108年報

財團法人金屬工業研究發展中心

MIRDC

ANNUAL REPORT 2019

Metal Industries Research & Development Centre

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董事長序—

創新驅動 產業活化 邁向尖端

自中美貿易競爭發生至今，深深影響全球經濟、科技與產業等發展，尤其更加速台商與跨國企業全球布局調整，形成供應鏈短鏈化、在地化。由於台灣是全球產業鏈相當重要的一員，在面對全球經貿加劇的時刻，如何趁此契機吸引或擴大更多企業來台投資。不僅是台灣的重要機會也是嚴苛挑戰。金屬中心身為研究型法人代表，除了持續深化研發創新量能作法，藉以支持產業永續經營發展，更重要的是鏈結中心研發量能，以推動既有傳產轉型升級作法，加速提升產業附加價值，另外透過扶植新興產業發展作法，驅動台灣產業結構優化，共同為台灣產業建構完整科技環境，奠定厚實創新與製造基礎，讓台灣在這場經貿競爭中脫穎而出，並在國際市場中搶奪先機。

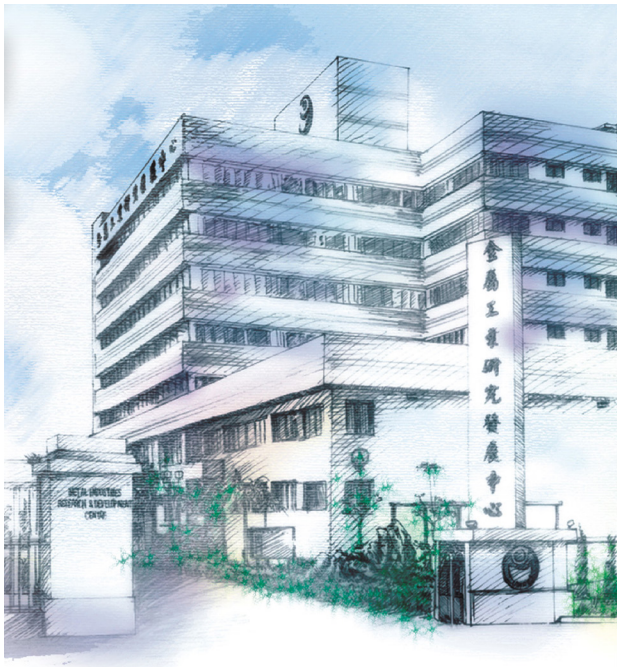
在深化研發創新量能方面，金屬中心長期聚焦金屬材料及製品、高值精微製品、醫療器材及照護、車輛、高值設備、綠能領域研發，協助重點產業科技發展與高值化應用。尤其透過系統整合、跨域合作、示範場域作法推動，已在研發基礎上奠定深厚的創新實力，如「智慧化 3D 視覺製鞋自動打粗塗膠技術」，將自動化設備導入於製鞋產業，整合 3D 視覺辨識、機械手臂與力補償技術，克服製鞋打粗工序自動化與鞋面 / 鞋底特定區域自動塗膠等技術瓶頸，成功取代傳統人工手動打粗及塗膠製程，協助國內製鞋業突破產業門檻，並同時榮獲愛迪生應用技術獎殊榮。另一項研發成果則是中心「協同搬運模組」技術，具備無線智慧、彈性運用、靈活移動三大特點，透過無線智慧協同搬運系統，可即時同步操控數台的自動導向車 (AGV)，更將若干個載具進行遠端操控串連結合與運行搬運，突破現有磁軌式或整車式搬運模式，更榮獲 R&D 100 Awards 及愛迪生運輸與物流獎殊榮。相關研發成果在在突顯出中心核心技術的穩固扎根與創新精進。

在推動傳產轉型升級方面，由於台灣南部與中部分別是傳統產業扣件與手工具產業聚落基地，前述產業發展與台灣經濟成長呈現高度關聯性與影響性，如何持續提升產業競爭力，是目前刻不容緩的議題。以扣件為例，台灣扣件產業為全球第 3 或 4 大生產國，近 3 年平均出口值約新台幣 1,200 億元以上。中心為協助扣件傳產業轉型升級，整合國內設備廠、軟硬體服務廠商、系統整合商等，並結合中心建立「金屬扣件產業智慧製造示範產線」，導入扣件智慧服務雲，串聯上中下游供應鏈的資訊，發展扣件創新合作模式。此外，台灣手工具業為台灣金屬製品之第二大出口產業，相關產業九成以上產品都是外銷，近 5 年平均出口值約新台幣 1,000 億元以上，有鑑於此，中

心與中鋼、台灣手工具工業同業公會、中衛中心共同成立「手工具研發檢測中心」，建立台灣第一家手工具專業研發檢測機構，就近提供台灣手工具產業高值化所需之研發、檢測、試製等服務，提供產業客製化解決方案。藉由整合中心研發量能與鏈結在地產業，不僅提升傳產與中小企業競爭實力，進而加速在國際市場站有一席之地。

在扶植新興產業發展方面，台灣能源 98%仰賴進口，提升能源自主及多元至為重要，如何藉由綠能產業培育推動，帶動國內產業及經濟發展，是目前重要議題，尤其綠能中之離岸風電推動，更被視為攸關台灣經濟、產業及能源結構優化關鍵動力。金屬中心執行經濟部「前瞻基礎建設計畫」，已協助政府於興達港成立「高雄海洋科技產業創新專區」，短期目標是離岸風電的人才培育，中長期逐步邁向海洋產業科技發展。同時中心鍵結國外機構如丹麥 Maersk、荷蘭 Marin、挪威 DNV-GL 等公司，進行各種海事工程合作與驗證。更聯合中鋼、台船等 66 家國內單位量能，分別成立 O-team、W-team、M-team、B-team 等聯盟，進一步協助台灣建構風力機供應鏈體系在地化與自主化。使得在地興達漁港得以蛻變成為亞太地區離岸風電的重要基地，進而創建出新興綠能產業發展，推動地區產業經濟永續經營。

面對全球化競爭，「創新、轉型」是重要關鍵，金屬中心將持續發揮「價值創造」之關鍵角色，提供金屬產業整體解決方案，幫助產業發展，促進國內金屬及相關產業升級，並持續深化核心技術、提高技術價值，透過鏈結國內外技術研發、人才、資源，凝聚產學研能量，協助廠商加速填補產業鏈缺口，扮演好政府與產業之間的溝通橋樑，為台灣創造產業價值與提升國際競爭力。



董事長 林仁益

執行長序—
活化深根 創造產業新價值

金屬中心長期以金屬科技研發帶動產業創新為目標，隨著新興產業的發展及全球產業快速變化，積極協助國內金屬產業轉型升級朝向產品高值化及製造智慧化發展，維持國內產業在國際競爭力。面對環境的巨變，金屬中心透過四大政策方針進行技術研發方向的調整及內部組織的活化，改變本中心的文化與價值，以持續創新研發並提升服務量能。在四大政策方針上，我們透過人才紮根進行專業能力的深化、穀倉調和建立跨域合作的機制、數位轉型上以運用大數據分析來協助中心營運決策並輔導產業由傳統製造製程轉型至智慧製造來提升競爭力、技術深耕上以推動 COE(Center of Excellence) 來深耕關鍵技術建立與布局，並與指標性廠商及國際機構合作創造技術價值。

金屬中心長期深耕電化學加工技術，透過 COE 的推動與國內航太龍頭廠、國際頂尖機構鏈結，成功開發國產自主電化學加工製程與模組設備技術，並完成世界首創電化學加工 (ECM) 配合沖壓複合的連續式生產製程系統技術，從專利完整布局、製程、設備一條龍服務；以創新製程技術解決航太產業於高溫金屬製品加工刀具耗損耗時問題。同時推動與航太大廠合作投入發動機關鍵零組件電化學加工設備開發，有效提升 1.5 倍以上預加工效率、降低 30% 以上製造成本等，促進廠商承接國際大廠更多訂單，推動國內航太產業往航太高端動態零組件製造發展，共創藍海市場。

近年來隨著工業 4.0 時代來臨，智慧製造翻轉了傳統製造業的製程，讓製造業變得更科技化及更智慧。智慧製造可幫助企業連結起先前獨立工作的流程，透過智慧機台和設備記錄並分析即時資料，協助工作人員做出更好的決策。金屬中心以智慧自動化技術為基礎，整合專業製程知識，投入相關智慧製造技術開發，透過分析模擬技術縮短產品開發時程，建立設備與製程可視化技術，可解決傳統生產線上依賴人工、缺乏即時生產資訊應用的產業特性，透過製程設備之生產資訊連網，可提昇生產製程監測能力，事先預警提升良率。另也協助國內機車大廠將現有產線優化導入智慧管理系統建置，並透過本中心開發之鍛造設備智能化應用技術協助業者將既有的零組件供應鏈轉型升級。

金屬中心內部也進行跨部門技術合作，共同協助水五金產業進行材料開發、產線智慧化、產品認證及行銷推廣。在「材料開發」方面，取得無鉛黃銅材料國際牌號認證並授權國內衛浴水龍頭大廠；在「產線智慧化」方面，協助水五金產業建置智動化鑄造生產示範場域，可降低生產成本 15%，提高良率至 95%；在「產品認證」方面，可協助廠商在本中心 TPL 所建置實驗室取得國際檢測認證，符合品質需求；「行銷推廣」方面，結合彰化縣政府觀光場域建置水五金精品館及水五金產業主題設計中心，提升在地產業價值。

金屬中心在地服務產業近 60 年，一直扮演協助傳統產業及中小企業的產業升級與轉型之角色，隨著全球環境及產業快速變化，未來我們將持續發揮創造價值的精神本位，在全體同仁的努力下為台灣產業注入更多創新動能，加速提升產業整體競爭力。

執行長 林秋鑒

「竭盡所能、創造價值」金屬中心作為鏈結金屬產業的關鍵角色，致力整合跨領域產業，持續精進核心技術、輔導產業轉型與升級，建立國際級研究發展機構。

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願景使命與重點產業回顧

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，也是其中唯一將總部設立在高雄的研究單位。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，並朝「成為以金屬科技領航創造跨領域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，隨著國家產業政策發展及環境變動，一直肩負著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，持續協助傳統「金屬材料及製品產業」升級，並將核心技術能量對焦深化，延伸應用至「高值設備產業」、「車輛產業」、「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、創新服務等能量，積極配合政府力推的「五加二產業創新政策」，持續扮演推動產業轉型及升級的關鍵角色。

此外，中心將形塑成為「Hub」角色，成為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。

在經濟部支持下，由本中心負責興建營運的「經濟部傳統產業創新加值中心」已於107年3月20日舉行揭牌暨開幕典禮，該傳產加值中心座落於本中心楠梓總部附近，設有傳產創新大樓1棟，廠房3棟（積層製造中心、金屬智慧製造中心、試作中心），可協助南部傳統產業業者導入快速產品開發、智慧化數位製程、發展高值創新產品，並成為產學研交流與示範的平台，創造多元化的產業發展資源，開創南部傳統產業發展之新局。

金屬材料及製品產業回顧與展望

金屬是經濟發展不可或缺的重要材料，金屬產業的榮枯也與經濟成長呈高度正相關，因此受到美中貿易戰影響全球經濟趨緩，2019年我國金屬產業（含基本金屬業、金屬製品業）產值為新台幣2.09兆元，較上一年度下跌9.4%（如表1所示）。其中鋼鐵業產值為1.13兆元，下跌10.0%；非鐵金屬業產值為2,126億元，下跌13.4%；金屬製品業產值為7,462億元，下跌7.3%。

以總量來看，基本金屬最大宗的鋼鐵，2019年出口金額預估為新台幣5,114億元，進口金額為3,017億元，與2018年相比之下，進出口表現均下滑將近一成，主要歸因於受到美中貿易戰影響全球景氣減緩，但從近幾年總量來觀察皆呈現貿易順差的情況；非鐵方面，2019年預估出口金額為新台幣1,823億元，進口金額預估約為3,005億元，貿易順差約-1,182億元，與鋼鐵相同，大宗金屬市場表現均受到貿易戰而下滑，其中貿易逆差有微幅增加，顯示後續台灣非鐵金屬材料在進口替代將是未來應持續努力之目標。

產業現況

表 1 台灣金屬材料及製品 產業產值變化

單位：新台幣億元；%

年度	基本金屬 -鋼鐵	基本金屬 -非鐵	金屬製品	總計	年成長率
2009	9,536	1,845	5,615	16,997	-33.4%
2010	14,128	2,686	7,402	24,216	42.5%
2011	15,146	2,871	8,288	26,305	8.6%
2012	12,905	2,782	7,895	23,581	-10.4%
2013	12,175	2,475	7,824	22,474	-4.7%
2014	12,712	2,632	8,265	23,609	5.0%
2015	9,624	2,540	7,616	19,780	-16.2%
2016	9,166	2,093	7,409	18,667	-5.6%
2017	11,205	2,266	7,790	21,260	13.9%
2018	12,626	2,455	8,053	23,134	8.8%
2019	11,360	2,126	7,462	20,949	-9.4%

資料來源：經濟部統計處工業產銷存動態調查 / 金屬中心產業研究組整理（2020/01）

表 2 台灣金屬材料及製品 產業進出口金額變化

單位：新台幣億元；%

進出口產品別		2015	2016	2017	2018	2019	年複合成長率
出口金額	1. 基本金屬鋼鐵（含半成品 / 一次 / 二次加工品）	4,750	4,537	5,149	5,627	5,114	1.5%
	2. 基本金屬非鐵	1,724	1,682	1,897	1,997	1,823	1.1%
	3. 金屬製品	1,363	1,312	1,350	1,377	1,402	0.6%
	合計（1+2+3）	7,837	7,532	8,396	9,001	8,339	1.3%
進口金額	1. 基本金屬鋼鐵（含半成品 / 一次 / 二次加工品）	2,709	2,508	2,843	3,331	3,017	2.2%
	2. 基本金屬非鐵	2,726	2,658	3,156	3,167	3,005	2.0%
	3. 金屬製品	234	241	232	251	246	1.0%
	合計（1+2+3）	5,669	5,406	6,591	6,749	6,268	2.0%
貿易順差	1. 基本金屬鋼鐵（含半成品 / 一次 / 二次加工品）	2,041	2,030	2,306	2,296	2,097	0.5%
	2. 基本金屬非鐵	-1,002	-976	-1,259	-1,170	-1,182	-3.3%
	3. 金屬製品	1,129	1,072	1,118	1,126	1,156	0.5%
	合計（1+2+3）	2,168	2,126	1,805	2,252	2,071	-0.9%

註：進出口碼範圍 - 鋼鐵半成品（7201~7207、7218、7224）、鋼鐵一次加工品（7208~7306，不含 7218、7224）、鋼鐵二次加工及製品（7307~7326）、非鐵半成品及一次 / 二次加工製品（7401~8113）、金屬製品（8201~8311）。

資料來源：台經院進出口資料庫 / 金屬中心產業研究組整理（2020/01）

產業貢獻及成果

為確保台灣金屬材料相關製品的國際競爭優勢，金屬中心透過高值化金屬材料產業創值平台的建立，結合業界科專、ERC、產學大聯盟、工業基礎技術等資源投入，持續朝產業高值化及附加價值提升之目標邁進。依目前規劃，將金屬材料及製品領域相關技術分為四個次領域，分別為：綠能材料及構件、生醫材料及製品、精密機械用材料及製品及高值化金屬製品。各次領域產業及技術發展現況如下：

綠能材料及構件

2019年協助業者因應國際趨勢及政府政策，鎖定再生能源與循環經濟領域，以智慧節能、多元創能、循環再生及科技儲能為發展方向，將依高效率、低能耗、循環延壽等需求，發展國內關鍵材料與製程優化技術，推動產業材料自主及技術扎根建構自主供應鏈，帶動綠能產業成長進軍國際市場。因應高效率/低能耗之節能趨勢，開發輕量化構件之成形技術，如玻纖熱塑複材（GFRTP）成形及與金屬異材接合技術（AB膠合件抗剪　度達3,102±194N/cm2，LAMP接合件抗剪負荷達3,378N），透過應用CAE模擬技術應用於金屬製品的生產製造，篩選最適化製程與提升減廢效果；並進行功能性合金（耐溫 /耐候）研發，結合回收再製及改質延壽技術，達材料循環再生運用。

產業推動方面，則推動建立國內高性能材料之自主研發能量，補足綠能元件應用產業缺口，以及促動在地標竿材料廠投入新材料研發，推動上中下游產業結盟，帶動業者轉型並切入終端產品供應鏈體系。（1）熱衝壓技術推動部分，推動業者將熱衝壓技術及B柱製品導入國內自主車廠車體結構應用，促進國產熱衝壓鋼材大幅提升銷售規模達12萬噸以上，為國內唯一熱衝壓供應商，市占率為100%，新產品已完成品質系統認證，順利導入小改款車型應用，已獲得超過8家知名車廠供應商資格認證。協助人才培訓2梯次專業熱衝壓人員，共完成20位碩、博士的完整訓練，並已實際投入模具開發與製程生產。（2）熱塑複材產業推動部分，創新金屬與熱塑複材異質混成，帶動產業邁向循環經濟圈，促建新產線、新投資，創造產品應用高度（長興、巨大、明安、美富公司），金屬與熱塑複材異質接合與混成材料技術，影響產業鏈新創產值30億元台幣以上/年。（3）離岸風電產業推動部分，金豐與CS Wind合作投入離岸風機塔架生產，以台中港工業區作為生產基地，投資額約6億元；獲西門子歌美颯（SGRE）與三菱重工維特斯（MVOW）訂單，預計在2020年可全面量產，年供貨預計可達100支離岸風機塔架，產值達30億元。

未來展望與規劃方面，持續推動綠能產業發展所需之關鍵材料與技術研發，如高效率流體機械材料及高導磁鋼材（High-Magnetically conductive steel）材料研發，亦發展海洋鋼構銲接製程技術以運用離岸風力機組（Offshore Wind Turbine）；並發展運輸載具（汽車/自行車）輕構件之相關技術，如碳纖熱塑複材成形及異材接合技術、高強度鋁合金熱衝壓技術等，以符合國際輕量節能、製程減廢及材料回收等發展趨勢，協助建立在地化產業供應鏈。

生醫材料及製品

2019年發展生醫級3D電子束列印鈦合金及可降解鎂合金等金屬材料及其應用技術，於電子束3D成形製程技術建立，鈦合金緻密度達99.9%，且建構不同晶系結構設計不同孔隙率之楊氏係數資料庫，目前楊氏係數可控於3-15 GPa，符合人體所需3-50 GPa。同時也輔導國內生醫廠商公司取得台灣（TFDA）、美國（FDA）之金屬醫療植入物許可證，將持續協助示範廠商試量產，使此產品投入國際市場與國內醫療院所通路；後續將此技術開發更多相關產品應用及推廣至醫材業者，提升國內品牌於國際市場能見度。

在可降解鎂合金部分，申請一種降解鎂合金粉末成份設計的方法專利，一種藉由合金混合熵值控制鎂合金降解速率的方法，開發大表面積活性金屬粉末之降解材料，達到粉末能在乾燥大氣中保存，且於水溶液中的均勻穩定的降解，發現鎂鋅鈣合金在SBF中之降解速率隨熵值增加而減少，可做為合金設計時重要之指標參考。傳統可應用於線材及塊材之合金，不適用於鎂合金粉末，主要原因為過大的表面積，CaMg2相將快速在空氣中吸收大量的水氣，造成鎂合金粉末失效。其次，發展出高鋅鈣含量之鎂合金，其在水溶液中的降解速度與線材相同。

在相關技術產業化推動方面，協助國內醫材骨科醫材廠商寶楠公司建立電子束3D成形技術，並進行多孔醫材試製，整合寶楠生技（醫材設計）、成大（生物相容性）、北科大（材料分析），取得美國FDA認證。希望藉標竿廠商經驗引領如材料、醫材等廠商跨足3D成形技術，可加強自身技術能量、自主開發新產品，且有效提升國內品牌於國際市場競爭優勢，預估創造產值1億元以上。另外經由金屬中心建立3D列印技術之經驗，輔導可成生技於案例之客製化設計，無論是力學模擬分析、多孔結構分布於植體設計，或是進行3D列印時，列印之位置、速度與產出成品之性質關聯性，皆可提出相關，以供可成生技作為參考依據，設計符合患者需求之客製化3D植體服務流程。

精密機械用材料及製品

2019年之領域技術發展方向，主要聚焦在精密機械用部品之製造技術再精進。例如近淨型伺服鍛壓成形技術建置部分，以政府機關之環構計畫為主軸，透過中心智慧化成形實驗室，建置伺服成形製程優化模組。其中包含低速多階速控成形模組及脈衝式速控成形模組應用，以機器人用諧波減速機之諧波齒輪做為開發載具，並進行伺服沖鍛成形模組及技術的開發及驗證。透過該模組及近淨型成形技術所製造之諧波齒輪，其尺寸精度可達±0.015mm、表面精度可控製在Ra≦0.8μm之等級。伺服成形製程技術之開發，可協助國內金屬製品製造業者往智慧製造領域邁進，有助於提升客製化搶單能力，預計相關影響產值可達1億元以上。在鑄鐵相關處理技術方面，2019年投入發展鑄鐵溫度循環處理技術、低鑄造應力熔鑄技術、振動處理技術，與國內工具機廠、鑄造廠共同合作，開發高尺寸安定性鑄鐵處理製程，有經複合安定化處理之鑄件尺寸變異量小於未處理者30%，運用相關技術於工具機結構鑄件，提升結構鑄件經時穩定性，並降低廠商自然時效時間70%以上。

在技術產業化推動方面之重點為：（1）藉由智慧化伺服鍛壓成形技術協助國外Indoseiki公司進行車用螺帽試作開發，並協助其產線建置，並鏈結國內設備廠商所提供之線上自動化系統，提升生產穩定特性，改善量產良率問題，達到高階金屬製品市場需求並切入全球高端市場。藉由本合作研發案促成Indoseiki公司於相關開發及產線建置投資達3000萬元，預計未來每年將有1億元以上之產值。（2）持續投入拓展中心所建立之厚壁沃斯回火球墨鑄鐵材料相關技術之產業化應用。除持續協助成大精機公司應用於太陽能廠設備用追日出力齒輪外，108年度相關衍生應用包含（A）嘉鋼精密公司外銷AGCO農機所用鑄件、（B）萬事興、川源、加興、高輝、高堃等營造廠使用之耐磨之幫浦零件、（C）浚峯及榮豐公司之攪拌手臂、（D）振豐公司之曲軸、（E）光隆公司之鍊輪。共計衍生產值達2000萬元以上。

在未來展望及推動規劃方面，本次領域除持續推動既有技術成果之產業化拓延應用外，將持續深化智慧化伺服鍛壓成形技術與模組合新技術，應用於高階金屬製品生產製造，提升金屬製品附加價值，協助業者朝電動車、機器

人、航太等產業所需用之關鍵精密部件供應鏈切入，以提升精密設備之關鍵部件國產自主之競爭能力。另在鑄件尺寸安定化技術推廣方面，將持續進行製程優化與產業驗證推廣，並規劃成立相關研發聯盟，建構上中下游產業鏈，協助國內業者建立高尺寸安定化鑄件處理自主能力。

高值化金屬製品

2019年在經濟部工業局支持下，金屬中心建立沖壓模具產業智慧製造示範場域，以及發展智慧模具開發與生產技術。示範場域主要設備包含包含400噸伺服沖床，及其週邊送料裝置、六軸機器手臂、成品快速3D掃描等裝置，全部採國產設備；同時發展雲端生產資訊平台、智慧虛擬試模與模具開發資料庫、線上模具監診等，以產品高值化、製造智慧化及管理數位化為三大目標，並提供觀摩參觀、模具開發、零件代工、智慧製造技術輔導等服務，未來可成為各單位合作研發之據點。

過去單靠低價及追求規模經濟、大量生產之策略已逐漸失效，台灣金屬製品產業已進入必須加速導入智慧製造能量引領產業轉型升級的階段。2019年輔導英發企業股份有限公司，結合崇碩機械（智動研磨系統、工件研磨參數資料建立）、協駿機械（智動研磨工站規格設計）共同開發扳手智動研磨系統；輔導捷流閥業股份有限公司，結合亞經科技（軟體、程控模組技術支援）、佳和公司（機構與組件加工、電鍍、特殊硬化處理）共同開發蝶閥製程快速智機化檢測設備；輔導再壕金屬有限公司，結合松浩機電（設備）、怡科科技（金屬CNC加工）、協易機械（終端應用）共同進行離心鑄造模內感測智慧製造；輔導國華鐵櫃實業有限公司，結合金豐機器（沖壓設備）與科智（機聯網行動數據）共同建置金屬沖壓智動化製造與可視化資訊平台。

衛浴五金產業推動方面，一直持續輔導業者於產品注入資通訊（ICT）科技與文創美學元素，製程導入智動化與綠能環保，也藉由水五金產業聚落優勢，共同發展創新商業營運模式。2019年推動水五金創新設計中心，計有水五金業者20家、創客硬幫幫10家加入，同時鏈結學界建國科大及明志科大設計學院能量，共同發展水五金產業創新（設計與技術創新）服務（B2B）營運模式。設計中心聚焦先進國家高階產品市場在水路結構高度複雜（造型特殊）、複合多功能以及具材料（抗脫鋅）與環境嚴苛（防凍）特殊需求類產品，提供聚落廠商設計方向與創新製程解決方案。

手工具產業推動方面，2019年由中國鋼鐵、金屬工業研究發展中心、中衛發展中心、台灣手工具公會四單位共同組成手工具研發檢測中心，針對台灣手工具業者現階段面臨的問題進行先期研究分析，依照產品市場需求量與急迫性，在套筒、鐵皮剪、扳鉗、切管器、扳手、氣動工具、工具車等7個研究主題，進行高值化、輕量化、結構優化與創新產品設計，協助廠商以共同研發或產學合作等方式，提升產品品級及附加價值。此外也針對業界共通性議題，舉辦研討會交流，共同學習國際手工具產業趨勢新知。

