term goals: focusing on the carbon removal and zero emissions technology applied to industrial furnaces with processes at a temperature above 550°C and MW flow cell to develop its corresponding management technologies for maintenance and operation of battery energy storage systems.
- The development technology of medium-term goals: expand the scope of application of high-temperature combustion technology for carbon reduction and zero carbon emissions and energy storage technology.
- The development technology of long-term goals: develop energy generation and system integration technology and optimize the use of chemical energy resources.

3. Promotion strategy

1. Coordinate domestic and foreign teams to develop innovative technologies. (master the know-why)
2. Establish testing and validation labs to validate technical benefits of a certain technology (master key configuration and validation technologies)
3. Transfer technology to related industries to build up domestic capacity of services (develop technologies and expand the service scope)
4. Assist the service team to promote through the industry associations and societies of industries (focusing the marketing for target industries)

4. Highlights

High-temperature combustion technology for carbon reduction and zero carbon emissions: establish flat flame high temperature air combustion technology and feedforward control system of high temperature air combustion in industrial furnaces to increase the air volume for heating space in the furnaces, effectively solve the temperature hysteresis of high temperature sensor and improve the temperature control to maintain average temperature in the furnaces. The application scope is extended to tunnel kiln for the firing of refractory with a high temperature of 1400°C, so as to facilitate the reconstruction of the highest temperature firing section of the kiln and reduce energy by more than 40%. At the same time, by switching from diesel to natural gas, the carbon reduction can reach 50%.

Energy storage technology: electrochemical energy storage based on vanadium battery plays a key role and has the characteristics of high safety and scalability.

Therefore, the center aims to apply this technology to high specific capacity energy storage vehicles, electrolyte technology with high efficiency and low energy loss, and battery management system with intelligent power compensation, so as to introduce key technologies to develop high-capacity industrial energy storage systems and meet the domestic small energy storage demand (kW level). The theoretical power of the stack module can reach 2.3KW. When combined with the balanced compensation system, the overall efficiency can reach more than 75%. Coulombic efficiency of electrolyte can be greater than 90%.



Operational Status

ANNUAL REPORT

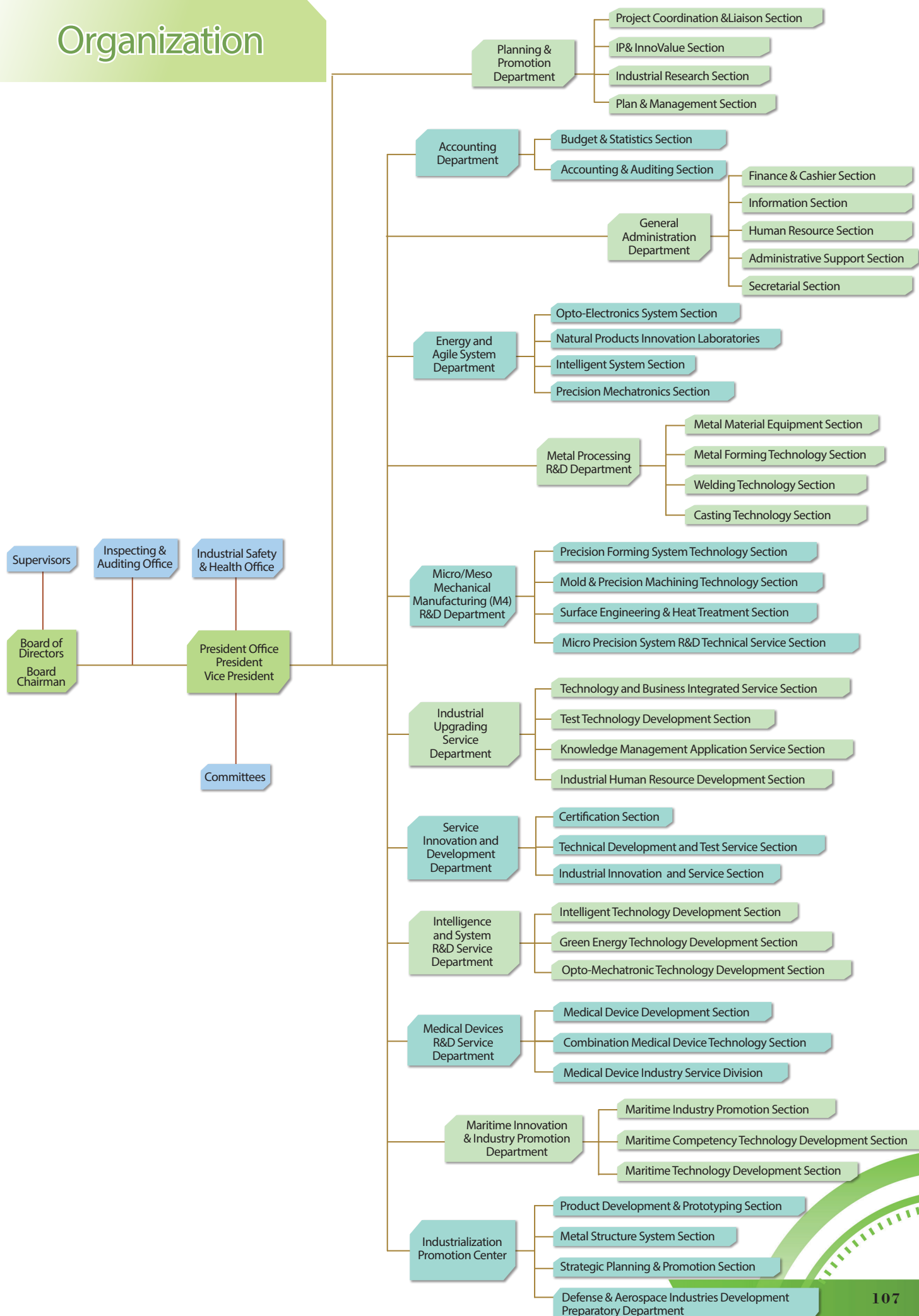


“Expand and collect resources in distinguished performance”. MIRDC aims at the goal of innovative service and innovative operation organization, gathers international r&d talents and professional technology capacity, introduces success opportunities and flow for the industry, as well as cooperates with the industry for sustainable development.

List of Directors and Supervisors

Title	Name	Institutions and Title
Chairman of the board	LIN, REN-YI	Chairman of the board, MIRDC
Managing Director	LIN, DER-SHENG	Deputy Director General, Department of Industrial Technology, Ministry of Economic Affairs
Managing Director	HSIEH, HAN-CHANG	Deputy Director General, Bureau of Standards, Metrology & Inspection, Ministry of Economic Affairs
Managing Director	LIN, HUA-YU	Chief, Metal & Mechanical Industries Division, Industrial Development Bureau, Ministry of Economic Affairs
Managing Director	LI, CHUN-LI	Deputy Director General, Bureau of Energy, Ministry of Economic Affairs
Director	CHEN, QIONG-HUA	Deputy Director General, National Development Council, Department of Industrial Development
Director	HSIEH, LONG FON	Secretary General, Small and Medium Enterprise Administration, Ministry of Economic Affairs
Director	WANG, SHYI-CHIN	President, China Steel Corporation
Director	MA, WAN-CHUN	President of Aerospace Industrial Development Corporation
Director	FONG, ZHANG-HUA	President of National Chung Cheng University
Director	JYWE, WEN-YUH	Professor of National Taiwan University
Director	CHENG, YING-YAO	President of National Sun Yat-sen University
Director	CHEN, YUEH-TUAN	President of National University of Kaohsiung
Supervisor	YANG, CHING-YU	President of National Kaohsiung University of Science and Technology
Supervisor	JHENG, WAN-CING	Section Chief, Department of Accounting, Ministry of Economic Affairs
Supervisor	YANG, PO-KENG	Director General, Export Processing Zone Administration, Ministry of Economic Affairs

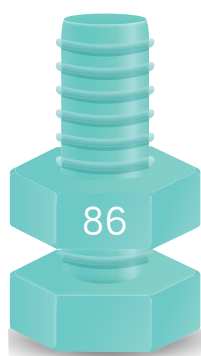
Organization



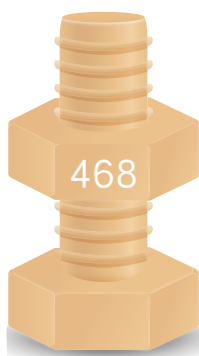
Manpower

Number of Full-time Employees : 736 | Average Age : 43

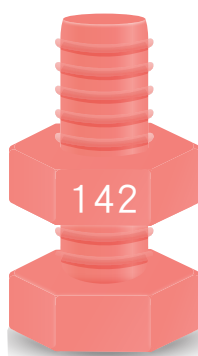
Education (Number of Persons)



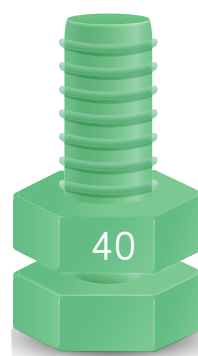
Ph.D



Master

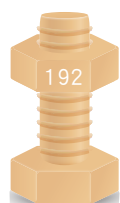


Bachelor



Junior College & Others

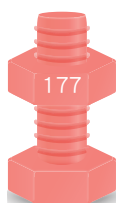
Service Year (Number of Persons)



1-5 years



6-10 years



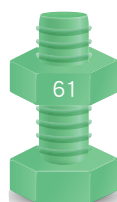
11-15 years



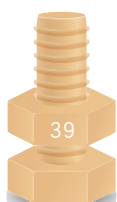
16-20 years



21-25 years



26-30 years



Over 31 years

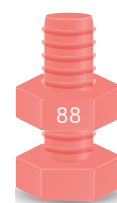
Major Fields (Number of Persons)



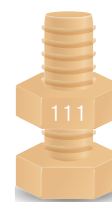
Machinery/
Automation/
Mold



Materials/
Chemical
Engineering/
Chemistry



Electric Machinery/
Computer Science/
Electro-optic



Medical/
Biotechnology/Oth
Engineering



Management/
Marketing/
Accounting/
Statistics



Other Fields

Note: The data was published in Dec.31, 2021.

Financial Statements

Income Statement

Unit : NT1

Item	Last Year Final Account		Final Account		More (less) than Budget	
	Amount	%	Amount	%	Amount	%
Operating Revenue	3,173,249,579	103.35	3,070,397,910	100.00	(102,851,669)	-3.24
Expense	3,094,026,923	100.77	3,038,770,442	98.97	(55,256,481)	-1.79
Net Operating Income	79,222,656	2.58	31,627,468	1.03	(47,595,188)	-60.08
Net Non-operating Income	52,562,546	1.71	18,863,003	0.61	(33,699,543)	-64.11
Net Income before Tax	131,785,202	4.29	50,490,471	1.64	(81,294,731)	-61.69
Income Tax	26,114,418	0.85	8,981,676	0.29	(17,132,742)	-65.61
Net Income after Tax	105,670,784	3.44	41,508,795	1.35	(64,161,989)	-60.72

Balance Sheet

Unit : NT1

Item	Final Account	%	Item	Final Account	%
Current Assets	1,430,967,661	63.65	Current Liabilities	699,390,987	31.11
Funds & Long-term Stock Invest	84,828,935	3.77	Long-term Liabilities	-	0.00
Property, Plant, and Equipment	596,173,038	26.52	Other Liabilities	133,856,159	5.95
Intangible Assets	78,177,468	3.48	Total Liabilities	833,247,146	37.06
Other Assets	58,147,893	2.59	Net Worth	1,415,047,849	62.94
Total Assets	2,248,294,995	100.00	Total Liabilities & Net Worth	2,248,294,995	100.00

The background is a warm golden-yellow color. It features several decorative elements: a large, semi-transparent yellow triangle pointing downwards from the top center; a series of stylized, overlapping wavy lines in a lighter yellow shade across the top; a large, stylized gear or sunburst pattern in the bottom right corner; and a series of concentric, semi-transparent circular lines in shades of orange and yellow on the left side. A small, bright white starburst is located near the bottom left of the yellow triangle.

Glorious Achievements

ANNUAL REPORT



Innovation

"Innovation of technology with new breed of experts". MIRDC establishes alliance cooperation and cross-domain cooperation platform to implement high-end research and application; the Centre also break through barriers and inject fresh water to set an excellent example in international awards and exhibitions.

Received Awards

2021/ Apr. Oct. Nov.	Awarded Team / Unit: HUANG, CHIA-HUNG; YEH, TING-KUEI; WU, CHENG-YEN; CHUNG, YU-LIN; CHEN, CHI-HUI; LIU, CHUN-CHENG / Micro / Meso Mechanical Manufacturing R&D Department Awarded by WTW Media LLC; Edison Awards; R&D 100; The Globee Awards
The "Continuous Micro Parts Heat Treatment System Equipment" first created by the Centre can improve the carburizing and quenching of micro parts (with a thickness of less than 2mm, such as carbon steel screws in mobile phones or small and medium motor shafts and pinions in fans) by the traditional large-scale heat treatment equipment, due to their small size and easy-to-cause uneven quality, easy to become brittle and fracture and with poor materials collecting rate at the same time, resulting in waste of raw materials, defective materials mixing and other problems and successfully integrated four innovative functions of "Automatic Feeding System, Automatic Monitoring and Real-time Control Main Heating Furnace, Innovative Oil Tank and Collecting device, and Intelligent Digital Service," making the overall collecting rate to reach 100% and the yield rate reach 99%. The products produced do not have deformation and have increased hardness, excellent dimensional accuracy and wear resistance characteristics, surpass the current domestic quality and reach international standards, while leading to greatly reduce the delivery schedule and cost and the manufacturing module can be quickly replaced based on product or functional requirements. At present, this system equipment has been used in the supply chain production of Tesla, BOSCH and other major international manufacturers and proceeded industrial cooperation with domestic companies including Sha Yang Ye and Xing Guang Industrial Company at the same time, expecting to jointly build a perfect micro production chain and drive the development of the process manufacturing of micro components and heat treatment related industries, and won the honors of 2021 R&D 100 Awards, the Bronze Award of 2021 American Edison Awards and the 2021 CEO World Awards.	
2021/ May.	Awarded Team / Unit: WU, CHEN-YU; LIN, CHIAN-YOU; CHENG, SHENG-YUA; SHIH, PO-KUN / Metal Processing R&D Department Awarded by Germany iF Awards
"Foamed Aluminum Inflatable Life Float" uses foam aluminum technology, which not only has buoyancy in water, but also has weather resistance and impact resistance. The volume is only 1/19 of the traditional lifesaving buoy, not only easy to carry, but also has enough buoyancy to allow adults to float in the water and won the honor of 2021 German iF Design Award.	
2021/ Oct.	Awarded Team / Unit: TSENG, CHUN-CHIEHE; TSAI, DUNG-LIN; CHEN, CHUN-MING; WENG, LI-WEN; WANG, PEI-HUA / Medical Devices R&D Service Department HSU, CHIA-HAO / Metal Processing R&D Department Awarded by The Globee Awards
The Controllable Hydro-Reactive Magnesium Alloy is applicable to agricultural technology, life health and medical care applications. For agricultural applications, hydro reaction of magnesium alloy can produce hydrogen and magnesium, zinc, calcium nutrients necessary for the growth of plants in a specific duration and grow better, where hydrogen can alter the physiological hormone reaction of plants and improve capability to withstand harmful environments. In medical device developments, implant applications such as bone nail, hemostatic clamp or intravascular stent can be made of this alloy, allowing even and slow degradation and full absorption by the human body during the repairing process of tissues or bones, eliminating the need for a painful secondary removal operation. Winner of the 2021 CEO World Awards.	
2021/ Oct.	Awarded Team / Unit: YANG, KUANG-HSUN; HSU, CHAO CHIEH; DAI, SHENG-JU; SU, BING-HUA / Maritime Innovation & Industry Promotion Department Awarded by The Globee Awards
The Continuously Rotating Wind Turbine UAV Inspection System, developed by MIRDC, is capable of inspecting a rotating wind turbine in a significantly shortened duration without interrupting its operation; 5 minutes is all it takes to inspect a single wind turbine. Any fracture as small as 4mm in the turbine blade can be detected; it saves inspection costs by at least 40%. Swarming formation of multiple UAVs can be organized to perform simultaneous inspection of large-scale wind farms, escalating inspection efficiency of the entire wind farm. Winner of the 2021 CEO World Awards.	
2021/ Oct.	Awarded Team / Unit: TSENG, CHUN-CHIEHE; TSAI, DUNG-LIN; CHEN, CHUN-MING; WENG, LI-WEN; WANG, PEI-HUA / Medical Devices R&D Service Department HSU, CHIA-HAO / Metal Processing R&D Department Awarded by Ministry of Economic Affairs
"Technology for Controllable Degradation Rate of Medical Magnesium Alloys" won the 2021 Meritorious Technology Transfer Award in the Achievement Praise of Technology Development Program (TDP) for Non-Profit Organizations.	

2021/ Oct.	Awarded Team / Unit: HU, PO-CHI; CHIEN, KUO-YU; WANG,HSIANG-PIN; LIN,CHIH-CHUNG / Micro/ Meso Mechanical Manufacturing R&D Department Awarded by Taiwan External Trade Department Council
"3D Dental Laser Milling" won the Gold Medal Award at the Taiwan Innotech Expo.	

2021/ Oct.	Awarded Team / Unit: HU, PO-CHI; CHEN,YEN-TING / Micro / Meso Mechanical Manufacturing R&D Department LIN,CHIH-CHUNG; HUANG,WEN-HUI/ Energy and Agile System Department Awarded by Taiwan External Trade Department Council
"Three-Dimensional Real-time Positioning Methods in Orthopedic Surgery " won the Gold Medal Award at the Taiwan Innotech Expo.	

2021/ Oct.	Awarded Team / Unit: YANG, KUANG-HSUN; HSU, CHAO CHIEH; SU, BING-HUA; LAN,TSUNG-YI/ Maritime Innovation& Industry Promotion Department Awarded by Taiwan External Trade Department Council
"The Aircraft with Fixed-wing Vertical Take-Off and Landing Function and Its Automatic Control Method" won the Silver Medal Award at the Taiwan Innotech Expo.	

2021/ Oct.	Awarded Personnel / Unit: WANG,CHUN-CHIEH/ Vice President Office WANG,LI-DE; CHEN,YEN-JU; HUANG,YEN-LIN; TSAI,PEI-JUNG; CHUANG,CHIH-YU/ Metal Processing R&D Department Awarded by Taiwan External Trade Department Council
"The Composite Laminated Board, Shell and Mobile Communication Device " won the Bronze Medal Award at the Taiwan Innotech Expo.	

2021/ Sep.	Awarded Personnel / Unit: WU,WEN-CHIEH / Intelligence and System R&D Service Department Awarded by Chinese Institute of Engineers-Taichung Chapter
Won the "2020 Outstanding Engineers Award"	

2021/ Nov.	Awarded Personnel / Unit: HUANG,WAN-YUN / Metal Processing R&D Department Awarded by Taiwan Foundry Society
Won the "2020 Youngster Foundry Engineer Award"	

2021/ Dec.	Awarded Personnel / Unit: LIN CHIU-FENG / The President Office Awarded by Chinese Society of Mechanical Engineering
Won the "2020 Mechanical Engineering Medal"	

2021/ Dec.	Awarded Personnel / Unit: HSU,KAI-CHENG / Industrial Upgrading Service Department Awarded by Chinese Society of Mechanical Engineering
Won the "2020 Outstanding Young Engineer Award"	

Industrial R & D Alliances

1. The Research and Development Alliance of Natural Medicinal Plants and Health Products

This alliance is jointly formed by the Metal Industries Research and Development Centre, I-Shou University and Ever Serve Nano Bio-Technology Co., Ltd help promote precision health and conduct innovative research and development, and new medicinal products development of plants and functional health foods, to create the milestone in cross-domain innovation through practical application of key and innovative technologies.

2. The Development Alliance of Automobile and Casting Carbon Reduction Key Technologies of Wind Power Components

This alliance is jointly formed by World Known Precision Industry Co., Ltd, Inductotherm Group Taiwan and Sunware Information System Co., Ltd. to put one of the existing casting production lines into high-efficiency equipment and innovative manufacturing process optimization, with four major strategies of high melting efficiency, automatic pouring, rapid verification of casting carbon reduction and IOT carbon reduction management, to achieve the establishment of key technology development for casting carbon reduction.

3. The whole case output alliance of innovative masks and the optimized equipment

The alliance is jointly formed by MIRDC, Motex Corp., Ming Jilee Enterprise Co., Ltd. And Wonderful Hi-Tech Co., Ltd to build the turnkey smart manufacturing system a production line for research and integration, expecting to increase the yield rate of the production line to more than 98%. In addition, to conform to the requirements of advanced countries in Europe, America and Japan, MIRDC has also established a high-level advisory consultation group for mask chains to combine the guidance and assistance of expert groups.

4. The Development Alliance of Industrial Valve Product Digital Upgrade and History Traceability Integration

The alliance is jointly formed by MIRDC, Proval Industry Company, Valwell Industry Co., Ltd. and National United University, to develop digital bus, digitization of quality assurance operation for the material information and verification certificates of the valve products and machinery components, and establish the accurate and rapid product data identification, production history, quality control, inspection reports and certificates, etc., these are used for customer review and cloud sharing of MTR information.

5. Die Casting Smart Manufacturing Alliance

The alliance is jointly formed by MIRDC, DITSA (Diecasting Industry Technology Service Alliance), BASSO Industry Corporation and Tojin Corporation, to assist manufacturers in mastering key process parameters, optimizing design and forming parameters, realizing online quality prediction, to achieve online full inspection and adaptive control and real-time assistance in quality judgment, process essential factor improvement systematization and the analysis results are effectively fed back, to facilitate the manufacturing process improvement. BASSO Industry Corporation is currently building a smart manufacturing demonstration site and integrates equipment factories and third-party factories to jointly organize an alliance.

6. The Alliance of Aerospace R&D and Maintenance Elite and Engine Production and Maintenance

The alliance is jointly formed by MIRDC, TJD Corporation Ltd, Nanya Institute of Technology, Aerospace Industrial Development Corporation and Drewloong Precision, Inc., to establish Indigenous Fighter Plane production and repair technologies as well as the parts and components development capabilities, with the military aircraft engine repair spare parts as the vehicle for the short term to lead Kaohsiung manufacturers to quickly enter the engine production and repair market and build Kaohsiung into the capital of aerospace parts and components.

7. The Exchange Platform of Cross-domain Digital Transformation

This alliance is jointly formed by HCP Pump Manufacturer Co., Ltd., Ling Cheng Technology Co., Ltd. and Calin Technology Co. Ltd., to promote and guide the industrial transformation demonstration of the Park industries and hope to promote the value-added innovation of the Park industries. By assisting the upgrading, transforming, renewal and activation of the industries in playing a greater synergistic effect, thereby to strengthen the operational efficiency, enhance the competitiveness of the Park industries.

8. The Development Alliance of High-intensity Focused Ultrasound AI-assisted Positioning Identification System

The alliance is jointly formed by MIRDC, Yang Der Instruments Co., Ltd. and Point Medical Equipment Co., Ltd., to promote the establishment of a R&D team in Taiwan to produce High-intensity Focused Ultrasound AI surgical assistance, spatial positioning, and complete machine system and to resolve the problems of 100% dependence on foreign imported and expensive equipment.

9. Machine Tool Work Table Casting Parts Alliance

The alliance is jointly formed by Yuan Jun Fong Casting Co Ltd., Je-Hung Co., Ltd. and SIGMA CNC Technology Machinery Co., Ltd, to integrate the upstream, midstream and downstream industries of machine tool parts and components in establishing the technologically independent industrial chain, and promoting the development trend of foreign machine tools and key technologies of heat treatment, and establishing new materials, new technologies and new products for independent applications.

10. The Research and Development Alliance of Domestic High-level Micro-screen Printing Technology

The alliance is jointly formed by Max Echo Technology Corporation, King's Metal Fiber Technologies Co., Ltd. and Taiwan Special Wire Netting, to integrate stainless steel materials, wire drawing and heat treatment, weaving manufacturing and 5G passive component manufacturing related technologies and assist Max Echo Technology Corporation to apply high-end micron-scale screen printing technology to manufacture 5G key passive components, to increase the global market share.

11. The R&D Alliance of Intelligent Milling and Leveling Equipment for Offshore Wind Power Underwater Infrastructure Flange/Pipe End

The alliance is jointly formed by Intake Mechanical Power Corp Co., Ltd. and CTCL Machinery Corporation. The forming processing and manufacturing equipment, machine and tools for large steel structural members are currently not developed by domestic manufacturers, but those are the necessary equipment for the production and manufacture of offshore structural parts. The developed intelligent milling and leveling equipment for the offshore wind power underwater infrastructure flange/pipe end can meet the needs of Taiwan's industry and market.

Interactions with Industry, Academic and Research Sectors

Allied Partner : Evergreen Aviation Technologies Corp.

January 1, 2021 / Dr. Chiu-Feng Lin, President

MIRDC and Evergreen Aviation Technologies Corp. signed an MOU to facilitate the cooperation between industry and research sectors in developing the machining technologies of aircraft engine parts.

Allied Partner : Fraunhofer IPA

June 1, 2021 / Dr. Ren-yi Lin Chairman

MIRDC and Fraunhofer IPA signed a Letter of Intent (LOI) to focus on the technical exchange of Bin picking with artificial intelligence.

Allied Partner : KYMCO

January 1, 2021 / Dr. Ren-yi Lin Chairman

MIRDC and KYMCO signed a strategic alliance to effectively apply talents exchange and knowledge sharing of two parties in order to jointly promote technical development for increasing industrial competitive strength.