未來展望及推動規劃方面，將持續聚焦金屬產業中，產值大、出口動能高、廠家數與就業人數多、產業聚落明顯以及具高值化潛力之領域，包括扣件業、手工具業、模具業、水五金業、工業用閥業、鑄造業、鎖製品業，以及共通性需求高的表面處理業與鋼鐵材料業，協助上述產業導入智慧製造能量，增強國內金屬產業之國際競爭力。

高值精微製品產業回顧與展望

產業現況

- 精微製品之應用領域包含:可穿戴式電子裝置、通訊（communication）、汽車（automotive）、微力學裝置（micro-mechanics）、微型驅動裝置（micro-actuators）、醫學微創醫材、光學（optics）、與工模具（tooling & mold/die）等。國際預估2020年全球精微製品之產值將達8,000億美元。
- 精微製品與製造技術之發展趨勢，將朝向輕巧與低能耗、循環經濟之需求、生產模擬與製造技術整合、與快速開發智慧製造能力升級等。
- 台灣精微零組件需求將達新台幣8,000億元，台灣製造產值約新台幣3,812億元（2017）。2021年需求預期5,225億（MIRDC MII 2017）。需求多為光學/光纖連接器、連接器射出模具、手機鏡頭模組、精微噴嘴、生技產品、與精微設備系統等。
- 台灣微型零組件專業製造廠家約145家，北部37%、中部39%、南部24%，代表廠商為大立光、鴻海、正崴、可成、宏致、新日興、丞威等，主要涵蓋精微精加工、精微成形、精微處理、精微結合及精微組裝等五大次領域。
- 國內廠商之生產系統仰賴進口且以單功能機種為主，而產品精度、生產良率提升、精微領域整合人才缺乏、數位化模擬分析能量不足、複合材料、與對微型件之物/化特性陌生等，為產業間待克服之處。
- 玻璃鏡片成形用模具，因需要承受450~700℃的玻璃軟化溫度，所以模具材料上大多以碳化鎢材料為主，但是碳化鎢材料硬度高，加工過程不易維持高形狀精度與低表面粗糙度，成為發展車用、醫療及智慧機械等產業用玻璃成形製程發展障礙。

表 1 台灣精微製品產業產值變化　　單位：新台幣億元；%

年度	高階光學模組	高速通訊零組件（細間距連接器+光纖）	其他	總計	年成長率
2010	100	-	618	718	19.7%
2011	150	-	537	787	9.6%
2012	300	80	588	968	23.0%
2013	900	82	700	1,682	73.8%
2014	1,200	87	618	1,905	13.3%
2015	1,500	93	637	2,230	17.1%
2016	1,853	101	656	2,609	17.0%
2017	2,186	106	675	2,967	13.7%
2018	2,405	180	695	3,280	10.5%
2019	2,645	450	716	3,812	16.2%

資料來源：各公司年報 / 金屬中心 MII 整理

表 2 台灣精微製品產業進出口金額變化　　單位：新台幣億元；%

進出口產品別		2015	2016	2017	2018	2019	年增率
進口金額	1.高階光學模組	285	260	235	205	183	-10.7%
	2.高速通訊零組件（細間距連接器 +光纖）	215	270	355	275	230	-16.4%
	3.其他	1,700	1,750	1,810	2,080	1,924	-7.5%
	合計（1+2+3）	2200	2280	2,400	2,560	2,337	-8.7%
貿易順差金額因相關產品無具體出口金額可查與統計，故懸缺							
資料來源：海關進出口統計 / 金屬中心 MII 整理							

產業貢獻及成果

精微製造泛指可製作各種不同材料（不限矽基）、高精度（~μm）、微小（~mm）及/或薄型（~10μm），具3D複雜形狀及/或微細槽/孔（~50μm）等特徵之技術統稱；零組件尺寸大小與精度等級介於傳統機械製造與矽基/LIGA製程之間。1990年代3C產品之內部裝置與零組件已見其蹤跡，2000年起世界潮流朝微型與高精度化發展（如可攜式裝置等），其後更擴展至生醫與光電領域（現今微型零組件已無所不在）；為提升與提早佈局國內製造業競爭力，精微製造系統技術與產業之建立為重要使命。

金屬中心區分4個階段進行，期能逐步完成該使命：2003~2004年進行先期研究，包含精微（傳統、非傳統）機械加工、精微塑性變形、微銲接、微量測與微組裝等技術與設備。2005~2010年進行精微模具及成形之相關實驗室建置，並以載具產品開發（微細軸扣件、微細齒輪、微型流體動壓軸承、薄型馬達、微型馬達、微型變速器、微型泵浦等）帶動精微製造技術研究與發展及關鍵製程模組（設備模組化)自主開發。2011~2017年進行可重組精微製造設備與整合型複合製造系統自主開發(包含：傳統/非傳統機械加工、塑性變形、銲接、熱/表面處理、量測、組裝）；期間結合整合型複合製造系統自主開發（多機整合型與單機多功能複合型），建立外包供應鏈體系，再與產品廠或其Tier 1 ODM廠共同成立微件創新「共同開發實驗室」（丞威、連展、幃翔等），進而擴展成為「精微產業群聚」（目前30家以上）；2018年起積極促成精微智慧製造之國內標竿廠商，期望能藉以帶頭引領發展客製化智慧生產系統完整解決方案提供之新營運服務模式，具體之成果如:與標竿廠商祥儀與興光工業等公司，共同投入建立精微零組件熱處理設備系　技術研發，用於微小齒輪、扣件、軸銷、彈簧、探針、與魚鉤零件之調質／滲碳連續熱處理，未來可應用於汽車產業、智慧自動化與機器人產業、半導體產業、與航太產業等。與連展與順德等公司，共同投入精微加工、複合加工設備系統、與超精密模具示範產線研發等，提供光通訊產品、次世代高速通訊、與利基新產品應用。與亞力士、鉅侖科技、建興安泰、醫百科技、長欣生技、台達電、與志聖精密等企業，合作發展客製化設備、精密驅動模組、以及光學影像量測系統開發，跨足醫療、工業應用以及精密量測領域整合; 金屬中心2019年對於高硬度材料不斷的深入研究與製程規劃改善，建構超精密加工系統平台，結合橢圓超音波振動輔助加工關鍵設備模組以及鑽石刀具檢測與補償模組的開發，透過材料加工對應的參數和刀具進行平台驗證，實現碳化鎢鏡面加工的可能性與累積技術門檻。同時透過模具形狀的改變不僅能應對不同尺寸的非球面鏡片成形，對於陣列微透鏡也有機會利用玻璃成形的方式製作，增加了高硬度材料模具的應用，使得光場相機、多相機複合模組等得以有更佳的鏡片能使用。

車輛產業回顧與展望

產業現況

2019年國內汽車產業（包含整車業及零組件業）產值達新台幣3,808億元，再加上汽車電子，已成為台灣龍頭產業之一；但由於台灣內需市場小，需仰賴海外訂單活絡，惟2019年中國大陸與美國汽車銷售紛紛下滑，全球經濟受到中美貿易影響，台灣汽車產業環境更加嚴峻；近年來也由於進口車銷售比例大幅提升，導致國產車市場需求不足，造成國內整車業、零組件業產值紛紛下滑。出口方面，汽車零組件以海外市場之售後服務件（AM）為大宗，2019年標竿國歐美車市不景氣，加上全球經濟復甦緩慢、導致消費信心退縮、車廠態度轉趨保守，影響拉貨動能，汽車零組件也間接受到影響。

汽車產業正面臨著轉型，綠能、自動駕駛和車聯網將是未來汽車產業發展趨勢，對台灣汽車產業是危機也是轉機，目前傳統的汽車零組件廠正積極地與國內擅長之ICT產業進行合作，使產品更加智慧化、智能化，將更有機會切入國際供應鏈，同時也積極布局在電動化、無人化、輕量化，預期將帶動台灣汽車行業提高產品的創新率，整合最新的硬體和軟體開發，讓台灣汽車產業更具競爭力。

表 1 台灣整車及零組件產業產值變化　　單位：新台幣億元；%

年度	整車業	零組件業	總計	年成長率
2015	2,081	2,342	4,423	-2.8%
2016	1,906	2,279	4,185	-5.4%
2017	1,831	2,316	4,147	-0.9%
2018	1,691	2,260	3,951	-4.7%
2019	1,589	2,219	3,808	-3.6%

資料來源：海關進出口資料庫、車輛公會

表 2 台灣汽車零組件產業進出口金額變化　　單位：新台幣億元；%

進出口產品別		2015	2016	2017	2018	2019（e）	年增率
出口金額	車燈照明	340	343	357	345	367	0.7%
	板金沖壓件	249	267	297	292	287	-1.6%
	輪圈	119	124	121	109	100	-9.0%
	前 3大合計	708	734	774	766	754	-1.5%
	總出口金額	2,145	2,110	2,149	2,147	2,150	0.1%
進口金額	引擎零件	156	134	129	127	142	12.0%
	自動變速箱	114	100	90	69	64	-6.5%
	板金沖壓件	51	47	51	54	54	0.6%
	前 3大合計	321	281	270	250	260	4.5%
	總進口金額	1,017	940	924	934	1,010	8.4%

資料來源：海關進出口資料庫、車輛公會 /金屬中心產研組（2020/01）

產業貢獻及成果

金屬中心建立車體乘員艙結構關鍵零組件與快速試作驗證關鍵技術，協同車廠（華創）、零組件廠（宏利、永仁、伍享）進行模組化高強度鋼車體試作，整合傳統與新的製程技術手段，如高強度鋼熱沖壓共用模具導入金屬三維積層製造成型（3DP）列印異形及變徑水路，改善模具冷循環系統，避免製程熱點集中問題，建立完成製程參數，並有效滿足產品尺寸精度要求。另外，透過變異解析及自動化電阻點銲技術，建立組裝精度可視化/數位化控制調整技術，克服了高強度車體異種異厚鋼組裝銲接及尺寸變異問題。達到零件模組化/輕量化/模具共用化/治具共用化效果並完成相關產品化驗證，並協助整車廠下世代車輛達到2020年Euro NCAP安全認證能力，於2019年公開發表「URX」量產車（已經接單>1000台）及「MBU」概念車款，皆導入本輕量模組化共用平台技術。

下世代車輛輕量模組化車體開發與驗證

金屬中心協助國內利基車業者亞帝發公司，以技術移轉及輔導協助設計開發「智慧輔助立車穩定系統」及乘適性調校後的設計回饋，關鍵零組件裝置於三輪商用平台車上，供應短距離物流配送，其利基型機種於馬來西亞設立新廠銷售東南亞市場。該公司並於108年度與裕隆汽車合作，增設新生產線，推進歐洲、日本三輪利基重型車市場。

以底盤結構技術移轉及專利授權-綸盛公司、碩陽、達民、L公司等，進行高操安乘適性設計與輕量化利基車結構應用，並解決車輛系統整合及操安驗證，由底盤系統配置分析、結構安全性、轉向系統、煞車等系統整合於利基車輛平台應用，已成功推動業者投資封閉型場域之利基車輛開發，促成於大寮工業區及中壢工業區投資，建構廠房與增加生產線，投資預估≧1.5億元，初期將以台灣本地封閉場域進行試驗回饋，目標為海外市場推廣銷售。

微型利基車輛開發與系統驗證

醫療器材及照護產業回顧與展望

產業現況

隨著醫藥發達，出生率及死亡率逐年降低，全球老年人口的比例正大幅增加。根據聯合國統計資料顯示，全球老年人口至2050年將占總人口比率的22%，台灣老年人口則預估在2026年時超過20%，成為「超高齡社會」。加上慢性疾病人口的增加，老人醫療照顧與健康養生等相關商機湧現，全球每年相關產業產值更高達兩兆美元。各國對於醫療器材和醫療照護設備的需求殷切，帶動醫療器材及照護產業的持續進展。依據Business Monitor International Research（BMI Research）的研究報告指出，2018年全球醫療器材市場規模約為3,891億美元，預估2021年可成長至4,625億美元，2018至2021年之年複合成長率約6.5%。

台灣的醫療器材產業發展，在全球高齡化趨勢下，將帶動骨科醫材、牙科醫材、醫 用耗材等各項需求之成長，2018年我國醫療器材產業營業額為新台幣1,592億元，較2017年的新台幣1,463億元成長8.8%。展望2019年，隱形眼鏡仍是台灣醫材主要成長驅動力，可望持續貢獻整體營業額，且全球高齡化趨勢也將促進行動輔具、醫用導管等產品出口持續成長。此外，廠商近期積極布局新興市場的成效亦將顯現，配合政府持續釋放利多政策，有望帶動2019年醫療器材整體營業額持續成長。

我國2018年醫療器材整體進口金額達新臺幣773億元，較2017年成長6.6%。進口的前十大醫療器材產品，由於醫療需求和健保連結度高，產業結構變化相對穩定；進一步觀察2018年前十大進口醫材產品，約占整體進口總值的56%。2018年醫療器材出口金額達新臺幣686億元，較2017年成長10.8%，其中隱形眼鏡產品成長力道強勁，蟬聯第一大出口品項，出口金額達新臺幣126.11億元，較2017年成長15.7%，占我國出口比例的18%。

表 1 台灣醫療器材產業經營概況變化

年度	營業額（新台幣億元）	營業額成長率（%）	廠商家數（家）	從業人員（人）
2009	825	4.4	553	22,900
2010	928	12.4	580	25,800
2011	993	7.0	626	30,250
2012	1,092	10.0	705	34,200
2013	1,163	6.5	761	35,040
2014	1,232	5.9	781	36,429
2015	1,330	8.9	1,041	38,400
2016	1,415	6.5	1,073	39,500
2017	1,463	3.4	1,090	40,300
2018	1,592	8.8	1,128	43,850

資料來源： 經濟部生技產業白皮書

表 2：台灣醫療器材產業進出口金額變化　　單位：新台幣億元；%

進出口產品別		2014	2015	2016	2017	2018	複合成長率
出口金額	1. 隱形眼鏡	62.31	76.35	92.5	109	126.11	19.3
	2. 糖尿病試紙，切成一定尺寸	50.07	55.63	60.02	63.39	68.89	8.3
	3. 其他塑膠製實驗室、衛生及醫療用之物品	55.4	68.35	63.6	61.05	63.68	3.5
	4. 其他第 9018 節所屬貨品之零件及附件	45.71	48.5	54.66	52.27	57.51	5.9
	合計（1+2+3+4）	213.49	248.83	270.78	285.71	316.19	10.3
進口金額	1. 其他第 9018 節所屬之貨品	82.48	106.31	110.54	119.69	124.6	10.9
	2. 其他診斷或實驗用有底襯之試劑及診斷或實驗用之配製試劑，不論是否有底襯，不包括第 3002 節或第 3006 節所列者	49.81	53.3	56.89	58.73	61.45	5.4
	3. 雷射，雷射二極體除外	46.15	52.74	48.01	51.28	66.23	9.5
	4. 其他第 9018 節所屬貨品之零件及附件	31.91	36.79	35.15	43.16	36.48	3.4
	合計（1+2+3+4）	210.35	249.14	250.59	272.86	288.76	8.2
貿易順差金額	1. 其他第 9018 節所屬貨品之零件及附件	13.8	11.71	19.51	9.11	21.03	11.1

註：第 9018 節為內科、外科、牙科或獸醫用儀器及用具，包括醫學插圖器、其他電氣醫療器具及測定目力儀
資料來源：經濟部生技產業白皮書

產業貢獻及成果

在產業推廣及服務方面，本中心積極協助醫療器材發展之環境支援，例如提供醫療器材廠商所需技術或產品之國內外臨床法規諮詢、產品驗證檢測服務、產業人才培育訓練等，解決醫療器材產品開發過程中可能遭遇之瓶頸，並針對醫材聚落產品所需相關檢測進行服務。另也協助產業聚落周遭學研單位建置相關檢測、臨床之輔導平台，加速帶動南部醫療器材產業聚落生根，以提高產值及促進就業。

在協助南部醫材產業聚落推動方面，南科生醫聚落2018年營業額為95.52億元，2019年1至10月份營業額為73.95億元（製藥57.43%、醫材37.58%及生技食品4.99%），其中醫材廠商較去年同期成長10%。2016年至2019年已累計於6家醫療機構建置10條體驗診線，預計將有更多園區產品進入醫院採購系統，增加園區產值。另外，協助南科推動臨床研究型計畫，鼓勵臨床醫師採用園區產品，2016年至2019年已累計19案，協助產品增加臨床信賴，提升產品吸引力。

在科專研發成果產業化應用方面，金屬中心在經濟部技術處的指導及支持下，執行2019年「數位口腔暨脊椎微創導航系統開發與數位骨科手術輔助系統關鍵技術評估計畫（4/4）」，研發成果包括精準口腔補綴、次世代牙根、快速取像口內掃描、脊椎三維影像手術導航、數位病理影像篩檢系統與數位骨科微創手術輔助系統技術等關鍵項目。其中所開發的口腔骨缺損修復軟體、MAO金屬植入物表面處理量產製程技術、植牙規劃導引器械技術及植牙術前規劃技術、醫學影像組織分割與植體路徑模擬技術、Laser-DLP Based攝像式技術等，分別授權予華致資訊、德創科技、鴻君科技、怡科科技、英濟等公司，協助我國業者獲得關鍵醫材軟硬體技術與智財專利授權。

高值設備產業回顧與展望

高值設備產業包含智慧機械與生技製藥相關設備業，依據經濟部規劃推動之「智慧機械產業推動方案」，即是規劃將「精密機械」產業結合智慧化元素，提升為「智慧機械」產業，並讓台灣成為全球智慧機械及高階設備關鍵零組件的研發製造中心。根據機械公會統計資料顯示，2019年因中美貿易戰的影響，產值達約1.1兆元，較去年衰退7.6%。此外，2019年，機械設備出口值為新台幣278億美元，較上年衰退6.7%。

金屬中心在高值設備產業主要發展成型機械（使用模具成形的製程設備）、製鞋機械及生技製藥設備（涵蓋食品機械及零件）。根據經濟部統計處資料顯示，2019年成型機械、製鞋機械與食品機械產值總計為新台幣270億元，較上年同期衰退3.8%，其出口值為新台幣223億元，較上年同期衰退1.8%。顯見2019年成型機械、製鞋機械與食品機械產值與出口衰退，主要受到中美貿易戰的影響，預期隨著中美貿易協議之簽訂，臺灣在成型機械、製鞋機械與食品機械出口仍有相當大的發展潛力，未來臺灣相關廠商可透過加強產品研發與努力拓展海外市場，積極掌握商機。

表 1 台灣高值設備 產業產值變化　　單位：新台幣億元；%

年度	成型機械	製鞋機械	食品機械	總計	年成長率
2009	189	11.0	50	250	-30.8%
2010	300	18.8	63	382	52.7%
2011	284	15.9	68	368	-3.6%
2012	295	10.5	76	382	3.7%
2013	264	12.1	71	347	-9.0%
2014	267	17.7	73	358	3.1%
2015	244	19.5	67	330	-7.6%
2016	235	19.3	60	314	-4.9%
2017	226	15.4	60	301	-4.1%
2018	203	12.1	66	281	-6.9%
2019	179	23	68	270	-3.8%

資料來源： 經濟部統計處

表 2 台灣高值設備產業進出口金額變化　　單位：新台幣億元；%

進出口產品別		2015	2016	2017	2018	2019	年增率
出口金額	成型機械	168	169	167	166	149	-10.1%
	製鞋機械	37	34	31	28	40	40.1%
	食品機械	45	39	36	33	34	3.8%
	合計	250	242	234	227	223	-1.8%
進口金額	成型機械	20	19	27	27	27	-1.1%
	製鞋機械	2.4	2.2	2.5	1.9	3	33.9%
	食品機械	57	57	57	59	66	12.3%
	合計	79	78	86	88	96	8.6%
貿易順差	成型機械	148	150	140	138	122	-11.9%
	製鞋機械	-12	-11	-15	26	37	40.5%
	食品機械	-12	-18	-21	-26	-31	23.3%
	合計	124	121	104	139	127	-8.4%

資料來源：財政部關務署資料庫、台灣食品暨製藥機械公會

為因應未來市場快速變化、產品生命週期短、個人化少量多樣生產模式，各國紛紛推出產業再造政策，如德國推動工業4.0、美國推動先進製造技術AMP 2.0、日本推動產業振興計畫、韓國推動製造業創新3.0、中國大陸推動中國製造2025，各國政策核心內涵無非為善用資通訊技術、強化製造業體系，以達到智慧製造目的。我國亦師法德國工業4.0，以網宇實體系統（Cyber-Physical System, CPS）及美國AMP強調資通訊加值服務為主，結合兩者優勢，納入精實管理為核心，推動生產力4.0，2018年更聚焦於推動產業導入智機化，建立智機產業生態體系及產業智慧機械化，以維持我國製造業在國際供應鏈體系配合度高、產業群聚彈性生產特色。

智慧製造並非僅是工廠自動化，而是讓生產者與終端客戶、供應商之間，整條價值鏈沒有時差、沒有誤差地緊密串連與互動，以提升效率與彈性，精準控制成本。其主要核心精神在「智慧」，依營運模式發展之需，表現於企業（包括供應鏈體系）內外相關活動上，並善用各類ICT工具，經由模擬分析與虛實整合，達到可精準預測，進而能預警與預防之全局優化（Global Optimization）決策與執行，創造企業最大價值為目的。

高值設備產業領域策略所規劃之智慧機械產業定位：整合國內智慧化相關技術（機器人、物聯網、大數據、CPS、精實管理、3D列印、感測器等），並加強製程Know-How/產業知識整合導入於智慧製造，為國內製造業提供專業智慧製造解決方案。智慧機械從2017年開始聚焦在使用模具生產之金屬成形加工設備、支援中心重點產業領域之設備/系統（如精微加工、綠能系統、生技食藥設備等）智慧化，以及支援處於工藝技術不連續階段之主力產業，如鞋業等。技術發展重點在（1） 彈性/快速製造，例如快速換線與調校（刀工模治具、機台製程參數）、與視覺/觸覺整合之機器人應用（快速取放、整列、製程加工、拋光/曲面塗膠、組裝等）；（2） 預測/精準生產，例如最佳製程參數預估（製程CPS-Twin Model）、工件品質預測、刀工模具壽命預測、機台健康預測與預知保養、產線前後製程參數優化（Tool Matching）等。

高值設備產業領域策略所規劃之生技醫藥設備產業定位：提供生技醫藥業從研發到量產階段，因應製程與配方所需之設備技術支援，解決量產設備技術橋接問題。生技醫藥設備將聚焦於從試產端銜接生技材料/藥品產業的關鍵設備，技術發展重點在（1） 生物相容微載體製備技術；（2） 生物反應器設備技術；（3） 微膠囊設備技術。

綠能產業回顧與展望

產業現況

國內能源供應以進口能源為大宗，共占97.96%。國內2019年1月至11月能源總供給量為136,296千公秉油當量，其中因國內燃氣發電需求減少，同期進口能源減少0.86%，自產能源增加5.08%。進口的主要能源包含煙煤-煉焦煤、煙煤－燃料煤（包含亞煙煤）、焦炭、原油、石油產品、液化天然氣及核能、生質能及廢棄物等。在自產能源方面，包含原油、煉油廠進料、天然氣、生質能、廢棄物、水力、太陽光電、風力、太陽熱能等，僅占2.04%。

國內2019年能源消費量為77,709千公秉油當量，總能源消費較2018年同期減少1.71%。其中，工業部門為最大宗，占總消費量31.38%；非能源消費次之，占28.36%；運輸部門占15.94%；能源部門自用占8.83%；住宅部門占7.71%；服務業部門占6.98%；農業部門占0.79%。本期再生能源發電量14,264百萬度，其中，廢棄物能3,307百萬度，占23.18%；慣常水力5,381百萬度，占37.73%；太陽光電3,812百萬度，占26.72%；風力1,615百萬度，占11.32%；生質能149百萬度，占1.04%。另外，再生油品供給量0.10千公秉油當量。本期再生能源發電量較上年同期增加22.75%；其中，廢棄物能增加1.33%；慣常水力增加25.77%；太陽光電增加52.32%；風力增加13.80%；生質能減少5.37%。另外，再生油品較上年同期減少35.60%。

國家節能減碳總目標每年提高能源效率2%以上，使能源密集於2025年較2005年下降50%以上，並促進全國二氧化碳排放減量，計畫於2020年回到2005年排放量，預計2030年前溫室氣體排放量可比現況減少50%。

資料來源：能源統計年報，經濟部能源局網站

產業貢獻及成果

為永續發展綠能產業、提高能源使用效率與研發國內綠能應用技術，本中心2019年度研發方向致力於建立能源系統發展量能，並依據第二期能源國家型科技計畫架構，分別在節能與創能主軸下，進行高效率燃燒、太陽光電、風電、地熱能等相關研究，發展智慧型可重組蓄熱燃燒系統、用於高效能矽晶太陽電池的關鍵製程研發設備、離岸風場設備檢修與維運技術、地熱溫泉能源多元開發關鍵技術及地熱溫泉熱導引於熱再生化學電池模組技術等，以及驅動產業發展，打造綠能創新產業生態系相關計畫，包括綠能產業推動計畫、推動離岸風電與太陽光電產業升級轉型推動計畫、海洋機械產業推動計畫等，共投入75.66人年，總經費2億4,551.7萬元（詳見表1）。

2019年度本中心於節能領域發展智慧型可重組蓄熱式燃燒系統應用於連續式工業爐整合設計技術，可協助大型工業爐與連續爐金屬高溫燃燒加熱製程業者節能35%以上；於創能領域發展用於高效能矽晶太陽電池的關鍵製程研發設備，開發關鍵製程研發設備平台驗證高效能23%鈍化型矽晶太陽電池產品；離岸風場結構檢修與運維技術因應2020~2025年建置離岸風場之20年運維需求，研發自動化及水下探測技術，協助運維人員檢修及監控風場運轉，以提升風場結構檢修效率；地熱溫泉能源開發利用既有技術基礎，快速將地熱溫泉能源轉化為民生用資源應用。此外，發展地熱溫泉熱導引於熱再生化學電池模組技術，促成地熱溫泉氣熱能捕捉與轉換再生電能運用，加值本國地熱溫泉水熱能發電技術應用與地熱溫泉綠能場域耕耘能量。除了研發型專案，本中心同時協助建構國內產業鏈，包括綠能產業推動計畫透過追蹤部會署計畫以產業需求帶動研發能量，驅動產業發展，打造綠能創新產業生態系。而離岸風電與太陽光電產業升級轉型推動計畫整合產業資訊，帶動大型企業帶領國內供應鏈，共同參與離岸風電區塊開發，並推動新興離岸風力機安裝服務能量，推動國際合作建構風力機安裝人才培育與提升離岸風力發電產業自主設計開發能力，媒合業者切入國際供應鏈。海