Allied Partner : Season Farm Technology Co., Ltd.

September 1, 2021 / Dr. Ren-yi Lin Chairman

MIRDC and Season Farm Technology Co., Ltd. implemented the hydrogen industry research center to carry out the cooperative R&D of seawater desalination system.

Allied Partner : Hamaster Technology Co., Ltd.

April 1, 2021 / Dr. Ren-yi Lin Chairman

MIRDC and Hamaster Technology Co., Ltd. signed a strategic alliance to promote SAF Business ByDesign market in providing a total solution for industry.

Allied Partner : Association for Dental Sciences of the R.O.C. and Myanmar Dental Association

October 30, 2021 / Dr. Chiu-Feng Lin, President

MIRDC, Association for Dental Sciences of the R.O.C. and Myanmar Dental Association were engaged in the cooperation with application of implant related products and technical sharing of dental industry.



Allied Partner : National University of Kaohsiung

April 29, 2021 / Dr. Ren-yi Lin Chairman

MIRDC and National University of Kaohsiung signed a strategic alliance agreement to proactively promote industrial and academic cooperation, facilitate the development of metal industry, to effectively apply mutual resources, to establish the cooperative relationship mechanism among government, academia and think tank for increasing mutual practical and experience exchange.

Allied Partner : Taiwan Instruments United Association (TIUA)

May 14, 2021 / Dr. Ren-yi Lin Chairman

MIRDC and Taiwan Instruments United Association signed an MOU by leveraging MIRDC's proficiency accumulated over years in developing industry talent to jointly promote labor resources for the instrumentation and equipment industry.



Allied Partner : Association for Dental Sciences of the R.O.C. and Faculty of Odonto-Stomatology, University of Medicine and Pharmacy at Ho Chi Minh City

October 30, 2021 / Dr. Chiu-Feng Lin, President

MIRDC, Association for Dental Sciences of the R.O.C. and Myanmar Dental Association were engaged in the cooperation with application of implant related products and technical sharing of dental industry.



Allied Partner : Taiwan Dental Association St. Frances
Cabrini Medical Center Inc.

November 10, 2021 / Dr. Ren-yi Lin Chairman

MIRDC, Taiwan Dental Association St. Frances Cabrini Medical Center Inc. were engaged in the cooperation with application of implant related products and technical sharing of dental industry.

Allied Partner : HOCHENG Corporation

December 23, 2021 / Dr. Ren-yi Lin Chairman

MIRDC and HOCHENG Corporation signed an MOU to facilitate the development and long-term inspection & testing cooperation for sanitary ware and home appliance industries.



Development Milestones



January 11, 2021

Opening ceremony of Maritime Technology Innovation Center (MTIC)

The opening ceremony of "Maritime Technology Innovation Center" (MTIC) was involved with the participation of Mei-hua Wang, the Minister of Ministry of Economic Affairs; Cheng-wei Yu, the Director of Bureau of Energy, MOEA; Chi-mai Chen, Kaohsiung Mayor; Kaohsiung City; Ren-yi Lin, the Chairman of MIRDC; and Chiu-feng Lin, the President of MIRDC. In order to complete the underwater foundation as well as the technology, human resource, and development capabilities for maritime engineering in Taiwan, MTIC will establish the manufacturing capabilities for underwater foundation required for offshore wind energy, cultivate relevant talents, and set up industrial self-reliance capability of maritime technology in Taiwan by taking "maritime engineering," "maritime talent competence", and "marine technology R&D" as the cores. MTIC promotes the localization of offshore wind energy engineering and technology and thus provides many employment opportunities in Taiwan. In the meantime, MTIC will facilitate the transformation and upgrade of the harbor, turning into one of the most important bases of offshore wind energy in Asia-Pacific Area.



April 27, 2021

Groundbreaking ceremony of Offshore Engineering Center, MTIC

On April 27th, Yi-Ling Chen, the Chief Secretary of Ministry of Economic Affairs, served as the Chief priest at the ceremony of breaking the ground with spade, together with Chi-Mai Chen, Mayor of Kaohsiung City Government, Cheng-Wei Yu, the Director General, of Bureau of Energy and other distinguished guests. As these invited guests participated in the ceremony of the breaking the ground with spade of Offshore Engineering Center, together they witnessed the start of the construction of the first national simulated real sea field. In the future the Offshore Engineering Center will provide multi-functional industrial services, including real sea area simulation test of the scale model can provide diver training, pilot training of underwater vehicle, underwater instrument testing or calibration, underwater structure testing or maintenance simulation training, etc. Combining more domestic and foreign academic and research capabilities, the center will continue to expand the potential application areas of deep-water basin, including renewable energy, maritime engineering, ocean instruments, offshore structures, security defenses, and academic research, so as to leverage the benefits of national R&D facilities in order to reach the goal of accelerating the development of domestic industries.

Models of Excellence /

Intelligent Heat Treatment Modules Upgraded Precision Parts and Components

"Continuous Micro Parts Heat Treatment System Equipment" won the 2021 Edison Awards and 2021 R&D 100 Awards
 Winning Team: HUANG, CHIA-HONG; YEH, TING-KUEI; WU, CHENG-YEN; CHUNG, YU-LIN; CHEN, CHI-HUI;
 LIU, CHUN-CHENG/ Micro, Meso Mechanical Manufacturing R&D Department

The Treatment Section of the Micro, Meso Mechanical Manufacturing R&D Department independently developed the "Continuous Micro Parts Heat Treatment System Equipment," with modular and intelligent design, innovative heat treatment feeding system, heating furnace, oil tank and collecting device to make the overall material collecting rate up to 100% and the yield rate up to 99%, and won the Bronze Award of 2021 Edison Awards and the 2021 R&D 100 Awards.



Rising Demand for Micro Parts, and Heat Treatment Technology is the core to solve

In recent years, 3C products have been developed towards the trend of being light, thin, small and portable, driving the rising demand for all types of micro parts, ranging from carbon steel screws in mobile phones, small and medium motor shafts or pinions in fans and even precision rotating shafts, probes for minimally invasive surgery and medical testing are all popular micro parts. After the micro parts are stamped and formed, they will be sent to the heat treatment stage in improving the toughness and strength of the metal by uniformly heating the material; the general heat treatment process includes heating, quenching, materials collection, cleaning, tempering steps. However, the micro parts are small and light, using the traditional equipment for heat treatment, it is necessary to be covered with the fine steel mesh to prevent it from wafting around, and it is necessary to accumulate a sufficient amount for processing to fit in with the cost, resulting the materials being stacked together for heat treatment and the materials are prone to have problems of uneven heating, deformation, embrittlement and delayed delivery time, becoming the pain spot in the industry for a long time.





Penetrate into the International High-value Market; Lead the Industry to Speed up the Transformation

In the past, the industry generally outsourced the heat treatment process. With the domestic equipment system coming out, the industry can build a self-management system to speed up operation scheduling and greatly improve the overall production efficiency and competitiveness. At present, MIRDC has transferred related technologies and equipment to Xing Guang Industrial Co., Ltd. which specializes in heat treatment and Sha Yang Ye Industrial Co. Ltd, which specializes in micro-precision motor gearboxes and assist several businesses to improve the heat treatment quality of micro parts, so that they can quickly penetrate into the international supply chain of precision parts, such as Tesla's electric door handles, bearings and gearbox parts; Bosch, Makita gearbox. In the future, it can also be applied to medical machinery, optoelectronic semiconductors, robotic arms, electric car and motorcycle, aerospace, etc., enabling the technology to enter the international high-value product market and speeding up the pace of digital and intelligent transformation of Taiwan's industries.

Independent Research and Development of Module Design, and Four Major Innovations which Improve the Yield

The traditional heat treatment process for micro parts is not only easy to embrittle and break the components, but also have problems of uneven quality, poor materials collection, waste of raw materials and faulty mixing, plus the large oil tank of traditional heat treatment system equipment is not suitable for micro parts and often causes parts to float around and are not easy to be collected, prompting the Metal Industries Research and Development Centre (MIRDC) to speed up and independently develop "Continuous Micro Parts Heat Treatment System Equipment." This equipment is developed for highly complex structures or parts with a diameter of less than 2mm. It adopts a modular system and integrates four major innovative designs of "Automatic Feeding System," "Automatic Monitoring and Real-time Control Main Heating Furnace", "Spiral Funnel Oil Tank," "Improved Material Collection Device" and integrates the oil tank and conveyor belt into one, making the materials collecting rate can be increased from 50~60% of traditional equipment to 100%; the quality yield rate is increased from 50~65% to 99%.

Introduction of Innovative 5G and AI to Customize the Unmanned Intelligent Production Line

Heat treatment processes play a key role in the production process, whether in traditional manufacturing or high-tech semiconductors, electric vehicles and drones. In order to meet the multiple demands of the industries, the Metal Industries Research and Development Centre (MIRDC) has also introduced the latest 5G communication and AI artificial intelligence technology into the Continuous Micro Parts Heat Treatment System Equipment, allowing the industries to customize the special process according to the product or function, quickly and accurately replace the module, and convert the traditional heat treatment experience into data decision-making, analyze the best heat treatment process parameters of temperature and time, control and predict the heat treatment processing quality for the parts. Above bring flexible application and high efficiency, but also reduce the dependence and exploration of human experience, and is beneficial to establish the industry-specific IoT solution. It also paves the way for the follow-up unmanned intelligent production line, assist the industry to build a perfect micro parts production chain, and promote the industries in creating new business opportunities.



Models of Excellence /

Waste Aluminum Saves life, and Circular Economy Creates Business Opportunities

"Foamed Aluminum Inflatable Lifesaving Float" won the 2021 iF Design Award

Winning Team: WU, CHEN-YU; LIN, CHIEN-YU; CHENG, SHENG-YUAN; SHIH, PO-KUN/ Metal Processing R&D Department

The Casting Section of the Metal Processing R&D Department developed the "Foamed Aluminum Inflatable Lifesaving Float" to reshape the value and usability of waste aluminum metal with the concept of recycling and reuse, combining recycled aluminum with patented foaming technology to design a small, light-weight and easy-to-carry life float for multiple types of marine activities and won the 2021 iF Design Award.



Responding to Green Environmental Protection Topics; Innovating Recycling and Renewable Resources

In response to the trend of environmental protection, many major international manufacturers such as automobiles, people's livelihood, consumer electronics, construction and other industries have set sustainable development goals, among them, recycling reuse is a fast and effective measure; how to use waste resources to create high-value benefits is a challenge which is testing the industry's innovative technologies. Aluminum is seen one of the most widely used materials in the metal industry, with waste materials and waste produced during the various processing procedures and the application of recycled aluminum and foamed aluminum has unlimited potential. Therefore, under the support of the Ministry of Economic Affairs MIRDC invested in "Low-pressure Casting Recycled Aluminum Foam Forming and Manufacturing Technology," strived for creating porous metals with the characteristics of being lightweight, capable of absorbing impact energy and soundproofing. The R&D results not only improve the high cost problem in traditional process, but also transform the waste metal into innovative green materials as well as brings high-value circular economy to the industry.



Recycled Aluminum Creates Benefits, and develops Inflatable Life Float

It is important to use innovative green materials to develop products. MIRDC, therefore, developed "Foamed Aluminum Inflatable Lifesaving Float" because of the foamed aluminum's characteristics of being light weight, weather resistant, buoyant in water, and impact resistance. Having a volume of only 1/19 of a traditional lifebuoy, which is convenient for individuals to carry. Simply pull the safety ring and throw it into the water, it will automatically inflate, which increases time of the drowning person to self-rescue in the water. It is suitable for athletes to carry when they are surfing, rowing rubber boats or water skiing. It also increases the number of life floats that the boat can carry, to provide passengers with more safety protection. Taking water rescue as an example, a drone with a load of 15 kilograms can only carry 3 to 5 traditional life floats, but now it can carry 10 to 15 foamed aluminum inflatable life floats.

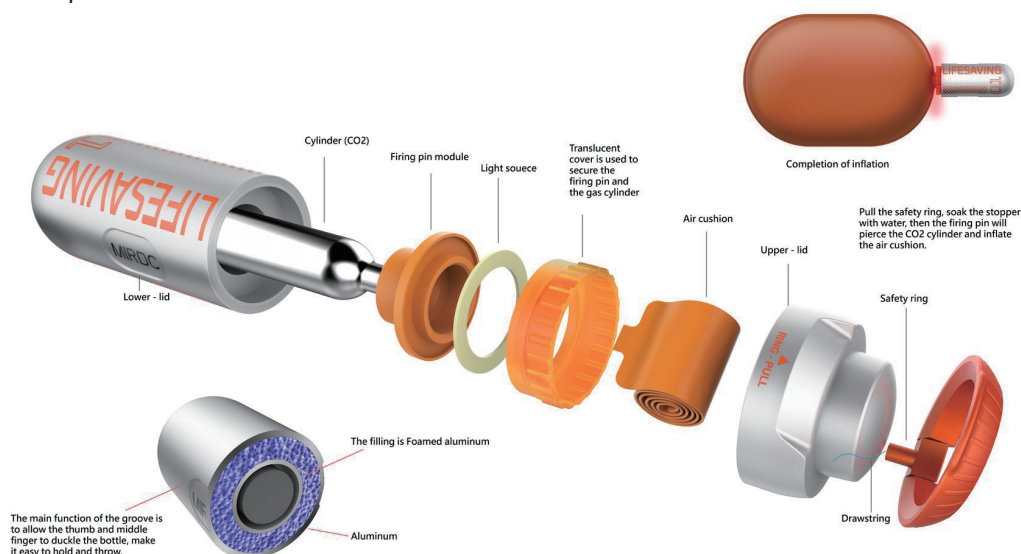
The First Domestic Process Equipment and Possess Patents for the Manufacture of Foamed Aluminum

In the past, foamed aluminum can only be obtained from the powder metallurgy process and assisted by adding a foaming agent of molecular compounds. It requires multi steps production, and is not easy to control the structure of the finished product, resulting in high raw materials costs and low market acceptance. Today, through the Foaming Aluminum Manufacturing Patents of the MIRDC, using the low-pressure casting method for gas injection foaming, and using the aluminum slag/magnesium waste with the pressure regulating and weight device to complete the in-mold filling and forming, which not only lowers the cost, but also increases the foaming rate, makes the foaming more uniform and resolves the disposal problem of aluminum slag and magnesium waste. On the other hand, MIRDC also converges the technology energy to build the first set of recycling aluminum low-pressure casting foam forming process equipment in Taiwan and uses all recycled aluminum (industrial waste aluminum material and waste aluminum bottles and cans from people's livelihood) for foaming manufacturing, not only to reduces the amount of aluminum slag production, but also creates high-value applications of recycled aluminum.



Diversified Applications of Functional Materials in Striving for Promoting the Sustainable Development of the Industry

Since many manufacturers already have the foundation of die casting equipment, the promotion and application in the future can reduce the burden on the industry and promote the wide application of recycled aluminum materials, such as using them in high-value anti-collision parts, with the energy-absorbing effect of foamed aluminum can reduce the reaction force of colliding the vehicle itself, improve the anti-collision damage coefficient of the product by more than 15%, increase the safety and life protection of drivers. It can also be used in high-value anti-vibration electric vehicle parts by filling the foamed aluminum casting pellets in the electric vehicle power module bracket, which can increase the shock absorption effect by 24%. In the future, products of large-area can also be produced and the porous structure of foamed aluminum can be properly used as a functional material for sound absorption, vibration reduction, heat insulation and electromagnetic shielding, such as building sound insulation materials, building fire-resistant materials, building anti-electromagnetic wave materials and machine tool anti-vibration plate, etc., to increase the added value of materials by 5-10 times and promote the industry to a sustainable future with high-value development.



Models of Excellence /

3D Relief Art Work Create Cross-domain Aids for the Visually Impaired

"3D Printing Sand Casting Technology - Application of Aids for the Visually Impaired" won the Time Magazine Best Inventions of 2021

Winning Team:

WANG, CHUN-CHIEH/ Vice President Office

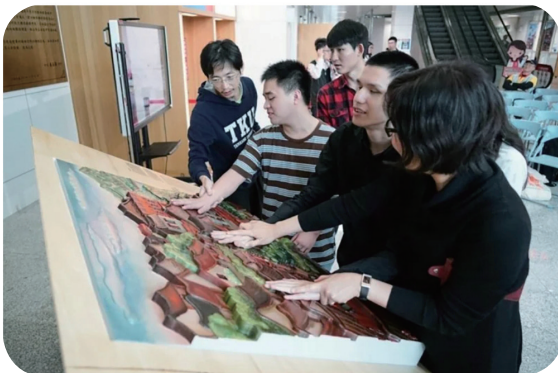
CHENG, PING-KUO; KUO, SHEN-HUNG; TSAI, HAN-LIN; WU, CHENG-PO; LU, CHIH-WEI/ Metal Processing R&D Department

Apply the "3D Printing Sand Casting Technology" to the development of aids for visually impaired, and copy the flat prints into three-dimensional reliefs, helping the visually impaired to appreciate the art works through touch; this technology has the characteristics of simplified working procedure, reproducibility, low cost, high efficiency and high quality, won the 2021 Time Magazine Best Inventions.



Possessed the First 3D Printing Machine and Established the Operations Service Center

In the past, traditional metal product manufacturing methods required working procedures of mold opening, sand mold making, trial production, mold modification and casting and metal molds could only be formed in solid form. The weight of the mold is several hundred kilograms, which is not only many and completed procedures, time-consuming and labor-intensive, but also easily limited in the case of large workpieces or complex shape designs. MIRDC introduced Taiwan's first 3D printing sand mold casting machine in 2016, with the advanced technology that can directly "print" the sand mold for casting, which greatly reduces the mold making time and overcomes the difficulty of machining complex-shaped workpieces and repeated modification of molds. The "3D Printing Casting Sand Mould Operation Service Center" was also established at the same time to assist key industries of casting, machinery, aerospace, automobiles, machine tools, sanitary hardware, ships, etc. The use of 3D printing technology would enhance the independent development capabilities of domestic industries and help enter the global parts and components industry supply chain.



Promoting Cultural Equality for the Visually Impaired and Establishing a Development Program for Assistive Devices

In addition to use the 3D printing sand mold casting technology to assist industries in developing the metal products, MIRDC also strives to respond to cultural equality and social welfare for the visually impaired with innovative technologies. In order to help the visually impaired friends to have a better art appreciation experience, MIRDC has built a development program for visually impaired aids that simplifies complexity, with high efficiency and low cost, to produce a replica of an identical size three-dimensional relief art work of "Tamsui Scenery" by the representative Taiwanese painter Chen Cheng-Po, using the large-scale 3D printing sand mold system combined with the mold-turning method, allowing the visually

impaired to feel the composition and layout of the original painting with both hands and to explore the shape of the house and the sense of space near and far in the painting as much as they like. Among them, in order to strengthen the strength and detail of the sand mold relief prototype, MIRDC also reset the sand material ratio and adhesive control technology and introduced the support design of the sand mold base in creating a brand-new style of industrial cross-domain art work.

One-piece Rapid Molding Helps Solve Complex Shape Gaps

The casting industry is one of the important basic industries in Taiwan. The casting industry has been developed for more than 40 years, creating the prosperity of many metal products including machine tools, sanitary ware and valve bodies. Through the 3D printing type of multi-layer manufacturing technologies, it can promote casting prototypes, model and mold development, widely used in the adhesive spray forming process and casting industry for the industry capable of quickly proofing, innovative proposals, designing complex shapes and using the one-piece rapid molding advantages to reduce the cost of casting molds used in product development, without consideration of draft angle, nor opening a wooden mold, which can effectively shorten the product development cycle and reduce the cost by about 35%, and solve the gap of technical application. Taking the cylinder head as an example, the development of traditional sand mold takes about 23 days. After the introduction of the 3D printing sand mold process, the development of innovative sand mold can be completed in about 15 days, which greatly reduces the time for development.

Provide Development Trial Field and Apply Innovative Technology Research and Development

In view of the fact that 3D printing sand mold casting technology can assist in the independent development of new products, shorten the time for the first sample and win orders, therefore, MIRDC provides the industry a small number and diverse, customizes development and trial fields. So far, MIRDC has assisted Chenta Precision Machinery Industrial Inc., HCP Pump Manufacturer Co., Ltd., All Star Pump Enterprise Co., Ltd., Chia Yi Steel Co., Ltd. and Yisinda Castings Co., Ltd. and other companies to apply advanced 3D printing casting sand mold technology, shorten the schedule and to meet the requirements of new product development in solving the problems of large size and complex shapes of new industrial parts and components. In addition, MIRDC has also independently developed the lightweight stamping molds, using topology analysis and structural lightweight design, integrating the advantages of 3D printing sand molds without shape restrictions and establishing the first sheet metal stamping mold technology, paired with recyclable zinc alloy mold material, to reduce the mold weight by more than 40% and reduce the cost and time schedule more than 25%, to jointly create the casting competitiveness with the industry.



3D PRINTING SAND CASTING TECHNOLOGY

MIRDC'S 3D RELIEF ART WORK IS SELECTED AS A
SPECIAL MENTION IN TIME'S BEST INVENTIONS OF 2021!



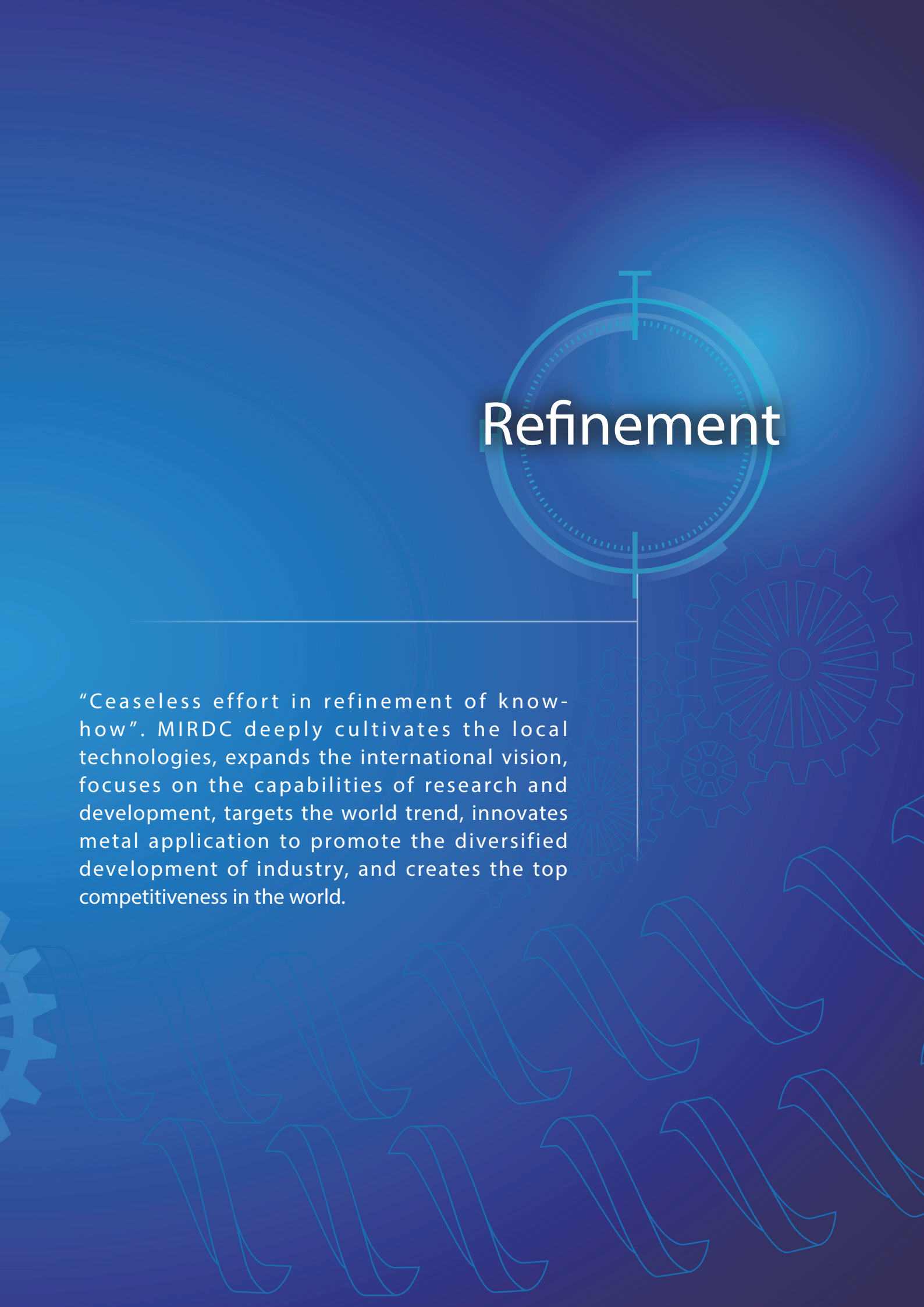


金屬工業研究發展中心
METAL INDUSTRIES RESEARCH & DEVELOPMENT CENTRE



Technology and R&D Innovation

ANNUAL REPORT

The background is a dark blue gradient. In the upper right, there is a circular gauge with a needle pointing to the top. Below the gauge, a vertical line descends and turns left as a horizontal line. To the right of this line, there are several interlocking gears of different sizes. At the bottom of the image, there are several wavy, ribbon-like shapes that look like they are flowing or vibrating.

Refinement

“Ceaseless effort in refinement of know-how”. MIRDC deeply cultivates the local technologies, expands the international vision, focuses on the capabilities of research and development, targets the world trend, innovates metal application to promote the diversified development of industry, and creates the top competitiveness in the world.

Casting Technology

In 2021, we continued our previous research and focused on the development of corrosion-resistant and free-cutting stainless steel materials. In view of the industry's demand for stainless steel materials with high strength, corrosion resistance and excellent processing performance, MIRDC has established the composition alloy design and product manufacturing process. By adding strengthening elements such as sulfur, calcium and cerium, the cutting performance, mechanical strength, and processing performance of the material are greatly optimized, making the quality even comparable to that of leading international manufacturers, which can be applied to 3C precision fasteners and vehicle fasteners, increasing the competitiveness of domestic products.

In the future, it will be focused on the development of high-strength cast iron materials in helping to improve the secondary processing and mass production technology of the industry, optimizing the mechanical properties and machining process performance of materials, and develop the key precision components of the robot arm of automatic control equipment, so as to overcome the gap of the domestic robot industry, reduce the cost of key components, and improve the advantages of the domestic robot and automation industry.

Current R & D Status

1. Development of corrosion-resistant and free-cutting stainless steel material

- The corrosion-resistant and free-cutting stainless steel materials can effectively improve the corrosion resistance and mechanical strength of stainless steel, and extend the material life, which is an urgent need for the industry.
- The mechanical properties are analyzed through the corrosion-resistant free-cutting stainless steel casting and hot forging forming process. The hardness is 176Hv, the tensile strength is 538MPa, and the corrosion resistance is 550 hr without rust. The processing performance is improved by 30%.
- The corrosion-resistant and free-cutting stainless steel materials are comparable to the material properties of major international companies (Nippon Steel & Sumitomo Metal). By replacing imported materials, which can reduce material costs by more than 10%.
- The export value of automotive Fasteners is as high as NT\$200 million per year.



Fasteners for electric vehicles

R & D Technologies in the Future

1. Development of high-strength cast iron materials

- Establish the formulation and heat treatment for free cutting high-strength austempered ductile iron (ADI) alloys, link secondary processing and use-end and other industries with mass production technical energy in developing precision components for automatic control system of manipulators, assisting the transformation of the industry, and enhancing the competitive advantage of the industry.
- Establish technology development for the heat treatment process of free-cutting high-strength austempered ductile iron and improve the mechanical properties and machining process performance of materials, so that the mechanical strength can reach more than 900MPa, and the impact value can reach more than 100J.
- Free-cutting high-strength austempered ductile iron is expected to be used in components for automatic control systems, which can surpass the material properties of major international companies (Harmonic Drive), with moment rigidity >64,000Nm/rad, design life >10,000 h.
- Overcome the gap in the manipulators industry, reduce the cost of precision components, improve the competitiveness of the manipulators and automatic control system industry, and create an output value of more than NT\$200 million.



Crank shaft for vehicle

Welding Technology

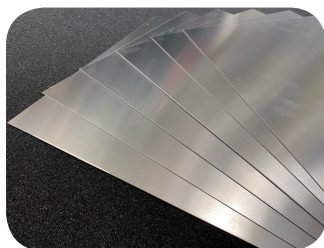
In response to the market's demand for high-strength, lightweight and rapid-welding metal plates, through the interface treatment technology of aluminum alloy and thermoplastic composites and vacuum hot pressing manufacturing technology, the Welding Technology Section of MIRDC has overcome the bottleneck of aluminum alloy weight reduction, completed the hybrid plate with excellent characteristics such as metal texture, high strength, lightweight and recyclability, and developed the high-speed friction stir welding technology of large-area aluminum plates, which greatly improved the welding speed and at the same time enabled the weld bead quality to meet the ISO international specifications, so that the aluminum industry can develop with high value.

MIRDC is committed to digital transformation, and is combining all the existing technical capacity, developing, and establishing digital welding process, integrating laser vision, motion control, welding simulation, heat input analysis and welding procedure planning technology, build digital welding procedure database, realize the visualization and automation of welding process, and achieving intelligent welding and quality control. In addition, the development of high-level welding technology for composite materials and dissimilar plates, as well as the promotion of the development of metal materials will be led towards diversified applications in order to enhance industrial competitiveness.

Current R & D Status

1. Development of metal matrix composite plate

- The development of hybrid laminated materials was carried out in response to the demand trend of high strength and lightweight materials for reducing carbon emission.
- The newly developed aluminum alloy and GFRTTP hybrid laminate is 20% lighter than the aluminum alloy sheet and the elastic modulus is $\geq 60\text{GPa}$.
- It is expected that the newly developed aluminum alloy and GFRTTP hybrid laminate will be applied to the housing of 5C products, which show the excellent characteristics of metal texture, high strength, lightweight and recyclability.



Hybrid laminate

2. Development of large area aluminum plate friction stir welding technology with high speed

- Corresponding to the application trend of lightweight aluminum materials for electric vehicles and the demand for high-quality joining, the development of large area aluminum plate friction stir welding technology with high speed has been carried out.
- The technology can increase the welding speed of large-area aluminum materials by 20%, the quality of the weld bead meets the requirements of the ISO 25239 international standard, and the welding variation is controlled within $<1.0\text{mm/m}$.
- It is expected that the newly developed technology can be applied to electric vehicle components and 5G signal measurement device products and overcomes the welding defects and deformation problems of aluminum alloy products, and promotes the application of high-value products of recycled aluminum materials.

R & D Technologies in the Future

1. Welding Technology for Recyclable Thermoplastic Composites

- In response to the development of new materials in the circular economy, thermoplastic composite materials have been developed due to their characteristics of recyclability and weldability.
- It is expected that electromagnetic coils are used to induce the heating of carbon fiber composite materials through the design of induction coils and equipment development, and temperature, pressure, time, and other parameters in the welding process of thermoplastic composite materials would be established. The lap shear strength of composite materials reaches over 20MPa .

2. Development of friction stir welding technology with hybrid thick plates

- The development of friction stir welding technology for lightweight and thick plates would be carried out in response to the continuous expansion of the application of recycled aluminum and lightweight aluminum alloy within international car factories.
- It is expected that the analysis technology for friction stir welding heat source, combined with the development of friction stir tools, would be used in comparing and adjusting the actual welding measurement and the heat source value to establish the key welding parameters of different-thickness plates, so that the welding strength of the different-thickness plates after welding can reach over 65% of the strength of the base metal.

Forming Technology

In 2021, the Forming Technology Section of MIRDC mainly developed the manufacturing process of screws, nuts and forging products, and carried out digital transformation for relevant modules and technologies, such as structural optimization of forming machinery and an automatic generation module of design data on forming machinery. This year, we will be continuously researching and developing rapid design and quick trial technology of molds and manufacturing technology of high-performance parts, so as to shorten the design time, reduce process loss and improve the added value and functionality of parts, and assist the domestic forming industry in upgrading and transformation through digital and intelligent systems.

The future R&D will focus on the key technologies of forging die design and process control. At the same time, we will refine the development of digital transformation technology, and give priority to technologies such as automatic generation module of manufacturing data on forming machinery, stamping digital design module and forming virtual and real integration modules. Providing the advantages of fast setting parameters would improve the module output value, decrease the generation time, reduce misjudgment from human experience, and at the same time increase the output, benefit and quality, and greatly lower the production line cost.

Current R & D Status

1. The technology of optimal design for press machine structures

- Introduction of the structural optimization technology into the design of the press machine and carrying out the topology optimization of a single component, thereby enabling the whole machine to reduce the weight of the molding machine by more than 10%, achieving the effect of both structural weight-reduction and added strength.
- For the C-type punch: the weight reduction ratio of the slider is 26%, and the weight reduction ratio of the machine body is 18.6%. H-type punch: The weight reduction ratio of the slider is 15.5%, and the weight reduction ratio of the machine body is 20%.
- It would help manufacturers of press machines save materials, improve structural efficiency, and achieve lightweight when designing large-scale press machines, which can greatly reduce manufacturing costs and increase profits.

2. The technology of smart Cyber-Physical System (CPS)

- The technology of CPS can automatically generate the stamping production schedule from the system integration of information, such as personnel, materials, molds and equipment. The use of digital management in production line is applied from customer order receipt to factory production. The digital management and centralized monitoring of production line information allow real-time reporting of machine and product line status, analysis and prediction to improve production efficiency.
- This technology can be applied in mold & die production lines, such as stamping, electroplating, injection, etc. Intelligent management can offer digital information on the production line, thereby reducing the reliance on human experience, reducing misjudgment, and improving management efficiency and production quality.

3. The automatic generation module of design data for press machines

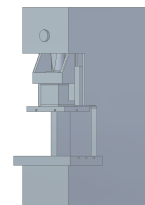
- Assist manufacturers to stylize and digitize experience, so that domestic designers would quickly learn the design method.
- The introduction of optimal design technology of forming machine structure enables the development technology of domestic forming machines to be shortened from 3 months to 1 month, increasing the output value of designers by more than 50%, and increasing the value by 10~20%.



Parameter guidance interface of stamping press



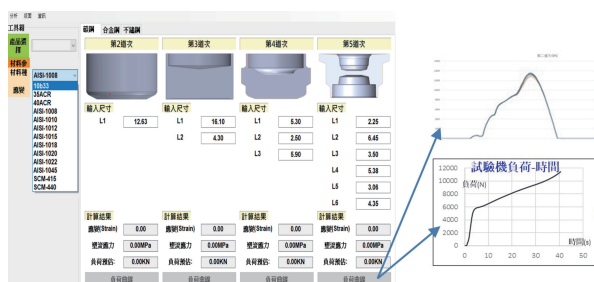
Standard parts library of stamping press



Complete the assembly of the whole press

4. The sensing technology of forming load for screws, and the analysis technology of upper-boundary for nut forming process

- MIRDC assisted domestic equipment manufacturers in establishing the relationships among mold material, geometry and sensor voltage, and obtaining the load curve through the voltage conversion formula, which helps to estimate the mold life. This technology would shorten the time lost during development and reduce costs.
- The rapid evaluation model of forming force is established by the upper boundary method of nut products, and the required load can be obtained after inputting the product size and material properties, thereby shortening the time wasted during development and reducing costs.



The rapid evaluation model of forming force

5. Decision-making technology for the process design of forging products

- In response to the current needs of the fastener industry, a digital aided design system for nut products has been developed to facilitate the establishment of digital design and analysis capabilities for the industry, the industries in this field accelerate their progress in smart manufacturing applications.
- By developing product classification and process design models, the product development time can be reduced by 40% (from 45 to 27 working days, from the beginning of the design to completion of the trial model), and the total development cost can be reduced by more than 10% (die was not repeatedly repaired).

6. Near-Net Shape Forging Technology in Non-Q-T Steel

- By developing Non-Q-T steel material and processes, the near-net-shape forging process could be conducted with the aid of multi-action dies, which would give a high yield rate up to 88%. Take forged non-Q-T steel gear for example; JIS 4 grade with a hardness of HRC 28 could be achieved after cold finishing process. Also, the hardness of non-Q-T parts could reach HRC 56.
- The developed technology could be applied to the manufacturing of transmission gears, hub parts, and knuckle parts. The cost of the manufacturing process could be reduced by more than 10%, accompanying the benefits of carbon reduction and energy saving.



High-hardness gear forgings

7. Rapid tooling technology of conformal cooling channel mold

- Conformal cooling channels in hot stamping dies could be manufactured with binder jetting technology. The manufacturing time of dies could be drastically reduced, which would contribute to the upgrading of business competitiveness.
- Conformal cooling channels with long and slender ceramic core could withstand the thermal impact from 8MPa molten iron at 1600°C. Hot stamping dies made by this technology are suitable for small batch try-runs, with advantages of 40% cost reduction, and 40% process development time reduced (50 days to within 30 days).
- This technology is suitable for processes in need of high thermal dissipation capability, or performing in-die quenching action, such as hot stamping, casting, and injection molding processes.



Sand mold with high slenderness ratio of the inner runner



8. The technology of high-strength aluminum alloy warm forming process

- Warm forming processes for 7xxx aluminum alloy is developed and verified by the manufacturing of door beam parts. It could overcome the dilemma that high strength aluminum parts could not be manufactured by a cold stamping process. The parts manufactured by warm stamping process could achieve a dimensional accuracy within ± 0.6 mm, and an ultimate strength up to 85% of that from 7075-T6 plate under room temperature.
- The newly developed high-strength aluminum alloy parts (warm/hot formed parts) are mainly used in lightweight components in the transportation industry; it is estimated that more than 30% of the weight can be reduced, in addition to the economic benefits of recyclable materials.



Trial production results of 7xxx aluminum alloy parts

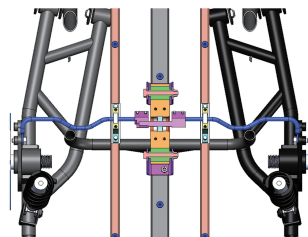
9. The technology of forming and simulation for laminate sheet components

- Laminate sheet made by aluminum sheets and glass fiber thermoplastic composite material sheets are adopted in the manufacturing of 3C parts. The manufacturing process combines a hot pre-forming stage and an edge radius adjusting process. The manufactured laminate sheet is free of crack and wrinkle defects both on the corner site and edge site. An edge radius of R 2 mm was formed, without the delamination phenomenon found on the deformed sheet, which could meet the requirement of 3C products.
- The simulation model of hot forming process for laminate sheets is established. The model contains 4 layers of sheets and 3 interlayer boundaries, and the simulation accuracy of hot forming process using this model could be above 78.59% (thickness reduction ratio, springback angle, etc.)

10. Development and verification of flexible components of trailing arm

Design and Development of Flexible Rotary Bracket for Suspension

- With the flexible rotary mount, vertical input force becomes rotational moment, which reduces roll angle variation.
 - According to ISO 4138, the lateral acceleration limit is increased by 41%.
 - Mounting Flexible rotary mount: the maximum limit value of lateral acceleration is approx. 3.99 m/s^2 .
- Vibration reduction platform for delivery vehicle
- structure contains: 1. Flexible carrier - absorbs lateral deflection; 2. Air spring - absorbs vertical vibration; 3. Concentric turntable - absorbs rotation.
 - Factory regulations (ADVIA) and ISO 7401 are used to verify the load, and the vibration reduction value is $\geq 30\%$.
 - 19.1dB lower amplitude.
 - Measurement of real vehicle: the minimum vibration reduction value is $\geq 30\%$, and the maximum is 76%.



Design and Development of Flexible Rotary Bracket for Suspension

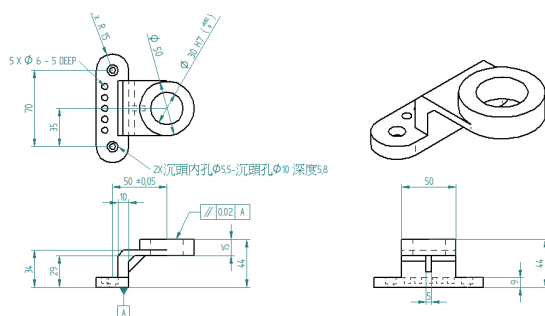


Vibration reduction platform for delivery vehicle

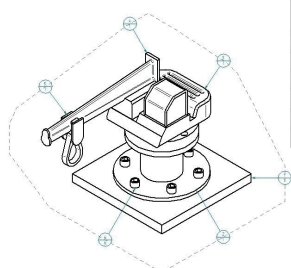
R & D Technologies in the Future

1. The automatic generation module of manufacturing data for press machine

- Assist manufacturers to stylize and digitize experience, so that domestic designers can quickly learn the design method.
- The introduction of optimal design technology of forming machine structure can be shortened from 4 months to 1 month, increasing the output value of designers by more than 60%, and increasing the added value by 10~30% for the development technology of domestic forming machines.



Automatic preparation of engineering drawing

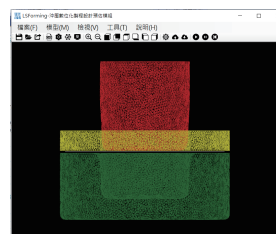


BOM automatic generation

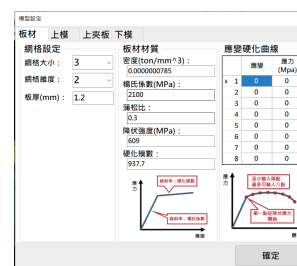
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2	底座		1
3	吊車座		1
4	吊臂聯成		1
5	吊環		1
6	螺絲		6

2. The development of digital design module for stamping process

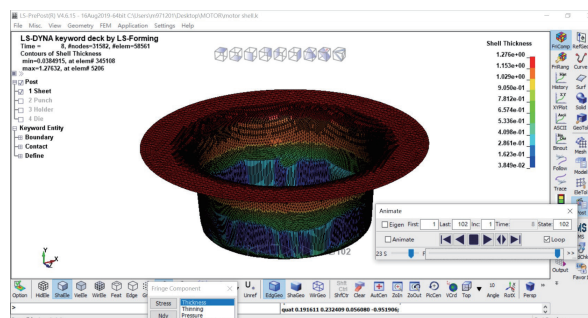
- Although CAE technology of the stamping process is developed and used in Taiwan, the design and optimization of stamping process are still made based on human experience or intuition.
- Users can quickly set conditions and parameters of CAE for the stamping process in this module, such as: CAD file of punch and die, material, stamping speed, etc.). It can reduce the time of learning and adjusting CAE software parameters for engineers.
- For the case of drawing process, the maximum thinning rate of blank thickness can be $\leq 20\%$; and for the case of stamping and forging process, the dimensional accuracy of workpiece can be ≤ 0.05 mm. The efficiency of die design and development can be increased by 36% (from 14 days to 9 days).



Module operation interface (main screen)



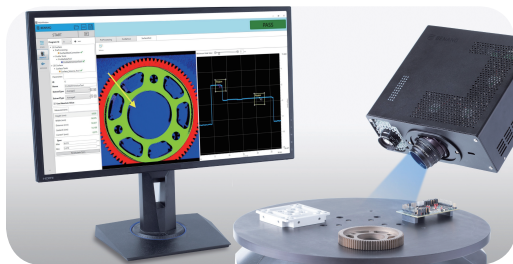
Module operation interface (model setting)



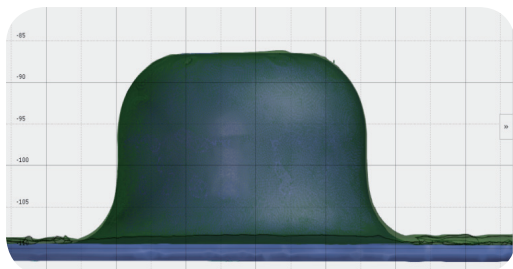
After the module is set, it is directly imported into CAE software for analysis

3. Forming virtual and real integration module

- At present, most of the main inspection work on the manufacturing industry is carried out by contact measurement method, and some require the production of precise inspection and jig and must be prepared with quite complex pre-work.
- This module can reversely scan the object to be measured into dense point-cloud data with 3D-scanning technology, and then use the convenient comparison function to automatically analyze and display the results, so that inspectors can grasp the quality in time.
- Through the comparison function of this module, engineers can adjust the mold & die with some information, so that the comparison error between the final design of mold & die and the actual processing result is $\leq 10\%$.



Use 3D scanning device to scan the appearance contour of formed parts and obtain point-cloud data



Compare the virtual and real results and judge whether they are OK or NG (Green Point Cloud: actual 3D scanning contour / Blue entity: CAE analysis results)

4. The expert system of forging die design

- To develop expert systems for forging die design, which can help domestic and foreign companies improve their R&D capacity to cater for small quantity, high diversity and flexible design products, and enhance their competitiveness by entering the field of smart manufacturing.
- To lower the barriers for traditional industries to enter the high added-value markets, provide independent R&D capabilities with technology-oriented design principles, and enable manufacturers to establish their own product knowledge bases, thereby enhancing the production and manufacturing capabilities of complex and customized products and encourage manufacturers' willingness to return home.



Interface diagram of forging die design expert system

5. The key technologies in grain of target

Semiconductor targets are all imported from abroad, and key materials are restricted by the US & Japan. It is important to establish an independent production technology for targets, and the fine crystallization of target is one key point. MIRDC will get the ingots from the manufacturers, and analyze the key parameters of processes by CAE, including radial forging, equal channel angular extrusion, and the thermomechanical recrystallization process. Then MIRDC will combine the actual processes to verify the results, and finally establish a semiconductor target that meets the needs of the industry.



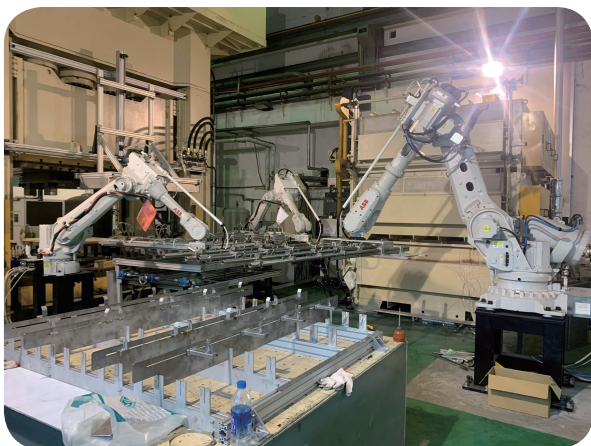
Schematic diagram of in grain of target

6. Technology of incremental sheet forming

Given that the domestic industry is facing problems of high cost and long delivery time when manufacturing a batch of sheet product, we aim to convert product 3D CAD into punch path data via the digital path control technology and establish a code that can be read by CNC processing equipment or robotic arms, to progressively form the sheet metal parts.

7. Warm/Hot Forming Process Technology for High-strength Aluminum Alloy

The warm forming process of medium-strength aluminum was developed in 2021. Research on the warm/hot forming process for heat-treated high-strength aluminum alloys will be continued. Meanwhile, the hot forming process for heat-treated high-strength aluminum alloys, which combines forming and heat-treatment process will also be studied in the future.



Warm / hot forming of high strength aluminum alloy
Schematic diagram of demonstration site

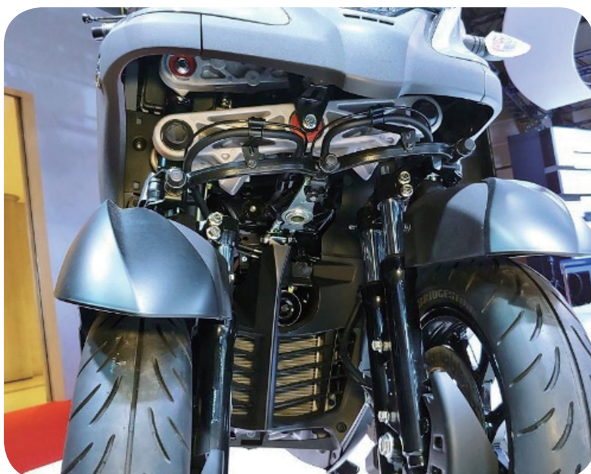
8. Forming Process Technology for Laminate Sheet Components

To define the out-of-line heating of the embedded antenna hybrid sheet according to the formability ($140^{\circ}\text{C}\sim 200^{\circ}\text{C}$) of aluminum sheet and glass fiber composite sheet at different temperature ranges, as well as the upper limit of high temperature damage of electronic components (below 220°C). The temperature ($180^{\circ}\text{C}\sim 200^{\circ}\text{C}$) is elevated in a box furnace to avoid softening and deformation of the antenna substrate (PCB). In order to maintain a suitable forming temperature ($160^{\circ}\text{C}\sim 180^{\circ}\text{C}$), a thermoforming die with variable die temperature, auxiliary heat and low thinning rate is designed to reduce the temperature drop caused by the contact of the mixed sheet with the die surface during the forming process, so as to avoid the reduction of the formability of the aluminum sheet layer, or the curing of the resin between the glass fiber layers leading to the rupture of the sheet and the glass fiber.

9. Terrain adapted suspension system for niche vehicle

In response to the application requirements of niche vehicles in multi-terrain fields, MIRDC will conduct the research on adaptive suspension systems with high handling characteristics, steering stability and safety. For different vehicle types with different wheelbases and different load capacities from different car manufacturers, MIRDC will provide complete development services to meet the special use environment.

- The body roll angle changes between $20^{\circ}\sim 25^{\circ}$ (load 200 kg to empty weight)
- Adjustable suspension dampers and shock-absorbing platform
- Load 150 kg; it can withstand 30 kgf side thrust statically
- According to ISO 4138, it can withstand 0.1 g lateral force, travel direction angle offset $\leq 10^{\circ}$



Schematic diagram of niche vehicle configuration

Surface Treatment Technology

The core of this year's processing technology research is roll-to-roll coating technology, which is applied in optoelectronics, energy and packaging materials for the civil industry. At the same time, the Centre will break through the bottlenecks of previous roll-to-roll equipment for photoelectric application and carry out functional designs and coating module changes, aiming to establish a domestic independent coating material production line for satellite application.

The Centre also focuses on long-life mold surface composite treatment technology by emphasizing the R&D of stamping/ hot forging/ die casting; micro continuous heat treatment equipment can solve the heat treatment problem of micro parts; the special hardening technology of Austenitic stainless steel will be applied to scratch prevention, self-tapping screws, high-pressure gas joints, and so on.

The future R&D will focus on the establishment of high-speed coating GFS technology and high-pressure gas quenching vacuum carburizing technology, so as to break through the sputtering rate, solve problems that manufacturers must reserve processing dimensions and make correction after heat treatment for motor vehicle gears, axles, knives and molds, as well as achieve the goals of low deformation, stable dimensions and reducing subsequent processing by controlling the gas cooling rate.