洋機械產業則推動計畫可因應遴選風場開發商落實產業關聯方案採購本地廠商產品，協助業者籌設或改建廠房設備、導入智慧化製程。

2019年度達成主要的績效指標為協助10家廠商取得綠能設備製程驗證，並節省能源1,000 KLOE，且透過技術移轉至工業爐業、太陽能設備業、海洋工程業、機械加工設備業及節能技術服務業者，並實際應用於鋼鐵業、精密鑄造業、金屬製品業、太陽能產品、綠能產業、表面處理業、電力設備業、金屬加工業、住宿業、溫泉業、化學電池、離岸風電產業、水產加工產業、海洋科技產業等，共促進業界投資逾4億1,455萬元，創造10億1,350萬元以上之產值。2019年度能源效益估計達8,407公秉油當量，約可減少17,772公噸CO_2排放，未來將持續投入高值化綠能技術，以創造友善環境之經濟體。

表 1 金屬中心 2019 年度能源領域研發計畫統計表　　單位：新台幣

計畫名稱	智慧型可重組蓄熱燃燒系統開發計畫	用於高效能矽晶太陽電池的關鍵製程研發設備開發計畫	離岸風場結構檢修與運維技術開發推動計畫	地熱溫泉能源多元開發關鍵技術研發計畫	地熱溫泉熱導引於熱再生化學電池模組技術探索創新前瞻計畫	綠能產業推動計畫	離岸風電與太陽光電產業升級轉型推動計畫	海洋科技人才育成、創新產業軟硬體及委託營運專案	合計
投入人年	17	3	17.08	4	3.5	8.9	12.8	42	108
計畫經費（千元）	57,000	11,500	45,000	12,000	10,000	20,000	66,960	239,000	461,460
促進投資（千元）	283,500	30,000	60,000	22,600	5,000	-	12,026	-	413,126
創造產值（千元）	480,000	395,000	120,000	-	-	-	18,502	-	1,013,502
協助產業別	鋼鐵業、化工業、金屬製品業、精密鑄造業	太陽能產業	綠能產業	鋼鐵業、表面處理業、電力設備業、金屬加工業、住宿業	溫泉業、化學電池、金屬零組件。	離岸風電產業、太陽光電產業、生質能、地熱產業	離岸風電發電系統開發商、風力機組者、零件製造業	離岸風電產業、水產加工產業、海洋科技產業	

「**凝聚能量、永續發展**」金屬中心重視國內外技術研發人才及技術資產，透過創新服務與革新營運組織，發揮產學研交流能力，創造出多元化的產業發展資源。

ANNUAL REPORT 2019

METAL INDUSTRIES RESEARCH & DEVELOPMENT CENTRE

營運概況

董事及監察人名冊

財團法人金屬工業研究發展中心第 23 屆董事及監察人名冊

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常務董事	林德生	經濟部技術處副處長
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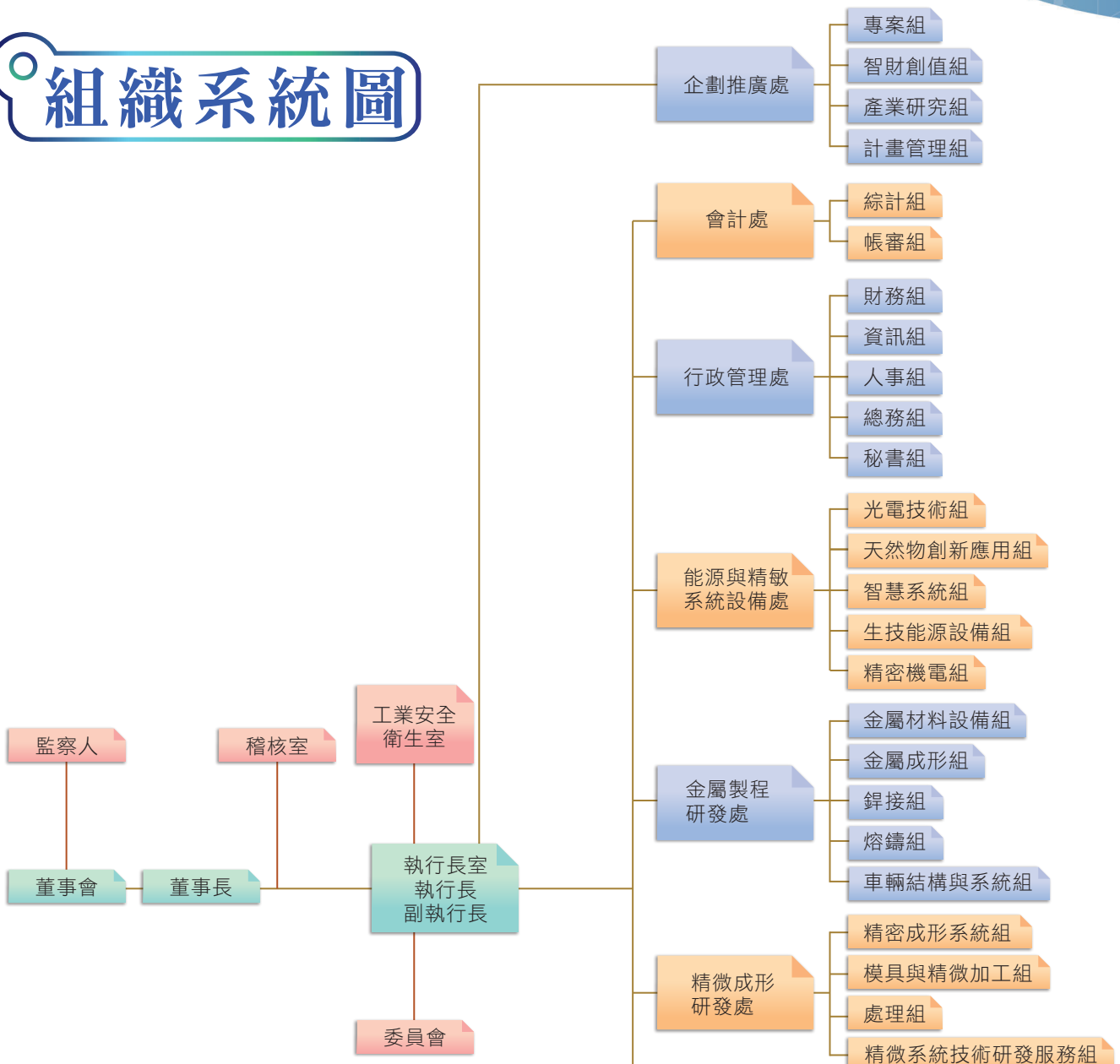
組織系統圖


監察人
稽核室
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董事會
董事長
執行長室
執行長
副執行長
委員會
企劃推廣處
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金屬材料設備組
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銲接組
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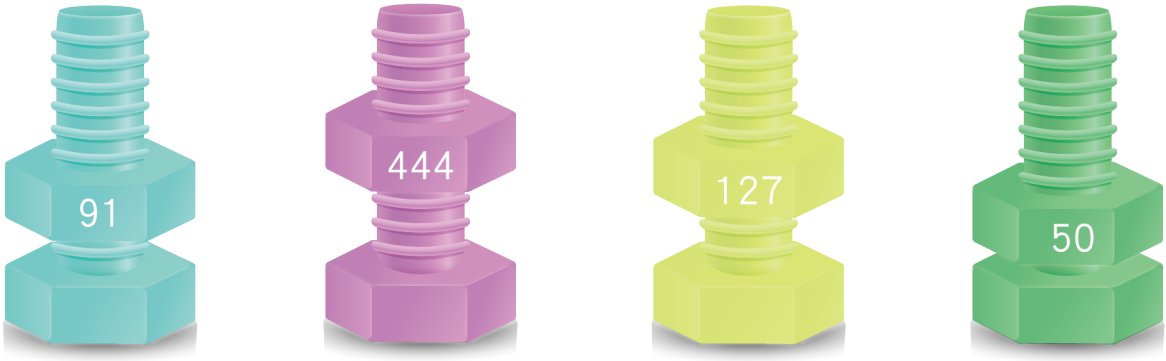
醫療器材研發組
複合醫材技術組
醫療器材產業服務組

人力

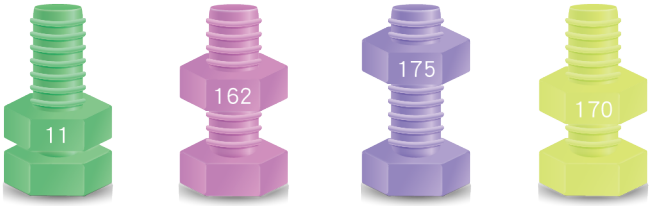
員工人數：712 人 ｜ 平均年齡：42 歲

學歷 （人數）

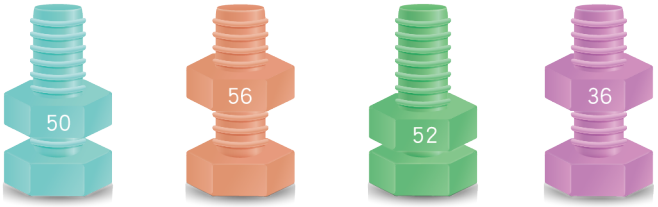


博士　碩士　學士　專科及其它

服務年資 （人數）



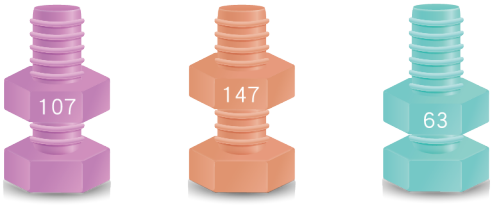
1年以下　1-5年　6-10年　11-15年



16-20年　21-25年　26-30年　31年以上

專長 （人數）

機械/自動化/模具　材料/化工/化學　電機/資訊/光電



醫療/生技/其他工程　管理/行銷/會統　其他

備註：資料基準日為 2019 年 12 月 31 日

財務報表

收支餘絀表

單位：NT

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	3,020,653,817	100.00	3,031,875,658	100.00	11,221,841	0.37
業務支出	2,953,719,105	97.78	2,957,581,408	97.55	3,862,303	0.13
業務賸餘	66,934,712	2.22	74,294,250	2.45	7,359,538	11.00
業務外賸餘	(2,510,542)	-0.08	2,907,586	0.10	5,418,128	-215.82
稅前餘絀	64,424,170	2.13	77,201,836	2.55	12,777,666	19.83
所得稅費用	8,467,804	0.28	14,433,084	0.48	5,965,280	70.45
年度餘絀	55,956,366	1.85	62,768,752	2.07	6,812,386	12.17

資產負債表

單位：NT

項目	本年度決算	%	項目	本年度決算	%
流動資產	1,024,653,347	54.23	流動負債	526,868,633	27.88
基金及長投	85,918,706	4.55	長期負債	22,265,308	1.18
不動產、廠房及設備	668,596,725	35.38	其他負債	72,583,079	3.84
無形資產	66,268,737	3.51	負債合計	621,717,020	32.90
其他資產	44,147,775	2.34	淨值	1,267,868,270	67.10
資產總計	1,889,585,290	100.00	負債及淨值合計	1,889,585,290	100.00

「**發揮實力、勇奪榮譽**」將扎根穩健的研發能量導入創意活水，持續突破研發的瓶頸障礙，打造國際競爭力及 MIT 美譽，開創金屬科技的創新價值與前瞻願景。

ANNUAL REPORT 2019

榮耀成果

獲膺榮耀

108 年 10 月

受獎人員 / 單位：楊光勳、戴聖儒、呂承祐、蘇炳華 / 製程處
呂英誠 / 執行長室
李月修、黃偉咸、雲貴鈴、魏燕伶 / 企廣處
頒獎單位：全球百大科技研發獎（R&D 100 Awards）

本中心所開發的「協同搬運模組」擁有無線智慧、彈性運用、靈活移動三大特點，透過無線智慧協同搬運系統，可即時同步操控數台的自動導向車 (AGV)，若干個載具可以進行遠端操控串連結合，執行搬運任務。同時採用 360 度移動全向輪設計架構，相較於傳統搬運模式，針對室內狹小空間傳統無人車無法順利運行的區域更具備靈活運用的優越性能；此外，對於體積大且不規則的載體時，僅需增加載台的數量即可完成任務，全方位移動平台均可輕鬆克服，不僅實現了未來智慧化的搬運模式，更勾勒未來科技的便利生活藍圖，獲得「2019 R&D 100 Awards」之榮耀。

108 年 4 月

受獎人員 / 單位：邱振璋、翁尉展、楊駿明、尹菀珊、林世偉、高銘傑 / 系統處
李月修、李道林、蔡孟君、雲貴鈴、黃偉咸 / 企廣處
頒獎單位：美國愛迪生

本中心「自動軌跡及特定區域塗膠設備」結合全自動化設備技術與製程、智慧型機械手臂，以及 3D 影像視覺軌跡辨識進行開發；以快速產生鞋面打粗的技術及採用塗膠機器手臂的運動路徑，取代傳統人工作業。該設備使原本需要至少 12 秒以上的塗膠等製程，縮短至 6 秒即可完成，效率足足提升一倍以上，並針對鞋配件做精準之噴膠，導入自動化製程，每條生產線可節省約 300 萬元的人事成本、大幅提升產量，獲得「2019 愛迪生銅牌獎」。

108 年 4 月

受獎人員 / 單位：邱振璋、翁尉展、楊駿明、尹菀珊 / 系統處
頒獎單位：經濟部

本中心鞋佼塗擊隊「智慧化技術，翻轉臺灣製鞋產業」獲頒「第六屆經濟部國家產業創新獎 - 團隊類：產業創新聯盟獎」。

108 年 4 月

受獎人員 / 單位：林恒育、蘇志強、唐紹文、陳建成、徐愷呈 / 升級處
頒獎單位：經濟部

本中心高效率燃燒節能技術研發團隊以「高溫廢熱回收最佳解決方案 - 高效率蓄熱式燃燒節能工業爐」獲頒「第六屆經濟部國家產業創新獎 - 團隊類：地方產業創新典範獎」。

108 年 4 月

受獎人員 / 單位：本中心
頒獎單位：中國工程師學會

本中心榮獲「產學合作績優單位績優獎」。

108 年 9 月

受獎人員 / 單位：林志隆 / 副執行長
胡博期、簡國諭、蔡元勛、 王祥賓、林庚達、鄒海清 / 精微處
林治中、黃文輝、蔡元斌 / 系統處
許智峯 / 企廣處
黃怡文、黃建元 / 醫材處
頒獎單位：生技醫療科技政策研究中心

本中心人員榮獲「第十六屆國家新創獎：學研新創獎」。

108 年 9 月

受獎人員 / 單位：洪正翰、林英傑、劉宗鑫、曾柏翰、林彧甫、黃家宏 / 精微處
頒獎單位：生技醫療科技政策研究中心

本中心人員榮獲「第十六屆國家新創獎：年度續獎」。

108 年 9 月
受獎人員 / 單位：莊允中、林偉凱、陳建任、王信富、簡佑庭、何詩怡 / 企廣處
頒獎單位：經濟部

108 年度法人科專成果表揚產業知識服務領航獎 - 團體獎：產業技術基磐研究與知識服務計畫 (1/1)。

108 年 8 月
受獎人員 / 單位：王俊傑處長 / 製程處
頒獎單位：經濟部

108 年度法人科專成果表揚科專貢獻獎 - 個人：王俊傑處長。

108 年 8 月
受獎人員 / 單位：江進豐 / 企廣處
頒獎單位：經濟部

108 年度法人科專成果表揚優良計畫獎：智慧化駕駛輔助系統關鍵技術計畫 (4/4)。

108 年 8 月
受獎人員 / 單位：施景祥 / 製程處
頒獎單位：經濟部

108 年度法人科專成果表揚優良計畫獎：產業創新新材料開發計畫 (1/4)。

108 年 9 月
受獎人員 / 單位：溫志群、林世偉、邱建勳 / 系統處
頒獎單位：中華民國對外貿易發展協會

本中心「螺絲模具調校導引系統」採用光學影像原理，快速轉換複雜的成形模台物理資訊為調模偏量，依導引系統的程序完成三件螺絲取樣後，系統即可判別所需頭厚、桿長、偏心 X 與偏心 Y 等調整分量之解析成果；將原先扣件所需的調模時間由 4 小時縮短為 1 小時，可快速且精準地達成所需產品尺寸的規範要求，獲得「台灣創新技術博覽會金牌獎」。

108 年 9 月
受獎人員 / 單位：孫宏源、蔣承學、施景祥 / 製程處
頒獎單位：中華民國對外貿易發展協會

本中心「高氮低鎳沃斯田鐵不銹鋼合金製造方法」乃藉由合金設計及製程增加氮溶解度，降低鎳含量後，不僅優於碳鋼的高強度，且可降低腐蝕速率及製作成本。此材料強化耐腐蝕特性，可應用於海上平台、海洋離岸設施等產業，獲得「台灣創新技術博覽會金牌獎」。

108 年 9 月
受獎人員 / 單位：陳登鑑、洪俊宏、陳綺慧 / 系統處
頒獎單位：中華民國對外貿易發展協會

本中心針對「生質油製備方法」進行優化，首先取得預熱槽中的預熱水，將預熱水通入水熱液化反應器中，致使處理步驟時間大幅縮短，既省時又具能耗低之優點，獲得「台灣創新技術博覽會銅牌獎」。

產業研發聯盟

1. 機車零組件產業研發聯盟

由光陽、榮璋、介隆興、金豐等單位共同組成，發展機車傳動中空軸鍛件製程技術，6 道次的成形模具與沖頭設計，優化成形鍛流線與提高製程可行性，材料利用率提升達 92%以上 (70% ->92%)，減少 16% 材料成本，與日本 YAMAHA 技術同等級。

2. 氣壓控制閥產業研發聯盟

由金器、高商、粘謹等單位共同組成，完成通訊式氣壓控制閥產品開發，協助氣壓控制閥業者導入關鍵 Ansys 模擬分析，完成閥體結構設計、磁場及流場最佳化分析。藉由工控整合完成通訊式氣壓控制閥開發，取代傳統由繼電器控制電磁閥方式，有效降低設備迴路配置成本 20%，提升配電及偵錯效率 30%，技術及功能性與日本 SMC 同步。

3. LED-UV 印刷設備產業研發聯盟

由光源、磐采、海德堡等單位共同組成，建構國產智慧化 LED-UV 印刷固化燈具，搭配雲端配色平台，引領印刷機產業朝向環保節能、智慧化發展，同時建立國內 LED-UV 印刷色彩品質標準，帶動印刷應用產業轉型升級。

4. 復健器材產業研發聯盟

由榕懋、春田、阿道夫等單位共同組成，整合產學研三方技術，合作建立復健器材智慧加值系統，聚焦國內中風手部復健產品開發，導入可調式輔助復健固定機構技術，翻轉傳統復健模式，提供醫病快速檢視與溝通橋樑，促進國內業者技術加值轉型。

5. 塑膠複合材料產業研發聯盟

由台達電、長興、達璞等單位共同組成，整合上中下游材料供應鏈及設計應用等不同領域之專長及優勢，共同合作開發新應用產品，聚焦複合材料用於高階伺服器散熱模組，使國內散熱模組廠商技術躍昇及產品加值。

6. 鑄造場域優化與技術傳承策略聯盟

由雅薪、大鏤科技、永冠、全弘等單位共同組成，協助廠商進行場域優化，吸引優秀人才投入鑄造產業，以解決人力缺工問題，縮短工時、確保勞工安全與衛生，並透過資深專家所提供之教育訓練，有效提昇人才素質與鑄造件品質，以促進產業升級。

7. 金屬熱塑複材層板應用產業聯盟

由金屬中心、明安國際、浩盟、文得等單位共同組成，應用異質接合 (鋁合金 / 複合材料) 利基型材料，滿足超輕薄筆電產品具備結構強度輕量化以及薄型化之目標，預期可提升附加價值率 2 倍以上，增加產值 1.6 億元 / 年以上。

8. 不銹鋼耐蝕性無損表面硬化處理設備產業聯盟

由金屬中心、萬潤科技、三雄精密、芳成工業等單位共同組成，藉由不銹鋼耐蝕性無損表面硬化處理技術，提升沃斯田體不銹鋼表面硬度 (由 Hv200 至 Hv1200)，且同時保持原有耐蝕性質與無導磁特性。預期可提升產品附加價值並跨入高階應用供應鏈，擴增訂單量達 5,000 萬元 / 年，促進廠商投資 3,000 萬元以上。

9. 熱處理設備智慧化推動產業聯盟

由金屬中心、祥儀科技、宏冠、高熱、文生等單位共同組成，協助國內業者 (祥儀) 成立特殊微小部件熱處理設備產線，可依不同產品需求完成所需模組之設備建置，使生產更具彈性。預期可促進產業投資約 NT$1 億元，並衍生碳鋼 / 合金鋼等高值高精度零組件關聯產值 NT$5 億元以上。

10. 高矽鉬渦輪殼與灰口鑄鐵中座之商用車系統零組件開發產業聯盟

由金屬中心、光隆、大鐳鑄造、鑫立等單位共同組成，協助自主開發高矽鉬合金渦輪輪殼等商用車系統零組件及相關技術，整合鑄造、精密加工及 3D 列印砂模模具，建立一貫化製程。預期促進產業投資約 NT500 百萬元，預計衍生相關車用零組件產值約 NT1,800 萬元 / 年。

11. 高強度耐蝕不銹鋼產業聯盟

由金屬中心、春雨、榮剛及燁興公司共同組成，開發一體型鑽尾螺絲，並拓展其他下游廠商 (如世豐、慶達等公司之結構及車用等扣件)，預計帶動中下游產業之研發能量，增加中下游企業之國際競爭力，並提供良好成形性及耐蝕性之高強度材料，將促使國內產業界衍生出高強度及耐蝕性之綠色、節能及環保之產品，翻轉傳統產業技術價值，提升國際競爭力。

12. 鎂合金產氫反應之智慧製造與監控技術產業聯盟

由金屬中心、富台工程、四季洋圃生物、輝燁機械工業，促進國內鎂合金產氫反應之智慧製造與監控技術研發，協助聯盟廠商申請聯盟型 SBIR，並爭取國際訂單美國 200 萬元，中國 500 萬元，協助促進就業 12 人，及輔導富台工程公司開發鎂合金產氫處理技術，並通過經濟部能源局業界能專計畫，計畫總金額 2,000 萬，提高廠商加工生產量能及實質獲益。

13. 玻璃陶瓷牙體瓷塊研發聯盟

由金屬中心、國立成功大學材料學系、棕茂科技、冠宏牙材等單位共同組成，針對於新世代即時復二矽酸鋰玻璃陶瓷產品，推動產品試量產規劃、技術移轉方案執行，棕茂科技新增二矽酸鋰試量產線廠房建置，斥資約 900 萬元興建。

14. 創新醫療用精準定位技術研發聯盟

以金屬中心調頻式射頻定位技術能量為基礎，銜接進入佳世達與川升技術團隊，建立通訊能量與醫療器材系統化整合，並且鏈結臨床醫療做先期評估合作機制，以銜接使用端與出海口。

15. 智能監控骨水泥灌注系統研發聯盟

由陽明、唯醫、金屬中心等單位共同組成，主要整合骨水泥灌注系統與智能套針模組開發。促成投資或研發投入 4550 萬，並於今年投資建置 GMP 廠房完成。並通過鏈結新創輔導計畫及育苗計畫，預計 109 年共同提出價創計畫，成立美國新創公司。

16. 國機國造檢量測聯盟

協助中科院邀集國內航太公會、機械公會、電電公會、台經院、國研院、金屬中心、工研院、電檢中心、資策會、車輛中心等共計 11 家法人單位與公協會，於 108 年 8 月 15 日「2019 年台北國際航太暨國防工業展」開幕典禮後，共同推動成立國機國造檢量測聯盟，整合全國檢量測與驗證能量，以協助國內航太相關企業獲得國際航太認證為目標。

產學研互動

結盟對象：和成欣業股份有限公司

時間：108 年 1 月 11 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簽署合作備忘錄，促進國內廚衛浴家電產業發展及長期檢測合作。

結盟對象：中鋼公司

時間：108 年 3 月 1 日 / 代表人：林董事長仁益

簽約內容：與中鋼公司，為有效運用雙方技術能量，提昇設備及零組件之研發效益，簽署策略聯盟協議書。

結盟對象：四季洋圃生物機電股份有限公司

時間：108 年 3 月 20 日 / 代表人：林董事長仁益

簽約內容：與四季洋圃生物機電股份有限公司簽署合作意向書，合作規劃成立水素產業研發中心。

結盟對象：Connectec Japan Corporation

時間：108 年 5 月 1 日 / 代表人：林董事長仁益

簽約內容：與 Connectec Japan Corporation 簽署合作備忘錄，共同致力於先進封裝技術之發展。

結盟對象：雙葉電子工業株式會社

時間：108 年 6 月 1 日 / 代表人：林董事長仁益

簽約內容：與雙葉電子工業株式會社簽署合作備忘錄，共同推動雙方之產業輔導業務發展及促進雙方於產業界技術之提昇。

結盟對象：經緯航太科技股份有限公司

時間：108 年 6 月 4 日 / 代表人：林執行長秋豐

簽約內容：與中經緯航太科技股份有限公司簽署合作備忘錄，進行智慧無人載具加值應用及人工智慧酬載系統暨調度派遣管理平台之合作研發。

結盟對象：國立高雄科技大學

時間：108 年 7 月 1 日 / 代表人：林董事長仁益

簽約內容：與國立高雄科技大學簽署合作意願書，為有效運用雙方技術人才與學術資源，共同推動科技發展促進產業技術提昇。

結盟對象：越南發明協會

時間：108 年 7 月 2 日 / 代表人：陳進明副執行長

簽約內容：與越南發明協會簽訂合作備忘錄，協助台灣及越南產業進行資訊交換及業務媒合。

結盟對象：
COMTES FHT a.s.CZECH TECHNICAL UNIVERSITY IN PRAGUE , MEDIN a.s.PROSPON, LTD.
愛派司生技股份有限公司 / 數可科技股份有限公司
秀傳醫療社團法秀傳醫院