Current R & D Status

1. Roll to roll PVD equipment

- To protect the satellites' exposed surfaces from the damage caused by energetic particles and radiations in the space environment, protective coating materials with high-reflectivity are developed to apply on PI films used on the sensors of satellites.
- The developed high-reflectivity Al materials were coated on PI films by sputtering process, giving optical absorptivity of $\alpha < 0.44$ and reflectivity ratio > 0.71
- The developed roll to roll equipment has double-sided coating function.



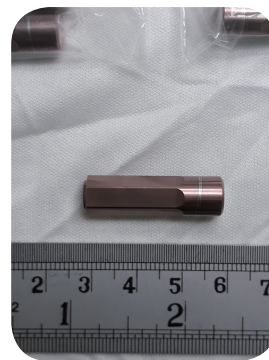
Roll to roll PVD equipment



Coating material for the sensors of satellites

2. Long-life duplex surface treatment for mold & die

- Due to the development and application of new and high-strength materials, mold & die tend to operate under severe conditions. MIRDC develops duplex surface treatment to further extend the lifetime of mold & die.
- When the developed nitriding without white layer duplex TiAlSiN high wear resistance coating surface treatment technology applied to produce punches, the process yield increased by 16.7% compared to CVD process.
- When the technology was applied to the punches for hand tool sockets made of SCM440, the lift-time of punches increased by 24.4% (5100 times).



Screw punch



Punches for hand tool socket

3. Special hardening processing techniques for Austenitic stainless steel

- Development of a special hardening treatment technology for Austenitic stainless-steel surface in response to the market demand for wear-resistance and scratch-resistance of the food-grade Austenitic stainless steel.
- Via special nitriding, carburizing or carbonitriding technology, the optimal depth of the nitriding layer is obtained, and the surface hardness is maintained at Hv0.1 800~1000.
- It is expected to be applied to decorative products; the surface hardness can be increased by more than 5-fold. It can also be applied to food processing equipment, and the service life is expected to more than double.



Equipment for special surface hardening of Austenitic stainless steel



High-value tableware.
(DOUXTEEL)

4. Continuous heat treatment system for micro components

- Patented material receiving mechanism; the fine parts are easily scattered in the oil tank during quenching due to their small size and light weight. The unique technology of the equipment design of this mechanism can increase the material collecting rate to >99%.
- Quenching furnace temperature uniformity $\pm 2^{\circ}\text{C}$; tempering furnace temperature uniformity $\pm 1^{\circ}\text{C}$
- No need to wrap the mesh, has uniform hardness and low deformation
- Customized modules can be equipped with quenching furnace, quenching tank, cleaning tank, tempering furnace and visualized module configuration according to customer's process requirements.
- Establishment of process parameter database and optimization of parameters. Through intelligent module, optimized parameters and optimization process were established from a large amount of process data.



The Continuous heat treatment system for micro components

R&D Technologies in the Future

1. Gas flow sputtering technology

- MIRDC will apply the principle of hollow cathode glow discharge to establish high deposition rate coating technology.
- The developed gas flow sputtering technology will be applied to diversified material systems to develop ceramic, magnetic material and other functional coatings with wear, corrosion and oxidation resistance.



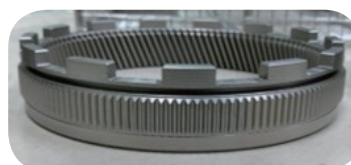
The gas flow sputtering technology

2. High pressure gas quenching and vacuum carburizing heat treatment technology

- The high gas quenching pressure is 20 bar, which is a pollution-free and green gas quenching method friendly to the environment.
- Controllable gas cooling rate for reducing the deformation of the workpiece and can be designed with different stages of cooling rate to meet the customized workpiece.
- Vacuum process technology for blocking other gas influencing factors; features good thermal uniformity.



High-pressure gas quenching and vacuum carburizing furnace



gears

Mold & Die and Micro-machining Technology

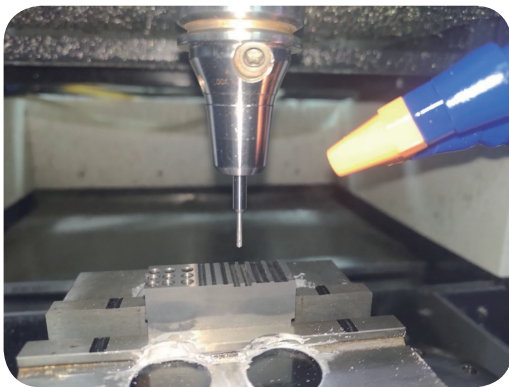
In 2021, R&D was conducted for satisfying the needs of the mold industry, aerospace component manufacturing and medical industry, including high-grade manufacturing of tungsten steel mold, value-added service of processing equipment and cloud smart module as well as surgical image navigation. In addition, in response to the demand of high-level precision manufacturing and industrial intellectualization trend, key technologies, such as advanced manufacturing and precision medical technology development have been invested; database construction technology was used to reduce the process gap, increase the advantages of cloud computing, and meet the new generation of intelligent transformation.

In terms of future research, the MIRDC will continue to move towards intellectualization, digitization and high value. Based on the needs of the industry, we will provide precision manufacturing technology APP of traditional and non-traditional processing technology and establish a decision support system to optimize and standardize the processing module. At the same time, the MIRDC is also committed to improving medical and pharmaceutical technologies. It is expected to flip the traditional treatment and give medical treatment new opportunities through the development of transcranial magnetic stimulation system technology, the development of innovative process mass production system with high uniformity microspheres and the preparation system of drug sustained-release carrier.

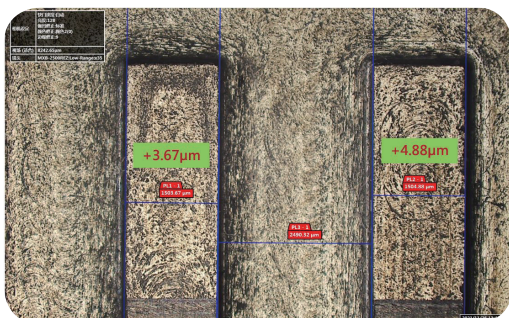
Current R & D Status

1. High-grade manufacturing of tungsten steel mold

- Established the development of tungsten steel direct milling processing technology to improve the machining quality of tungsten steel molds; with surface roughness $\leq R_a 0.093\mu\text{m}$ and featuring machining accuracy between $-1.2\mu\text{m}\sim+7\mu\text{m}$.
- Through FEM cutting simulation analysis, the design and production of PCD tools with optimized angles for tungsten steel machining were completed, and the actual machine cutting test showed that tool life was improved by $>33\%$ compared with the general-purpose tools on the market.



PCD tool machining status



Processing quality of tungsten steel mold

2. Value-added services of processing equipment and cloud smart modules

- Established a database construction technology for cutting process characterization, which supports three-axis simultaneous process identification, and has 3 categories of classifiers (process, tolerance, path planning weight), classification accuracy $\geq 90\%$.
- Established a digital model of processing vibration, which can provide the first six sets of natural frequencies and amplitudes of the machine; the verification error of the actual machine is less than 10%, enabling users to avoid resonance frequencies during processing and improve processing quality.



AE sensor and fixture



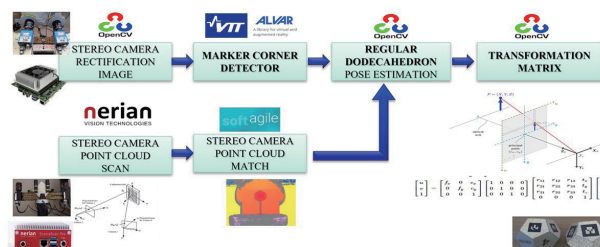
Signal amplifier and PICO capture card box

3. Surgical image navigation

- Development of 6DOF posture space technology: including the development of binocular vision and far and near field architecture Mutile-Markers 6DOF module, and the introduction of SVD matrix decomposition algorithm and point cloud real-time recognition algorithm to optimize the 6DOF posture space accuracy, which can simultaneously identify 10 sets of geometric spheres, refined to achieve pre-positioning accuracy of $\text{RMS} \leq 1 \text{ mm}$, and update frequency $\geq 40\text{Hz}$.
- Development of a scanning probe trolley system with real-time spatial positioning: including integrated high-speed grating real-time scanning probe and light source system for adapting to the compact space of an operating theatre; probe size $\leq 750 \times 200 \times 200 \text{ mm}$, range $\leq 1000 \times 1000 \text{ mm}$; resolution $\geq 12\text{Mpixels}$, update rate $\geq 60 \text{ FPS}$, projection resolution $\geq 2\text{K}$.



A scanning probe trolley system with real-time spatial positioning



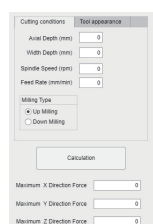
The development of binocular vision and far and near field architecture Mutile-Markers 6DOF module

1. Micro-lubrication processing module technology for difficult-to-cut molds

- According to the needs of different use targets, we aim to provide a precision manufacturing APP for traditional and non-traditional processing technology, establish a decision support system, and integrate difficult-to-machine / difficult-to-form alloy processing process sensing modules to establish a standardized evaluation procedure for the goal of stable optimization and precision manufacturing of molds.
- To establish a processing technology for the cutting process with auxiliary oil mist lubrication, lower the technical threshold for domestic manufacturers to enter MQL auxiliary cutting, accelerate the improvement of production quality and yield, and strive for new orders with high added value.



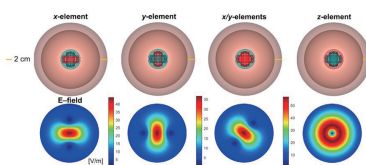
Micro-lubrication processing module technology for difficult-to-cut molds



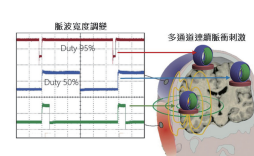
Prediction and analysis of cutting force

2. The development of transcranial magnetic stimulation system technology

- Multi-channel 3-axis coil technology developed with XYZ-axis stereotaxic coil and multi-array coil configuration for precise focus and high energy output in small areas. No need to change treatment coils. Advantages: 3-axis inter-sensory modulation for simultaneous treatment of multiple affected areas, and multi-channel small diameter ($<50 \text{ mm}$) coils for rapid integration of MRI OPMs for immediate post-treatment measurements.
- Development of multi-pulse modulation technology; the multi-channel treatment mode is in line with the new generation of i-TBS/c-TBS treatment mode, with IGBT high power technology to generate fast pulses with short pulse intervals ($<10\text{ms}$ pulse interval).



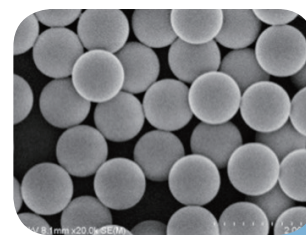
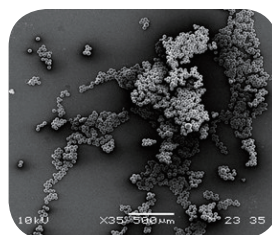
3-axis coil design configuration and CAE analysis simulation



Multi-pulse modulation technology

3. Development of innovative mass production system for microspheres with high uniformity

- Development of a new generation of microsphere mass production and preparation system, combined with ITRI's OEM factory production and after-sales service for long-term cooperation with biotechnology factories.
- At present, we mainly develop innovative technologies for microspheres, drug sustained-release and long-acting carriers, and development of biomedical-grade mass production equipment. Subcutaneous tissue injection (carrier particle size $25\sim 50\mu\text{m}$) or skin delivery (carrier particle size $400\text{nm}\sim 1\mu\text{m}$) can be used. Designed for immediate release or controlled release delivery systems for up to several months, this technology is mainly used for cosmetic delivery products, medical beauty needles, etc.



Development of innovative mass production system for microspheres with high uniformity

Precision Mechatronics and Automation Technology

In 2021, our research continuously focused on the development of equipment and technology for intelligent manufacturing, including the technology for robotic arms combined with 3D visual automatic and the generated path record by the field action, complex curved surface metal forging pick-and-place technology, high speed inspection equipment technology for passive components, AI safety monitoring in petrochemical industry, intuitive capture module, and intelligent automatic shoe roughing and cementing technology, etc. Moreover, the Centre also assisted the plumbing industry in developing smart manufacturing.

In addition to using upgrading technologies such as 2D, 3D and AI, we also integrated equipment intelligent perception and information networking to ensure process safety and product quality, and to avoid errors easily caused by manual operation and recording; in response to the needs of industrial electromechanical integration and intelligent manufacturing, we provide various precision electromechanical and automation technology services to meet the transformation trend of industrial intelligentization.

We also assisted domestic industry in introducing robotic arm cells in traditional industry and the 3D laser surface level difference measurement of electro components to provide key module technology to fill the gaps in application, thereby increasing the home-made rate of high-value equipment, promoting unmanned manufacturing in traditional industries and decreasing the frequency of public security in petrochemical industry. In the future, the R&D will focus on intelligent robot and manufacturing application by using an AI system and advanced catalyst center AI security monitoring system, also delve into the integration of intelligent systems at the same time.

Current R & D Status

1. Intelligent robot and manufacturing application by using AI system

Soft material manufacturing technology by using robot technology - shoemaking process action learning technology

- The intuitive processing motion capture module applied 3D digital information and AI learning technology. It implements robot arms on the production line.
- The processing motion accuracy is less than or equal to 0.5 mm.
- This technology improves the machine efficiency about 25%.

3. High-speed chip strip inspection equipment

Inspection technology for high-speed image defects

- Inspection speed up to 50 images per second (depending on inspection items).
- Inspection items include: appearance, shortage, flipping, rotation, scratch, breakage, character code, etc.
- Mixed light inspection technology for RGB three-color light source.



AUTO VC high-speed inspection equipment

2. Automated 3D laser optical inspection equipment

High precision 2D+3D image inspection technology

- The high-precision 2D instantaneous measurement technology uses the mixed light detection technology for RGB three-color light source and has a measurement accuracy of $\pm 2\mu\text{m}$.
- The measurement technology for 3D laser surface level difference has a measurement accuracy of $\pm 2\mu\text{m}$.



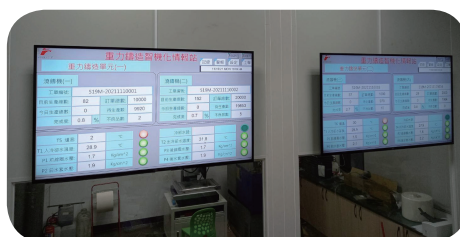
Automated 3D laser optical inspection equipment

3. Establishment of smart machinery information station for gravity casting

- Facing the trend of industrial intelligent transformation, in order to assist the upgrading of the smart manufacturing capacity of the plumbing industry, the "Establishment of Smart Machinery Information Station for Gravity Casting" is carried out.
- Production line networking and production management visualization technology were introduced to achieve machine networking, which can upload production information such as the temperature of copper water in the melting furnace, the temperature and pressure of cooling water, the number of workpieces produced by the casting machine, and abnormal alarms. These information are displayed on sign or smartphone in real time, avoiding errors that are easily caused by manual operations and recording.
- The establishment of the information station has contributed to an increase of about 15% in production quality, and an increase of about 14% in output value. At the same time, it also solves the problems of lack of labor and technology inheritance, and deepens the technology related to the casting process, thereby upgrading the plumbing industry to be in line with the international trend of smart manufacturing technology.



Gravity casting site



Information station electronic sign

R&D Technologies in the Future

1. Intelligent robot and manufacturing application by using AI system

- Soft material manufacturing technology by using robot technology - additive manufacturing motion capture integrated system
- Soft objects block deformation estimation technology is established.
- Collaborative robotic arm with gripper and manufacturing technology: The multi-layer aligned accuracy specify less than 10 mm with deformable area of 800 mm*600 mm.
- Additive gluing force control technology: The effective laminating area is larger than 70%. The reproducibility of force control deviation is less than 10%.

3. Intelligent system integration Scheme for big data analysis of plumbing parts manufacturing process

- In response to the development trend of smart manufacturing in the plumbing industry, the development of intelligent system integration scheme for big data analysis of parts manufacturing process is carried out.
- It is planned to develop a smart system integration solution for big data analysis of parts manufacturing process, which will have process data visualization and automatic storage capabilities.
- By using intelligent technologies such as process big data analysis and feedback to replace the judgment of manual experience, it is possible to detect abnormal signs of the process in advance, eliminate possible problems in the machine, and establish high-quality production control technology.

2. Advanced catalyst center AI security monitoring system

- The goal of this system is to use RFID and AI intelligent image recognition technology to monitor the status of personnel wearing safety gear in the workplace, assist in industrial safety management, and reduce the risk of personal injury.
- We will use RFID tags to embed various safety equipment, including helmets, goggles, portable gas detectors, etc., to detect whether the wearing status of personnel when entering and leaving the control area meets the operating standards.
- Finally, the artificial intelligence-based image recognition system is used to manage the digital fence in the control area and locate the location and behavior of the operator.
- In addition, the system can issue warnings and notify the control center for relevant event processing to ensure the safety of on-site personnel in the event of abnormal personnel behavior.

Inspection Technology

In 2021, the scope of R&D in inspection technology included improving the quality of domestic die-casting, design development and verification in the valve industry, as well as inspection technology for energy storage systems and offshore wind farm technology. In terms of die-casting products, we developed in-mold sensing modules and steel surface residual stress testing and analysis technologies to help improve the manufacturing process of vehicle, aerospace, and machinery industries. In the future, we will promote the domestic casting and forging industry to high value through industrialization of testing and process linkage technologies.

For the valve industry, we have established measurement technology for flow control valves, and provided structural design verification for various products such as ball valves, ball plug valves, check valves, butterfly valves, balancing valves, and pressure reducing valves to promote export competitiveness. In the future, we will add performance testing technology for flexible stainless-steel fittings and tubing products to help improve the performance and tolerability of new fittings and tubing products and promote the sustainable development of the industry.

MIRDC is also dedicated to energy-related inspection technologies and has set up an energy storage system safety test laboratory to provide international standard performance tests for electric vehicles, and to build a safety environment for lithium battery storage and electric vehicles. On the other hand, the government's offshore wind energy policy has now entered the actual construction stage. The Centre also assists the Bureau of Standards, Metrology & Inspection of the Ministry of Economic Affairs in establishing an independent testing and certification system to promote the localization of key components and improve the quality and efficiency of the domestic offshore wind energy industry.

Current R & D Status

1. Product Measurement and Certification Technology for Control Valves

- In response to the design and certification needs of the valve industry, we have established the development of CV measurement technology for flow control valve products
- The developed ISA 75.02 control valve CV measurement technology can enhance the design of control valve products and provide the structure design for testing control products. The volume flow rate (gallons per minute) is measured when the pressure difference is 1 psi.
- It is expected that the newly developed CV test measurement equipment can improve the certification efficiency of product performance by more than 20%.
- The new CV measurement equipment can also be applied to other pipeline fluid control products in the future, which is expected to improve product quality by more than 15%.



CV flow test equipment



Control valve product development

2. Mold Sensing System for Pressure and Temperature Measurements of Injection Molding Process

The technology involves the conversion of pressure/temperature into electrical signals to obtain state changes during the in-mold molding process, and through direct information combined with quality standards (bubbles, shrinkage holes...), an AI quality prediction model is established to achieve full product quality inspection.



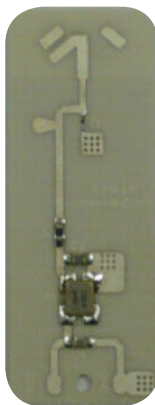
In-mold signal acquisition module

3. Radio Frequency Positioning

The development of a radio frequency positioning module this year consists of positioning with 8 radars, RF circuitry improvement and embedded hardware computing module. Tags with angled dipole antenna of 10 IDs, trolley for 8 radars, positioning algorithm for signal shielding, and embedded computing module are built. The accuracy of RF positioning is better than 1.5 mm and the positioning rate is 30 Hz.



Integrated microcontroller 24GHz Radar



Dipole antenna locator

4. Analysis technology for residual stress on curved steel surface

The technology consists of integrated portable residual stress measurement equipment and curved surface analysis model to construct a detection and analysis module for curved surface residual stress. The measured radius of curvature is between 1.5 and 25 mm, resolution is 0.1MPa, and accuracy is less than $\pm 3\%$. The residual stress analysis has the ability of surface and plane analysis to solve the problem of undetectable and excessive error of steel sample shape. This technology can be used as one of the detection and analysis frameworks for product anomalies, and can be applied to industries such as vehicles, aerospace, and machinery manufacturing.



Residual stress on curved steel surface

5. Inspection Technology of Energy Storage System

- In response to the need for energy storage and industrial policy promotion, MIRDC has established a 360kW/360kWh energy storage testing laboratory. In addition to being a third-party verification unit, MIRDC can also assist manufacturers to improve product design and meet regulatory standards.
- We held 11 review meetings of national standard exposure drafts and assisted in programming 5 of the exposure drafts.
- We also held 2 public engineering procurement cases (including the turn-key project procurement case, manufacturing supervision service procurement case).



Energy storage testing laboratory

6. Upgrading of offshore wind testing and certification equipment

- In 2021, we established the offshore wind testing and certification for 10 different types of equipment, including four types of large-scale fastener test equipment, high-level non-destructive testing system, image recognition system, ANSYS software extension with fluid-structure interaction numerical analysis module, and SESAM software which analyze the fixed underwater structure of offshore wind turbines.
- Regarding new equipment, we have also established corresponding standard operating procedures and technical capabilities to strengthen the independent testing and certification capabilities of offshore wind energy.



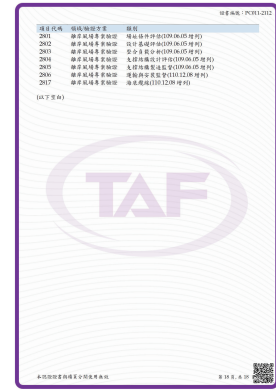
Large-scale fastener test equipment



High-level non-destructive testing system

7. Accreditation for additional wind farm project certification modules

- The certification body passed the TAF accreditation in 2019 for 5 wind farm project certification modules (site conditions assessment, design basis evaluation, integrated load analysis, support structure design evaluation, and support structure manufacturing surveillance), taking the lead in becoming the first offshore wind farm certification body in Taiwan.
- We continuously establish capabilities to complete the whole project certification modules target. Therefore, "Cable design evaluation", "Cable manufacturing surveillance" and "Transportation and installation surveillance" modules passed the TAF accreditation on December 15, 2021.



Certificate
Wind field verification module

R & D Technologies in the Future

1. Performance testing technology for flexible joints and pipe fittings

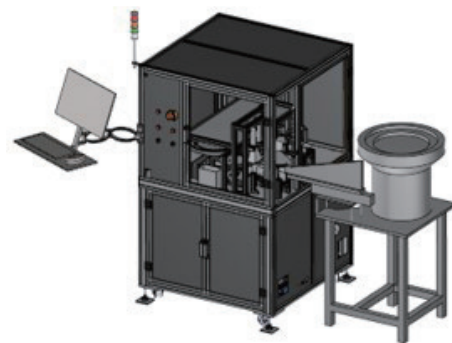
- In response to the design and certification needs of the industry, we will create the product performance testing technology for flexible stainless-steel joints and pipe fittings.
- The development of performance testing equipment, such as internal pressure repetition and tensile testing can improve the design of flexible joints and pipe fittings and provide certification of the maximum resistance to the pullout of the structure under normal pressure.
- It is expected that the newly developed product performance testing equipment for flexible stainless-steel joints and pipe fittings can improve the efficiency of product performance certification by more than 25%.
- The new product performance testing equipment for flexible stainless-steel joints and pipe fittings can also be applied to other joints, pipe fittings and pressure vessels in the future, which is expected to improve the product quality by more than 15%.



Product development for flexible stainless-steel joints

2. External defect detection applied to smart identification technology

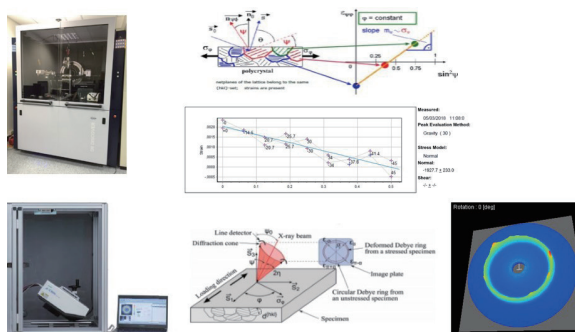
In response to the AI intelligent detection and high-value development of fastener products, the need for full inspection of external defects and the introduction of intelligentization will increase, and image detection will be combined with AI discrimination applications. The AI automatic defect recognition technology combines real-time digital images to collect big data. It is estimated that the AI module discrimination rate is $\geq 90\%$ and the detection speed is ≤ 400 pcs/min, which can improve detection efficiency.



Screw appearance inspection machine

3. Residual stress detection and process technology

In response to the demand of the domestic casting and forging industry to gradually increase in value, the development of residual stress detection technology and the linking process are used as factor analysis for abnormal characteristics. Surface stress can be measured and integrated with process parameters to establish quality standard indicators and life analysis indicators. It can also be applied to vehicles and aerospace products in the future; it is estimated that quality and process improvement technologies can be developed.



Residual stress analysis diagram

4. Inspection Technology of Energy Storage System

- Provide industries with complete and rigorous testing energy including electrical safety of the product, environmental safety, mechanical safety, and other testing verification with service platform.
- Shorten the time between product testing and product launch and accelerate process for the industry to enter the international market.
- Integrate technical capabilities and professional background of personnel to cultivate technical verification talents in the energy storage industry.

5. International Cooperation in Offshore Wind Farm Project Certification

MIRDC, CR (Classification Society), SOIC (Ship and Ocean Industries R&D Center), TERTEC (Taiwan Electric Research & Testing Center) and the international certification body DNV formed a Taiwan Offshore Wind Project Certification Alliance in July 2020. January 2021, DNV and Alliance members began contact with EPC FOXWELL to negotiate the Project Certification business of the Taipower offshore windfarm. Through DNV experience guidance and local members' capabilities, this cooperation case will carry out project certification starting from the site conditions assessment module all the way through to wind farm completion, covering all of the modules. The real offshore windfarm certification will help establish real case experience and improve all member's capabilities.



Test validation cases

6. Demonstration case of testing and certification of key components of offshore wind energy

Offshore wind energy is an emerging industry in Taiwan.

Currently, there are only 2 offshore wind farms operating during these 2 years in the Taiwan Straits. There is still a lack of practical application and opportunities for on-site testing technology and verification implementation. Therefore, the testing experience and long-term parameters related to operation and maintenance are still insufficient.

Thus, coordinating with multi-organizations to negotiate with offshore wind farm operators to promote the implementation of demonstration or real cases, is very significant to the development of standards and testing procedures. It will assist the operation and maintenance industry chain to localize.



Verifying international cooperation

Management Technology

In 2021, management technology focused on optimizing enterprise products, system verification technology and innovative services. In order to optimize product manufacturing, develop intelligent monitoring technology of equipment and machines, achieve early fault warning and visualization, improve production capacity, and reduce unexpected fault downtime, in the future, MIRDC will combine 5G, AIoT and AR applications to complete remote cooperation guidance of metal products industry, guide novices to maintain and repair equipment, and solve the problem of replacement of equipment components in traditional manufacturing industry.

In terms of system verification technology, we will continue to improve the verification services of management systems such as ISO and TOSHMS, and develop QMS of domestic medical devices, foreign QSD and other verification technologies in accordance with the special law of medical devices of the Ministry of Health and Welfare, so as to ensure the safety and efficacy of medical devices. In addition, we also focus on mechanical safety verification capacity development and construction activities in order to ensure the safety of workers through international compliance evaluation procedures. In the follow-up, we will develop machinery and equipment risk management technology.

In terms of innovation service, we are committed to accelerating the upgrading and transformation of industrial value chains, using smart manufacturing serial equipment, software and systems to provide complete smart manufacturing factory tools, promote the deployment of digital base, innovate business model management (cross-sector alliance / virtual and real integration), enable small and medium-sized enterprises to form a cross factory smart production interconnection system, and speed up the transformation of Taiwan enterprises. In the future, we will develop greenhouse gas management tools to help enterprises keep track of their carbon footprint and emissions.

I. Innovative service

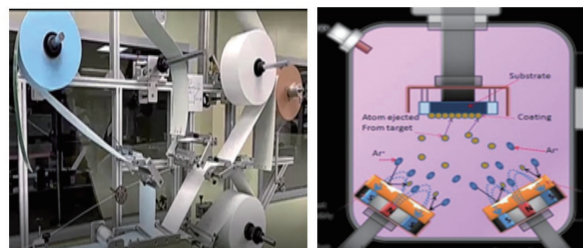
Current R & D Status

1. The ecosystem of recycled artworks

- The car and motorcycle parts dismantled in the recycling yard are transformed into products or services such as furniture, home decoration, installation art, event curation, and other products or services through the remanufacturing technology of artisans and craftsmen. It also embodies ideas of education, entertainment, food, handcraft, customization and so on. Cooperative partners can also be gradually expanded by craftsmen, and recycled items can also be gradually spread by vehicles, so as to create a more diversified business model of circularity.
- The project involved 31 SMEs, invited 15 creators or related professionals, gathered five key professionals, completed field copywriting and cooperation models, and developed 7 extreme works and 10 artworks or services remade from recycled materials.

2. The potential ecosystem of innovative masks and manufacturing

- The COVID-19 epidemic has driven a huge global demand for medical-grade masks and other anti-epidemic materials. Faced with the pressure of global competition for medical materials, products with short lifecycles, diverse and small quantities, and fast delivery, we focused on producing masks from antibacterial and antiviral materials. The technology uses second-generation intelligent production and online testing, automatic packaging, information monitoring systems, and presents digital results in VR or situation rooms, creating Taiwan's high-value mask competitiveness.
- The project drove 16 SMEs, assisted in matching nurses associations, manufacturers, and marketers for cooperation, designed 8 innovative masks and epidemic prevention products, and improved the business opportunities of innovative anti-epidemic masks for daily use.



Silver-Copper-Titanium sputtering technology

3. The tea industry value system

- In Taiwan, the younger generation does not want to enter the tea industry, resulting in the slow progress of the digital process, and all quality relies on the masters' experience and know-how. Therefore, this plan used the raw material process evaluation system, an inventory tracking system, temperature and humidity monitoring system, integrated digital/cloud technology, Internet of Things, and mass analysis to promote the digital tea product quality industry chain, stabilize the flavor quality, and trace the quality of mass production.
- After the digital transformation, the time-cost of product inventory reduced by 10%, the quantity of poor raw materials due to dampness was reduced by 9%, the safety stock and material shortage rate reduced by 10%, while the number of employees was increased, including tea testing personnel and digital system maintenance personnel. It will be used as a demonstration and verification in the future, and the experience will be copied and extended to the coffee industry.

4. The plastics value system

- In the plastics industry, the old equipment and highly manual operation have resulted in poor quality and efficiency. Therefore, this plan developed an assembly platform, imported a visualization module, established an abnormal real-time display mechanism, and used intelligent manufacturing and assembly chain equipment in the system.
- The on-site self-inspection rate was promoted to 100%, the yield rate increased from 98% to 99.5%, and the derived international orders increased by nearly 50 million NTD. In the future, machine technology will be introduced and improved to increase the operating capacity of local smart production lines.

R&D Technologies in the Future

1. Management tools development for greenhouse gases

- To assist SMEs in quickly calculating Categories 1 to 6, the interface design of this inventory tool was designed with simple fields for selection and filling. After completing the filling, emission data and charts can be generated, allowing organizations to grasp the proportion of emissions, and the estimated emissions can also be used as the basis for organizations to establish base year data.

II. System certification

Current R & D Status

1. Management System Certification Technology

Continually providing clients with the best certification solution of ISO management systems in response to the enhancement of domestic industry's awareness for corporate sustainable operation.

- In addition to obtaining the ISO 45001 occupational safety and health management system accreditation from TAF, MIRDC is one of the first two certification bodies that have been accredited the TOSHMS certification scheme by TAF and approved by the Occupational Safety and Health Administration, which can assist corporates to improve their performance of occupational safety and health management.

- Continually improving certification technologies of ISO 9001, ISO 14001 and other management systems. Also, to assist corporates to meet international standards and deepen the international competitiveness of the industry.
- More than 580 clients were certified and 893 certificates issued.

2. Product Certification Technology

To establish product certification and inspection capabilities according to ISO17065 and ISO17020 accredited by TAF and obtain product certification qualification according to governmental regulations.

1. Machinery safety certification and testing organization designated by Ministry of Labor
 - Product certification of automatic voltage reducing device.
 - Product certification of fork lift truck and hydraulic aerial cage.
 - Product certification of lathe and milling planer machine and grinder.
2. Establishing the factory inspection technology for H-type steel, galvanized steel pipe products of Bureau of Standards, Metrology & Inspection, M.O.E.A.

3. The Development of Medical Device Certification Technology

MIRDC establishes the certification technology in response to the Medical Devices Act of Ministry of Health and Welfare.

- Improve the QMS inspection technologies of domestic medical devices manufacturers.
- Improve the QSD reviewing technologies of imported medical devices manufacturers.
- Establish the inspection technologies for imported high-risk medical devices manufacturers.
- Establishing inspection techniques of GDP on medical device dealer.
- Make plans for the Medical Device pre-warning system.

R & D Technologies in the Future

1. Certification Market Development

- Develop the certification business of children's playgrounds of the National Education Administration to improve the safety of children's playgrounds.
- In response to the deterioration of climate change and the need for digital transformation of enterprises in the post-epidemic era, the certification field will be developed towards ISO 50001 Energy Management Systems, ISO 14064 Greenhouse Gas Verification, and ISO 27001 Information Security Management Systems.

2. Risk Management Assessment Technology for Machinery and equipment

- MIRDC developed risk management assessment technologies for machinery and equipment in accordance with the international standards to improve the safety of the machinery and equipment also ensure labor safety.
- MIRDC researched and introduced international standards for machinery safety, promoted machinery and equipment safety protection concepts and technologies, and developed safety strategies required for risk assessment.

III. Management

Current R & D Status

1. Enterprise overall competitiveness enhancing consultation

- The innovative operation guidance for servitization of the manufacturing industry.
- Management performance analysis and strategic planning (including balanced score card).
- Enterprise excellent management benchmark consulting.
- Mittelstand, Taiwan Excellence Award, consulting of Rising Star Award.

2. Enterprise process management digitization value-added services

- Setup of Business Process Re-engineering (BPR)
- Setup of Global logistics Management (GLM)
- Collaborative Design Management (CDM)
- Setup of Product Data Management (PDM)
- Setup of Customer Relationship Management (CRM)
- Supply Chain Management (SCM)
- Setup of High-integration Mold Operation Smart System (Hi-MOSS)
- Mold Design Knowledge Navigation System (DNS)
- Power Project Management (PPM)

3. Big data analytics

- Platform for intelligent business operation data management
- Forging force in-line quality prediction model technology
- Internet of machines and data visualization technology
- Bearing wear analysis and lifetime prediction technology
- Equipment predictive maintenance technology
- 5G AR auxiliary equipment precise maintenance technology

R&D Technologies in the Future

1. Assisting corporates in creating a new situation by technology application and innovative transformation: realizing customers' expectations and industrial innovative operation to establish the paradigm model and demonstration site also assist the corporates in upgrading and transformation

- Applying data acquiring and analyzing method, tracking priority industries and companies, also identifying new products and new technologies by industries, as well as conducting public opinion analysis to support operational decision making.
- Achieving the goals of quality improvement and intelligent operations by offering AIoT smart manufacturing solutions such as process quality forecast, diagnosis for equipment faults, prediction of cutting tool wear and data visualization in intelligence rooms
- Enhancing AIoT smart manufacturing solutions with a combination of local 5G network and AR technologies and offering value-added services in 5G AR auxiliary equipment precision maintenance and factory walk-around inspection.

Food (Biotechnology)

Equipment Technology

To facilitate diverse processing of agricultural products, MIRDC developed vacuum microwave drying equipment, which was not only applicable to the drying process, but also able to assist businesses in the fishery industry and various food and biotech industries in carrying out related promotion and trial production. In addition, food processing history technology was also developed. Mastering process records can not only enable effective management of process quality, but also provide a complete process history, which is beneficial to the export market opportunities. GOLDEN REALM Company and MIRDC built coffee mixing and stirring equipment in 2022. With the low temperature extraction process and equipment technology, the distribution and dissolution between coffee and water was greatly improved. We assisted the vender to develop a cold brew espresso instant drink product that differs from traditional coffee products and has a strong aroma. The new product has reached a million turnover on the fundraising platform.

MIRDC will focus on the development of processing technology and equipment of agricultural products to shorten the time of food baking and roasting and even heating, as well as assist businesses in establishing a ripening environmental monitoring system, which monitors environmental gases and controls temperature and airflow, so as to deliver consistent quality and ensure the best time for sale. In addition, we will work on the development of a seamless capsule molding process and equipment technology in the fields of health food, cosmetics and medicine.

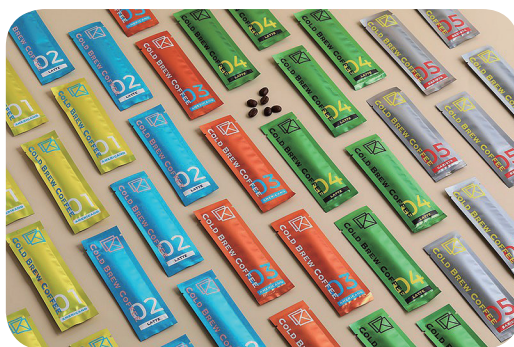
Current R & D Status

1. Low temperature extraction process and equipment technology

- The technology is developed with a special low-temperature process to completely extract the functional compounds from Chinese herbal medicines and other substances, while retaining the aromatic components.
- With the rapid filtration system, the product achieves solid-liquid separation, and molecular vibration is performed, which greatly improves the flavor and taste of the product, and effectively increases the concentration of the extraction. This method can be widely used in the food industry.

2. Food processing history technology

- Facing the safety of food processing and export marketing, the history record of the processing helps to manage the production process and control food safety.
- MIRDC assisted manufacturers in establishing processing records, automatically recording the conditions and status of each processing, and avoiding manual record problems.
- Mastering process records would not only allow effective management of the process quality, but also provide a complete process history, which is beneficial to the export market opportunities.

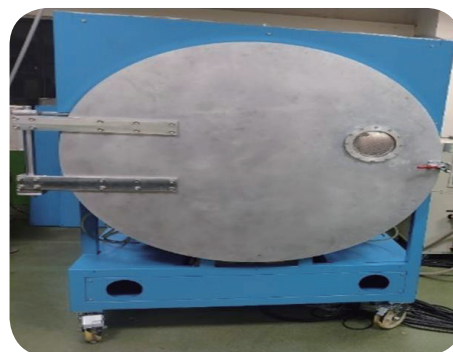


Instant drink of cold-brew espresso

3. Vacuum microwave drying equipment technology for rapid dried fruit production

- The vacuum microwave drying equipment is the combination of vacuum microwave drying equipment and new product manufacturing process technology using vacuum and microwave technology. And through the cooperation between the university and the research institute to verify the actual equipment manufacturing process and new product development, so as to confirm the energy efficiency of the equipment and product quality.
- The equipment can achieve rapid heating water removal efficiency through the characteristics of low boiling point of water under vacuum and microwave penetration heating characteristics. In the process development, in addition to the drying process for fresh fruits, it also can implement drying process for related processed food, so as to achieve the R&D of new product production technology.
- This technology completed product and process verification for various fruits, and had good performance in process time and production energy consumption. In the future, it can not only be used in the drying process of various agricultural products, but also will be combined with aquatic products and

all kinds of food biotechnology companies to carry out relevant promotion and production testing, and put the R&D results into industrial application, and effectively improve the product added value of domestic agricultural products and other related food industry.

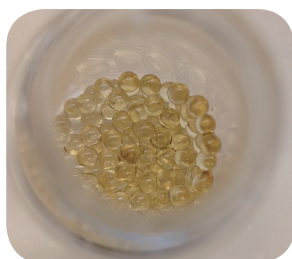


Vacuum microwave drying equipment technology for dried fruit

R&D Technologies in the Future

1. Seamless capsule molding process and equipment technology

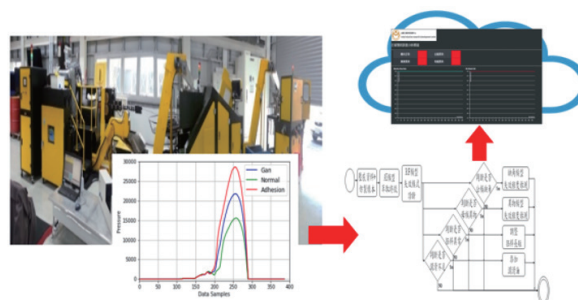
- The seamless capsule was made of gelatin; it can encapsulate oil or water solutions. This technology enables liquid material to be converted into solid, protects functional activity, prevents nutrient loss, and increases absorption efficiency.
- The seamless capsule could be widely used in health food, cosmetics and medicine.



Seamless capsule products

2. Agricultural product ripening control technology

- The agricultural product ripening control is complicated, which will affect the uniformity of agricultural product aging and the time to market.
- We will assist manufacturers to establish a ripening environmental monitoring system, monitor the environmental gas of agricultural products, and control the temperature and airflow to avoid artificial judgment from affecting the ripening time.
- Mastering of the ripening records will not only enable effective management of the process quality, but also fully control the ripening process, which is beneficial to the export business opportunities.



Status Analysis Module of Forming Equipment

3. Compound vacuum microwave drying system

- The compound vacuum microwave drying system continued the further refinement of past vacuum microwave techniques, on food drying process through vacuum microwave technology can effectively solve the problems of traditional baking process time and occupation of equipment. Compare with the traditional hot air drying process method, the drying process time can effectively shorten 25%. However, hot inside and cold outside heating characteristic of microwave heating make the outer layer of some dry products appear soft and wet characteristics, so adding compound baking will be able to solve this problem, so that the applications of equipment technology toward a more diversified development.
- Although the vacuum microwave drying technology developed in the past solves the dilemma that the heat cannot be effectively transferred to inside caused by the traditional surface thermal diffusion drying equipment, such as hot outside and cold inside and external excessive drying. However, in the process of equipment verification and product development, we found that there are many foods with soft inside and crisp outside taste requirements. In view of this, we combine the traditional infrared baking function again to solve the problem of interference in the combination of related equipment and technology, and achieve the best taste demand of food through the way of internal and external synchronous heating.
- It can be used in all kinds of food drying process. It also has the utilization benefit for other plastic, chemical and pharmaceutical material manufacture procedures.

Optoelectronic System Technology

The R&D focus in 2021 was deepened in intelligent manufacturing technology, including data collection, equipment condition monitoring, process quality monitoring, digital positioning technology, size measurement digital spc (statistical process control), artificial intelligence technology, network technology, cloud computing, sensing technology, AI optimization technology, etc. Those applications improved industrial process efficiency, reduced product defects, and accelerated industrial application.

Based on data, we aimed to build an intelligent production model, equipment and management process, and to connect design, production, and service in series, so as to reduce costs, improve manufacturing efficiency, optimize quality and experience, and promote the progress of the industrial environment. In the future, we will focus on optical positioning technology and software engineering, ripening control technology for agricultural products, standard support tools for the cloud industry and ALD/ALE for semiconductor process applications to control the process time, improve the precision and reduce errors.

Current R & D Status

1. The development of 3D real-time positioning and compensation methods for orthopedic surgery

- In order to improve the problems of large orthopedic surgery incision, high radiation and unstable operation, orthopedic surgery robots have been introduced into the operating room. At present, medical precision positioning technology products mainly rely on foreign systems (mainly Canadian NDI system provider) for independent product integration and development, whose important technical features are optical probe and infrared positioning module consisting of a reference frame embedded with a reflector ball. The huge cost of consumables and the limitation of system integration greatly limit the space for independent development. This technology will provide domestic medical positioning system owners with an independent and complete optical RF composite positioning system to replace the Canadian NDI system and increase the market share of independent positioning systems.
- This technology integrates the multi-directional marker pattern recognition algorithm through self-developed precision positioning technology, converts the image coordinates to WCS coordinates by using the transposed matrix, calculates the 6DOF directional spatial coordinates (XYZ axis, coordinates), and completes the transposed matrix algorithm to establish and coordinate the fusion method. The concept of primary and secondary coordinates is introduced into the stereo coordinates, and the spatial coordinates of the primary coordinates are projected through the surrounding secondary coordinates when the primary coordinates are blocked. The spatial coordinates of the main mark are calculated instantly by the spatial surface quadrangular sub mark detection technique.
- MIRDC developed 3D point cloud 3D visual positioning technology, including: (1) real-time image positioning system GUI and spatial marker blind spot attitude detection module combined with 6DOF attitude algorithm with imported primary and secondary marker real-time recognition algorithm; (2) 3D point cloud scanning and segmentation module, embedded point cloud pre-processing module and pose conversion module, integrating self-developed 6DOF blind spot-free pose calculation to achieve final positioning accuracy of $\text{RMS} \leq 2 \text{ mm}$.

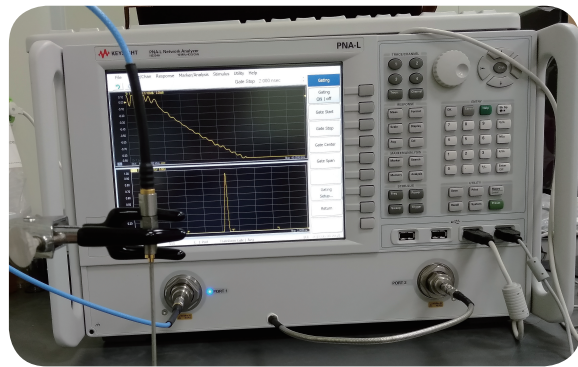


Real-time positioning system and GUI interface

2. Non-contact ultrathin metal radio frequency detection technology

- MIRDC innovates the non-contact ultrathin metal radio frequency detection technology demands, and develops a high frequency antenna sensor with operating frequency: 1-10 GHz, response performance > -30dB.
- This technology could be applied to measure the metal film properties, such as 5G PCB, 5G silver paste, the detection of fasteners' surface characteristics and the detection of the depth of heat treatment.
- Using the technology can obtain the real-time product metal surface characteristics and heat treatment resolution, it's not necessary to do the offline check and can significantly increase the yield. In conjunction with the control system can improve the controllability of process.

This radio frequency detection technology can be used in fastener industry, steel industry, automobile component industry, etc. It is obviously helping Taiwanese metal related manufacturers in smart manufacturing.



Development of non-contact ultrathin metal films detection technology

R&D Technologies in the Future

1. Optical positioning technology and software engineering

- We refine the multi-marker positioning module technology for 3D composite positioning, develop a Multi-Markers 6DOF module with binocular vision architecture, and import SVD matrix decomposition algorithm and point cloud real-time recognition algorithm to achieve spatial marker blind spot attitude detection. We also integrate the embedded 3D point cloud pre-processing module and the optimized point cloud segmentation and classification algorithm and feedback to the navigation system to achieve the final positioning mechanism and refine the positioning accuracy to $RMS \leq 1mm$.



Positioning system for surgical navigation

2. Ripening control technology for agricultural products

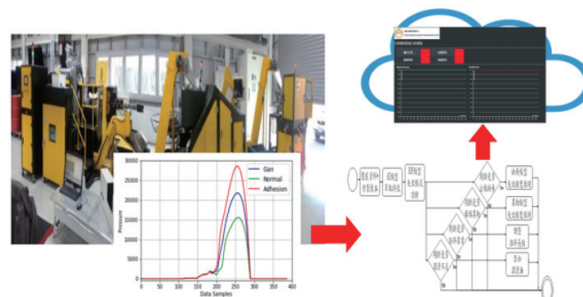
- The ripening control of agricultural products is complicated; it will affect the ripening uniformity and the time to market of agricultural products. We assist manufacturers to establish a monitoring system of ripening environment, monitoring the environmental gas of agricultural products, and controlling the temperature and airflow to avoid artificial judgment from affecting the ripening time.
- Mastering the ripening records will not only allow effective management of the process quality, but also fully control the ripening process, which is beneficial to export business opportunities.

3. Standard support tools for the cloud industry

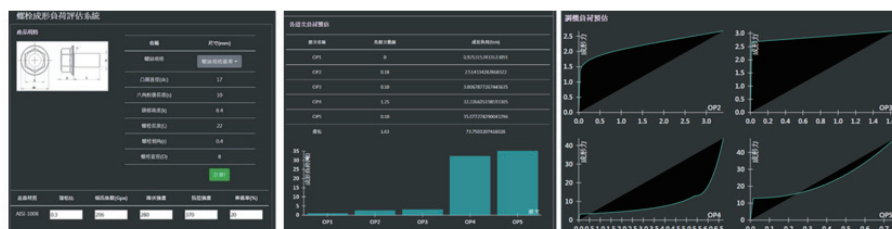
Heterogeneous Cloud Integration System (Metal Fastener Cloud and Smart Machine Cloud): The following three metal fastener cloud SaaS modules will be connected to the Smart Machine Cloud shop-in-shop (MIRDC Zone) in accordance with the Smart Machine Cloud standard, and banners will be provided for advertising rotation on the Smart Machine Cloud:

- **Smart Mold Adjustment Guide Module:** With optical assistance and through a fixed process and small amount of sample data, the user is guided through the mold adjustment process via the WebUI interface, reducing operational errors and effectively shortening the mold adjustment time by at least 50%.
- **Molding equipment status analysis module:** It can be used with cloud computing for model development, training and dispatching, and applied to the ground for data collection and model analysis to identify abnormal events to achieve the goal of real-time monitoring of the molding process.

- **Rapid mold design evaluation module:** It can input adjustable parameters such as specifications, materials, and dimensions of each process through the Web interface, and produce mold forming load and mold stress strain for each process for user evaluation reference, which can reduce the mold test time of fastener molds by about 50%.



Status Analysis Module of Forming Equipment



Rapid mold design evaluation module

4. ALD/ALE for semiconductor process applications

- The feature of the developed atomic layer deposition (ALD) technology equipment is that it has a square cavity design that can carry substrates with different morphologies and integrates atomic layer deposition (ALD) and atomic layer etching (ALE). This functional innovation is combined in the same cavity; coupled with the technology of room temperature coating, it can be applied to the surface modification, surface etching (roughness) of compound semiconductors, electronic components, micro light-emitting diodes (Micro LED) and other products. The key process of improving and surface protection, and the completion of these three technologies in the same equipment can effectively reduce product contamination, thereby improving reliability and yield.
- In the future, it will cooperate with Taiwan compound manufacturers to develop surface defect treatment and repair technologies, novel precursor materials and product verification platforms. The equipment and foundry markets for semiconductors and Micro LEDs are also laid out simultaneously, and they will be applied to the third-generation semiconductor GaN and SiC materials, as well as heat dissipation materials and new packaging technologies, so as to effectively improve reliability.