時間：108 年 8 月 10 日 / 代表人：林董事長仁益

簽約內容：與 COMTES FHT a.s., CZECH TECHNICAL UNIVERSITY IN PRAGUE, MEDIN a.s., PROSPON, LTD., 愛派司生技股份有限公司，數可科技股份有限公司及秀傳醫療社團法秀傳醫院等機構簽署合作意向書，對於”積層製造應用於小型關節植入物開發”進行合作。

結盟對象：國立成功大學

時間：108 年 9 月 15 日 / 代表人：林董事長仁益

簽約內容：與國立成功大學簽署策略聯盟，為有效運用雙方技術人才與學術資源，共同推動科技發展促進產業技術提昇。

結盟對象：財團法人義守大學

時間：108 年 10 月 8 日 / 代表人：林董事長仁益

簽約內容：與財團法人義守大學簽署合作意向書，積極推動人才培訓，導入產學交流資源，建立以企業需求為導向之產學研訓合作平台，共同促成產學合作。

結盟對象：長榮航太科技股份有限公司

時間：108 年 11 月 7 日 / 代表人：林執行長秋豐

簽約內容：與長榮航太科技股份有限公司簽署合作備忘錄，促進產研合作發展航空發動機零組件加工技術。

結盟對象：DH RegSys Pte Ltd., MD-Clinicals SA 及信益生物科技股份有限公司

時間：108 年 11 月 21 日 / 代表人：林執行長秋豐

簽約內容：DH RegSys Pte Ltd., MD-Clinicals SA 及信益生物科技股份有限公司簽署合作備忘錄，建立醫材法規服務平台，協助台灣醫材廠商快速取得認證。

結盟對象：社團法人高雄市鋁門窗經營協會

時間：108 年 11 月 25 日 / 代表人：林執行長秋豐益

簽約內容：與經營協會簽署策略聯盟，促進雙方互動合作交流與產業技術資訊分享。

結盟對象：中山大學

時間：108 年 11 月 26 日 / 代表人：林董事長仁益

簽約內容：與中山大學簽署合作備忘錄，促進台灣離岸風電和海洋科技產業之發展，共同推動高雄海洋科技產業創新專區。

發展見證

結盟對象：海洋科技產業創新專區動土典禮

時間：108 年 5 月 31 日

簽約內容：離岸風能被視為海洋經濟之一環，是全球海洋經濟附加價值毛額 (GVA) 貢獻度成長最快的產業，更是政府近年來主力推動的項目。現規劃高雄興達漁港為據點，設立「高雄海洋科技產業創新專區」，108 年 5 月 31 日由總統府陳菊秘書長擔任主祭，率領行政院陳其邁副院長、經濟部林全能次長、高雄市政府葉匡時副市長等貴賓，一同於專區內舉行三中心動工典禮，共同見證離岸風電邁入新里程碑。

結盟對象：手工具研發檢測中心揭牌儀式

時間：108 年 5 月 31 日

簽約內容：由中鋼公司、台灣手工具工業同業公會、金屬工業研究發展中心與中衛發展中心共同成立「手工具研發檢測中心」。108 年 5 月 31 日由經濟部曾文生政務次長、台中市盧秀燕市長、技術處羅達生處長及工業局張明煥副組長等貴賓共同舉行揭牌典禮，未來將營運場地設立在金屬中心智慧暨系統研發服務處 (台中工業區內)，可望發展產業鏈共通性技術，帶領台灣手工具邁向產業新高峰。

結盟對象：離岸風電人才培訓開班儀式

時間：108 年 9 月 17 日

簽約內容：在經濟部能源局指導下，108 年 9 月 17 日上午在金屬中心進行離岸風電人才培訓開班儀式，全台首座移動式訓練基地正式同步啟用，行政院核定前瞻基礎建設計畫中，將在高雄興達港成立高雄海洋科技產業創新專區，並由經濟部能源局委託金屬中心進行離岸風電人才培訓，該人培中心為亞太地區先進海事工程訓練與驗證基地，可促進人力供給在地化，提升我國海事工程既有水準，以支援離岸風電海事工程產業發展，並促進海上勞動環安衛條件與國際接軌。

卓越典範—

智能協同立大功
360度搬運模組超暢通

「協同搬運模組」榮獲全球百大科技研發獎殊榮

獲獎人：楊光勳、戴聖儒、呂承祐、蘇炳華 / 製程處；呂英誠 / 執行長室；
李月修、黃偉咸、雲貴鈴、魏燕伶 / 企廣處

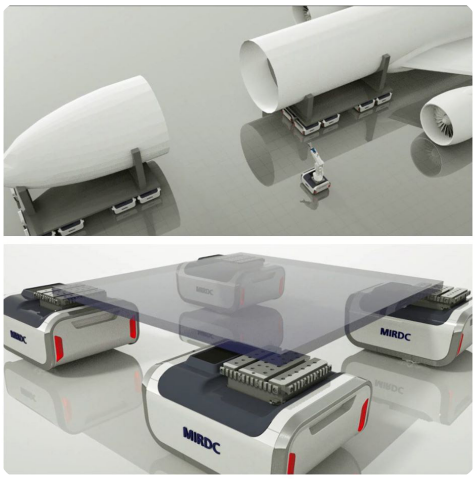
金屬中心在經濟部支持下，落實創新前瞻計畫的研發成果，仿效蟻群協同合作概念推出「協同搬運模組」，將自動導向車模組化、無線智慧化串聯，實現智能化靈活搬運，勇奪全球百大科技研發獎之殊榮。

邁向工業4.0　滿足智慧搬運

在工業4.0概念驅動下，全球製造業正在積極朝向電腦化、數位化及智慧化邁進，以統整工業相關技術、銷售與產品體驗，將資源達到供應端最佳化運用。而台灣多數企業空間場域有限，在產品多樣化及複雜化的限制下，無論是生產製造業，或是物流業、倉儲業都花費許多資源及人力在進行搬運。近年來在全球密集合作與物聯網快速崛起的趨勢下，產品需要效率化分類與即時搬運處理，以達到高機動性的需求，因此需要更加智能及彈性的系統協助搬運。

無線彈性模組　協同完成任務

為了滿足產業搬運需求，金屬中心以群蟻合作為創意激發，搭配無線智慧、彈性運用、靈活移動三大概念打造出「協同搬運模組」，透過無線智慧協同搬運系統，可即時同步操控數台自動導向車，使若干個載具在遠端操控下串連結合。相較傳統搬運模式在狹小空間內無法順利運行無人車，智能協同搬運模組具有更加靈活的優越性能，移動不再受限於產品形式、尺寸和類型，且平均每個運輸載具約可乘載100公斤，在調配運作下可以快速達成搬運任務。



圓柱架構設計　全方位都暢行

由於協同搬運模組必須克服狹小及複雜空間的搬運需求，因此載具採用圓柱型搬運架構及全向輪設計，將載具上的每個輪子都視為單一模組，此設計結構不僅可以擁有全方位的360度靈活移動，亦能在無軌、無機構鏈結的狀態下承受負重，使搬運調配更加便捷無礙。對於體積大且不規則的載體，僅需增加載具數量即可完成任務，適合工業4.0等自動化技術應用，有效開發製造業的市場潛力；不僅實現了未來智慧化的搬運模式，更勾勒未來的科技生活藍圖。

增安全降成本　推動智慧技術

協同搬運模組的運輸系統架構具有高智能、高彈性，可依照搬運重量增減載具數量，多個運輸載具之間可保持固定距離移動，同步執行搬運任務，以協助國內地面型無人載具業者由線性運動模式改變為非線性無軌模式，降低軌道鋪設成本及增加空間利用率。未來藉由本模組高度靈活的運輸系統，不但得以大幅增加安全性及生產力，亦可降低人力成本，並作為無人化技術之能量，接軌國際高科技趨勢，協助國內產業轉型提升，促進下個產業世代之成長。

全方位移動協同搬運模組

2019 R&D 100 WINNER

驚豔國際!

iF DESIGN AWARD 2018

智慧化無人搬運模組，3大特點

無線智慧、彈性運用、靈活移動

- 透過無線智慧協同搬運系統，可即時同步操控數台的AGV，執行搬運任務。
- 可隨需求增減AGV數量，彈性運用於不同空間、不同體積及重量貨物搬運。
- 採用全向輪設計架構，可360度靈活移動。
- 產業接軌應用加值，透過協同搬運可彈性化依重量、體積、不規則形狀增減進行平台運作規劃，靈活運用於倉儲、生產、製造等相關產業。

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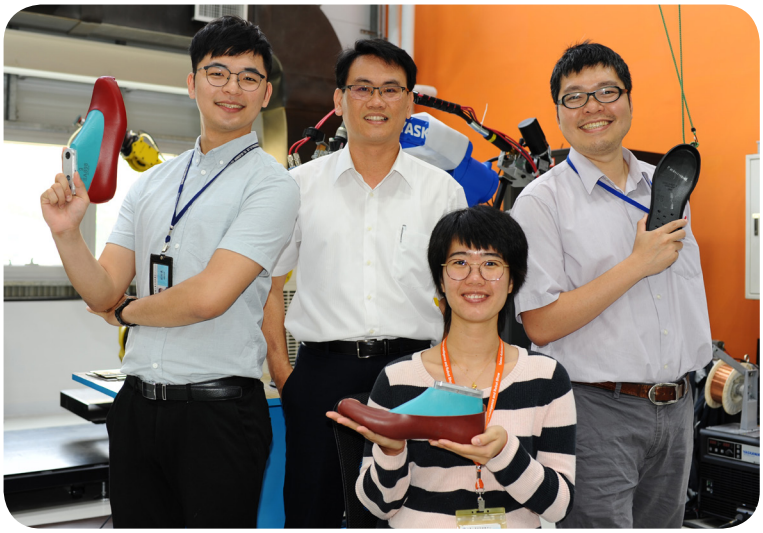
卓越典範—

製鞋技術大突破　自動打粗好"膠"傲

「智慧化 3D 視覺製鞋自動打粗塗膠技術」獲得美國愛迪生應用技術大獎

獲獎人：邱振璋、翁尉展、楊駿明、尹菀珊、周阜毅、林世偉、高銘傑 / 系統處
李月修、李道林、蔡孟君、雲貴鈴、黃偉咸 / 企廣處

金屬中心執行經濟部在地產業創新加值整合推動計畫的成果卓越，其中「智慧化3D視覺製鞋自動打粗塗膠技術」結合自動化設備、智慧手臂，以及3D影像視覺軌跡辨識技術，突破傳統人工打粗及塗膠製程，獲得美國愛迪生銅獎。

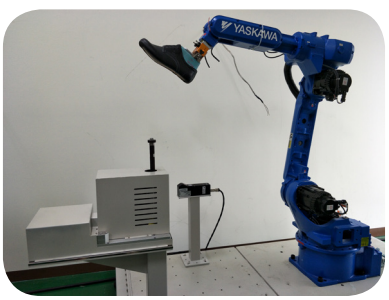


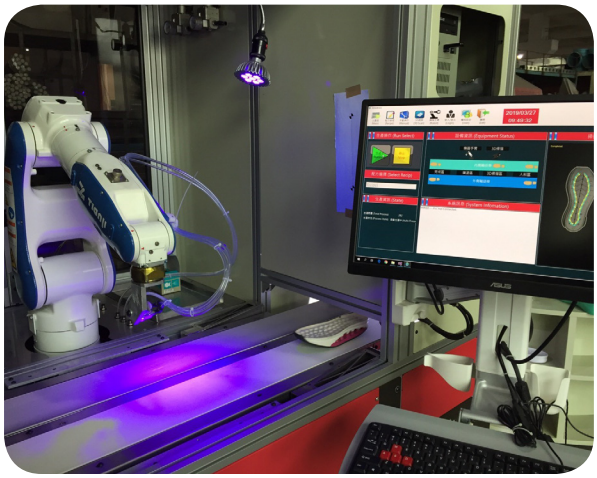
傳統製鞋瓶頸　人力資源吃緊

製鞋產業普遍被認為是技術門檻不高、勞力密集的產業，特別是傳統鞋業成型端的打粗與塗膠兩項工序，是運用砂輪機將光滑的鞋材磨粗後，再執行下一步的塗膠作業，需要仰賴大量人工處理再完成結合工序。若在打粗與塗膠黏合的過程中產生瑕疵，鞋子的耐用度將會大打折扣；在打粗階段中，力道過與不及都不行，而在塗膠時也必須謹慎控制膠量，因此過去皆是透過製鞋師傅的經驗與手感進行製作，十分耗費人力與時間資源，需要導入技術突破瓶頸。

打粗技術整合　媲美人工手藝

為使人力打粗升級為自動化製程，金屬中心運用自動化技術與相關研發經驗，積極為製鞋產業整合國內設備系統商及製鞋廠商，並運用智慧3D視覺影像辨識技術、機械手臂與力補償技術，透過軟體規劃打粗路徑，再由機械手臂搭配三維線掃描機執行工作，成功克服打粗自動化的瓶頸。整合後的自動化設備不僅可以透過運動路徑比擬老師傅的打磨工藝，且可因應市場需求控制生產速度，且可針對材料軟硬不一、尺寸不等、調整變異等問題進行有效控管。





自動精準塗膠　增加速度良率

運用金屬中心精湛的視覺技術及機械手臂的完美合作，便可以透過鞋面與鞋底軌跡完成特定區域的自動精準塗膠，並且同時改善產業工作環境，減少粉塵與化學藥劑危害人力作業的健康安全。過去人工方式平均一雙鞋須花至少12秒以上的時間進行噴膠，使用自動化製程可以將時間縮短至6秒，效率足足提升一倍以上，並針對鞋配件做精準之噴膠。導入自動化後每條生產線可節省約300萬元人事成本，大幅提升產量，並減少人工操作導致的不良品問題。

促產學研合作　扶持產業轉型

金屬中心整合多年來鑽研的自動化設備、機器視覺，以及機械手臂、力補償等各項技術，成功打造出智慧化3D視覺製鞋自動打粗塗膠技術，將鞋底打粗、塗膠、鞋件噴膠，以及鞋面與鞋底黏合的工序皆轉為自動化製程。經過整整一年的試煉，金屬中心帶領跨產學研及廠商聯盟進行合作，共同解決了製鞋業的第一線問題。目前該技術不僅應用在台灣五大製鞋廠中，也已技轉至國內知名代工廠；未來金屬中心將提供客製設備規劃，輔導產業共同轉型與成長。

卓越典範—

回收工業廢熱 打造節能生態鏈

「高效率蓄熱式燃燒節能工業爐」勇奪第六屆經濟部國家產業創新獎——

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金屬中心成立高效率燃燒節能技術研發團隊，在經濟部能源科技專案中，整合南部地區在地工業爐業者、節能設備業與關鍵零組件業者，共同合作開發「高溫製程最佳廢熱回收技術」，獲得第六屆經濟部國家產業創新獎的榮譽。

工業爐耗能高　造成環境隱憂

在節能減碳的議題下，工業耗能一直受到大量檢討，許多製造科技的進步，皆源自希望工業製造能在減少污染及節能的情況下進行，以減少經濟與環境的對立。而高雄地區的鋼鐵業產值居全國之冠，在處理材料常需使用工業爐進行加熱或熔煉製程，且業者採用的工業爐數量極多，所產生的高溫廢熱將對環境造成隱憂；當地受到長期影響，不僅導致環境品質下降，製造出來的大量二氧化碳也恐危害人體健康，甚至使得溫室效應加劇，各界皆迫切期待改善。

回收高溫廢熱　有效節能減排

為改善工業爐產生的高溫廢熱問題，金屬中心整合南部在地工業爐業者、節能設備業與關鍵零組件業者建立本土化蓄熱燃燒服務能量，運用分別針對高溫燃燒、蓄熱及爐體等三大次系統進行研究。透過工程理論模擬分析和設計，中心運用歷年來累積的蓄熱燃燒系統與工業爐整合能力，以及各界的資源協助，成功研發出業界適用的700℃以上高溫製程最佳廢熱回收技術，使節能率達到30%以上，並精準控制各種加熱物的需求，以確保優良的均溫、品質和效率。

蓄熱式批次氧化鋅爐

蓄熱式批次固溶化爐

蓄熱式批次氧燒結爐

蓄熱式批次退火爐

蓄熱式連續固溶化爐

開發智慧設計　建置示範場域

為確保爐體保持節能效益與產品製程穩定度，金屬中心推出工業爐雲端節能監測系統與智慧模組，可即時呈現燃料用量與爐體及蓄熱系統在溫度、壓力等20多項相關數據；透過智慧演算法，提供業者、管理人員與技術人員同步掌握即時爐體狀態、能耗效率管理指標，以作為品質管理的領先指標，同時有效提升產品穩定性。 本中心亦透過開發符合國際規範之創新應用示範場域，建立工業爐節能減排典範及燃燒參考標準，逐步建立廢熱回收節能生態鏈。

客製特殊結構　技轉促競爭力

目前金屬中心已成功開發5 種類型高溫製程工業爐，提供鋼鐵業、精密鑄造業、化工業、金屬製品業，以及鑄造業高溫廢熱回收最佳解決方案；累計促進投資超過新台幣1.6億，增加產值超過20億元，並累計節省1715萬度天然氣，約相當於減少32,228公噸的二氧化碳排放。中心未來將視業者需求，提供客製化燃燒器預鑄件與特殊耐火材等相關產品，以滿足各產業不同製程的蓄熱節能的目標，並透過技轉方式持續分享研發成果，為業界帶來實質效益及國際競爭力。

「**深耕技術、落實產業**」金屬中心鎖定國際趨勢，專業分析產業需求、佈局專利，鏈結業界資源並促進跨領域合作，大力推動創新政策，積極研發金屬核心技術。

ANNUAL REPORT 2019

METAL INDUSTRIES RESEARCH & DEVELOPMENT CENTRE

技術與研發創新

熔鑄技術

因應各界金屬材料使用需求趨向高可控性、高機能性，以及高價值性，2019年熔鑄技術重點開發抗腐、耐蝕、具相容性之高強度機能材料。例如耐蝕高強度不銹鋼材料不僅可以提升耐蝕性能與機械強度，亦可延長材料壽命，是產業迫切渴求的開發技術。

除此之外，本團隊也專注於可應用醫材、航太、3D列印精密鑄件之製造技術，積極協助國內相關產業開發高附加價值產品。例如鈦合金電子束積層製造技術和真空惰氣霧化製粉技術皆可應用於骨科醫材開發，而3D列印陶殼模技術則可解決傳統精密鑄造製程時間過長等問題。

中心未來將繼續導入研發能量，針對車用及精密機械扣件材料進行研發，並專精國內汽車、醫材、航太等創新高值材料開發，為產業不斷提升競爭力。

研發現況

1. 耐蝕高強度不銹鋼材料開發

- 耐蝕高強度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。
- 添加析出強化元素如V、Nb等，並透過N元素添加，達到高強度性質，經由抽線成形製程，完成線徑Ø4.42mm的盤元，機械強度可達1,756 MPa，鹽霧試驗經過1,200hr無產生銹蝕現象，線材中心硬度達到Hv 605、外部硬度達到Hv 642。
- 材料可應用至一體型鑽尾螺絲，取代材料進口成本達10%以上。一體型鑽尾螺絲可減少螺絲汰換產值高達新台幣1.6億元/年。

車用扣件

一體型鑽尾螺絲

2. 鈦合金電子束積層製造技術

- 因應3D列印醫材製作趨勢及市場需求，將建立鈦合金積層製造技術，進行骨科醫材開發。
- 新開發3D成形鈦合金醫材其機械性質可達 900MPa以上，優於傳統製程醫材，且符合ASTM 國際規範。
- 積層製造技術應用之醫材產品，可提升原產品附加價值約5億元以上。
- 可應用於醫療及航太產業，未來可進一步搶佔國際上百億美金市場。

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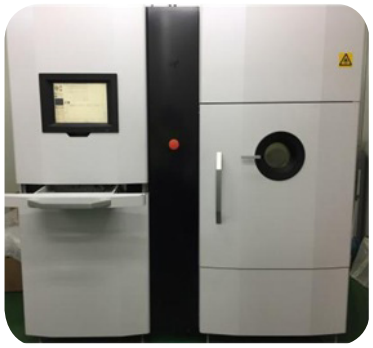
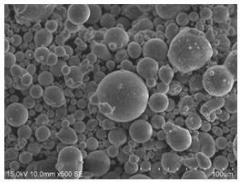


主機

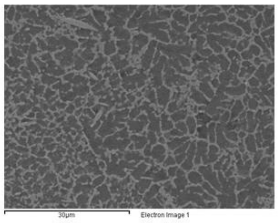
3. 真空惰氣霧化製粉技術

- 因應高活性粉體之醫材產業需求，進行可降解鎂合金金屬粉體之開發。
- 所開發之高活性材料真空惰氣噴粉模組，可依據各式不同的合金及粉末粒徑需求，製備高品質生醫金屬粉體材料，已完成可降解鎂合金粉末試製，粉末粒徑控制在10μm-200μm，D50=44μm，粒徑50μm以下真圓度為0.82。粉末得料率74%，150μm以下粉末得料率53%，50μm以下得料率22%，為國內首次成功製備鎂合金粉末。
- 新開發之鎂合金粉體可應用至金屬粉末射出成型製程(MIM)，製備醫材，如骨釘、骨板。

鎂合金粉體圖



鎂合金粉體SEM圖



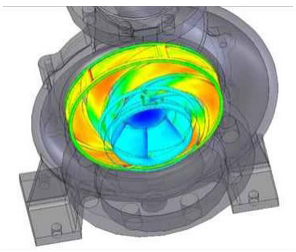
鎂合金粉體熱壓SEM圖

粉末冶金用粉體及目標齒輪載具

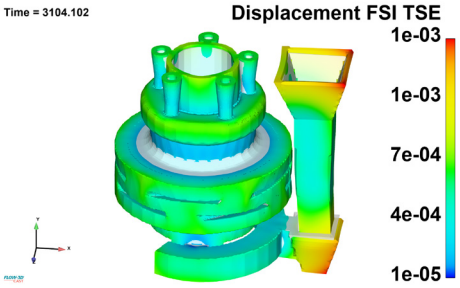
4. 3D列印陶殼模技術

- 按照不同粒徑、不同熱膨脹係數之陶瓷材料作混合，使不同熱膨脹度陶瓷粉產生抑制效果，降低熱變形。加入纖維粉材於1100度燒結，揮發產生微細孔隙，增加殼模透氣性，殼模澆鑄冷卻後，收縮使孔隙撐開，形成良好崩散性，完成3D列印用陶殼模配方調控技術。
- 利用不同殼模厚度的生成，確實能夠有效控制金屬液凝固的方向，提升冒口補縮效果。產品結構若以厚薄差異比1/2，其殼模壁厚設計為厚處模壁的5倍，冒口的補縮效果可以提升2倍以上。
- 因應鑄造產業技術升級轉型之需求，進行3D列印鑄造陶殼模之開發，解決傳統精密鑄造製程開發週期長、成本高、與難以大型化之缺陷。
- 新開發之3D列印陶殼模其鑄模高溫強度≧700MPA、熱膨脹係數:≦2x10^{-6} (1/℃)、熱應力≦3.5MPA、表面粗糙度Ra=3.2~6.3μm。
- 預期本技術所應用之精密鑄造產業，在精密鑄件試作成本上可縮減20%以上。

3D列印陶殼模列印



葉輪結構模擬



3D列印陶殼模模擬

葉輪輕量化

未來研究

1. 耐蝕高強度不銹鋼材料產業化

- 持續導入開發高強度易切削不銹鋼，應用於車用及精密機械扣件，滿足國內產業材料需求，加速高值產品上市時程。
- 高強度易切削沃斯田鐵系不銹鋼材料為線徑ψ5.5mm、T.S≦750MPa、硬度≦HV230。
- 透過國產化及製程技術優化應用研發，材料製程技術可與國際領先（日本VIPIAS）者具有之水準。
- 透過技術移轉，鏈結南部材料上中下游業者，建立量產產線，應用開發生產高附加價值扣件產品
- 預計材料取代進口產值可達3億以上，產品應用產值可達20億以上。

2. 鈦合金電子束積層製造技術

- 因應3D列印醫材製作趨勢及市場需求，將建立鈦合金積層製造技術，進行骨科醫材開發。
- 新開發3D成形鈦合金醫材其機械性質可達900MPa以上，優於傳統製程醫材，且符合ASTM國際規範。
- 積層製造技術應用之醫材產品，可提升原產品附加價值約5億元以上。
- 可應用於醫療及航太產業，未來可進一步搶佔國際上百億美金市場。

3. 真空惰氣霧化製粉技術

- 突破現有批次法之真空惰氣霧化粉體製程，採用連續進料熔解，大幅提升粉體之生產效率。
- 將開發Fe-C-Cu合金粉末其流動性：25S/50g，粉末冶金之生胚密度7.1g/cm^3，生胚強度12Mpa，燒結後硬度HV_{10} 210，YS 500Mpa，UTS 660MPa。
- 新開發之粉體可應用於精蜜之粉末冶金齒輪製備，應用於車輛及機械產業，提升尺寸精度，尺寸變化<0.12%。