A single cavity equipment with the atomic layer deposition (ALD) and atomic layer etching (ALE) double processes

Medical Devices and Healthcare Technology

In 2021, MIRDC developed medical devices and healthcare technologies for smart orthopedic surgery, group physiological monitoring devices, and bone defect repair products. Through assistive technology, MIRDC integrated positioning and image navigation with robotic arm applications to meet the rising demand for precise surgery, improved displacement accuracy, and shortened image alignment time. We will further integrate the robotic arm to provide a complete and stable surgical assisting system for clinical use.

In terms of group physiological monitoring device technology, MIRDC developed wearable devices, integrated physiological monitoring bracelets and communication modules, and used the Health Internet of Things (HIOT) as an application to meet the demand for physiological measurements in various environments. At the same time, we developed a user-friendly cell phone App software to facilitate independent health management by the public, which can be applied in places such as senior living communities, nursing institutions, and marathons.

MIRDC has also focused on the development of bone defect repair products by freeze-drying molding technology to produce flexible collagen/ceramic composites. It can be used with liquid to achieve arbitrary shaping effect and self-hardening after filling, which is suitable for filling many types of bone defects.

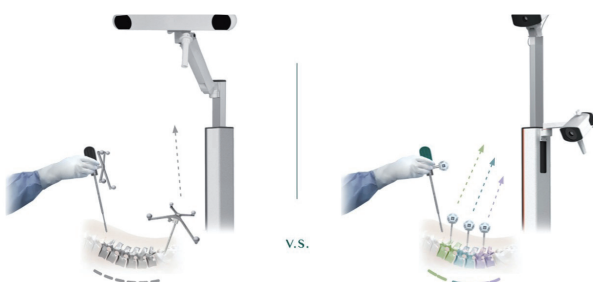
Current R & D Status

1. Multi-vertebral navigation technology

- The development of multi-vertebral navigation technology aims to improve the quality of spine surgeries for the aging population in the society and the need for new high-grade medical devices.
- The error of automatic image segmentation and registration of the spine is under 0.5 mm in less than 120 sec.
- During a surgical navigation, the technology aims to save more than 50% of the time performing image registration and reduce C-arm fluoroscopic radiation by 80%.
- The technology can also be applied to trauma reduction and neurosurgery, in which the estimating accuracy is beyond 95%.



Multi-vertebral image guided surgical assist system



Real-time correction of surgical vertebrae information

2. Development of Surgical Assisted Robotic Arm System

- The increasing clinical demand for precision surgical assistance systems has led medical material manufacturers to seek system support, such as navigation /positioning and surgical robotic arms.
- The intraoperative adaptive position compensation algorithm uses the mutual distance and attitude between the auxiliary manipulator base and the patient to obtain the corresponding transformation matrix and drives the manipulator to reach the target position. The calculation speed is 0.036 s, and the system linear positioning accuracy RMS= 0.75 mm.
- A prototype conversion technology is developed for relocation of virtual and real surgical environments. The cumulative loss function after training was 0.018, and the cumulative number of training sessions was about 250. The average achievement rate of the end displacement of the surgical-assisted robotic arm gripper was maintained at 100%, and the average displacement time was 16 seconds.



The real environment of the robot arm intelligent path

3. Group physiological monitor system

- LoRa wearable device

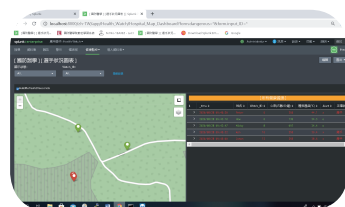
The basic specifications include LoRa communication and information transmission, bluetooth connection through the APP of smart phones, time display, battery display, and other functions. Physiological measurements include body temperature, steps, heart rate (PPG), etc.

- Group physiological monitor system

The background development of the group physiological monitoring system has been completed which includes the main system program and system operation manual. It can receive the LoRa bracelet measurement data uploaded by each LoRa gateway, manage group physiological measurement information and location information through the Web Management System, and establish a database system in achieving the purpose of personnel safety control and health management.



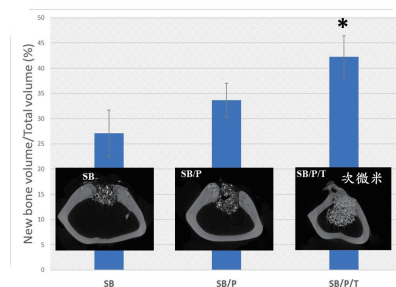
LoRa Gateways
group health data collection



Group physiological monitor system

4. Development of ceramic sub-micronization technology

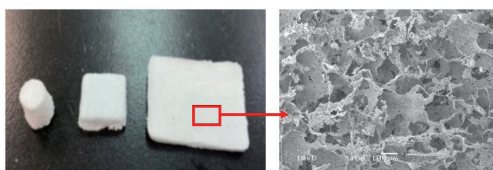
- In order to improve the absorption efficiency and poor bone growth efficiency of clinical bone substitution, the sub-micron ceramic powder with biological activity can be obtained by adjusting the size of ceramic particles.
- The average particle size of the sub-micronized ceramic can be reduced to 0.556 μm , D50=0.445 μm .
- The differentiation and mineralization ability of sub-micronized ceramic powder is increased by about 40% and 30 % respectively, compares with the larger particles. After three months of implantation in animal experimentation, the proportion of new bone formation is about 20% higher than that of traditional bone graft.
- Sub-micron technology can be widely used in the food industry and cosmetics industry in the future, which can improve the powder refinement efficiency by about 15%.



New bone growth volume after 3 months
of implantation in animal experiments

5. Development of collagen/ceramic composite scaffold molding technology

- The doctor can arbitrarily shape the bone substitute during the operation since the bone substitute exhibits the characteristics of plasticity and flexibility. Therefore, the development of the collagen/ceramic composite scaffold technology will be carried out.
- The developed compounding technology can shorten the time of ceramic dispersion and collagen cross-linking by about 50% and ensure mixing uniformity by maintaining the variation rate of stirring shear force at <5%.
- Collagen/ceramic ultrasonic cross-linking and dispersion technology can improve the dispersion efficiency of ceramic particles in collagen solution by 20%.
- This technology can also be applied to slurry mixing and chemical reaction in the future, and it is estimated that it could save more than 10% of the operation time.



The surface of the collagen/ceramic composite
exhibits a porous structure after molding

6. Development of hydration hardening technology for collagen/ceramic composites

- In orthopedic clinics, the bone block needs to be cut due to its fixed shape, but a bone block is also brittle, so it is not easy to fill complex defects. After the bone graft is filled, there is no attachment point and it is easy to disperse. Thus, a double-agent bone substitute has been developed to achieve the initial curing function while filling the defect.
- After mixing A the collagen/ceramic composite, and the special formula by MIRDC, which can be hardened within 15 mins and maintain porosity of 50~70%. In addition, its compressive strength is >3 MPa.
- It is expected to see the collagen/ceramic composite material meets the requirements of clinical bone substitutes in terms of properties, and at the same time increase doctors' surgical efficiency.
- In the future, the applications related to bone growth including dentistry and orthopedics would be applied to implants and filling materials.



Double dose collagen/ ceramic composite hydration
curing system

R & D Technologies in the Future

1. Development of Surgical Assisted Robotic Arm System

- The increasing clinical demand for precision surgical assistance systems has led medical material manufacturers to seek system support, such as navigation and positioning and surgical robotic arms.
- The Development of human-machine collaborative drilling end effector system aims to provide orthopedic surgery-assisted robotic arms for bone breaking, drilling and tapping functions. Through the artificial bone test robot arm cooperative drilling, the drilling depth deviation can achieve $RMS \leq 1 \text{ mm}$.
- Reinforcement learning and virtual-real training are used to repair the difference between the virtual and real environments and increase the recognizability of the object features of the spinal process probe. The number of training times of the surgical-assisted robotic arm in the real surgical laboratory environment has reached 1,000, and the L1~L5 vertebral segments of the spinal prosthesis are tested. The success rate of Zhizhi's spinal process nailing is 98%.

3. Technology of Multi-layer composite for cartilage repair

- Due to the problems of separation and shedding from current clinical cartilage repair, the technology of multi-layer composite structure has been developed. The lower layer uses a higher proportion of ceramic mixed with collagen for fixation to the hard bone below the cartilage; the upper layer uses high collagen content for cartilage tissue attachment.
- Tensile strength of multi-layer composite cartilage filling: $>1 \text{ MPa}$, pore size: $>100 \mu\text{m}$ and porosity: $>50\%$
- It is expected that the multi-layer composite cartilage filling can be combined with the hard tissue at the bottom layer and induce and promote the repair rate of the soft tissue through the biological matrix. Compared with the collagen membrane, the tissue growth rate can be increased by about 20%.
- In the future, it can also be applied to dental bone repair, plastic surgery, etc., and achieve good hard and soft tissue growth efficiency.

2. Injectable bone regeneration material technology

- Due to the slow absorption rate and the lack of biological activity of the traditional injection bone cement, bone tissues do not grow easily. Therefore, the development of injectable bone regeneration material technology has been carried out.
- The newly developed injectable bone regeneration material the hardening rate within 15 mins through the double agent ratio, and its mechanical strength is $>5 \text{ MPa}$. In addition, the differentiation and mineralization ability can be improved by more than 20%
- It is expected that the bone growth efficiency of injectable bone regeneration material can be improved by more than 15% when it is applied in-vivo.
- Combined with different biological matrices, this technology can also be applied to plastic surgery, minimally invasive bone repair, etc., in the future. It is estimated that the clinical effect of injectable bone regeneration material would be improved by more than 15%.

4. Invasive wireless bioresorbable blood flow measurement system

- In view of the current clinical vascular anastomosis repair surgery prone to thrombosis, resulting in insufficient perfusion of intravascular occlusion, and in order to monitor the abnormal blood flow and thrombus status after operation, a blood flow measurement system with continuous monitoring is being developed, which requires no removal of sutures after operation, reduces operation difficulty and has high accuracy.
- The subcutaneous tissue detectable depth and blood vessel detection pressure of the invasive wireless absorbable blood flow measurement system is in the range of $0.5 \sim 1.5 \text{ cm}$ and $2 \sim 5 \text{ kPa}$, respectively.
- It is expected that the invasive wireless absorbable blood flow measurement system can perform continuous detection and does not need to be removed after surgery compared with the traditional wired type.
- The development of micro-degradable implantable medical materials can also be applied to precision equipment, software development, information communication and intelligent automation technologies, such as medical electronics, soft and rigid printed circuit boards, etc.

Green Energy Technology

The research scope of green energy technology in 2021 included wind power generation technology, solar cell key coating process equipment technology, and industrial combustion and heating equipment-related technology. For the wind power industry, in addition to guiding the domestic industry to develop small and medium-sized wind turbines, MIRDC also assisted the Industrial Development Bureau in promoting localization guidance for offshore wind power, the establishment of third-party verification capability for the Bureau of Standards, Metrology & Inspection, and the development of offshore wind power operation and maintenance technology for the Bureau of Energy. In addition, MIRDC developed intelligent inspection systems to significantly improve maintenance efficiency and focused on digitizing the manufacturing process to provide the domestic industry with the technology of interaction between the Internet of Things and production line equipment.

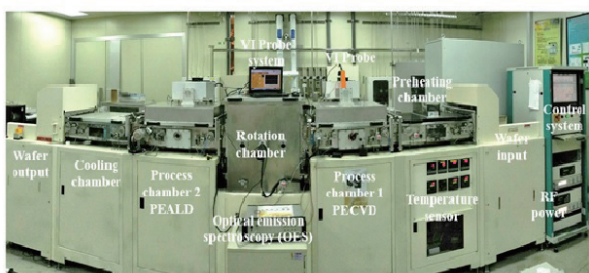
In terms of solar cell key coating process equipment technology, MIRDC has successfully developed ultra-high frequency vacuum coating equipment for high performance solar cell process equipment technology, and this year, MIRDC will be upgrading the new generation of passivated solar cell key coating process equipment to significantly increase the self-production rate of process equipment; MIRDC will continue to develop key trial production process equipment in building a high performance solar cell equipment industry chain.

On the other hand, in the research and development of industrial combustion and heating equipment, since the industrial furnace heating process in the industry has high energy consumption and poor temperature uniformity, MIRDC provided demonstration sites through decentralized flat flame thermal storage combustion technology and energy-saving intelligent control technology, assisted the industry in developing restructuring design technology, and will later develop self-preheating combustion and pulse control technology to improve manufacturing efficiency and competitiveness.

Current R & D Status

1. The equipment development of key coating process for new generation of passivated solar cells

- MIRDC has completed the domestically produced equipment and verification platform for key passivation processing of Tunnel Oxide Passivated Contact (TOPCon) solar cells and achieved independent research and development. The goal of the equipment system is to solve the high development cost with a lack of industry's key process equipment.
- MIRDC has broken through foreign patent deployment of high-efficiency passivation type silicon solar cells, and achieved full localization of key process equipment.
- The completion of the self-made rate of PEALD/VHF Plasma/PECVD deposition equipment with 70% local content and established the industry chain for solar photovoltaic equipment.
- The completion of the integration of the key processes of Tunnel Oxide Passivated Contact (TOPCon) solar cells, including poly-Si, Al₂O₃, SiO₂, and SiNx passivation films. The selling price is 40% of foreign equipment, largely improving international competitiveness.



The equipment development of key coating process for new generation of passivated solar cells

2. Development of intelligent reconfigurable regenerative combustion system

- Heating process equipment with high-temperature (above 800°C) combustion reduces energy consumption by more than 30%.

Distributed flat flame combustion technology

- Regenerative flat flame burner
- External-circulative flue gas blending combustion technology

Energy-saving smart control technology for industrial furnace regenerative combustion system

- Partition feedforward control technology
- Reversing valve monitoring technology
- Multi-burner energy-saving control optimization model

Flat flame combustion technology with reconfigurable design

- Formulation of equation based on the operation data of the flat flame regenerative burner
- Quick setting technology for modular simulation
- Smart flat flame regenerative combustion system with fast input of the human-machine interface
- Demonstration field of the first domestic flat-flame intelligent reconfigurable regenerative combustion refractory firing process equipment.

3. Development of Wearable Assistance System

- Traceability of manufacturing and maintenance is essential in the wind energy industry. Wearable assistance system is developed for this demand for digital traceability.
- Assistance features for the inspection of wind turbine towers are accomplished by implementing AI-assisted vision inspection, visual positioning and augmented reality.
- Wearable Assistance System provides O&M technicians with reminders of working procedure and digital records, thus reducing human errors.
- Wearable Assistance System can also assist drone operations and support structure production.



Development of Wearable Assistance System

4. Electrochemical inspection module for cathodic protection

- Electrochemical inspection module is developed to reduce manual inspection time and risks involved with the inspection of cathodic protection.
- Current measurements are utilized to record the state of corrosion protection, with accuracy of over 70%.
- Reduce inspection time of sacrificial anode to less than 30 minutes.
- Can also be applied in monitoring impressed current cathodic protection.

R&D Technologies in the Future

1. The development of key process equipment for mass production of passivation solar cells

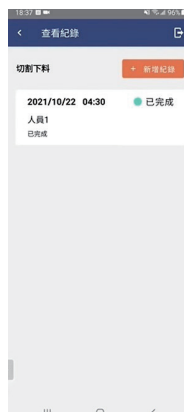
- Domestic solar cell companies have already put into pilot run of TOPCon cells, and also conducted field verification of system products. Therefore, if domestic process equipment can enter the field when the cells are put into mass production, it can effectively enhance the market competitiveness of cells.
- The production capacity of the newly developed equipment is 240 pieces (M6) in a single process; it can support ultra-thin tunneling oxide (thickness ≤ 2 nm) and polysilicon layer process.
- The production capacity of the mass production equipment expected to be developed will support the production line capacity of 50MW, and produce battery products featuring an increase of energy efficiency by over 10%.

3. Digitalized Manufacturing Procedure Trackability

- Traceability of manufacturing is essential for quality control. Thus, digitalized manufacturing procedure traceability is developed for this demand
- Implementing augmented reality through mobile device or smart glass to provide solutions.
- Digitalized manufacturing procedure traceability system will provide domestic suppliers with fast quality control solutions.
- Digitalized manufacturing procedure traceability system can interact with the IoT devices of production line in the future.

2. Smart self-recuperative and indirect combustion energy-saving technology

- To develop self-recuperative burners and radiant tubes, smart decision-making and pulsed combustion control technology, self-recuperative industrial furnace integrated design and establishment of the demonstration areas. This will provide waste heat recovery technology for domestically produced medium and high temperature heat-using process equipment from traditional processing to high-end manufacturing in metal-related industries, achieving the goal of 15-20% energy saving and 15-30% carbon reduction.



Digitalized Manufacturing Procedure Trackability

Electrochemical Machining Technology

The research and development of electrochemical machining technology in 2021 focused on the rapid modeling technology of process parameter decisions, and on the current problems encountered by domestic mold manufacturers in the discharge processing, such as poor surface roughness, slagging carbon, electrode consumption, long discharge time, etc., and then proposed rapid modeling technology using the Tesla car fastener mold petal profile as the target, successfully improving the roughness and shortening the processing time.

The electrochemical machining module developed by MIRDC can be used with a self-built vibration module for slag removal and reduction of electrode workpiece clogging, thereby shortening machining time and improving surface roughness. In the future, MIRDC will continue to research and develop the electrochemical composite grinding technology to improve the efficiency of die and mold processing, and to solve the pain point of the industry with high tool wear and tear for difficult-to-process metal materials.

Current R & D Status

1. Rapid modeling of process parameter decisions

- In response to the mold manufacturing industry's demand for long electrical discharge machining time and electrode consumption, the development of rapid modeling electrochemical machining technology was proposed.
- The processing time of the petal profile of the automotive fastener mold is shortened from 2 hrs to 10 mins, with the surface roughness improved by more than 50%.
- The new technology can also be applied to the aerospace industry in the future, and it is estimated that the process cost can be reduced by more than 30%.



Analog nerve processing prediction module

R & D Technologies in the Future

1. Electrochemical composite grinding technology of tungsten steel mold materials

- In response to the problems of grinding wheel consumption and poor processing efficiency in grinding tungsten steel molds in the mold manufacturing industry, the development of electrochemical composite grinding technology was proposed.
- The tool life is increased by more than 25%, and the machining efficiency by more than 30%.
- The new technology can also be applied to precision machinery in the future; it is estimated that the process cost can be reduced by more than 30%.

Maritime Industry Technology

To comply with the Executive Yuan's goal to build Taiwan as Asia's industry cluster of Offshore Wind Technology, and at the same time reach a 20% Renewable Energy Ratio in 2025, the government has announced a 5.5 GW target by 2025, and another 15 GW from 2026-2035. The renewable energy transition is also meant to stimulate domestic employment and industry development and promote energy diversification and self-supply.

MIRDC has foreseen the increasing demand of trained technicians from all levels; hence, in 2021, the blade repair training of Global Wind Organization (GWO) will be added. In order to meet the manpower requirements for the operation of wind turbines, the necessary training of automatic blade inspection technology and maintenance will be invested. In the future, the advanced and customized training content of blade repair will be expanded to assist the complete establishment of the domestic wind turbine operation and maintenance industry.

Current R & D Status

1. Blade repair training technology

- The blade repair training technology of Global Wind Organization(GWO)
- In response to the promotion of renewable energy policies and the training needs of offshore wind farm operation and maintenance technicians, the development of blade repair training technology was carried out.
- According to the training standards of the Global Wind Organization, the training projects include blade front and back edge repair, lamellar material replacement, core material repair and surface coating repair, etc.
- It is expected to provide 50 advanced training requests per year.
- Improve the wind turbine blade repair technology manpower to 50%.



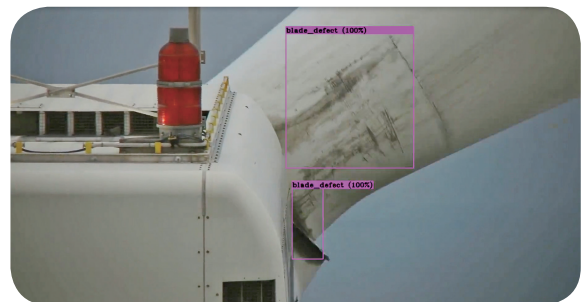
Blade repair training technology



2. Automated solutions for wind turbine inspection

Worldwide blade maintenance is estimated at 187,399 days per year, which translates into more than 500 years of downtime; Traditional manual inspection methods are often expensive, time consuming and dangerous, so developing safer, efficient and reliable alternatives to manual inspection can help make the wind energy O&M industry more competitive.

- Automatic vehicle inspection technology can detect blade defects up to 10mm.
- Through The AI image analysis technology, the captured images can be analyzed instantly and 15 defect categories can be classified.
- Blade detection can be completed in 10 minutes without stopping, and the detection efficiency can be improved by more than 30% compared with traditional manual detection.



Automated solutions for wind turbine inspection

R & D Technologies in the Future

1. Basic safety training: online retraining

GWO Basic Safety Training: online retraining

- In response to the requirement of basic safety retraining every two years, more than 1,000 people have been trained in Taiwan from 2019 to 2021. With significant demand for retraining, online retraining technology has been developed.
- According to the training standards of GWO, the development of digital teaching mode includes video teaching, standard video and online teaching interface, etc.
- This is expected to provide 150 training needs per year.



Basic safety training: online retraining

2. The technology of tower lifts training

The technology of tower lifts training of GWO

- In response to the promotion of renewable energy policies and the training needs of offshore wind farm operation and maintenance technicians, the technology of tower lifts training was carried out.
- According to the training standard of GWO, MIRDC develop various kinds of lift inspection, including the inspection before the operation, operation mode and safety inspection after the operation.
- This is expected to provide 150 training needs per year.

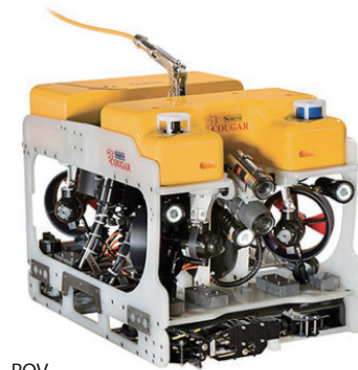


Diagram of the use of forming equipment status analysis module

3. Multi-vehicle collaborative inspection technology

As offshore renewables expand and these maintenance tasks become truly huge and complicated, vehicle (robot) cooperative operation technology will become an important development trend. Through the cooperative operation technology, the vehicles can not only operate independently but also work with offshore technicians.

- ROV: Subsea cable life monitoring, such as modeling of seafloor morphology, optimized design of seabed cable-laying, optimal installation topography and route, distributed temperature sensing (DTS) systems for monitoring seafloor displacement, temperature and burial depth, anti-corrosion detection applications etc.
- ASV: Provides sonar detection technology and image processing technology for the domestic offshore wind energy operation and maintenance industry to implement underwater maintenance.
- It is estimated that this technology will shift workers from hazardous environments at sea to onshore control room roles and reduce the cost of energy by 10% (including a 27% reduction in operating expenses).



ROV



ASV

Aerospace Manufacturing Engineering Technology

In response to the global aircraft replacement trend and international trade demand, MIRDC assisted the industry in transforming into the aerospace military and civilian fields in 2021, and at the same time promoted the industry to pass the strict aerospace quality system certification to improve the competitiveness of the domestic industry in the international aerospace market and drive the domestic industry to upgrade and transform together. On the other hand, MIRDC also links system integrators and manufacturers to organize an aerospace supply chain management system, aiming to compete for large orders in the international market under the mode of division of labor and collaboration.

The main research direction in the future is to assist the defense industry in strengthening the independent capacity in national defense. In addition to refining the existing forging capacity, the F16 maintenance system will be established to solve the problem of high failure and high unit cost of the aircraft fleet. In addition, it is expected to establish isothermal forging, thermal mold forging, and ring forging production technologies to enable high-end civil engines to leap into the international supply chain system, and at the same time introduce the aerospace diagnostic cloud platform to drive domestic investment, digital transformation, and civil business opportunities.

Current R & D Status

1. Investment of High Value-Added Aerospace Products Development

- In response to the SMEs' digital transformation policy, domestic companies are assisted by matching with aerospace system integrators and by using digital management system for production transformation within high value-added aerospace products.
- Since aerospace products are highly sensitive to safety and traceability, digital management systems and automatic production equipment are used, resulting in 20% production efficiency increase, and gross value tripled.

2. Development of Key Aerospace Technologies and Digital Application

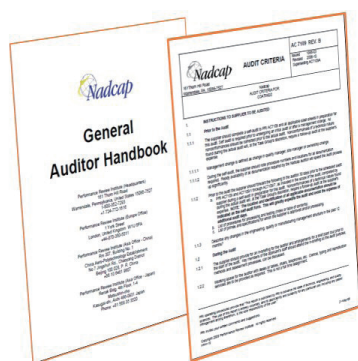
- By matching the cooperation between domestic aerospace enterprise and ASP (Application Service Provider), aerospace technologies and digital application are provided, leading to the transformation and development of high value-added aerospace application products.
- Safety and effectiveness are improved and risk of equipment damage and training costs are reduced, driving the aerospace output value to increase by more than 500 million NTD.

3. Establishment of Reward Aerospace Quality System and Supplier Certifications

- Aerospace quality system is introduced to provide professional guidance and assist in AS9100, Nadcap special process and supplier certification. The visibility of Taiwan manufacturers in the international aerospace market is also significantly improved.