4. 3D列印陶殼模於葉輪輕量化結構開發

- 因應能源效率提升之市場需求，將進行水泵葉輪產品結構輕量化之開發。
- 導入結構輕量化設計，針對葉輪內部進行多孔結構設計成形，並結合數值分析技術，針對葉輪運作時，其扭力產生之應力與應變分析，提供輕量化結構疲勞壽命等可靠性分析。
- 預期新技術應用之葉輪產品，在產品結構上，減重可達15%，能源效率上可提升10%以上。
- 新技術未來亦可應用於車輛、航太、能源使用，預估可節能15%以上。

銲接技術

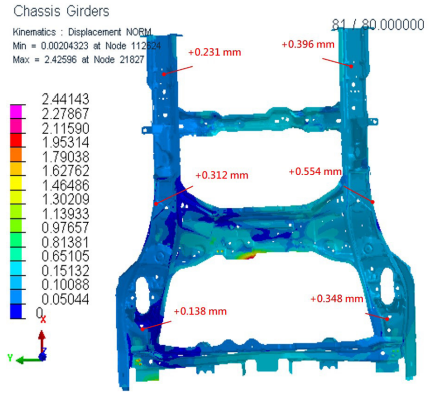
有鑑於國際交通、人車流動、物流運輸之大量需求，以及科技產品日異月新，不斷追求輕量化的趨勢，2019年銲接技術瞄準國際運輸工具及車輛相關產業、3C產業，開發項目包含銲接組裝變異解析技術、摩擦攪拌銲接技術、金屬熱塑複材層疊接合技術。

銲接組裝變異解析技術可以進行入熱控制，解決鋼材組件在銲後導致麻田散鐵分布不均的情況，減少變形量並提升模組結構之治具共用化。摩擦攪拌銲接技術為摩擦攪拌銲接工具及製程提高了壽命，以降低攪拌工具的高消耗成本。而金屬熱塑複材層疊接合技術則使金屬突破更輕薄、更強韌的功能，可為3C產業打造出優質輕便的高質量筆電殼件。未來團隊將持續精進以上各項研究技術，朝多功能化、數位化、高值化邁進。

研發現況

1. 銲接組裝變異解析技術

整合車體乘員艙模組量測解析驗證技術可達成銲接組件的入熱控制，可解決高強度及熱沖壓鋼材組件銲後麻田散鐵組織分布不均之情況，並改善疲勞破壞與抑制熱效應變形，減少變形量≧20%，模組結構之治具共用化≧55%。



銲接組裝變異解析技術

2. 摩擦攪拌銲接技術

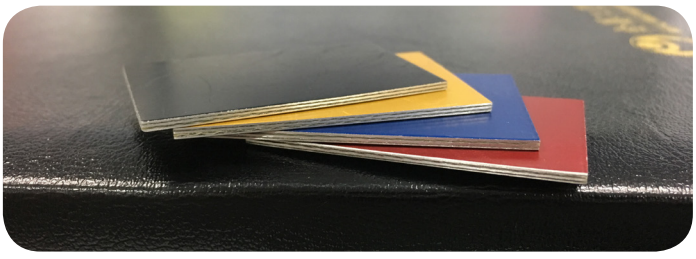
有鑑金屬製品業者在鋁合金產品摩擦攪拌銲接需求增加，銲接組開發高速長壽命之摩擦攪拌銲接工具及製程，可應用於新產品開發試作，並降低量產時攪拌工具高消耗率所造成的成本問題。

- 鋁合金（t<4mm）銲接速度：1500mm/min。
- 鋁合金（t<4mm）銲接用之攪拌工具壽命：500m/pcs。

摩擦攪拌銲接工具

3. 金屬熱塑複材層疊接合技術

- 商務筆電殼件以金屬質感為消費需求，佔比75%以上，面臨數位產品追求「輕還要更輕」的需求，需突破更佳的單位密度之殼件成本效益，追求極致輕量化方案。
- 鋁合金/玻纖熱塑複材層板，厚度<0.8mm，密度<2.2g/cm^3，彎曲強度>270MPa，運用鋁合金結合熱塑複材，在相同強度之下，突破輕量化20%以上。



金屬纖維複材

金屬纖維複材

未來研究

1. 數位化銲接技術

將結合影像監控、數值模擬分析與智慧化量測等數位技術，建立完整銲接數據資料庫，實現銲接自動參數調整回饋補償及優化銲道品質，達到智能化銲接生產與品質控管。

數位化銲接技術

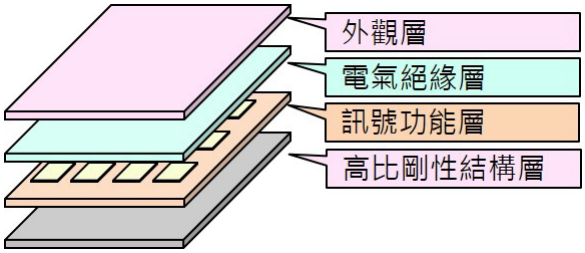
2. 低耗能鋁材潔淨摩擦攪拌銲接技術

3D曲面及異質低耗能摩擦攪拌接合技術，朝回收鋁材高品質接合開發，達成複雜曲面之低耗能接合（節省40% 製程耗能），同時具備製程無汙染、可提升回收鋁再應用之優勢。

低耗能鋁材潔淨摩擦攪拌銲接技術

3. 功能性金屬熱塑複材層疊接合技術

- 為解決傳統四大材料（金屬/陶瓷/高分子/複合材料）特性已無法滿足應用需求的現況，採複層材料概念於結構件本體上進行功能性的增加。
- 以金屬材料為基底，對複合材料進行異質整合，研究使其異材間接合強度>120 kgf/cm2，且彎曲強度>200MPa。
- 金屬熱塑複材層疊接合同時內嵌功能層，如光、電、磁或熱等功能，提升產品附加價值率>30%。
- 功能性金屬熱塑複材層板未來可應用於汽機車鈑金、3C殼件、建築資材等。



金屬纖維複材

成形技術

我國金屬成形技術高度發展，已邁入智慧化、複動化、高性能化及製品高附加價值化之階段，因此本團隊亦致力朝AI智能、複合及機能技術邁進。

2019年所開發之成形相關技術，除聚焦於高精度、高強度、輕量化之沖鍛、沖壓零部件，鋁合金擠型技術外，並研發虛擬試模技術及產線智慧監測。透過智慧化設計、伺服成形技術、模擬分析及虛實整合等技術導入，協助業者有效提升成形製程設計研發效率。

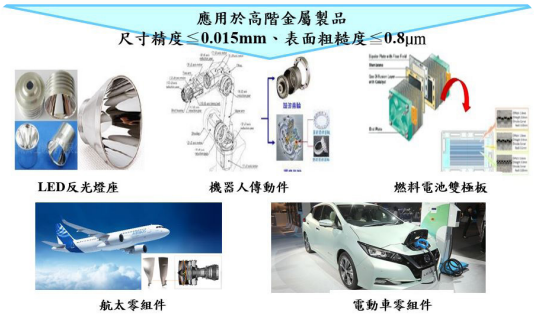
未來本中心將持續針對國內具產業規模之金屬高值製品投入智慧化成形技術及虛實整合技術，並發展高功能性材料相關應用（如醫用鎂合金線材）、智慧產線及沖黏模具的開發，以及專精相關製程技術之研發，以協助國內業者縮短研發時程，強化金屬製品之國際競爭力。

研發現況

1. 近淨型鍛壓製品智慧化伺服成形系統開發

- 針對目前沖鍛製造產業需求，以開發智慧化伺服沖鍛成形技術與模組，用以提升業者於少量多樣且更彈性化之研發製造能量，加快切入智慧製造應用領域。
- 透過開發伺服低速多階速控成形模組成形燃料電池用金屬雙極板，其成形製品可達翹曲量≦2.2mm/95mm及最大減薄率≦33%之國際廠使用規範。
- 協助國內製造業者於高階金屬製品製造技術提升，成形金屬製品尺寸精度可達≦±0.015mm、表面粗糙度可控至Ra≦0.8μm，以提升產品附加價值。
- 建置之技術與模組可提升製品尺寸精度，減少零部件成形所需道次，有效降低成本並提高生產效率，可導向電動車、機器人、航太等未來主要產業應用。

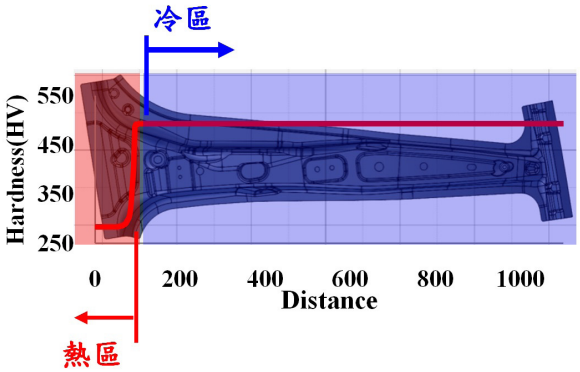
金屬雙極板



高階製品應用

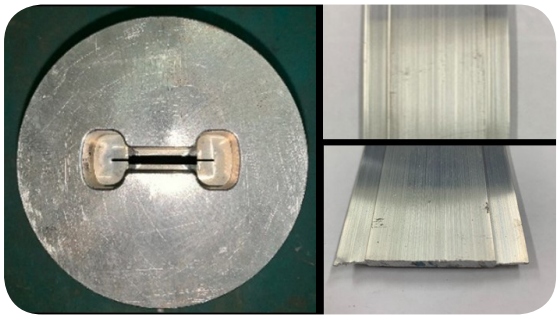
2. 超高強度汽車零部件熱沖壓成形技術

- 提升車體安全性能以及改善車輛能源效率之市場需求，持續進行先進超高強度汽車零部件之熱沖壓成形技術開發。
- 新開發之超高強度汽車零部件（熱沖壓B柱）將具有變強度功能，硬區抗拉強度達1300MPa以上，軟區抗拉強度達1000MPa以下。
- 開發熱沖壓模內沖切技術，達到部件成形與餘料切除於同一組模具之工藝，大幅降低熱沖壓部件雷切成本60%以上。
- 技術應用於變強度超高強度汽車零部件（熱沖壓部件）產品，在減重效率上預期可提升15%以上。未來亦可應用於新能源車產品，預估可節能30%以上。



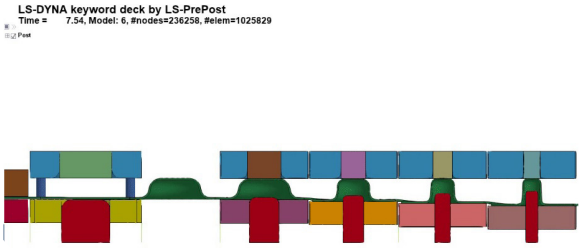
3. 高異厚薄壁鋁合金擠型技術

- 因應複雜結構件輕量化之市場需求，進行具高異厚特徵且壁厚超薄之鋁合金型材開發。
- 開發之鋁合金型材，其T5抗拉強度可達到280MPa以上，厚度差可達到4倍以上，且最薄處僅0.9mm。
- 應用於帷幕牆或鋁門窗結構件，提升產品性能。
- 研發成果亦可應用於其它民生產品，如帳棚支架等，可較傳統產品減重達15%以上。



4. 成形模具智慧虛擬試模技術

- 模具設計結果需要專業人員實際進行試模、修模作業，以符合成品品質要求。
- 由導入基於AI演算法（基因或類神經）之最佳化程式於有限元素分析軟體之前處理器中，再將求解器之結果回饋到最佳化程式進行製程參數（如模具尺寸、伺服曲線等）學習與優化。
- 本系統應用於3C或車用電子零件生產線，可避免人為經驗判斷盲點，並降低試模次數與成本。



成形模具智慧虛擬試模技術

5. 金屬沖壓製品產線智慧監診技術

- 目前國內金屬沖壓產業之產線生產品質管理制度，常以人工方式進行管控，不但效率低且容易出現管控不良情形，無法因應車用或工業用產品之高品質要求。
- 開發沖壓產線線上監視系統，可提供管理者遠端即時監視沖床狀態、模具狀態、送收料狀態、沖壓次數、工作速度等產線資訊。
- 預期可應用於3C或車用電子零件生產線，提升機台平均稼動率約10%以上。

金屬沖壓製品產線智慧監診技術

6. 馬達鐵芯模內連續沖黏技術

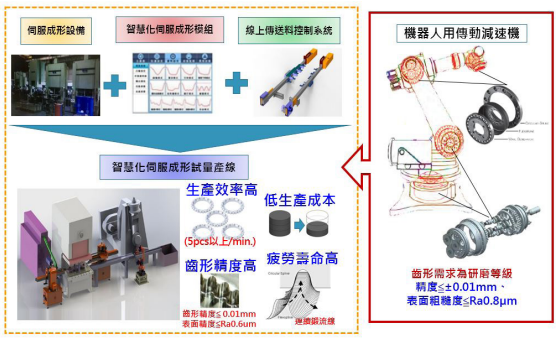
- 目前國內黏合鐵芯製作方式，是將矽鋼片沖壓為散片後，在模外進行堆疊黏合。
- 為提升堆疊尺寸精度與產能，比照國外技術發展方向，已完成線上連續鐵芯沖黏模具開發。
- 相較鉚合鐵芯，黏合鐵芯除維持95%以上疊積率之外，並提供0.34MPa以上之抗拉強度。

分割式馬達定子黏合鐵芯
(50x40x150mm)

未來研究

1. 近淨形鍛壓製品智慧化伺服成形系統

- 透過建置智慧化伺服成形試量產系統與環境場域，可協助國內外業者一少量多樣且彈性化開發、試作平台，加快業者切入智慧製造領域，提高自主開發高階金屬製品附加價值能力。
- 透過智慧化伺服成形試量產系統，可提供高階金屬製品一成形高精度、高彈性、高穩定性等開發製造平台，其成形製品尺寸精度可控制≦±0.01mm，表面粗糙度≦Ra0.6μm。
- 以智慧製造為主軸建置之開發試量產場域，協助業者製造技術轉型，提高在航太、電動車、機器人等高階金屬零組件市場之搶單能力，打進國際高階製品供應鏈。



智慧化試量產系統

2. 高強度鋁合金零部件溫/熱成形技術

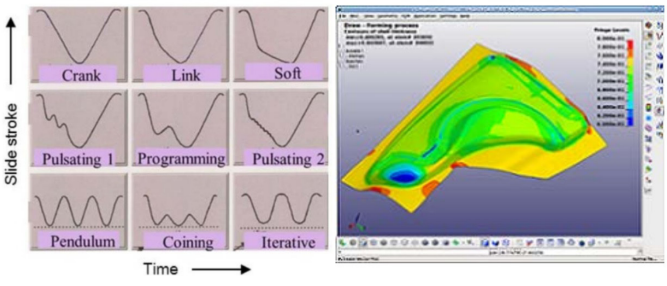
- 因應新能源車輛產業發展趨勢，以及能源效率提升之市場需求，開發高強度鋁合金零部件溫/熱成形技術。
- 產品抗拉強度400MPa以上，可一道次成形，突破傳統冷沖壓多道次成形工法。
- 新開發之高強度鋁合金零部件（溫/熱成形部件），主要應用於車體結構件，並具有可回收之循環材料經濟效益，預估可減重25%以上。

3. 可降解鎂合金伸線技術

- 因應可降解醫材需求進行合金材料開發，以擠型製造之母線素材進行伸線技術研究，開發具可降解性之鎂合金線型材。
- 開發之鎂合金線材，抗拉強度約200MPa，且延伸率約20%，結合表面處理可控制降解週數，達到控制目的。
- 可應用於微創手術，且因為其具有可降解特性能使在術後檢查恢復情形時，不會因金屬殘留干擾影像辨識，提升術後核磁共振及斷層掃瞄診斷之準確性。
- 研發成果亦可應用於其它民生產品，預估可較鋁合金產品減重達20%以上。

4. 虛擬伺服成形模組技術

- 模具設計結果需要專業人員實際進行試模、修模作業，以符合成品品質要求。
- 本技術預計導入大變形有限元素分析軟體 LS-Dyna，針對伺服沖床多種加工曲線，應用於鈑金或其他成形模具，進行虛擬模具與製程分析系統之標準化流程建立，可降低平均實際試模次數，由原先之 5 次以上減少為 3 次以內，大幅減少試模時間與成本。
- 本技術應用於3C或車用電子零件生產線，可避免人為經驗判斷盲點，並降低試模次數與成本。



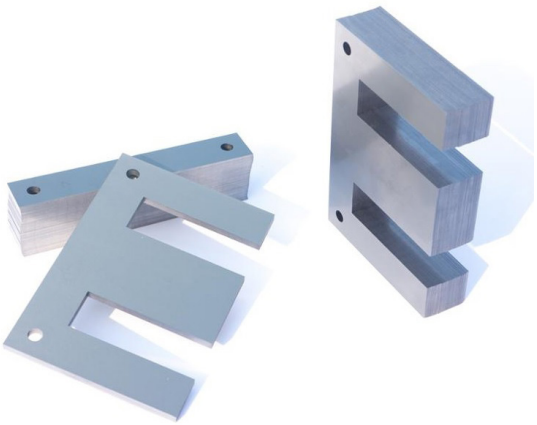
5. 沖壓智慧製造示範產線應用

- 近年，日、韓模具技術持續進步，中國大陸、泰國、越南等發展未曾間斷，我國除掌握現有技術與客戶，需持續精進模具開發與生產能力。
- 本產線皆採國產設備，包含伺服沖床，自動化機器手臂、3D掃描裝置等，同時發展雲端生產資訊平台、智慧虛擬試模與模具開發資料庫、線上模具監診等智慧製造系統，可成為產學研單位合作研發之據點。
- 金屬中心長年深耕於模具產業，並擁有多系統整合技術，可根據客戶的特定需求，輔導廠商升級轉型，將以最適化的解決方法和創新服務營運模式，促進台灣模具與機械產業再創高峰。

沖壓智慧製造示範產線應用

6. 各式沖黏鐵芯模具開發

- 相較鉚合鐵芯，黏合鐵芯，馬達之輸出預估約可改善轉矩1~5%、效率1~2%不等。
- 後續根據不同形式、尺寸之鐵芯，持續開發黏膠塗佈、堆疊初固之關鍵模組，整合於沖壓模具之中。
- 推展產業優先鎖定於為高值化馬達；如：車輛動力馬達、伺服馬達、工具機主軸馬達等，並將此技術拓及發電機與變壓器鐵芯。



變壓器鉚合鐵芯（35x30x15mm）

處理技術

為滿足複雜及高機能的金屬材料需求，2019年處理技術致力開發複合式的高機能處理項目，為金屬材料增加強度及安定度，以促進產業高值化。

例如不銹鋼耐蝕性無損表面硬化處理系統開發技術，將增加不鏽鋼耐蝕及耐磨程度，降低零件的高磨耗率，提高材質壽命及緊固性能。而溫度循環尺寸安定化技術，則可以增加鑄件處理效率及安定性。另外，本團隊亦鑽研石墨碳氈表面的改質方法，以提升釩液流電池的功率瓦特，並節省30%組件成本。

中心將持續精進金屬材料耐高溫、耐磨、抗蝕、抗刮等機能性的研發技術，為扣件、鑄件、閥件或模具等各項製造提供高效率的複合式處理方法。未來還會針對半導體測試用探針開發鍍膜技術，為AI及5G的科技世代做足準備。

研發現況

1. 不銹鋼耐蝕性無損表面硬化處理系統開發

- 因應不銹鋼高磨耗零件的市場需求，進行不銹鋼耐蝕性無損表面硬化深層處理之開發。滲層深度可達30μm，並將表面硬度維持在Hv0.1 800~1000。
- 技術應用於防鬆墊片，可提升緊固性能5倍以上。
- 技術應用於幫浦不銹鋼葉輪，可提高使用壽命3倍以上，並降低1.5倍的使用成本。

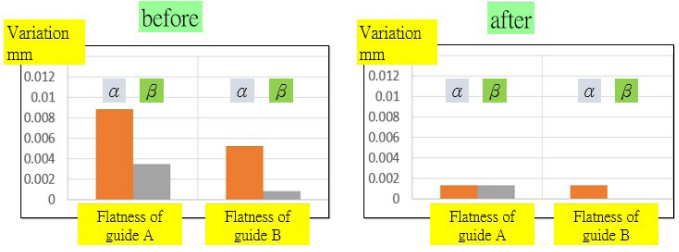
應用防鬆墊片

泵浦零件

2. 鑄件溫度循環尺寸安定化技術

- 因應工具機高值化及市場需求，進行結構鑄件尺寸安定性之開發。
- 新開發之鑄件安定性技術的自然時效處理時程已由傳統需一年降低至約需半個月，且效果相近。
- 預期工具機所用之鑄件產品，在尺寸安定性上可提升70%以上。
- 溫度循環尺寸安定化技術未來亦可應用於風力發電機、工業閥類鑄件，預估可降低50%以上變形。
- 將振動處理結合溫度循環處理可進一步提升安定性。

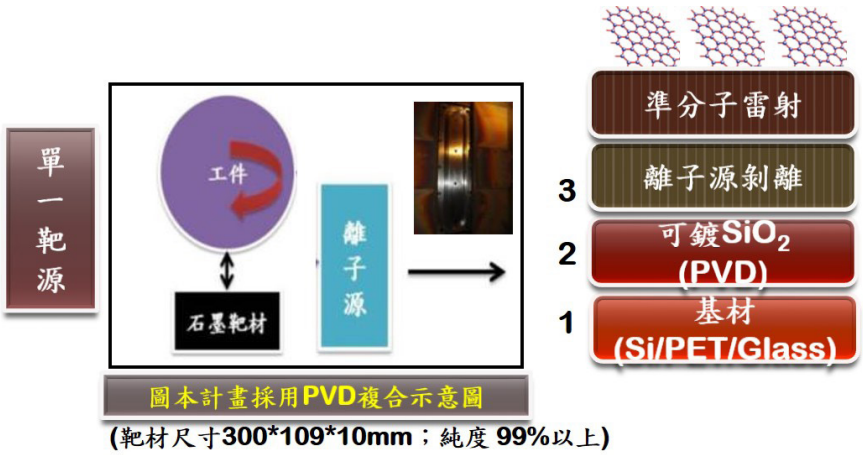
鞍座鑄件



導入前後穩定性比較

3. 石墨碳氈電極表面石墨烯改質處理技術

- 因應釩液流電池提升功率密度之需求，開發石墨碳氈表面改質處理技術。
- 改質後石墨碳氈，電流密度提升至80 mA/cm^2，是未處理碳氈的4倍，且均勻處理最大面積為100*100 mm^2。
- 此技術運用在釩液流電池上，以100*100 mm^{2}之工作面積，單電池功率為12.8W，提升為原本4倍。而且此技術可使同功率之釩液流電池堆節省約30%組件成本。

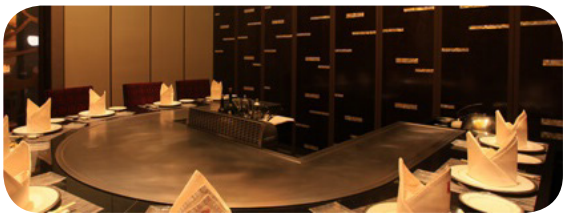


複合式鍍膜鍍石墨烯

未來研究

1. 沃斯田體不銹鋼特殊硬化處理技術

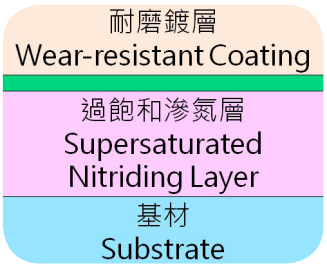
- 因應食品級沃斯田體不銹鋼耐磨抗刮的市場需求，進行沃斯田體不銹鋼表面特殊硬化處理技術開發。
- 由藉由特殊滲氮、滲碳或碳氮共滲技術，得到最佳滲層深度，並維持表面硬度在$Hv_{0.1}$ 800~1000。
- 預期應用於裝飾性產品，表面硬度可提升5倍以上。應用於食品加工設備，預估可提高使用壽命2倍以上。



不銹鋼食品烹飪板

2. 高壽命模具表面複合處理技術

- 因高強度材料之應用，以及新材料的開發，模具使用環境已經愈趨嚴苛，故將開發複合表面處理技術，提高模具使用壽命。
- 開發滲氮加鍍膜複合處理技術，耐磨耗提升20%、腐蝕率≦0.26 mg/cm^2/hr。
- 預期較未複合處理之模具壽命提升20%以上。
- 未來可應用於塑膠/沖切/熱鍛/壓鑄模具等，提高機台稼動率，增加生產效率20%以上。



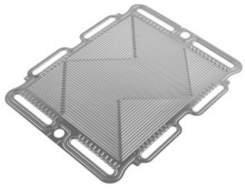
表面複合處理結構示意圖

手機塑膠殼件模具

3. 先進半導體測試用探針鍍膜技術開發

- 隨著AI與5G兩大技術的演進，為提供更準確、更穩定IC測試，將開發半導體測試用探針鍍膜技術。
- 開發碳化鉻系鍍膜，硬度由傳統電鍍金的HV90提升至HV1700，接觸阻抗<200mΩ、水滴接觸角≧90°。
- 具耐磨、抗沾黏特性，預期探針壽命可提升3倍以上。未來可應用於探針/金屬連接器/燃料電池金屬雙極板等，取代電鍍金降低鍍膜成本35%以上。

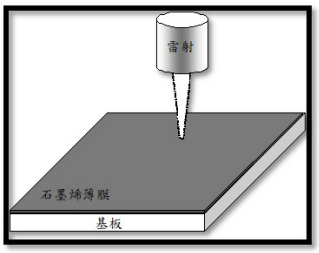
測試探針



金屬雙極板

4. 石墨碳氈電極表面石墨烯改質處理技術

- 因應釩液流電池提升功率密度之需求，開發石墨碳氈表面改質處理技術。
- 改質後石墨碳氈，原先已將電流密度提升至80 mA/cm^2，未來期望達到150 mA/cm^2，且均勻處理面積達200*300 mm^2。
- 預期此技術運用在釩液流電池上，以200*300 mm^{2}之工作面積，單電池功率為144W。而且此技術可使同功率之釩液流電池堆節省約60%組件成本。