Development of aerospace virtual reality products



Aerospace Nadcap Special Process Certification

4. Management of Organic Aerospace Supply Chain

- Linkage of domestic aerospace system integrators to cooperate with airframe structures and engine components manufacturers, import supply chain management system, and strengthen collaboration models.
- Supply chain collaboration model has brought large scale international orders, driving the domestic output value to increase by 1 billion NTD.

R&D Technologies in the Future

1. Aerospace Engine Forging Technologies and Application Development

- By following the guidance of National Defense Industry Development Policy, domestic industry will be assisted to develop key technology for engine hot section components, thereby eventually entering the international supply chain.
- Through introducing government resources, key technologies such as isothermal forging, hot die forging and ring forging have been established, driving domestic investment value by more than 1 billion NTD; at the same time, meeting the goal of strengthening national defense independence as well as driving domestic business opportunities.

2. Promote Maintenance Supply Chain for F-16s

- According to instructions from President Tsai and attached resolutions from the Legislative Yuan, the domestic aviation industry will be assisted in establishing self-reliant maintenance and manufacturing capability of the various systems of F-16s, as well as building an MRO solution for Taiwan Air Force for solving issues of high-failure rate, high-unit price and long-delivery.
- Through introducing Government resource, domestic aviation industry will be assisted to establish the self-reliant maintenance and manufacturing capability for F-16s to meet the goal of development of at least 4 key technologies and leading at least 3 domestic companies to join the F16 aircraft MRO supply chain system annually.



Promoting the industry to invest in the maintenance and production technology development of F16s

3. Development of Aerospace Cloud Platform for Capability Determination Used

- In order to create access to international markets, aerospace-related certification regulations are introduced to provide professional guidance for new entrants. By the government's promotion of Digital Transformation and establishment of aerospace cloud platform, new entrants will be guided to join the domestic aviation industry. It is expected to increase the number of enterprises in the aerospace industry by at least 3% annually.

附錄

ANNUAL REPORT



科專成果統計表

計畫名稱					金屬中心創新前瞻技術研究計畫	金屬中心產技術環境建構計畫	學研雙引擎推動在地產業科技加值創新計畫	網通裝置混成板材開發與應用計畫	模具產業鏈整體數位轉型關鍵技術開發計畫	植物性飲品加工機具與製程精進研發計畫				
成果項目														
成果產出	A、技術成果	專利申請	國內	件數	17	4	3	3	5	3				
			國外	件數	7	1	0	3	2	0				
		專利獲得	國內	件數	27	4	3	0	3	2				
			國外	件數	9	2	0	0	1	0				
	B、產學研合作	合作研究		件數	0	0	0	0	0	0				
				金額	0	0	0	0	0	0				
				配合款	0	0	0	0	0	0				
	C、國際合作	技術引進		件數	0	0	0	0	0	0				
				金額	0	0	0	0	0	0				
		合作開發	件數	0	0	0	0	0	0					
			金額	0	0	0	0	0	0					
	D、參與制定國際標準或國際組織	持續參與		件數	0	0	0	0	0	0				
				新增提案	件數	0	0	0	0	0	0			
	E、機構認證	持續參與	國內	件數	0	20	0	0	0	0				
			國外	件數	0	0	0	0	0	0				
		新增提案	國內	件數	0	2	0	0	0	0				
			國外	件數	0	0	0	0	0	0				
	成果擴散	F、推廣研討	研討會議		場次	0	3	7	1	3	6			
人次					0	69	359	88	232	257				
廠商訪視推廣			家數	0	0	132	13	54	37					
		G、人才培育			人次	0	0	0	0	0				
研發應用	H、專利技轉	國內		件數	16	7	10	2	24	12				
				國外		件數	0	0	1	0	1			
						專利技轉收入	金額	0	4,056.381	5,079.048	670	11,793.525	2,954.8	
	I、技術移轉	國內		件數	11	9	12	13	24	16				
				國外		件數	0	0	0	0	0			
		技術暨專利移轉總收入				金額	8,797.144	5,401.381	7,681.299	7,265.714	12,783.525	4,254.8		
				繳庫數		金額	1,761.374	2,700.691	3,167.795	3,632.857	6,159.539	1,891.911		
	J、研發成果總收入					金額	8,797.144	5,401.381	7,681.299	7,265.714	12,783.525	4,254.8		
	K、開放實驗室	設備使用	業界	次數	0	1,056	0	0	0	0				
				時數	0	7,557	0	0	0	0				
			學界	次數	0	247	0	0	0	0				
				時數	0	1,784	0	0	0	0				
			其他機構 (含執行單位)	次數	0	1,565	0	0	0	0				
				時數	0	10,788	0	0	0	0				
		主要設備使用率			%	0	73.73	0	0	0	0			
	L、推動學產參與科專研發	企業創新研發專案		件數	0	0	0	0	0	0				
				金額	0	0	0	0	0	0				
		學界科專計畫		件數	0	0	0	0	0	0				
				金額	0	0	0	0	0	0				
		其他計畫		件數	0	0	27	0	2	3				
				金額	0	0	66,675	0	1,2710	4,170				
	M、委託及工業服務	中小企業	件數	0	18	13	7	12	10					
			家數	0	17	13	7	11	10					
			金額	0	9,605.6	5,011.738	6,627	7,926	2,718					
		其他	件數	0	9	1	3	7	1					
			家數	0	9	1	3	7	1					
			金額	0	6,424.6	588	3,670	11,457.4	524					
經濟效益	N、促成產業聯盟	件數			0	0	6	1	1	0				
				中小企業		廠家數	0	0	90	3	0	0		
						其他		廠家數	0	0	0	2	3	0
	O、新創事業 (含衍生公司、新事業部門之設立)			家數	0			0	0	0	0	0		
				資本額	0			0	0	0	0	0		
				員工數	0			0	0	0	0	0		
					0			0	0	0	0	0		
	P1、帶動國內廠商投資促進就業	件數			0	15	405	7	12	29				
				廠家數			0	15	405	7	12	29		
						投資金額			0	379,000	651,375	147,000	249,000	165,000
								增加就業人數			0	36	336	27
						衍生產值					0	1,435,500	1,312,660	315,000
	P2、帶動國外廠商投資促進就業	件數			0			0	0	0	0	0		
				廠家數			0	0	0	0	0	0		
						投資金額			0	0	0	0	0	0
								增加就業人數			0	0	0	0
						衍生產值					0	0	0	0
Q、其他	創新服務模式應用 / 服務度			項數	0			0	0	0	0	0		
				家數	0	0	0	0	0	0				
				試驗場域	0	0	0	0	0	0				
				創新服務系統	0	0	0	0	0	0				
				體驗人次	0	0	0	0	0	0				
	滿意度	研究報告	5 分量表	0	0	0	0	0	0	0				
			研討會議	5 分量表	0	0	0	0	0	0				
	獲獎	學術成果	項數	0	0	0	0	0	0	0				
			技術成果	項數	0	0	0	0	0	0				
	媒體曝光			篇數	0	0	0	0	0	0				

計畫名稱					智慧設備暨系統雲端加值服務技術開發計畫	綠能科技技術分析與策略推動研究發展計畫	產業技術基礎研究與知識服務計畫	新興產業技術研發布局及策略推動計畫	產業創新新材料開發計畫	循環鋁材創新應用製程技術開發計畫	
成果項目											
成果產出	A、技術成果	專利申請	國內	件數	1	0	0	0	1	7	
			國外	件數	1	0	0	0	1	6	
		專利獲得	國內	件數	3	0	0	0	3	6	
			國外	件數	2	0	0	0	0	0	
	B、產學研合作	合作研究		件數	0	0	0	0	0	0	
				金額	0	0	0	0	0	0	
				配合款	0	0	0	0	0	0	
	C、國際合作	技術引進		件數	0	0	0	0	0	0	
				金額	0	0	0	0	0	0	
		合作開發		件數	0	0	0	0	0	0	
				金額	0	0	0	0	0	0	
	D、參與制定國際標準或國際組織	持續參與 新增提案		件數	0	0	0	0	0	0	
				件數	0	0	0	0	0	0	
	E、機構認證	持續參與	國內	件數	0	0	0	0	0	0	
			國外	件數	0	0	0	0	0	0	
		新增提案	國內	件數	0	0	0	0	0	0	
			國外	件數	0	0	0	0	0	0	
成果擴散	F、推廣研討	研討會議		場次	1	1	7	0	1	4	
				人次	30	1,500	1,104	0	45	274	
		廠商訪視推廣		家數	0	0	0	6	7	30	
G、人才培育				人次	0	0	0	0	0		
研發應用	H、專利技轉			國內	件數	3	0	0	0	6	15
				國外	件數	0	0	0	0	0	0
				專利技轉收入	金額	1,015	0	0	0	6,607.143	11,389.048
	I、技術移轉			國內	件數	6	0	0	0	7	14
				國外	件數	0	0	0	0	0	0
				技術暨專利移轉總收入	金額	2,153.5	0	701.54	0	7,307.143	13,436.667
				繳庫數	金額	1,076.75	0	280.615	0	3,583.05	6,718.335
	J、研發成果總收入				金額	2,153.5	0	701.54	0	7,307.143	13,438.257
	K、開放實驗室	設備使用	業界	次數	0	0	0	0	0	0	
				時數	0	0	0	0	0	0	
			學界	次數	0	0	0	0	0	0	
				時數	0	0	0	0	0	0	
			其他機構 (含執行單位)	次數	0	0	0	0	0	0	
				時數	0	0	0	0	0	0	
				主要設備使用率		%	0	0	0	0	0
	L、推動學產參與科專研發	企業創新研發專案		件數	0	0	0	0	0	0	
				金額	0	0	0	0	0	0	
		學界科專計畫		件數	0	0	0	0	0	0	
				金額	0	0	0	0	0	0	
		其他計畫		件數	0	0	0	0	1	0	
	金額			0	0	0	0	2,000	0		
	M、委託及工業服務	中小企業		件數	1	0	0	0	5	12	
				家數	1	0	0	0	2	11	
				金額	2,940	0	0	0	5,211	4,079.05	
		其他		件數	2	0	0	0	1	7	
				家數	2	0	0	0	1	7	
			金額	4,920	0	0	0	441	6,205		
經濟效益	N、促成產業聯盟	件數 中小企業 其他		廠家數	0	0	0	0	1	1	
				廠家數	0	0	0	0	1	1	
				廠家數	0	0	0	0	0	0	
	O、新創事業 (含衍生公司、新事業部門之設立)			家數	0	0	0	0	0	0	
				資本額	0	0	0	0	0	0	
				員工數	0	0	0	0	0	0	
	P1、帶動國內廠商投資促進就業	件數 廠家數 投資金額 增加就業人數 衍生產值			3	0	0	0	3	12	
					3	0	0	0	3	12	
					28,500	0	0	0	352,000	213,400	
					1	0	0	0	11	51	
					16,000	0	0	0	556,000	1,078,000	
	P2、帶動國外廠商投資促進就業	件數 廠家數 投資金額 增加就業人數 衍生產值			0	0	0	0	0	0	
					0	0	0	0	0	0	
					0	0	0	0	0	0	
					0	0	0	0	0	0	
					0	0	0	0	0	0	
Q. 其他	創新服務模式應用 / 服務度			項數	0	0	0	0	0	0	
				家數	0	0	0	0	0	0	
				試驗場域	0	0	0	0	0	0	
				創新服務系統	0	0	0	0	0	0	
				體驗人次	0	0	0	0	0	0	
	滿意度	研究報告	5 分量表	0	0	0	0	0	0		
			研討會議	5 分量表	0	0	0	0	0	0	
	獲獎	學術成果	項數	0	0	0	0	0	0		
			技術成果	項數	0	0	0	0	0	1	
	媒體曝光			篇數	0	1	0	0	0	0	

計畫名稱					高值金屬成型機械智慧機電整合技術開發計畫	智慧機器人與製造應用AI系統開發計畫	工業伺服電機節能驅動關鍵組件開發計畫	新興智慧自動駕駛決策與控制關鍵技術整合應用研究計畫	電動車輛底盤系統技術開發計畫	複合系統與技術室關鍵技術開發計畫
成果項目										
成果產出	A、技術成果	專利申請	國內	件數	1	1	1	1	3	13
			國外	件數	2	2	0	6	2	11
		專利獲得	國內	件數	1	1	0	1	4	13
			國外	件數	0	0	0	3	2	2
	B、產學研合作	合作研究		件數	0	0	0	0	0	0
				金額	0	0	0	0	0	0
				配合款	0	0	0	0	0	0
	C、國際合作	技術引進		件數	0	0	0	0	0	0
				金額	0	0	0	0	0	0
		合作開發		件數	0	0	0	0	0	0
				金額	0	0	0	0	0	0
	D、參與制定國際標準或國際組織	持續參與		件數	0	0	0	0	0	0
				新增提案	件數	0	0	0	0	0
	E、機構認證	持續參與	國內	件數	0	0	0	0	0	0
			國外	件數	0	0	0	0	0	0
		新增提案	國內	件數	0	0	0	0	0	0
			國外	件數	0	0	0	0	0	0
成果擴散	F、推廣研討	研討會議		場次	0	1	0	0	1	4
				人次	0	40	0	0	21	505
		廠商訪視推廣		家數	6	5	0	3	10	51
	G、人才培育			人次	0	0	0	50	0	109
研發應用	H、專利技轉	國內		件數	1	6	3	3	7	25
		國外		件數	0	0	0	2	0	3
		專利技轉收入		金額	1,000	3,812.38	2,622.857	3,533.333	3,700	16,740.714
	I、技術移轉	國內		件數	3	5	5	4	5	15
		國外		件數	0	0	0	0	0	0
		技術暨專利移轉總收入		金額	3,600	3,812.38	3,422.857	3,533.333	3,700	16,740.714
		繳庫數		金額	1,608.794	1,643.308	1,605.324	1,491.452	1,850	8,370.359
	J、研發成果總收入			金額	3,600	3,812.38	3,422.857	3,533.333	3,700	16,740.714
	K、開放實驗室	設備使用	業界	次數	0	0	0	0	0	0
				時數	0	0	0	0	0	0
			學界	次數	0	0	0	0	0	0
				時數	0	0	0	0	0	0
			其他機構 （含執行單位）	次數	0	0	0	0	0	0
				時數	0	0	0	0	0	0
			主要設備使用率		%	0	0	0	0	0
		L、推動學產參與科專研發	企業創新研發專案		件數	0	0	0	0	0
	金額				0	0	0	0	0	34,700
	學界科專計畫		件數	0	0	0	0	0	0	
			金額	0	0	0	0	0	0	
	其他計畫		件數	1	0	0	0	0	7	
			金額	4,002	0	0	0	0	19,400	
	M、委託及工業服務	中小企業		件數	3	2	4	0	2	16
				家數	3	2	4	0	2	16
				金額	2,391	4,525	1,585	0	2,420	9,118
		其他		件數	2	0	0	2	1	7
				家數	2	0	0	2	1	6
				金額	2,728	0	0	5,135.715	402.5	5,783
經濟效益	N、促成產業聯盟	件數			0	0	0	0	0	1
		中小企業		廠家數	0	0	0	0	0	3
		其他		廠家數	0	0	0	0	0	0
	O、新創事業 （含衍生公司、新事業部門之設立）			家數	0	0	0	0	0	0
				資本額	0	0	0	0	0	0
				員工數	0	0	0	0	0	0
	P1、帶動國內廠商投資促進就業	件數			3	2	2	1	5	21
		廠家數			3	2	2	1	5	20
		投資金額			203,502	8,500	80,000	50,000	110,000	549,960
		增加就業人數			53	7	7	3	7	109
		衍生產值			65,000	31,000	150,000	85,000	62,000	867,040
	P2、帶動國外廠商投資促進就業	件數			0	0	0	0	0	0
		廠家數			0	0	0	0	0	0
		投資金額			0	0	0	0	0	0
		增加就業人數			0	0	0	0	0	0
		衍生產值			0	0	0	0	0	0
Q. 其他	創新服務模式應用 / 服務度			項數	0	0	0	0	0	0
				家數	0	0	0	0	0	0
				試驗場域	0	0	0	0	0	0
				創新服務系統	0	0	0	0	0	0
				體驗人次	0	0	0	0	0	0
	滿意度	研究報告	5 分量表	0	0	0	0	0	0	
			研討會議	5 分量表	0	0	0	0	0	0
	獲獎	學術成果	項數	0	0	0	0	0	0	
			技術成果	項數	0	0	0	0	0	1
	媒體曝光			篇數	0	0	0	0	0	9

計畫名稱					智慧醫療科技應用與跨場域驗證計畫	亞5GAIoT區域發展先期推動計畫	多元合金氮化物於高階切削製造之效能躍升計畫	110年度無人載具科技創新沙盒暨實證運行推動計畫	可控制醫用鎂合金降解速率技術與應用開發計畫	鋁合金壓鑄品高值化之關鍵共通模組技術研發計畫		
成果項目												
成果產出	A、技術成果	專利申請	國內	件數	4	0	2	0	3	2		
			國外	件數	1	0	0	0	4	3		
		專利獲得	國內	件數	3	0	0	0	3	0		
			國外	件數	0	0	0	0	1	0		
	B、產學研合作	合作研究		件數	0	0	0	0	0	0		
				金額	0	0	0	0	0	0		
				配合款	0	0	0	0	0	0		
		C、國際合作	技術引進		件數	0	0	0	0	0	0	
				金額	0	0	0	0	0	0		
	合作開發			件數	0	0	0	0	0	0		
				金額	0	0	0	0	0	0		
	D、參與制定國際標準或國際組織	持續參與		件數	0	0	0	0	0	0		
				新增提案	件數	0	0	0	0	0	0	
	E、機構認證	持續參與	國內	件數	0	0	0	0	0	0		
			國外	件數	0	0	0	0	0	0		
		新增提案	國內	件數	0	0	0	0	0	0		
			國外	件數	0	0	0	0	0	0		
	成果擴散	F、推廣研討	研討會議		場次	0	0	0	6	1	2	
				人次	0	0	0	165	52	45		
廠商訪視推廣				家數	5	0	0	0	16	18		
G、人才培育			人次	0	0	0	0	3	0			
研發應用	H、專利技轉		國內	件數	3	0	0	0	9	3		
			國外	件數	2	0	0	0	1	1		
				專利技轉收入	金額	3,279.333	0	0	6,933.333	3,200.001		
	I、技術移轉		國內	件數	3	0	0	0	3	4		
			國外	件數	0	0	0	0	0	0		
				技術暨專利移轉總收入	金額	3,279.333	0	0	6,933.333	3,428.572		
				繳庫數	金額	1,356.585	0	0	3,466.667	1200		
	J、研發成果總收入		金額	3,279.333	0	0	0	6,933.333	3,428.572			
	K、開放實驗室	設備使用	業界		次數	0	0	0	0	0	0	
					時數	0	0	0	0	0	0	
				學界		次數	0	0	0	0	0	0
						時數	0	0	0	0	0	0
			其他機構 （含執行單位）		次數	0	0	0	0	0	0	
					時數	0	0	0	0	0	0	
			主要設備使用率			%	0	0	0	0	0	0
			L、推動學產參與科專研發		企業創新研發專案		件數	0	0	0	0	0
		金額				0	0	0	0	0	0	
	學界科專計畫				件數	0	0	0	0	0	0	0
					金額	0	0	0	0	0	0	
	其他計畫				件數	0	0	0	0	4	0	0
		金額			0	0	0	0	44,900	0	0	
M、委託及工業服務	中小企業		件數	0	0	0	0	6	7	0		
			家數	0	0	0	0	5	7	0		
			金額	0	0	0	0	10,301	1,397.6	0		
	其他		件數	3	0	0	0	0	2	0		
			家數	3	0	0	0	0	2	0		
			金額	1,750	0	0	0	0	1,070.98	0		
經濟效益	N、促成產業聯盟	件數			0	0	0	0	0	1		
		中小企業			廠家數	0	0	0	0	5		
		其他			廠家數	0	0	0	0	2		
	O、新創事業 （含衍生公司、新事業部門之設立）			家數	0	0	0	0	0			
				資本額	0	0	0	0	0			
				員工數	0	0	0	0	0			
	P1、帶動國內廠商投資促進就業	件數			3	0	2	0	9	5		
		廠家數			3	0	2	0	9	5		
		投資金額			89,000	0	90,000	0	107,000	202,000		
		增加就業人數			12	0	0	0	55	17		
		衍生產值			81,000	0	0	0	241,000	380,000		
	P2、帶動國外廠商投資促進就業	件數			0	0	0	0	0	0		
廠家數			0	0	0	0	0	0				
投資金額			0	0	0	0	0	0				
增加就業人數			0	0	0	0	0	0				
衍生產值			0	0	0	0	0	0				
Q. 其他	創新服務模式應用 / 服務度			項數	0	0	0	0	0	0		
				家數	0	0	0	0	0	0		
				試驗場域	0	0	0	0	0	0		
				創新服務系統	0	0	0	0	0	0		
				體驗人次	0	0	0	0	0	0		
	滿意度	研究報告	5 分量表	0	0	0	0	0	0	0		
			研討會議	5 分量表	0	0	0	0	0	0		
	獲獎	學術成果	項數	0	0	0	0	0	0	0		
			技術成果	項數	0	0	0	0	4	0	0	
	媒體曝光			篇數	2	0	0	0	0	0		

計畫名稱					高穩定抗天候環境協同 作業載具開發暨驗證 計畫	智慧機械雲通用地雲架 構建置計畫	PCB製程特用感測技術 先導計畫				
成果項目											
成果產出	A、技術成果	專利申請	國內	件數	1	0	2				
			國外	件數	1	0	1				
		專利獲得	國內	件數	0	0	1				
			國外	件數	0	0	0				
	B、產學研合作	合作研究		件數	0	0	0				
				金額	0	0	0				
				配合款	0	0	0				
	C、國際合作	技術引進		件數	0	0	0				
				金額	0	0	0				
		合作開發		件數	0	0	0				
				金額	0	0	0				
	D、參與制定國際 標準或國際組織	持續參與		件數	0	0	0				
				新增提案	件數	0	0	0			
E、機構認證	持續參與	國內	件數	0	0	0					
		國外	件數	0	0	0					
	新增提案	國內	件數	0	0	0					
		國外	件數	0	0	0					
成果擴散	F、推廣研討	研討會議		場次	1	0	0				
				人次	68	0	0				
		廠商訪視推廣		家數	10	5	0				
	G、人才培育			人次	0	0	0				
研發應用	H、專利技轉	國內		件數	1	0	3				
				件數	0	0	0				
				專利技轉收入	金額	1,000	0	3,304.762			
	I、技術移轉	國內		件數	1	0	3				
				件數	0	0	0				
				技術暨專利移轉總收入		金額	1,000	0	3,304.762		
						繳庫數	500	0	1,652.382		
	J、研發成果總收入		金額	1,000	0	3,304.762					
			K、開放實驗室	設備 使用	業界	次數	0	0	0		
	時數	0				0	0				
	學界	次數			0	0	0				
		時數			0	0	0				
	其他機構 (含執行單位)	次數			0	0	0				
		時數			0	0	0				
	主要設備使用率			%	0	0	0				
	L、推動學產參與 科專研發	企業創新研發專案		件數	0	0	0				
				金額	0	0	0				
				件數	0	0	0				
		學界科專計畫		金額	0	0	0				
				件數	0	0	0				
				金額	0	0	0				
	M、委託及工業 服務	中小企業		件數	2	2	3				
				家數	2	2	3				
				金額	800	1,053	1,047.618				
		其他		件數	0	1	0				
				家數	0	1	0				
				金額	0	500	0				
經濟效益	N、促成產業聯 盟	件數			0	0	0				
					中小企業		廠家數	0	0	0	
							其他	廠家數	0	0	0
	O、新創事業 (含衍生公司、新事業部門之設立)			家數	0	0	0				
				資本額	0	0	0				
				員工數	0	0	0				
	P1、帶動國內廠 商投資促進就業	件數			2	1	2				
					廠家數			2	1	2	
								投資金額	21,000	15,000	23,500
								增加就業人數	0	3	6
								衍生產值	0	40,000	0
	P2、帶動國外廠 商投資促進就業	件數			0	0	0				
					廠家數			0	0	0	
								投資金額	0	0	0
								增加就業人數	0	0	0
								衍生產值	0	0	0
Q. 其他	創新服務模式應用 / 服務度			項數	0	1	0				
				家數	0	1	0				
				試驗場域	0	1	0				
				創新服務 系統	0	1	0				
				體驗人次	0	5	0				
				滿意度	研究報告	5 分量表	0	0	0		
	研討會議	5 分量表	0	0		0					
	獲獎	學術成果		項數	0	0	0				
				技術成果	項數	0	0	0			
	媒體曝光			篇數	0	0	0				