準分子雷射石墨烯改質處理

模具暨精微加工技術

2019年模具暨精微加工技術主要針對模具產業、精密加工、成形設備業、半導體，以及醫療產業等需求進行開發，取得技術突破的項目包含高溫用金屬零組件之先進製造技術、數位牙體掃描與牙體製造技術、光學玻璃鏡片成形用模具超精密切削加工技術。

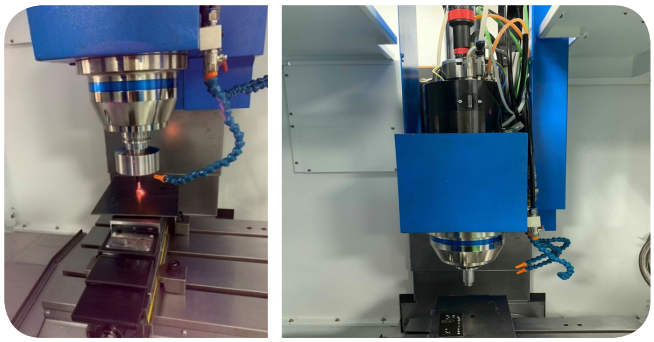
高溫用金屬零組件之先進製造技術，可提升加工效率並縮短產品開發的成本和時間，而數位牙體掃描與牙體製造技術能為患者達到即時補綴、即時治療，光學玻璃鏡片成形用模具超精密切削加工技術則克服了模具製造限制，有利於發展小型光學玻璃元件及模具。

未來，中心將投入金屬零組件之先進製造技術、具虛實整合加工製程決策系統、及橡塑膠機械設備AI加值的隱形眼鏡成型品質預診技術等開發重點進行研發佈局。

研發現況

1. 高溫用金屬零組件之先進製造技術

- 配合國家發展航太與能源產業政策，以高溫合金之耐高溫/高壓之金屬零組件自主研發為主軸，強化我國產業鏈於產品材料、成形、加工與後處理之技術量能，輔導以鋁合金/鈦合金零件代工業者轉型升級至具高溫合金零組件之高附加價值金屬製品，以提升產業國際競爭力。
- 高溫合金718Plus複合製程粗加工，並以航太發動機之關鍵零組件特徵為驗證載具，建立加工虛擬製造數值模型，完成718Plus具切削力與溫度之加工虛擬製造系統架構，有效提升加工效率及縮短產品開發成本與時間。
- 高溫合金純切削&複合切削之數值模型開發與實務驗證，整合輔助切削之Deform 3D切削模型有限元素解模擬、喬治亞解析解修正與實驗切削力量測，完成切削實驗比對，切削力吻合度達80%上。新技術未來亦可應用於各式難加工或新興材料的製程開發應用上。



雷射輔助銑削設備主軸

2. 數位牙體掃描與牙體製造技術

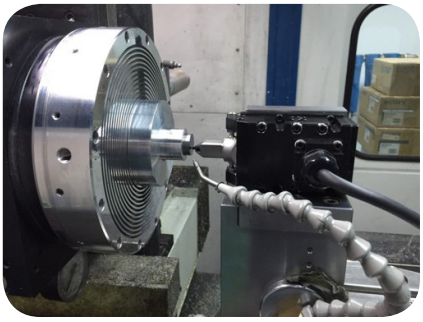
- 完成二矽酸鋰/全燒結氧化鋯陶瓷牙材單顆牙加工，因應即時治療/即時補綴為未來主流趨勢，即時　復治療結合口內掃描器與診所端微牙雕機，補綴治療案例在診所完成。
- 二矽酸鋰/全燒結氧化鋯陶瓷牙材單顆牙加工時間4Hrs，外型加工精度約≦±0.1mm。粗加工粗糙度量測為Ra4.39±0.53um，精加工粗糙度量測為Ra3.05±0.25um。

二矽酸鋰 /全燒結氧化鋯陶瓷牙材加工解決方案

二矽酸鋰 /全燒結氧化鋯陶瓷牙材加工設備

3. 光學玻璃鏡片成形用模具超精密切削加工解決方案

- 因應車載光學與機器人視覺等產品對玻璃鏡片的需求，開發微小、具微結構的玻璃鏡片模具技術，克服模具製造限制，有利於發展小型光學玻璃元件及模具。
- 以鑽石刀具直接加工鎢合金及碳化鎢提供高效率加工製程，表面粗糙度達Ra 20 nm以內，形狀誤差控制在0.5 μm以下。
- 搭配氣體、液體車削輔助模組，以CO2作為氣體冷卻，建立車削參數優化實驗提高碳化鎢車削的刀具壽命及刀具壽命分析（車削力、表面粗糙度）；建立BLUPC刀具切削碳化鎢模具（M78）能力測試，蒐集多組不同參數切削後與其量測PV值的數值，後續建立演算法學習，可以預測未來車削加工效益。

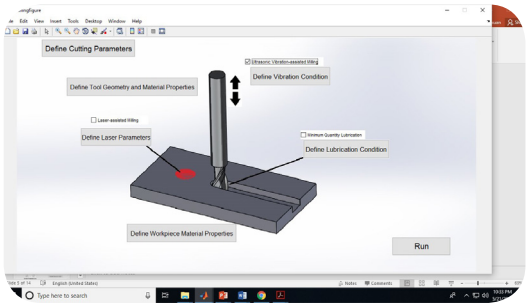


光學玻璃鏡片成形用模具超精密切削切工

未來研究

1. 金屬零組件之先進製造技術開發

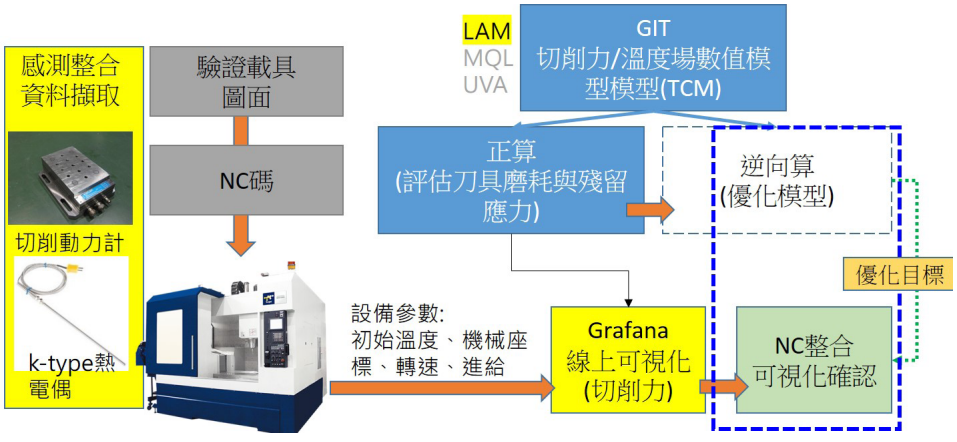
- 因應新產品暨零部件材料性能要求，建立雷射輔助切削殘留應力與刀具磨耗數值模型、超音波震動輔助切削數值模型建立與輔助切削虛擬製造系統，藉此提升切削效率、降低切削力及成本等高溫合金加工問題。
- 針對718Plus材料進行切削數學模型之切削力與溫度場預測值與實驗值比對驗證，在切削力數值準確度可達81%、溫度場數值準確度可達74%。
- 在輔助切削虛擬製造數學模型上，首創融合傳統銑削/雷射輔助銑削與超音波輔助銑削虛擬製造系統架構，並鏈結相關物理量計算，可提升30%以上加工速度，降低30%以上加工耗損成本。



輔助切削虛擬製造系統

2. 具虛實整合加工製程決策系統開發

- 建立CPS-based輔助智慧化製造技術解決方案，提供輔助切削加工設備之高速多點資料處理技術及IMS同步量測模組，14個類比同步取樣通道，單通道擁有16bits解析度。根據機台當下狀況，完成設備參數資訊整合感測資料，透過IMS量測模組，結合解析解模型，透過Grafana線上可視化，藉由正算模型估算出假想量測切削力值，協助製程開發人員掌握更多資訊，達到智慧精準製造之目的。
- 完成高溫合金零組件先進製造設備系統智慧化整合，可以線上感測蒐集製程狀態數據，萃取複合製程加工特徵，達成線上可視化監測，可縮短加工前置試驗時程、減少試驗廢料、未來以優化參數提升材料移除效率、維持製程穩定、減少失效停機，可提供先進製程加工系統設備模組監控及提高製程效率。

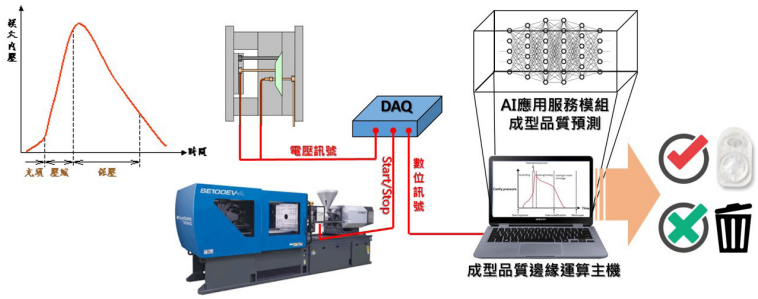


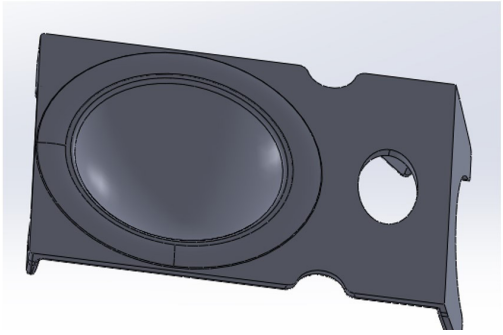
具虛實整合加工製程決策系統

先進製造設備系統智慧化整合

3. 橡塑膠機械設備AI加值-隱形眼鏡成型品質預診　技術開發

- 隨著全球消費生態的快速變遷驅動供應鏈少量多樣的生產需求，橡塑膠供應鏈面臨挑戰。全面導入物聯網技術至設備、整線及整廠，使橡塑膠產業know-how數位化，串聯所有機台設備之即時數據，以強大的智慧製造技術後盾，以及彈性、客製化、高效能與低耗能、環境友善的創新製造能力。
- 射出成型週期短，尺寸檢測耗時，僅以抽檢維持品質管理。透過模內感測技術與演算法，搭配多模穴的成型，監測模具內部的壓力、溫度變化，品質預測準確性預期可達到95%以上，提供近似於全檢的方法，解決量產時產品品質確保的問題。





隱形眼鏡成型品質預診技術

電動車輛技術

因應國內外車輛全面啟動電動化政策，預期將大幅推動電動車的銷售數量，並且為台灣零組件產業帶來轉型與升級的發展機會，同時促進台灣技術接軌國際大廠。在研發趨勢方面，電動化及自動化是現今車輛研發重點，2019年電動車輛技術除了深耕線傳底盤電控化次系統，亦致力於提升利基車底盤系統動態操控的安全與靈活性，並開發適應性懸吊系統加強阻尼控制精準度。

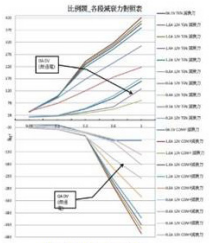
為符合未來的電動車輛發展與科技需求，本中心凝聚專業經驗，搭配相關核心技術能量，將積極發展底盤電控化懸吊與懸架系統，除可有效提升車輛之操控安全、乘適性外，亦可避免車輛在過彎時發生的側傾問題，使產業順利銜接未來電動化、智慧化車輛發展之趨勢，有利於提升該產業的全球競爭力。

研發現況

1. 適應性懸吊系統設計技術

- 可依路況即時調整阻尼控制系統，有效抑制過彎側傾、提升舒適度。
- 產出模式可調阻尼電控懸吊避震器控制模組，阻尼力精準控制可達：±25%+40 N@0.3 m/s、可連續調整阻尼力控制解析度：±25~30%@0.3 m/s，另車姿適應性感測控制技術，取樣頻率>1 kHz，控制器驅動能耗降低>20%。
- 自主創新模組化疊層阻尼控制閥片設計，高彈性化車型對應，共用件使用率>50%，模組化設計高性價比。

連續阻尼可調模組



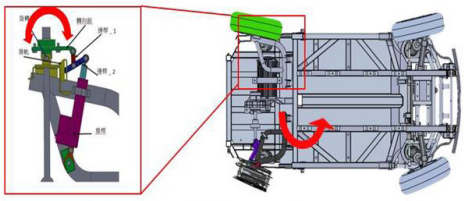
連續阻尼可變

懸吊控制驅動模組

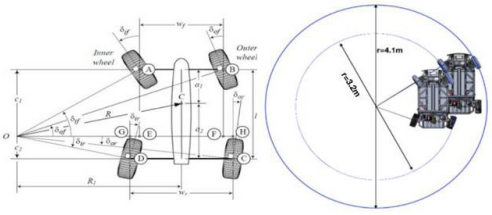
電動車輛

2. 高操安乘適性底盤技術

- 提升利基車底盤系統動態操控安全與靈活性。
- 以共用底盤為基礎，設計後輪輔助轉向機構（Rear wheel assistance），於轉向過程中後輪改變Toe角度（+7.3° ～-12.59° ），進行Roll方向姿態變化，改變轉向瞬時中心，縮減轉向半徑，設計結果根據ISO 7457標準最小轉向半徑3.2m、轉向不足係數：2.63 deg/g 。



後輪轉向機構設計（專利申請號：108137331）

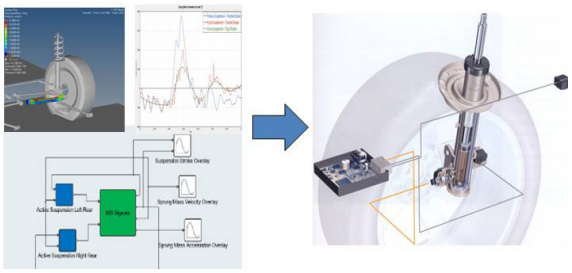


高操安乘適性底盤技術

未來研究

1. 適應性懸吊電控系統模組

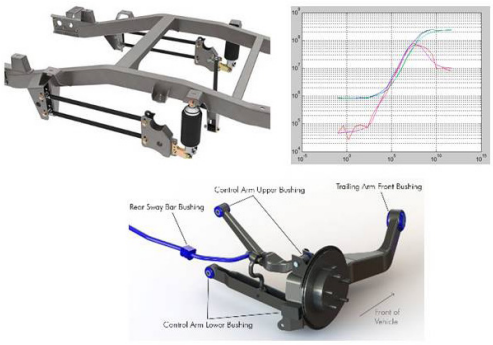
- 讓車輛牽引力控制、操穩性以及舒適性得到更佳的表現。
- 適應性懸吊系統模組試製，以SKYHOOK控制理論設計，應答速度：>5Hz、單體阻尼力精準控制：±20%+40 N@0.3 m/s。
- 透過電控化懸吊實車搭載與調整，確認乘適性及操控性，整體加速度加權均方根值aw<0.8 m/s2（根據ISO 2631-1規範）、整車操控側傾角≦10°@0.3 G（根據ISO 3888規範）。



電控系統模組

2. 懸架關鍵零組件與驗證

- 滿足車輛操控安全、乘適性、減震的要求。
- 拖曳臂撓性元件研製，解決因側向支撐力不足，Roll方向側傾抑制問題。減振能力由10dB提升至15dB ，及整車加速度0.3G時，車身側傾角度變化≦4° 。
- 發展空氣彈簧嵌入式感測器技術，改進純機械式空氣彈簧之可控制參數受限，以達到應力/應變/限位感測介面數位化統合。



電動車輛

精密機電及自動化技術

精密機電及自動化技術2019年研發重點聚焦於整合機電控制與智慧化技術，專注於光電半導體零組件加工技術、醫用投影取像領域，包含光電探針自動化加工系統技術、機器手臂結合3D視覺自動路徑生成技術，物聯網式工業電磁閥製、鞋智慧化自動打粗，以及車用電磁閥檢測驗證等多項智慧高值化關鍵模組設備與技術開發。

因應產業智慧製造的發展趨勢，本中心未來將持續推動智慧自動化，並運用數位技術、自動化技術、感測技術、人工智慧AI優化技術以及物聯網雲端相關技術，結合各應用領域專業知識發展專用設備；藉提升技術能量提供高產率與良率之系統方案，並加速產業化應用以滿足產業智慧製造、高附加價值產品與產業自動化之需求。

研發現況

1. 光電探針自動化加工系統技術

- 因應光電金屬探針生產品質提高與產率提升之市場需求，進行光電探針自動化加工系統技術開發。
- 所開發光電探針針尖自動化加工系統，具備分割旋轉台提供上下料、粗磨、細磨、拋光及檢料之平行工作能力，加工產率由傳統人工研磨1pcs/min提高為自動加工達4pcs/min以上，且具穩定良率品質，不因人為操作影響。
- 自動化探針加工系統技術，未來亦可應用於其他精密金屬針尖零組件，預估可加速產率4倍以上，並可升級具備線上檢測升級能力。

微細光電探針

光電探針自動化加工系統

2. 光學輔助調模系統SaaS化

- 以簡潔便利的導引介面，協助現場人員進行操作，縮短人員訓練時間至少50%以上。
- 光學輔助調模系統精度為≦±0.12 mm。
- 有效的導引程序可提高調模效率約70%以上。

SaaS化調模流程

調模系統 SaaS化介面

3. 製程高效能化

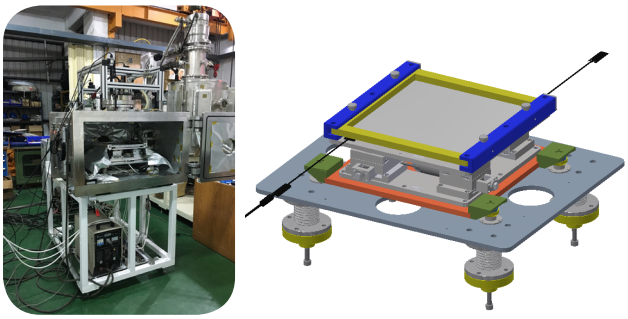
彈性化自動組裝模組

- 因應組裝程序愈來愈複雜與精細，操作員在產線設定上也須花費許多的時間與成本，缺少更簡易與彈性的自動化技術。
- 開發視覺辨識技術與力量回饋控制技術，結合機械手臂進行金屬元件自動鎖附與組立等動作，藉由視覺對位技術與力量控制技術提高組裝精度與良率，減少倚賴人工經驗，確保品質與穩定，達自動化組裝之效能，提升生產效率達30%以上。

彈性化自動組裝模組

4. 真空設備精密對位模組技術

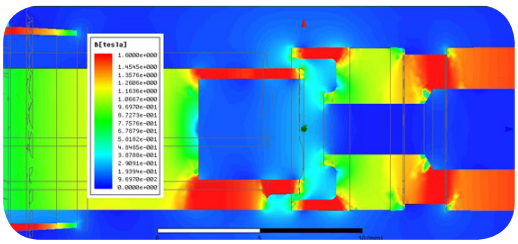
- 開發真空製程環境下之精密視覺回授對準模組，建立隔絕外部振動與腔體形變、真空腔體內直驅XXY平台、視覺回授對位等關鍵技術，協助國內真空設備業者建立可切入高階對準製程產業應用供應鏈能力。
- 視覺回授與平台控制模組，應用製程精度≦±0.005mm，適用導入於有機顯示器、晶片電阻、晶圓、精密量測等產業真空蒸鍍或濺鍍製程設備。



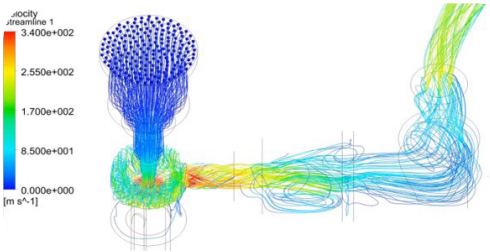
真空設備精密對位模組設計

5. 氣壓控制閥模擬技術與通訊控制整合軟體開發

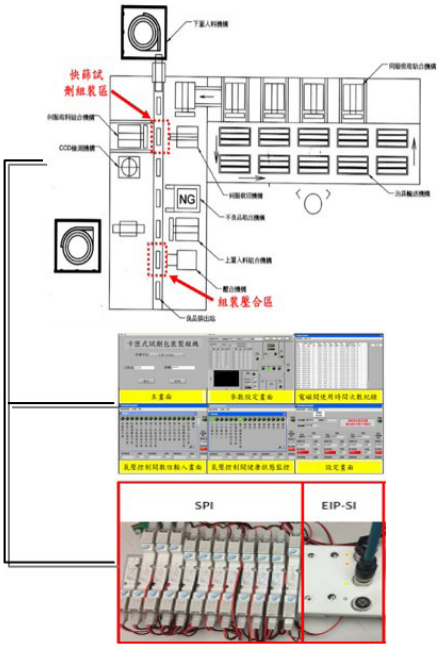
- 為開發高階氣壓控制閥，可協助業者導入關鍵CAE模擬技術。
- 開發電磁閥磁場模擬技術，藉由最佳化方法改善磁吸力效能提升2倍。
- 開發閥體結構流場模擬技術，藉由最佳化方法改善流場結構設計。
- 輔導產品電子化，開發通訊式氣壓控制閥與設備控制整合軟體，可進行電磁閥狀態監控、計次、計時、預警等功能。



磁通密度最佳化設計



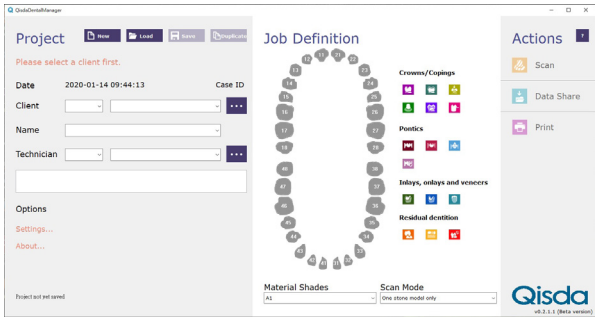
流場結構最佳化設計



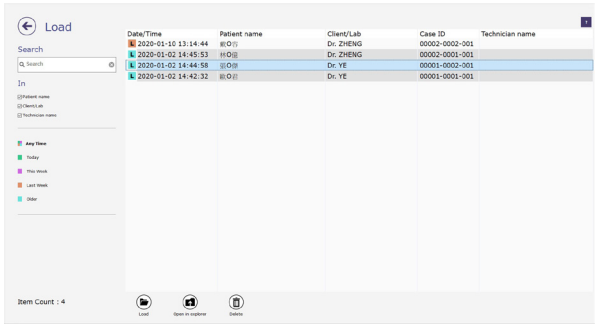
通訊式氣壓控制閥與設備控制整合軟體開發

6. 投影取像方法開發

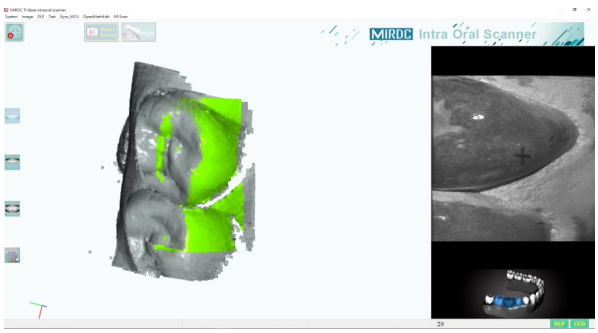
- 為了滿足數位牙科診所端之臨床醫師使用需求，建構新世代3D口內掃描系統之先進技術能量，並自主開發友善之病歷訂單管理介面，提供使用者簡易操作方式，奠定本計畫軟體系統之可靠度。
- 整體系統包括TI DLP微型投影模組、薄型高速CMOS模組、高品質CMOS成像鏡組，以及嵌入式計算機模組。
- 以混和式光柵(Hybrid Structure Light)之取像建模分析方法，建置完成口內掃描程式作業平台，口掃系統之單一面向掃描精度可達≤±20um。



口內掃描訂單管理介面



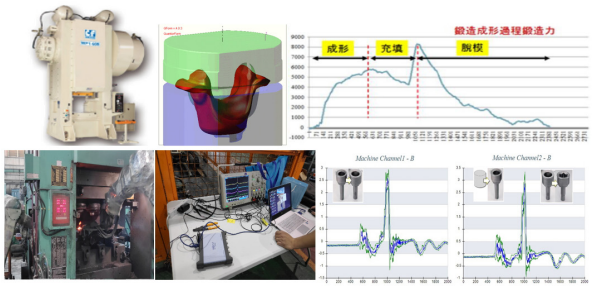
口內掃描訂單工作表單建立



口內掃描視窗畫面

7. 鍛造成形製程感測監測技術

- 面對產業缺工問題與全球智慧製造趨勢下，本計畫以協助產業建置鍛造成形製程感測監測技術，改善目前事後抽檢方式。
- 協助廠商發展鍛造成形製程感測監測模組，讓每一件鍛件都可即時監測品質，避免瑕疵件混料情形。
- 鍛造成形製程感測提升產業製造技術，以實際成形訊號資料，掌握鍛件品質，提高客戶信賴，爭取商機。

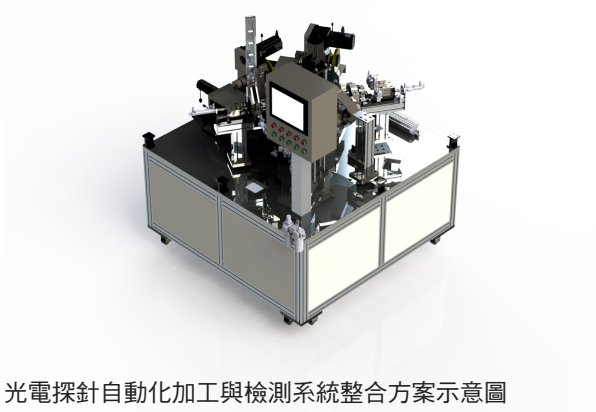


鍛造成形製程感測監測示意圖

未來研究

1. 光電探針零件智慧加工與檢測系統整合方案

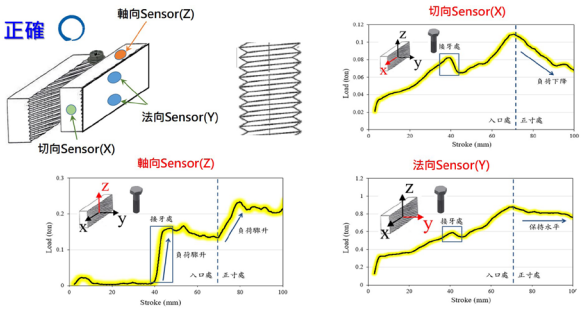
- 因應光電金屬零組件產業智慧製造發展趨勢，進行零件智慧組裝與檢測系統整合方案開發。
- 擬發展零件智慧加工與檢測系統整合方案，將具備自動化組裝、線上檢測及數據可視化能力。
- 整合智慧製造周邊技術，光電金屬探針零件智慧加工與檢測系統整合方案可支援產業建立高品質產品生產調控與品管能量。



光電探針自動化加工與檢測系統整合方案示意圖

2. 搓牙調模輔助系統

- 透過光學影像與力量感測趨勢，協助現場人員進行快速調模導引。
- 開發之牙板調模導引技術，預計可提高20%以上的調模效率。
- 減少人員於牙板調模訓練時間至少30%。

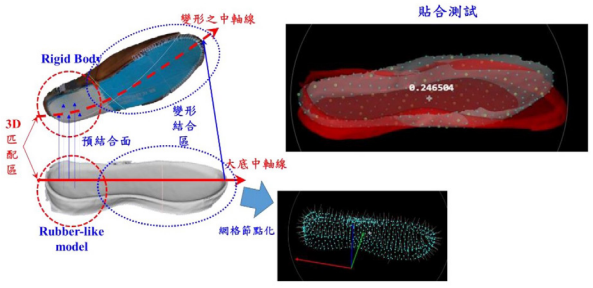


搓牙成形與力量模擬示意圖

3. 智慧機器人與製造應用AI系統

軟性材料機器人加工系統技術-虛擬貼底畫線技術

- 利用虛擬3D模型透過材料變形計算鞋面加工邊界。
- 虛擬貼底畫線技術可提昇原有製程效率達30%。



虛擬貼底示意圖

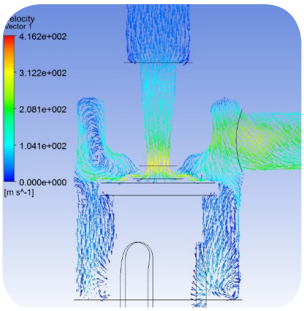
數位模型建立後驗證方式

4. 產業技術精進整合

氣壓控制閥產業

- 比例閥關鍵技術開發。
- 鏈結業者運用CAE雲端服務加值中心平台軟/硬體能量，協助電控比例閥結構建模、磁場及流場分析，補關鍵，縮短研發時程(國際同步)。
- 驗證及場域試驗：

1. 建立產品洩漏及可靠度驗證測試平台(國際同步)。
2. 導入電子設備驗證/示範，以實績展現成果縮短市場接受期(國內領先)。

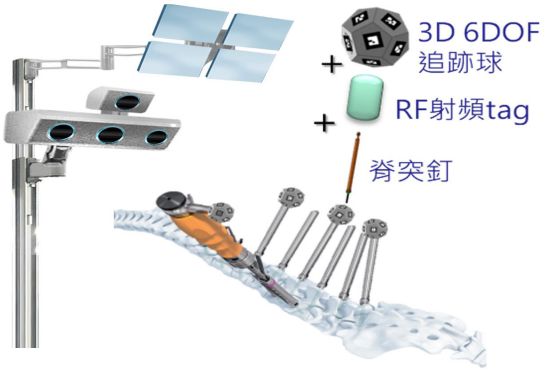


鏈結業者運用 CAE雲端服務加值中心

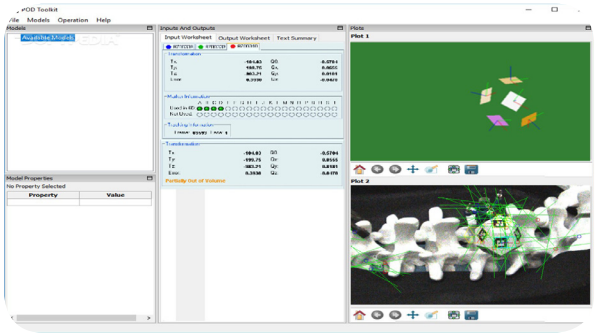
建立產品洩漏及可靠度驗證測試標準

5. 光學體表定位技術與軟體工程(治中)

- 針對臨床骨科手術需求，開發智慧骨科手術輔助系統關鍵技術，將為國內醫療定位系統業主建立自主完整化光學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。
- 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，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，達到預對位處理。(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≤1mm。



3D 6DOF系統



即時影像定位 GUI

6. 鍛造感測資料與建模技術應用

- 產業面對全球智慧製造趨勢下，本計畫以協助產業建置鍛造成形製程感測資料建模與應用，改善目前人工判定方式。
- 導入製程感測品質監測技術，於製程設備裝設感測器，擷取成形受力狀態，可即時進行品質監測把關。
- 整合鍛造感測資料與建模技術，協助鍛造製程即時品質監測與製程失效模型建置，協助機車鍛件生產效能提升。

檢測技術

為確保國內業者的產品內容與規格符合標準，檢測技術核心以AI智慧化檢測與高值化發展為目標，在產品使用安全與製造產能等多種項目中，提供標準、測試、檢驗、校正、查證等相關服務，協助金屬相關產業逐漸往高值化發展。

2019年本團隊針對醫療手術輔具、水五金產業認證、工業用閥類檢測驗證、離岸風場專案驗證技術與驗證審查、Homi家電檢測等五大類別進行技術研究與檢驗開發，藉此發展品質、改善製程及管理效率，提高產品良率和製程品質指標。

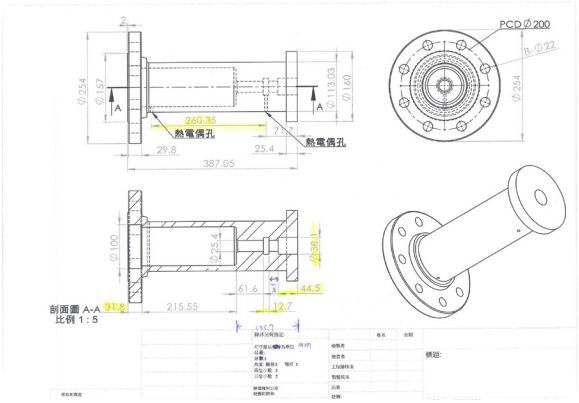
中心檢測技術未來會持續投入我國機械設備器具開發、智慧化技術研發、以及協助完善產品資格文件審查與驗證機制。除此之外，本團隊亦將輔助業者申請國外專業認證，以提升國際競爭力，為台灣產業爭取商機，打造MIT美譽。

研發現況

1. 工業用閥類檢測驗證技術

- 因應產業產品零組件設計驗證需求，進行閥門中軸盤根設計驗證技術的建立。
- 開發的API 622盤根逸散量測技術，可提升閥軸盤根零組件設計，低逸散設計降至100ppmv以下。
- 預期新開發之試驗量測方法，在產品驗證效率上可提升35%以上。
- 新盤根逸散量測設備未來亦可應用於其他球閥產品，預估可促進產品品質提升10%以上。

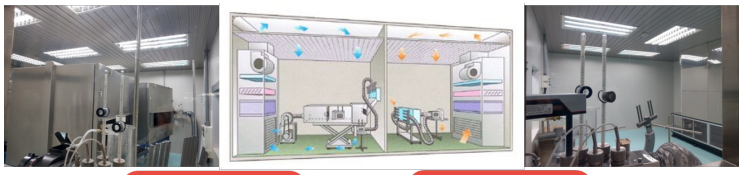
盤根逸散量測設備



盤根逸散量測設備 -盤根箱模組

2. Homi家電檢測技術一元化 - 冷氣空調

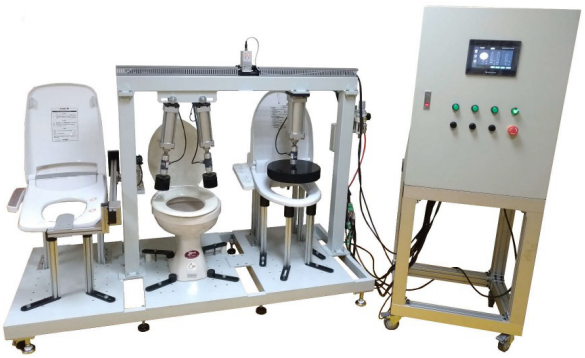
- 因應產品法規標準、業者產品需求與產業政策推動，建立冷氣空調檢測實驗室，除了可作為第三方驗證單位，也可協助製造商在製程及設計上缺失改善與產品調適數據紀錄分析。
- 鏈結中心電器安規實驗室、電磁相容實驗室、馬達測試實驗室，提升及擴大檢測技術服務之能量包含產品能效、零組件能力試驗、溫升、耐久性、耐電壓、結構安全、電磁干擾等測試驗證。
- 對應產品法規標準，從量測儀器準確度要求、量測儀器校正要求、測試條件、測試作業程序、測試結果等要項來闡述冷氣空調檢測作業及評鑑注意事項。



室內側環境室　　室外側環境室

3. Homi家電檢測技術一元化 - 電子式馬桶（便）座

- 因應產品法規標準、業者產品需求與產業政策推動，建立包含家電、3C產品、冷氣空調，以及免治馬桶產品檢測標準技術一元化服務資訊平台。
- 檢測技術服務之建置能量包含產品防電擊保護、溫升、耐久性、消耗電力、結構強度、洩漏電流與耐電壓測試、恆溫恆濕、馬桶垂直方向均勻力、坐墊垂直平均力、坐墊加熱彎曲、耐熱耐燃與耐蝕…等測試驗證。
- 透過一元化的資訊平台，提供國內業者詳細標準、測試、檢驗、校正、查證等相關服務協助國內業者符合產品安全等多種驗證標準，最終使國內業者加快之產品上市週期，提升產業競爭力並打造MIT產品的國際知名度。



免治馬桶測試

4. 澳洲AS 4020飲用水五金產品檢測模組建置及技術研發

- 本計畫為依據澳洲AS 4020所建置系統用飲用水五金產品溶出試驗檢測模組，其系統能量如下所示。

（1）溶出過程中的環境溫度控制：20±2℃

（2）溶出液試劑配製之DI Water：18 .2 MΩ・cm

- 未來針對系統用飲用水五金產品皆可透過此檢測系統進行品質驗證
- 預計應可協助國內業者提升澳洲市場於系統用飲用水五金產品銷售產值1~2%

實驗室前處理區

5. 離岸風場專案驗證技術與驗證審查

- 國內離岸風電正積極發展中，除風場建置與產業發展，建置國內檢測驗證制度亦是刻不容緩。本年度持續協助標準檢驗局發展風場第三方驗證機制。

（1）辦理DNV GL離岸風場專案驗證技術訓練與諮詢，包括8模組計17次課堂訓練，以及3組計15場次案例實務訓練，參與單位包括中心及國內3專業法人單位。

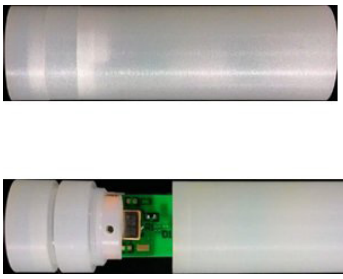
（2）委託台北科技大學辦理「離岸風力機結構-基樁-土壤互制分析研究暨人才培育」、委託中央大學辦理「離岸風電場址風況、海洋參數及負載分析技術研究」、委託國震中心辦理「地盤反應及基準地震分析研究」，藉專業學研單位強化離岸風場專案驗證能力，並藉教育體系達成人才養成、擴散之效。

（3）建立驗證機構品質文件及驗證技術文件，並申請TAF認證，已提出風場專案驗證方案認證申請共12項模組，並已執行5場次驗證方案審查會議。

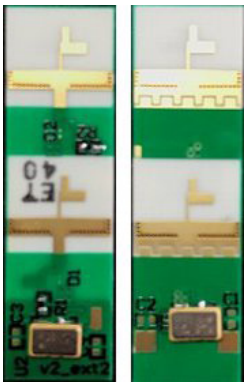
（4）協助標準局建立專案驗證審查制度，參考歐陸先進國家如德國、丹麥作法，研析其審查機制與流程，協助擬定國內專案驗證審查制度，並受理開發商之案件申請、執行專案驗證資料技術審查，以及召開技術審查、審議會議、出具審查報告與審議建議書等。

6. 調頻式射頻定位系統

- 本年度調頻式射頻定位系統，投入定位標籤微型化開發、定位標籤與雷達收發模組之封裝機構開發、6 ID射頻定位、醫療器材電性安規前測以及動物試驗。完成雙天線射頻電路尺寸35×10 mm（單一天線電路面積縮減37.5%）、定位標籤封裝尺寸φ15×50 mm、雷達收發模組封裝尺寸160×160×40 mm、三維空間定位精度0.07 mm，準度1.75 mm（20 mm測距誤差）。



定位標籤封裝殼件



定位標籤微型化射頻電路

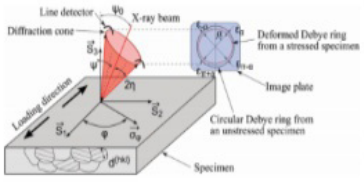
7. 應用於壓鑄之模內壓力感測器設計開發

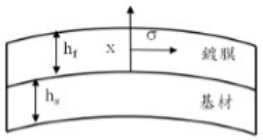
- 目前壓鑄產業面臨成品良率不足，是因為無法掌握製程參數與環境參數之變動。因此，本技術開發耐高溫模內壓力感測器，藉由量測模具內部之壓力，提供壓鑄成型品質判別之關鍵因子。

感測器原型圖

8. 應用於攜帶型X-ray系統於曲面殘留應力檢測分析技術開發

- 改善目前製程無法即時判別殘留應力與曲面形態導致應力量化失真等問題，以掌控表面處理品質標準增加生產效率，並提供有效數據協助參數優化與製程改善。本技術結合攜帶式X-ray繞射殘留應力設備結合曲面殘留應力運算公式，建立一套適用於攜帶式設備之曲面鍍膜的非破壞殘留應力檢測與驗證方法，其最小量測曲率半徑為1.5mm，殘留應力重複性誤差小於±4%。



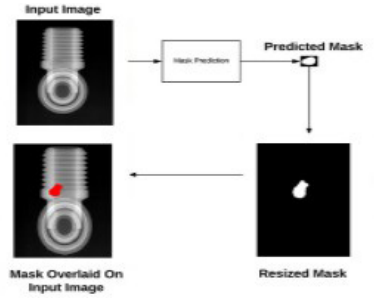


$$\sigma = E_f[(\varepsilon_0 + \varepsilon) + (x - t_n)k]$$

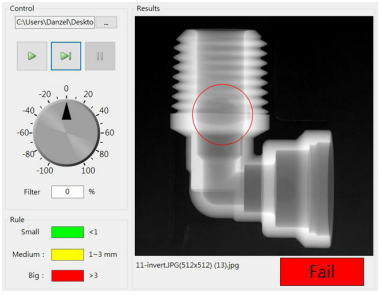
曲面殘留應力分析圖

9. 應用於內部缺陷檢測與智慧辨識技術開發

- 因應橡塑膠製品AI智慧化檢測與高值化發展，對於內部缺陷全檢以及智慧化需求日增，將進行CT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≧85%、反應時間≦10s，可提升檢測效率50%。



CT影像缺陷標註

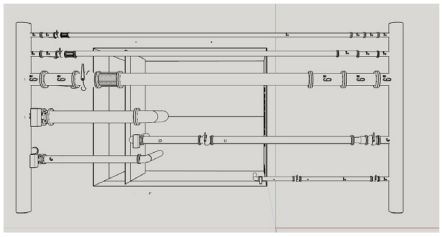


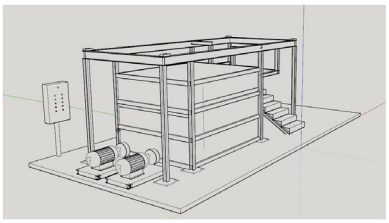
辨識模型

未來研究

1. 工業用閥類檢測驗證技術

- 因應國內閥產業設計驗證需求，將建立控制閥類產品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）。
- 預期新開發之試驗量測方法，在產品性能驗證效率上可提升35%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，預估可促進產品品質提升15%以上。





CV量測設備規劃

控制閥產品開發

2. 冷氣空調馬達檢測技術

- 為因應國際電器產品節能、馬達系統高效能潮流，未來預計建立與提升產品系統效率檢測技術及驗證能量，並協助國內業者與學界合作，創造產、學界互助互利之關係，以利於產業發展和提升競爭力。
- 各開發階段測試數據回饋產品開發端，協助分析原因及改善，脫離Try & Error迴圈。
- 整合各實驗室提供產品各項法規驗證需求，減少業者多處奔波，並協助取得認證及標章。
- 協助國內廠商紀錄及收集產品調適過程，建立數據庫及經驗，降低後續相似機型開發時間。
- 協助取得產品相關認證及標章，藉由品牌效應提升產品價值10~15%。
- 輔導國內廠商取得產品相關認證，降低進入市場及取得標案難度與整體產品驗證時程，可增加營收10億元/年，促進投資帶動產業整體效益45億元/年。

冷氣空調馬達檢測技術

3. 美國 NSF 61-9溶出性能測試之快篩試驗開發

- 為提供國內業者於開發階段時，可快速了解產品品質，縮短從開發到取得認證的時程。
- 14種元素偵測極限皆可達1ppb以下。

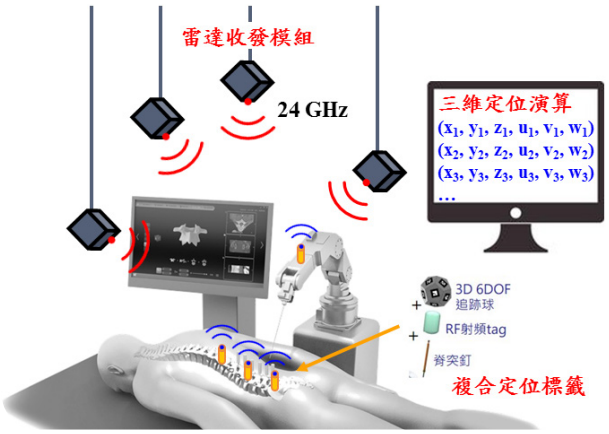
感應耦合電漿質譜分析儀

4. 離岸風場管理機制與關鍵零組件檢測驗證技術

- 建立離岸風場生命週期驗證與協助建立管理機制。
- 發展離岸風場運維至除役間之檢測驗證技術。
- 擴展離岸風電關鍵零組件檢測驗證能量。

5. 射頻定位模組技術

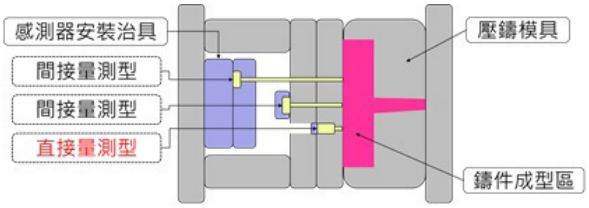
- 未來研究方向包括多目標定位、複合定位與主系統開發等技術。透過多目標（10 ID）定位可達成患部與器械其位置座標與方位角度之定位，複合定位則是結合光學與射頻定位技術，滿足醫療手術定位導航之需求，而主系統開發整合電源模組、硬體電路介面、機構封裝以及軟體API介面。



醫療定位系統之射頻定位模組

6. 應用於壓鑄之模內複合感測器設計開發

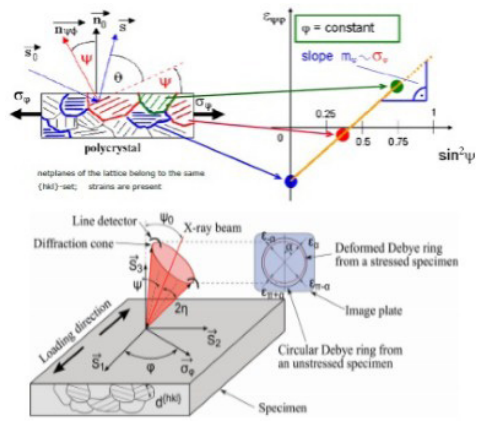
- 目前壓鑄產業面臨成品良率不足，是因為無法掌握製程參數與環境參數之變動。因此，本技術開發耐高溫模內複合感測器，藉由量測模具內部之壓力與溫度，提供壓鑄成型品質判別之關鍵因子。



模內感測安裝示意圖

7. 殘留應力檢測產業化與製程鏈結技術

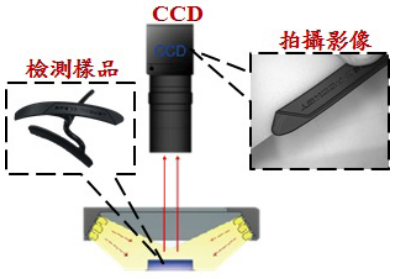
- 因應國內鑄鍛件產業逐漸往高值化發展需求，發展殘留應力檢測技術並鏈結製程，作為異常特徵要因分析因子。預期量測技術所應用之大型鑄鍛件產品，可進行表面應力量測並與製程參數鏈結建立品質分析標的與製程品質指標，殘留應力量測未來亦可應用於車輛、航太產品，預估可發展品質、製程改善等技術。



殘留應力分析示意圖

8. 應用於外部缺陷檢測與智慧辨識技術

- 因應橡塑膠製品AI智慧化檢測與高值化發展，對於外部缺陷全檢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≧90%、反應時間≦10s，可提升檢測效率。



外部缺陷與智慧影像辨識示意圖

管理技術

管理技術以創新為核心，帶動傳統鑄件提升品質、醫療機械手臂國產開發，以及航太電源供應器轉型升級，並推動水五金產業進行跨域生態整合。本團隊會持續為企業進行策略規劃、智慧應用、蓄熱節能、流程電子化等營運輔導。

此外，中心提供企業專業管理系統驗證服務已有30年經驗，獲頒全國認證基金會（TAF）認證，可頒發ISO 9001/ 14001 / OHSAS 18001等三項系統驗證證書，充分掌握國際管理系統驗證稽核技術，滿足企業整合驗證需求，輔助其達到國際品質標準。

未來中心將更進一步加速產業升級，提升產品附加價值，並以技術應用管理（人機協作/痛點分析/聯網機制）、營運制度管理（AS 9100/AS 9110）、創新商模管理（跨域結盟/虛實整合）為推動主軸，協助企業開創嶄新的道路。

一、管理

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)

數據智慧應用

- 營運情資服務平台
- 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

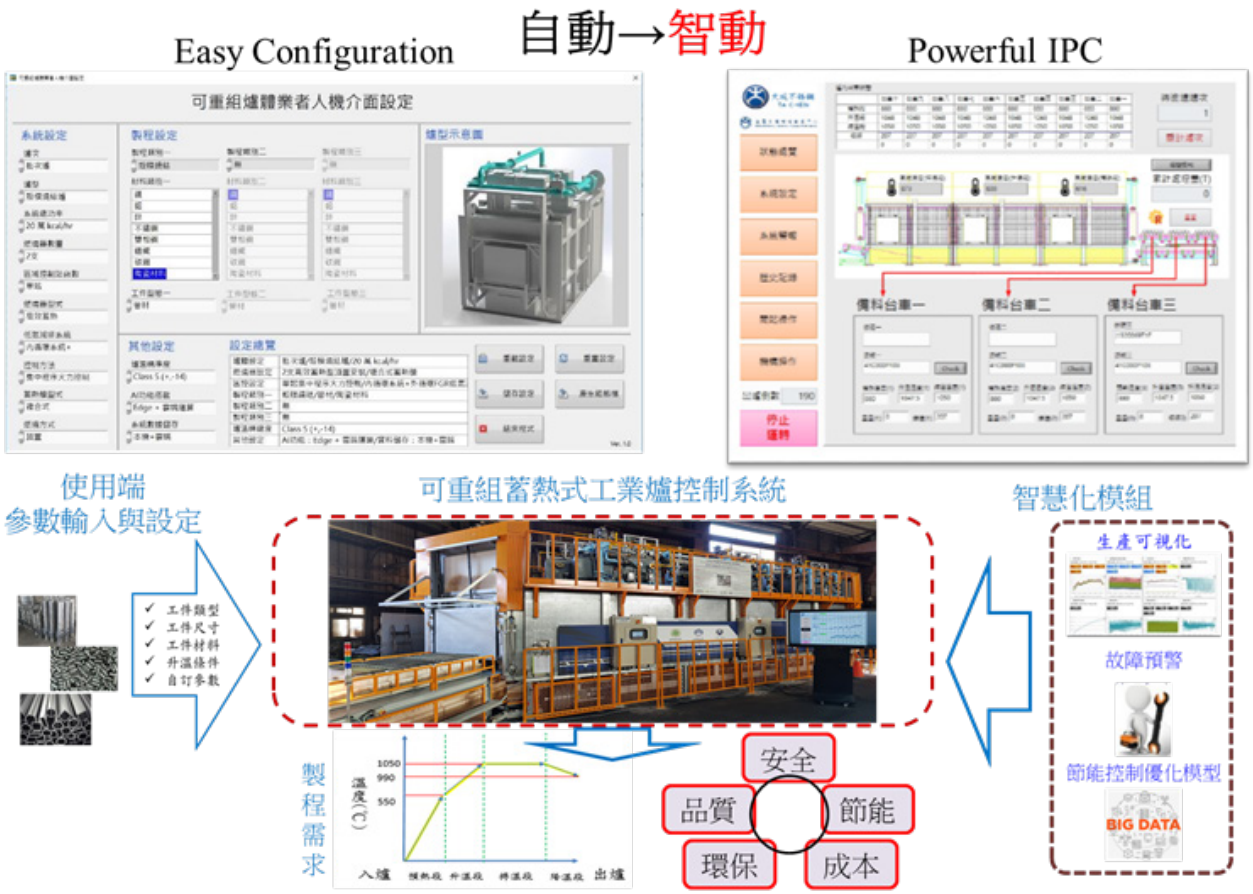
廠商關係管理系統 (CRM)