工服案統計表

工業局

計畫名稱	輔導項目	輔導案數
水五金及手工具產業升級計畫	輔導 /服務國內水五金及手工具產業廠商建立技術升級、開發新產品或導入智慧機械應用，俾以提高生產效能、降低成本、提高產品附加價值，促進國內產業升級。藉由共通性關鍵技術輔導，形成產業聯盟型態，間接減緩產業外移趨勢，並增加就業人口。	9
醫療器材產業技術輔導與推廣計畫	依據國際市場趨勢、國內臨床與產業需求，協助潛力廠商及重點輔導對象，含醫學影像、介入式醫材、微創手術器材、新興診斷醫材等，輔導產業進行創新產品概念驗證與協助快速商品化，並針對具市場潛力的創新醫療器材產品提供概念驗證與快速商品化輔導，引導傳統產業與異業跨入醫材領域，提供配套輔導協助，以降低異業跨入生醫產業的門檻。	8
離岸風電與太陽光電產業升級轉型推動計畫	因應風場建置安裝及後續運轉效率需求，進行風力機零組件 /相關次系統產品開發（如鼻錐罩、電纜線、不斷電系統、電力設備、制動系統等），輔導業者建立製造及相關維修能量，切入風場供應鏈。 輔導國內具風力機零組件（機構件、電力設備、電力傳輸等）製造能量之業者，建構風力機零組件維修技術開發能量，發展在地維修備品製造切入供應鏈。	4
電子設備產業推動計畫	電子設備業者過去核心技術以提供顯示器設備為主，半導體設備為輔，因顯示器產業逐漸邁入成熟期，為持續擴大電子設備整體產業產值，電子協會白皮書建議未來將以次世代顯示器設備、半導體前段關鍵零組件及後段整機設備為轉型重點及目標。本年度輔導項目為：「高壓產生模組開發」、「智慧視覺檢測模組開發」、「曝光模組開發」、「巨量轉移放放模組開發」等 4項技術輔導案	4
半導體設備產業推動計畫	國內半導體終端廠商之設備多以外商供應為主，導致耗材零組件仍需大量進口。本計畫依據終端廠耗材零組件需求，了解在地化零組件開發規格，輔導國內半導體零組件業者進行開發，並由終端廠商進行驗證，建立在地化零組件供應鏈體系。本年度輔導項目為：低溫熱積存製程之氣體擴散盤、乾蝕刻特氣品質分析模組、高濃度臭氧產生系統之陶瓷電極。	3
產業園區產業輔導創新計畫	依據產業園區之產業特性、群聚等因素，以園區為主體、區域經濟發展為核心，鑑別園區產業能量，串聯區內外供應鏈合作，以創新服務 技術加值協助園區重點群聚產業發展，推動區域產業供應鏈整合，打造區域產業成功模式，複製至各園區，強化國內產業供應鏈競爭優勢，達到園區特色發展與產業轉型升級之目的。	3
推動機電產業智慧製造計畫 -家用機械智慧製造能力提升分項	促成 2案智慧化技術應用，推動產業智慧化，運用產業輔導與補助機制，導入智慧化生產、創新營運模式等多元化技術，協助家用機械產業推廣智慧化服務應用，提升生產效能；及促成國內 2家業者建立符合客戶特定要求及國際標準驗證，以利於國內家電業者拓展全球市場。	4
運具產業智慧製造提升計畫 -機車產業數位應用技術深化	透過運用視覺系統與機械手臂整合輔助產線運行，解決統益公司上下料作業及模具內鑲件定位等關鍵製程問題，並增進品質穩定度。 透過機械手臂搭配視覺感測、後處理程式遠端傳輸輔助加工、以及由感測生產資訊輔助產線管理等功能，改善提升金華興公司車削加工關鍵製程之效能。	2
食品產業智慧生產推動計畫 -食品工廠製造系統智慧化輔導	輔導立群食品公司建置自動化雞肉調理設備暨蒸煮溫度與醬汁品質監控系統，透過製程管制點的感測數據（如醬汁 pH值與液位計資料）分析，以進行製程控制參數預測；提供作業員即時可視化介面，以遠端監測製程狀態與加速異常排除能力，並透過系統回饋品質調控參數，將可優化製程生產能力；使自動化製程具有感知能力，建立通訊與感測技術應用，解決人力誤判重要製程管制點資訊，強化產品品質的穩定度。 輔導政益食品建置自動化魚薯條油炸設備暨油溫、油量與油品質監控系統，應用品質影像辨識結合製程設備上（如油溫、油量與油品質等）感測器量取油炸製程管制點資料，經由感測資料收集、資料庫儲存管理，透過可視化介面直觀數據、圖表呈現管理，可提供業者依其不同產品屬性生產，可快速進行產品品質、製程（油溫、油量及油品質等）現況生產資訊分析，以進行製程參數優化調控。	2
智慧健康照護產業發展推動計畫 -智慧型穿戴式裝置結合運動感測量測模組開發計畫	本計畫「整合」全球領先關鍵體感科技及穿戴式裝置技術，運用 KinMAS 的智能量測系統與復能項目結合，連結動態即時姿態量測的 FitMatrix 雲端管理平台，精準評估動作是否到位、記錄訓練歷程，並透過遠端視訊平台追蹤在家訓練狀況，協助患者與治療師掌握復能進度。 開發的穿戴裝置，該系統透過慣性感測器（Inertial Measurement Unit, IMU）捕捉肢體運動的資訊；晶翔機電跨業整合結合金屬中心的優勢，將多點感測技術（Multi-Sensing）與精密線材、金屬中心軟硬整合資料分析測試驗證，提供全方位的智能化資訊，提升國際競爭力，本產品訊號傳導線路部分，為嵌入感測器的智慧衣，並可拆可洗，如此不僅是跨界異業聯合提出最佳解決方案，更是晶翔機電與金屬中心各盡其專業實力，展現不同技術領域的整合能力，大幅提高競爭門檻。	1
智慧健康照護產業發展推動計畫 -心血管健康 AI判讀與精準復能管理服務計畫	本計畫針對血管硬化及心血管疾病，開發心血管健康 AI判讀與精準復能管理服務，積極介入疾病預防，藉由非侵入可攜式即時快速檢測血管硬化指數及心臟狀態，並以 AI疾病資料庫演算分析，讓使用者可以隨時精準掌握心血管狀態；開發健康管理 APP及雲端平台 -依分析級別提供血管復健 -血管體外反搏療法（Enhanced External Counter Pulsation, EECPP）、智慧運動平台、營養保健諮詢及長期檢測監控報告之服務，利用健康幣獎勵機制，維持健康好動力，並持續追蹤飲食、運動或藥物管理後的心血管狀態。 心血管健康 AI判讀與精準復能管理服務，提供非侵入式精準心血管指數分析，並且連結血管復健、智慧運動及營養諮詢之服務，並提供長期監控報告，可成為心血管健康促進管理之指標。	1

工業訓練人才培訓業務執行

一 政府、公協會計畫委辦案

1. 110年度智慧型可重組蓄熱燃燒系統開發計畫，開辦熱處理爐設計規劃工程師培訓系列課程共7班，完成144人次人才培訓，協助熱處理爐設備廠與使用端人才養成。
2. 110年度經濟部工業局地區產業整合發展計畫，進行扣件成形技師培訓內容優化、新增扣件搓牙技師培訓量能、辦理扣件高階管理師系列課程，共計培訓扣件產業技師級及相關專業人員92人次。
3. 110年度執行科技部南部科學園區管理局委託計畫「園區智慧機器人創新自造基地計畫自造場域營運委託專業服務案」，本年度實際執行成果共公開班17班次以上，企業包班9班，延伸服務案1案、使用場域至少6班次以上，累計培育人次463人次以上，其中園區從業人員參與人次247人次以上。
4. 110年機械產業專業人才培訓-財團法人金屬工業研究發展中心合作委託案，執行期間：110年2月1日至110年10月31日，在職班辦理人才培訓完成114人次。
5. 鋼鐵產業產學合作暨技術人力培育推動計畫(鋼鐵公會)，執行期間110年2月1日至111年1月31日。專屬技術課程因應疫情警戒改以實體與線上同步教學模式辦理，完成8門課程，共計培訓222人次(含線上118人次)。鋼鐵產業技術研習營1場次以智慧製造應用為主題，安排至南科AI基地以案例介紹智慧製造概念及產業導入之應用，並體驗MBOT設計操作，共計12位學員參加。
6. 110年度因covid-19造成三級警戒，5月至7月三級警戒期間，政府及公協會委辦課程計畫執行上採取視訊上課統計資料：南部科學園區管理局委託計畫12班，時數85小時，人數195人；鋼鐵公會委託案 4班，時數24小時，人數85人(實體15人+線上85人)；情資平台計畫 3班，時數6小時，人數157人；蓄熱計畫 2班，時數18小時，人數60人；工研院委託案-機械產業專業人才培訓 3班，30小時，12人(實體30人+線上12人)。採用視訊總計共 24班，時數163小時，人數509人。
7. 110年度勞動部勞動力發展署產業新尖兵試辦計畫補助「國際銲接技師培訓專班」，培訓失業青年具銲接技能並已考取國際銲工ISO 9606-1之141/136 3G證照為目標，課程時數152小時，共培訓17人次，15人次取得ISO9606-1銲工證照，通過率88.2%。
8. 110年度高雄市政府勞工局訓練就業中心委託辦理失業者職業訓練「物料搬運工具專業人才培訓班」，培訓失業者取得天車及堆高機期滿證明，輔導考取技術士技能檢定證照，使學員習得一技之長，增加就業機會。課程總時數120小時，訓練期程：110年8月19日～110年9月7日，結訓人數21人，取得天車證照17、堆高機證照18人，至90天就業追蹤時至110年12月6日，就業人數18人，就業率85.71%。
9. 110年度產業人才投資方案開班至12月底止：a.SolidWorks 3D繪圖設計標準課程班，學員28人；b.IATF16949核心工具實務訓練班，學員25人；c.CNC銑床工程師技能訓練班，學員22人；d.製造現場改善實戰技巧實務班，學員21人；e.CNC多軸程式技能進階班，學員18人；f.非破壞檢測技術及應用訓練班，學員22人；g.SolidWorks 3D繪圖設計標準課程，學員18人；h.Solidworks進階班，學員23人，累計共8班，培訓學員117人次。
10. 110年度即測即評及發證技術士技能檢定術科測試，至12月底止已完成8梯次堆高機操、固定式起重機操作—架空式(地面操作)、固定式起重機操作—架空式(機上操作)、移動式起重機操作—伸臂可伸縮式、第一種壓力容器操作5項職類共報名人數1,639人；堆高機操作檢定合格發證人數共692人，固定式起重機操作—架空式(地面操作)檢定合格發證人數共6人，固定式起重機操作—架空式(機上操作)檢定合格發證人數共397人，移動式起重機操作—伸臂可伸縮式檢定合格發證人數共28人；總合格率为73.34%。資料來源：勞動部勞動力發展署技能檢定中心。

一 自主及民間委辦案

1. 職業安全訓練課程110年度至12月底止共辦理524班，上課人數共計11,603人；臨廠工業安全訓練課程共辦理80班，上課人數共計2,051人。
2. 管理類課程110年度至12月底止共辦理24班，上課人數共計444人；臨廠管理類課程共辦理3班，上課人數共計96人。
3. 技術類訓練課程110年度至12月底止共辦理68班，上課人數共計1,009人；臨廠技術類訓練課程共辦理2班，上課人數71人。
4. 110年度因covid-19病毒肆虐，5月至7月三級警戒期間，採用視訊上課統計資料：內部委託1班，時數3小時，人數17人；企業臨廠包班1班，時數42小時，人數40人；自辦職業安全類16班，時數331小時，人數407人；自辦技術管理類3班，時數9小時，人數180人。110年度採用視訊共21班，時數385小時，人數644人。
5. 110年度總開班數：701班，總上課時數：10,380小時；總報名人數：25,863人，總上課人數：15,274人。

前瞻技術之學研合作

學校	總計畫名稱	研究名稱
國立中山大學	110年度智慧型可重組蓄熱燃燒系統開發計畫 (3/3)	蓄熱高均溫性工業爐內操作條件優化之研究分析
國立屏東科技大學	110年度智慧型可重組蓄熱燃燒系統開發計畫 (3/3)	工業爐熱交換流場數值模擬分析
國立臺北科技大學	110年度智慧型可重組蓄熱燃燒系統開發計畫 (3/3)	實驗平台爐系統方塊圖建立與數學模型推導
國立臺北商業大學	110年度無人載具科技創新沙盒暨實證運行推動計畫 (2/4)	無人載具營運 / 服務模式探討與研析
財團法人中華經濟研究院	110年度無人載具科技創新沙盒暨實證運行推動計畫 (2/4)	無人載具國際政策觀察與研析
財團法人資訊工業策進會	110年度無人載具科技創新沙盒暨實證運行推動計畫 (2/4)	無人載具國際法規觀測與國內法規調修研析
財團法人資訊工業策進會	110年度無人載具科技創新沙盒暨實證運行推動計畫 (2/4)	無人載具國際產業發展趨勢研析
國立成功大學	工業伺服電機節能驅動關鍵組件開發計畫 (3/4)	高速射出製程模擬整合硬體迴路
國立臺灣大學	工業伺服電機節能驅動關鍵組件開發計畫 (3/4)	伺服電機整合油壓系統之感測技術開發
國立臺北科技大學	工業伺服電機節能驅動關鍵組件開發計畫 (3/4)	感測資料融合系統之訊號處理
國立高雄科技大學	用於高效能矽晶太陽電池的關鍵製程研發設備開發計畫 (3/3)	太陽能電池之多晶矽鈍化薄膜鈍化接觸特性分析
國立中山大學	用於高效能矽晶太陽電池的關鍵製程研發設備開發計畫 (3/3)	穿隧氧化鈍化與堆疊型太陽能電池之特性分析
國立成功大學	地熱溫泉能源多元開發關鍵技術研發計畫	地熱兩相流孔板產能量測及分析技術開發
國立虎尾科技大學	多元合金氮化物於高階切削製造之效能躍升計畫 (1/1)	複材加工刀具設計研究
國立臺灣大學	金屬中心創新前瞻技術研究計畫 (1/1)	鈦鋁合金平衡相圖模擬與組織控制
國立高雄科技大學	高值金屬成型機械智慧機電整合技術開發計畫 (2/4)	伺服沖鍛有限元素分析與模具開發研究
國立高雄科技大學	循環鋁材創新應用製程技術開發計畫 (2/4)	應用回收鋁料多孔性成形之半固態溫度區控制技術
國立高雄科技大學	循環鋁材創新應用製程技術開發計畫 (2/4)	壓鑄件熱處理技術研究
岱冠科技有限公司	循環鋁材創新應用製程技術開發計畫 (2/4)	大面積鋁結構摩擦攪拌銲接模擬變異分析技術
國立高雄科技大學	智慧設備暨系統雲端增值服務技術開發計畫 (1/4)	視覺檢測整合輔助試模系統開發
財團法人鞋類暨運動休閒科技研發中心	智慧機器人與製造應用 AI系統開發計畫 (2/4)	除膠製程模組技術開發
國立虎尾科技大學	智慧機器人與製造應用 AI系統開發計畫 (2/4)	柔性材質數位參數建立研究
國立成功大學	智慧醫療科技應用與跨場域驗證計畫 (2/4)	數位口腔病理光譜分析與偵測探頭設計研發
國立臺北大學	新興智慧自動駕駛決策與控制關鍵技術暨整合應用研究計畫 (3/4)	車輛 AVB攝影模組之遠端影像顯示設計
嘉藥學校財團法人嘉南藥理大學	新興智慧自動駕駛決策與控制關鍵技術暨整合應用研究計畫 (3/4)	車輛自動駕駛 (ADS) HIL模擬動力計連線技術設計
凱思博科技有限公司	電動車輛線傳底盤關鍵次系統技術開發計畫 (3/4)	整車動態路況與懸吊調校模擬分析
國立高雄科技大學	電動車輛線傳底盤關鍵次系統技術開發計畫 (3/4)	底盤懸架感測動態分析研究
高苑科技大學	綠能科技技術分析與策略推動研究發展計畫 (3/4)	我國綠能太陽光電科技計畫研析

學校	總計畫名稱	研究名稱
國立臺灣大學	綠能科技技術分析與策略推動研究發展計畫 (3/4)	能源領域科技研發關鍵技術研析
財團法人塑膠工業技術發展中心	網通裝置混成板材開發與應用計畫 (1/4)	熱塑複材循環再生造粒及射出特性研究
國立中興大學	網通裝置混成板材開發與應用計畫 (1/4)	混成板材界面微觀結構研究
達璞股份有限公司	網通裝置混成板材開發與應用計畫 (1/4)	混成板材料機械特性及介面接合建模技術研究
國立高雄科技大學	網通裝置混成板材開發與應用計畫 (1/4)	混成板材熱成形模具設計準則研究
國立聯合大學	模具產業鏈整體數位轉型關鍵技術開發計畫 (2/4)	鑄鐵 (鋼) 件無冒口電腦模擬熱點分析研究
國立高雄科技大學	模具產業鏈整體數位轉型關鍵技術開發計畫 (2/4)	扣件產品製程設計模型研究
唐草設計股份有限公司	複合手術室系統與關鍵技術開發計畫 (2/4)	導航台車系統與探頭 ID 人因工程外觀美學協同設計
國立中山大學	複合手術室系統與關鍵技術開發計畫 (2/4)	3D 點雲 AOI 暨射頻定位技術
國立成功大學	複合手術室系統與關鍵技術開發計畫 (2/4)	自動化髖關節發育不良篩檢可行性技術評估
國立屏東科技大學	學研雙引擎推動在地產業科技加值創新計畫 (1/4)	法人推動在地產業科技加值創新 - 食品加工產業
國立陽明交通大學	離岸風場結構檢修與運維技術開發推動計畫 (3/3)	電化學技術運用於風力機結構件防蝕系統之檢測原型性能優化及數據分析報告

專利

專利名稱	案別	國別	證書號
狼尾草萃取物、製造方法及其用途	發明	中華民國	I718351
製造錐狀物之電化學加工方法及其加工設備	發明	中華民國	I719364
自動控制方法以及自動控制裝置	發明	中華民國	I734055
自動控制方法以及自動控制裝置	發明	中華民國	I734237
醫學影像建模系統以及醫學影像建模方法	發明	中華民國	I719365
積層金屬粉末回收裝置	發明	中華民國	I737947
化學氣相沉積設備、用於化學氣相沉積設備之方法及非暫態電腦可讀取媒體	發明	中華民國	I719361
鑄鐵結構件及其製造方法	發明	中華民國	I727230
阻尼控制裝置	發明	中華民國	I719712
封閉式輪葉之電化學加工裝置	發明	中華民國	I720442
磁浮軸承系統及其控制方法	發明	中華民國	I724348
肘關節復健系統與方法	發明	中華民國	I739097
形成半導體結構之方法及半導體結構	發明	中華民國	I733229
球狀顆料食材造粒裝置	發明	中華民國	I728513
熱交換裝置	發明	中華民國	I731501
導熱模組	發明	中華民國	I731500
在真空環境下可連續熔解金屬塊材的金屬件製程設備及製造方法	發明	中華民國	I734231
手術器械的校正裝置	發明	中華民國	I715290
燃燒控制方法	發明	中華民國	I733266
探針加工裝置	發明	中華民國	I723649
探針加工方法	發明	中華民國	I732612
換能器及其壓電環堆疊	發明	中華民國	I724671
摩擦攪拌銲接組件及摩擦攪拌銲接加工方法	發明	中華民國	I723841
殼模製造方法	發明	中華民國	I718785
金屬粉末製造裝置及方法	發明	中華民國	I721692
近眼顯示與取像頭戴裝置	發明	中華民國	I727511
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扣件尺寸的線上預測方法與扣件尺寸的線上預測系統	發明	中華民國	I729627
扣件成型機的測量系統	發明	中華民國	I724870

專利名稱	案別	國別	證書號
耐蝕不銹鋼	發明	中華民國	M607396
可局部拋光裝置及電漿電解拋光系統	發明	中華民國	I738427
造粒裝置	發明	中華民國	I737448
手術導航標記元件的固定裝置	發明	中華民國	I736402
使用高分子膜之拋光方法及裝置	發明	中華民國	I742862
具鈍化層之太陽能電池	發明	中華民國	I741814
鍛造模具組及其鍛造衝頭	發明	中華民國	I740646
低渦電流襯套	發明	中華民國	I750882
自動搬入箱系統	發明	中華民國	M607128
光學檢測模組	發明	中華民國	M607466
入料構造	發明	中華民國	M607474
具銅-氧化石墨烯複合薄膜的表面增強拉曼散射感測器、其製造方法、其檢測	發明	中華民國	I736419
側翻收容式巡軌台車設備及巡軌台車	新型	中華民國	M607989
優化金屬沖壓製程參數的方法與系統	發明	中華民國	I732655
手術器械的支持構造及其支持模組	發明	中華民國	I726801
手術器械的支持構造及其支持模組	發明	中華民國	I736502
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3D列印金屬粉末後處理設備	新型	中華民國	M606535
移動載具內輪差之警示系統	新型	中華民國	M607656
成形模具及應用其之殼件的局部持壓熱成形方法	發明	中華民國	I738541
定位方法與系統	發明	中華民國	I745156
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溫間輥抽裝置	新型	中華民國	M608019
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金屬發泡成形製程及其製造發泡金屬的方法	發明	中華民國	I744085
可調式懸吊裝置	發明	中華民國	I749913
用以改善鑄造流動性的鈦鋁介金屬及其製造方法	發明	中華民國	I744075
修復微粒、具有修復微粒的自癒性金屬材料及其製造方法	發明	中華民國	I745167
複合材料的製備方法	發明	中華民國	I740738
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鍛造成形道次預估方法及使用該方法的鍛造成形設計系統	發明	中華民國	I734641
摩擦攪拌銲接壓持治具系統	發明	中華民國	I739681
複合積層板、殼體及行動通訊裝置	發明	中華民國	I729965
骨科植入物用器械	發明	中華民國	I742925
手術空間註冊系統與方法	發明	中華民國	I749921
手術影像註冊系統與方法	發明	中華民國	I749922
手術空間註冊系統與方法	發明	中華民國	I741889
影像定位系統之即時定位補償方法及可即時定位補償之影像定位系統	發明	中華民國	I735390
影像分析系統與影像分析方法	發明	中華民國	I749909
手持式醫療磁消融裝置	新型	中華民國	M606707
感測電極	發明	中華民國	M615964

專利名稱	案別	國別	證書號
微粒噴頭、微粒成形裝置及其微粒成形方法	發明	中華人民共和國	ZL201611125131.8
基于深度值的手勢操作方法及其系統	發明	中華人民共和國	CN108073274
光學對位設備與光學對位方法	發明	中華人民共和國	CN109597178B
微波染色設備	發明	中華人民共和國	CN109423791B
振動線棒塗佈方法及塗佈裝置	發明	中華人民共和國	ZL201711304607.9
定位鎖固裝置	發明	中華人民共和國	4372446
以生理監測結合車輛控制的方法	發明	中華人民共和國	CN109849925
調整扣件成形機之模座相對位置的方法	發明	中華人民共和國	CN111069423B
鍛壓製品背壓輔助成形模組	發明	中華人民共和國	CN111097872B
複合沖壓成形裝置	發明	中華人民共和國	CN111069428B
碰撞緩衝裝置	發明	中華人民共和國	CN111347990B
封閉式輪葉之電化學加工裝置	發明	中華人民共和國	CN111715954
複合式加工主軸裝置	發明	中華人民共和國	CN111230153B
Minimally invasive bone fracture positioning device	發明	美國	US10939945B2
PENNISETUM EXTRACT, PROCESS FOR MANUFACTURING THE SAME, AND USES THEREOF	發明	美國	US 11,033,599 B2
MEDICAL IMAGE MODELING SYSTEM AND MEDICAL IMAGE MODELING METHOD	發明	美國	US10,909,773B2
RADIO FREQUENCY POSITIONING SYSTEM	發明	美國	10915718
SENSING DEVICE OF PRESSURE AND TEMPERATURE IN MOLD	發明	美國	11041767
METHOD FOR PROCESSING PROBE	發明	美國	US11,173,561
APPARATUS CAPABLE OF LOCAL POLISHING AND PLASMA-ELECTROLYTIC POLISHING SYSTEM	發明	美國	US11,186,920B1
METHOD FOR INTEGRATING VITAL SIGNS MONITORING WITH VEHICLE CONTROL	發明	新加坡	10201808395Q

出版品

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國際合作



法國 France

合作單位 Institution：IMT-MINES

計畫名稱 Project Title：

高溫耐磨金屬加工工具製程技術應用研析國際合作開發計畫

Application Analysis of Process Technologies for High-temperature Wear-Resistant Metal Tools

德國 Germany

合作單位 Institution：Fraunhofer IPA

計畫名稱 Project Title：

混合感知型 AI 學習智慧爪技術開發國際合作推動計畫

International cooperation of artificial intelligence bin picking with multisensors gripper technology

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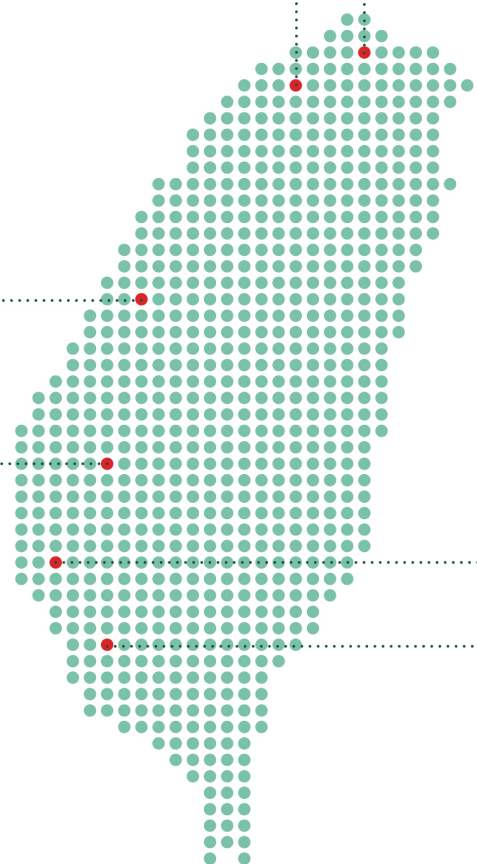
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110 年報

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