鍛力感測監測平台

3. 智慧型可重組蓄熱燃燒系統開發技術：

- 協助國內高溫(800℃以上)大型金屬製程發展蓄熱式燃燒廢熱回收系統，減少能耗30%以上。
- 可重組高效蓄熱式燃燒系統模組，節能率達30-40%。
- 智慧分散型均溫控制技術與操作參數優化模型，再提升節能5%。
- 蓄熱燃燒工業爐系統模組設計驗證技術，將開發時程從110天縮短為51天，節省50%時間成本。
- 建置國內首座智慧型可重組蓄熱燃燒系統示範場域：實測能耗節省35.4%。
- 可重組蓄熱式燃燒工業爐，未來可應用至汽機車零件業，金屬製品業，熱處理業等高階產品上，預估可達節能30%以上。

蓄熱式連續固溶化熱處理爐



智慧型可重組蓄熱燃燒系統開發技術

未來研究

1. 科技應用創新轉型協助企業開創新局：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。
- 創新營運模式:建立測試場域以O2O虛實整合發展高值產業鏈。
- 智慧型可重組蓄熱式燃燒技術：發展規格化燃燒器、蓄熱模組及智慧化控制技術，大幅縮短各式爐體節能改善建置時間與提升各式直火式工業爐能耗效率，促進產業化的推動。

二、創新服務

研發現況

1. 精密噴砂機械手臂開發（人機協作管理）

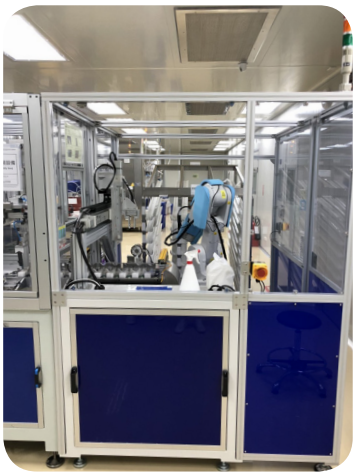
- 為翻新傳統鑄造業3K形象及提升鑄件品質，建立智慧噴砂技術，以程式驅動智慧路徑走行進行精密噴砂，配合人機協同機制管理使之符合實際作業所需，不僅提高產能150%，且鑄件品質良率亦由95%精進至99%。
- 協助傳統鑄造設備及材料商轉型為技術服務提供者，擴散至計畫體系應用端業者，達到節省成本295萬、增加營收9,300萬、促進投資2,110萬等效益。

精密噴砂機械手臂

鑄件精密噴砂作業

2. 血液透析器智能化生產設備開發（製程痛點分析）

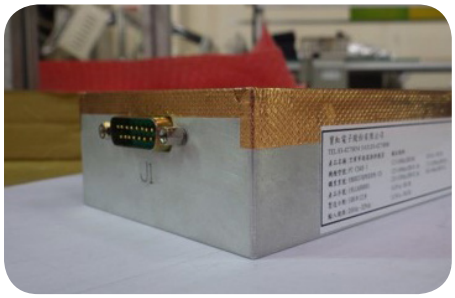
- 為跳脫血液透析器國際市場競爭不足的困境，進行血液透析器智能化設備國產化開發。
- 開發機器人工作站，運用機械手臂放料，提升產能17%、產能利用率13%、半成品帶菌數＜500 CFU。
- 導入自動光學檢測，建置O-Ring影像判別機制與統計品質可視圖表，作業時間節省25%、誤檢率低於0.5%。



血液透析器智能機器人工作站

3. 航太電源供應器研發（AS 9100）

- 因應國機國造之產業政策及市場需求，協助廠商導入AS 9100系統，由傳統交通用電源供應器轉型升級至航太無人機電源供應器，提高產品價值。
- 預期新系統所研發之電源供應器產品，生命週期長度可提升50%以上。



航太電源供應器

4. 跨域創新生態系合作（跨域結盟籌組）

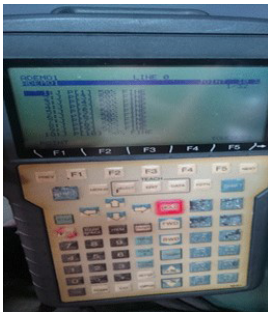
- 因應中小型傳統產業跨域轉型需求，以水五金產業為標的進行跨域生態系推動，讓傳統水五金業者轉型提供整合服務，滿足高複雜、多功能、特殊性的創新市場產品需求。打造及改良高階市場所需創新產品3項，產值增加5千萬以上。
- 聚集生態系超過40家廠商，共同培育數位跨域創新人才36人；帶領業者開發海外市場，使國際訂單成長6%以上。

餐飲用多功能性水龍頭

未來研究

1. 視覺辨識噴砂與品檢技術開發（人機協作管理）

- 因人工判斷噴砂類型與目視檢測鑄件品質皆有耗時與缺失風險，開發視覺辨識噴砂揀選與品檢技術，結合精密噴砂手臂推出智慧型系統整合方案。
- 鑄件噴砂表面處理達完全智慧化作業，預計進一步提高產能200%與減少噴砂失敗成本600萬。
- 整合性系統預計噴砂類型判斷正確率由95%（人工）提升為99%（視覺）；及缺陷檢出率由90%（人工）提高至97%（視覺）。



鑄件圖像及標識分類資料

2. 聯網智慧雲平台開發（聯網機制規劃）

- 為持續進步打造全台第一條「智能物聯透析器產線」目標，協助導入聯網智慧雲平台，進行血液透析器生產設備之系統整合與智慧互聯。
- 平台導入預計人均產值提升10%、設備稼動率提高20%，降低廢品比例25%，且具備設備預防保養與維修功能。

聯網智慧雲平台

3. 散熱/通訊裝置電源供應器開發（AS 9110）

- 未來產品開發面可應用於包括散熱系統、通訊裝置等電源供應器上，預估可增加產值15%以上。
- 系統面可增加AS 9110維修認證系統服務認證。

散熱及通訊裝置電源供應器

4. 以UX導向之虛實整合平台開發（虛實整合管理）

- 因應中小型產業進行跨域轉型需求，透過經驗驅動與價值共創的有機開放式創新網絡系統進行跨域生態系之推動。
- 發展虛實整合的平台服務、工具或技術，讓商業生態系統中的所有成員都可以使用，藉以提高參與廠商業績。

跨域媒合服務平台

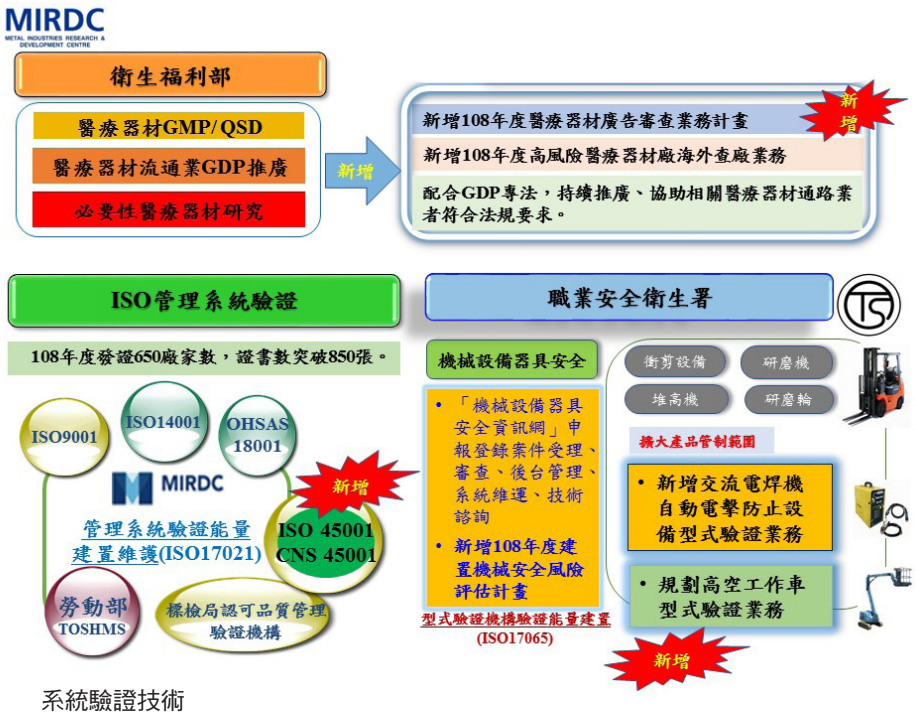
三、系統驗證技術

研發現況

1. 管理系統驗證技術開發

因應ISO各項管理國際標準改版，持續強化ISO管理系統驗證能量：

- ISO 45001/TOSHMS職安衛管理系統、ISO 50001能源管理系統驗證。
- ISO 9001、ISO 14001、ISO 27001等管理系統驗證技術持續精進。
- 累計取得驗證合格廠商數620家，共核發850張登錄證書。



系統驗證技術

ISO驗證管理系統驗證

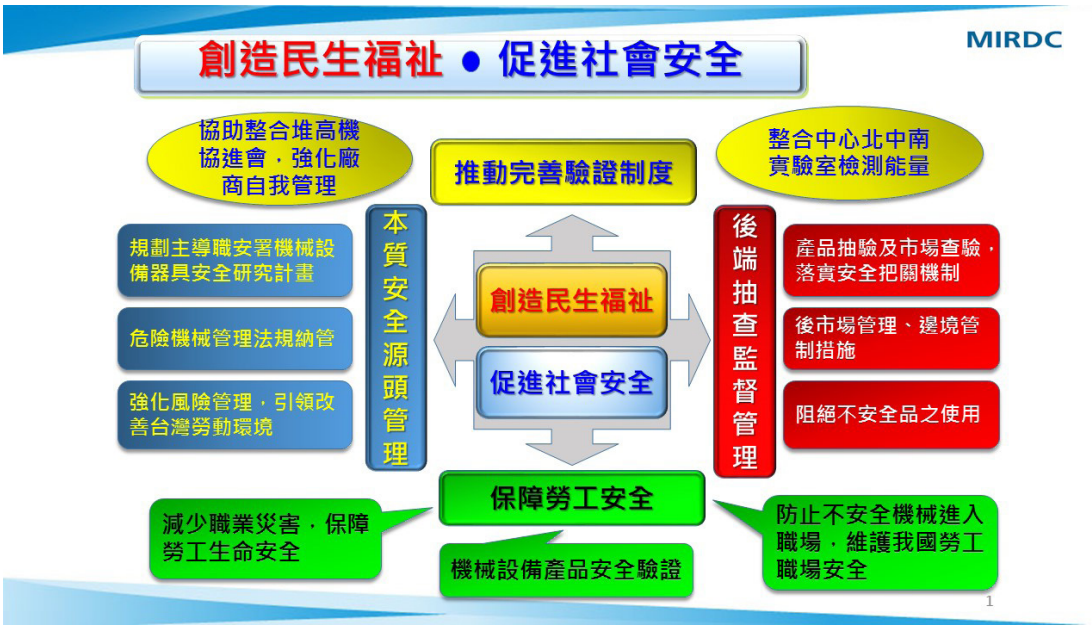
2. 產品驗證技術開發

規劃並建置ISO 17065之產品驗證能量，取得TAF認可登錄證書，配合政府法規要求，取得型式檢定機構資格。

1、勞動部機械安全驗證與檢測能量建置

- 自動電擊防止裝置型式試驗
- 堆高機檢測與型式試驗
- 高空作業車檢測與型式試驗

2、經濟部標準檢驗局H型鋼產品工廠檢查技術建置。



機器安全驗證

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。

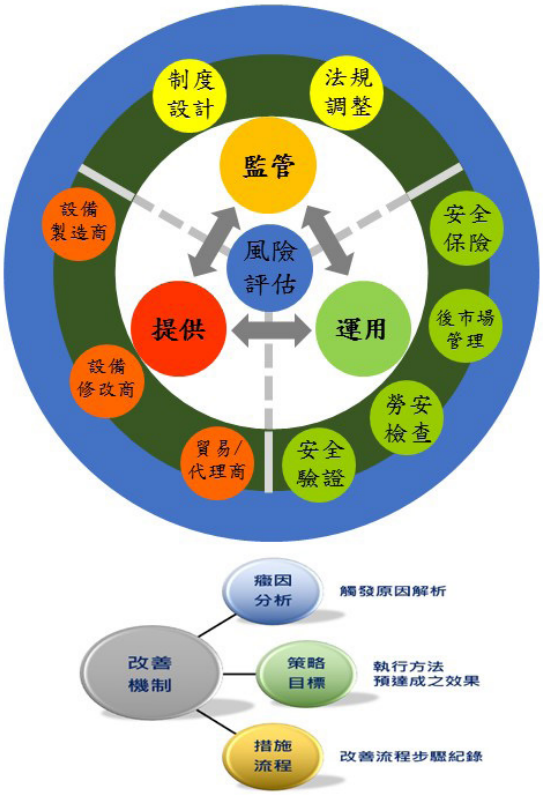
- 國產醫療器材GMP驗證技術推展。
- 進口醫療器材QSD審查技術推展。
- 進口高風險醫療器材海外查廠技術建置。
- 流通業者GDP驗證能量規劃。
- 必要性醫療器材預警系統機制規劃。

未來研究

機械設備風險管理技術

1、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。

2、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。

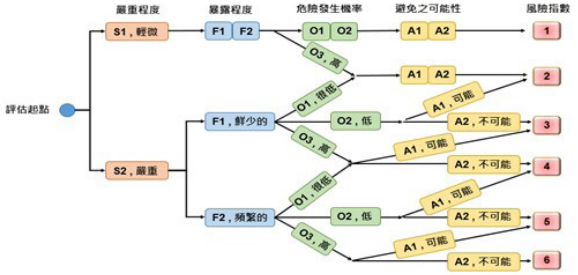



危害源

每頁筆數： 30 筆 目前頁數： 1 / 總頁數：1 頁 / 資料總筆數：2 筆

新增

代碼	名稱	排序	啟用	子參數	編輯	刪除
25	機械危害	10	Y	子參數	編輯	刪除
37	電氣危害	20	Y	子參數	編輯	刪除
59	熱危害	30	Y	子參數	編輯	刪除
79	噪音危害	40	Y	子參數	編輯	刪除
83	振動危害	50	Y	子參數	編輯	刪除



機械設備風險管理技術

食品（生技）設備技術

因應營養保健食品、化妝品等產業對於粉劑原料的製造需求，近年來食品生技設備技術產出國內第一台CPF製程之超臨界流體微粉成形設備，以完善微粉成形技術，解決高黏度萃取物及易氧化物粉末化不易操作之技術門檻，為產業增加粉劑成形技術的選擇性。

此外，為將機能性成分包覆成圓球狀食品顆粒，以利保存並創造新口感，褐藻膠已更加廣泛應用於食品製造，故本團隊也著手研發褐藻膠微球成形製程與設備技術，開發旋轉裁切造粒以及柱塞推進造粒設備，提供國內本土化的食品顆粒造粒技術。

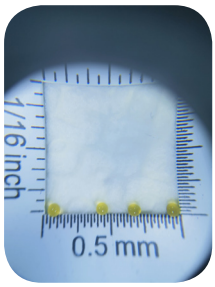
除了達到設備國產化的目標，降低設備進口的依賴，未來中心將更進一步掌握基礎配方技術，期待補足產業技術缺口，支持保健食品、化妝保養品等趨勢產業的創意開發。

研發現況

1. 褐藻膠微球成形製程與設備技術

- 因應植物膠製備機能性食品顆粒市場需求，進行褐藻膠微球成形設備技術之開發。
- 褐藻膠微球以其人體相容性高和水溶性/油溶性成分皆可包覆，成為機能性或休閒食品製造的重要技術，需要國內本土化製程與設備技術支撐。
- 目前可以提供最大粒徑範圍1.5~12mm，滿足食品顆粒製造的需求式樣。
- 可應用於生技和食品製造業，解決國內沒有對應設備的窘境。

微球大小顆粒



1.5mm胡蘿蔔微球

2. 超臨界流體微粉成形製程技術

- 國內機能性成份粉劑原料、辛香料以進口為大宗。發展超臨界流體微粉製程技術可補足產業上游缺口，解決高黏度萃取物及易氧化物粉末化不易操作之技術門檻。
- 以修飾澱粉包埋油溶性機能性物質，完成包埋之微粉粒徑可控制在50~500μm，油溶性機能性成分包埋率>30.0%。
- 超臨界流體微粉可進一步應用於保健食品及化妝品中。

超臨界流體微粉製程
Powder Generation by Supercritical Fluid Spray Processes

- 保留香氣成分
  Keep the flavor
- 全製程無使用有機溶劑
  No organic solvent is used in whole process
- 低溫無氧製程
  Low temperature anaerobic process

未來研究

1. 褐藻膠微球成形製程與設備技術

- 延續褐藻膠微球成形技術之開發，在微球內加入其他異質性顆粒以包覆多樣性機能成分。
- 新形態食品顆粒，除粒徑範圍可控、水溶性/油溶性物質皆可包覆外，可同時包覆多種機能性成分 。
- 除機能性成分包覆功能外，可以在食品視覺包裝和咀嚼口感上創造話題，開發新形態食品顆粒，引領風潮。

異質包覆顆粒

2. 超臨界流體微粉成形製程技術

- 傳統製程技術溫度高，易破壞產品中機能性成分。發展超臨界流體微粉成形製程技術，補足目前產業之缺口。
- 透過超臨界流體微粉成形製程取代傳統流體化床製程，減少原料機能性成分因加熱過程所造成的損害。
- 超臨界流體微粉可作為營養保健品開發應用。

保健食品原料
Health Food Ingredient

- 低溫製程減少熱敏性功效成分破壞
  Minimize the destruction of active ingredients in low temperature process
- 高黏度萃取物製粉操作方便
  This technology can be applied to spray high viscosity extracts on powdery carriers

保健食品原料

光電系統技術

2019年光電系統技術的重點項目包含高效能太陽電池製程設備技術、複合式微波熱固化技術，以及非接觸式金屬薄膜厚度之射頻檢測技術。

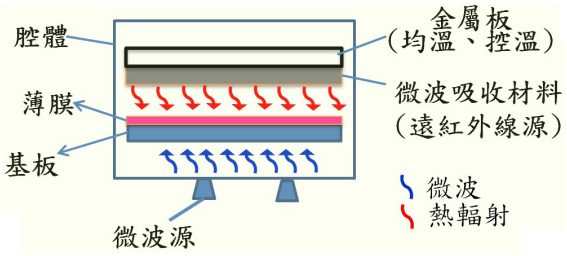
高效能太陽電池製程設備使用自主開發的ALD與超高頻電漿與真空鍍膜，製作TOPCon技術的太陽電池，達到使目標轉換效率>23%以上的元件效率。而自主研發的複合式微波熱固化技術相較傳統技術，可以節省一半的製程時間，並且在其他具加熱乾燥製程的產業皆可有效應用推廣。應用高頻電磁感測技術採非接觸快速量測金屬表面特性與缺陷，可擴大檢測解析度，並讓產品於線上進行檢測，大幅提高產品良率。

未來本團隊將凝聚光電技術之能量，持續提升自主開發的競爭力，針對電池關鍵鍍膜、5G相關天線元件，以及微波乾燥設備進行開發。

研發現況

1.複合式微波熱固化系統

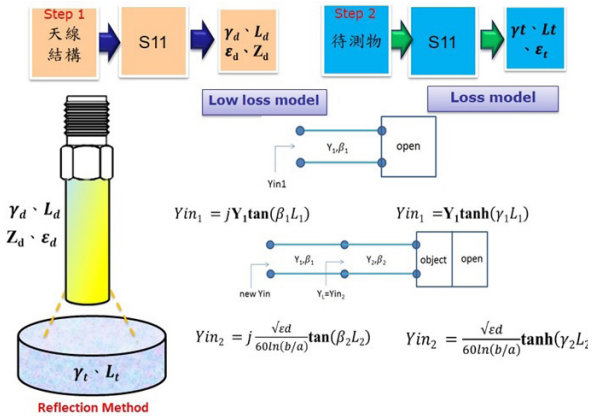
- 採用複合式微波熱固化系統於塗佈濕膜的乾燥製程上將具有快速去除溶劑、迅速固化之功能，可有效解決傳統烘烤製程時間及設備佔地過長的問題，節省製程時間達50%。
- 複合式微波熱固化技術可針對具部分微波吸收性或非具微波吸收性之塗料或物品進行快速加溫處理，相關技術除可使用於噴塗產業外，其他關於汙泥、紡織、塑料、食品、紙製品等具加熱乾燥製程產業皆可有效應用推廣。
- 現有市售微波設備僅以微波能量之大小控制吸收物之溫度，若處理物本身為非具微波吸收性的話，則無法達到加熱固化之目的。本研發技術為不管處理物是否具備微波吸收性皆可進行定溫處理，因此使用對象範圍廣泛，此複合式微波應用技術可使能源使用效率大幅提高，解決傳統熱風及紅外線加溫的高能耗問題。



複合式微波熱固化系統

2. 非接觸式金屬薄膜厚度之射頻檢測技術開發

- 因應非接觸式金屬材料厚度微米級檢測與快速熱處理性質測試之需求，自主發展射頻天線與電路模組。
- 預期此射頻量測技術可用於金屬薄膜(如印刷電路板、螺絲扣件)表面特性的檢知以及熱處理深度檢知，頻率範圍：10~12 MHz、增益範圍：0-100 dB。
- 運用此射頻檢測技術可於產線上立即獲得產品金屬表面特性與熱處理解析度(10-120μm)，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。
- 本射頻檢測技術可用在扣件產業、鋼鐵產業、汽車零組件產業等，對於我國工廠智慧化製造有明顯幫助。

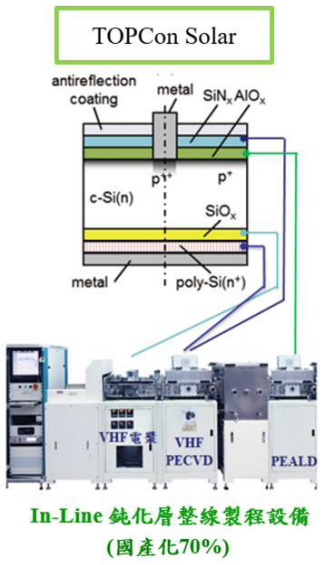


非接觸式射頻檢測技術開發

未來研究

1. 鈍化型電池關鍵鍍膜製程設備開發

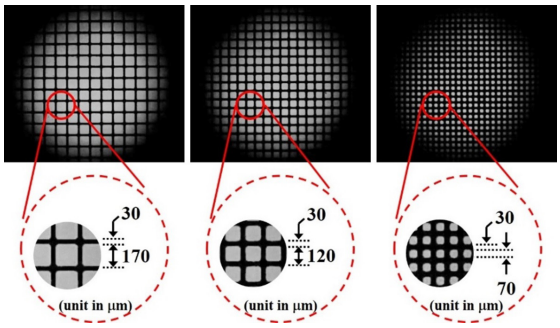
- 成為國內研究電漿輔助化學沉積高鍍率原子層沉積（PEALD），及超高頻電漿沉積（VHF plasma）設備用於TOPCon太陽電池鈍化及穿隧氧化製程設備之先驅，達成自主研發關鍵設備系統的目標，解決產業只能購置國外設備導致的高開發成本問題。
- 突破國外在高效鈍化型矽晶太陽電池的專利佈局，並在關鍵製程設備上達成全面國產化。
- 完成ALD/PECVD/Plasma Deposition電漿設備自製率達70%，建構太陽光電設備產業鏈。
- 完成整合ALD/PECVD/Plasma Deposition整線設備，售價為國外設備40%，提升國際競爭力。



鈍化型電池關鍵鍍膜製程設備開發

2. 5G透明微型網狀天線元件開發

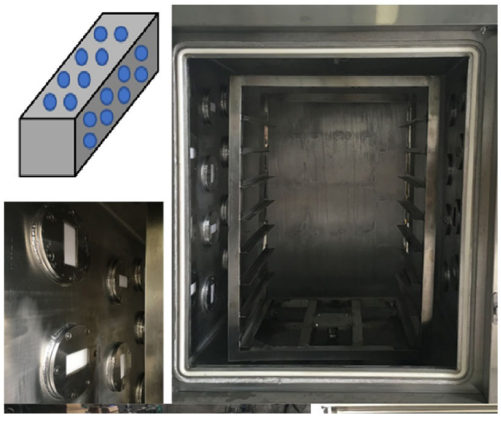
- 因應5G通訊產業（如：自動駕駛及次世代網路）之需求，自主發展透明5G天線。
- 新開發之該透明天線中心頻率在5G高頻段及高反射損失。
- 預期新開發之透明5G天線，在頻寬上可由kHz提升至MHz以上。
- 5G高頻段具有高千兆位多媒體服務，未壓縮的高清晰度視頻流，高速互聯網，無線千兆位乙太網路和近距離汽車雷達傳感器等多千兆位通信服務而備受關注。



5G透明透明微型網狀天線元件開發

3. 應用於快速果乾生產之真空微波乾燥設備技術

- 本技術為即時解決國內鳳梨等水果產銷失衡問題，透過真空與微波設備技術的結合，開發具有快速果乾製作能效之真空微波乾燥設備，並透過學界量能合作進行實際驗證測試以確保開發設備能效。
- 本開發設備技術透過微波所獨有穿透式加熱特性，搭配真空帶來的低溫蒸發環境，可建立節能快速且安全穩定的乾燥製程，解決現有熱風烘烤果乾製程時間過長、產率過低、時間及能耗成本過高之問題。
- 本開發技術可於各類農產品乾燥製程使用，用途廣泛。未來可結合農民們、公協會、果乾代工乾燥廠商及設備製造商進行實務果乾生產驗證及銷售推廣，將研發成果實際應用於產業。提高我國農產品之附加價值，並解決水果產銷失衡且無法延長保存時間之窘境。



真空微波果乾設備

醫療器材及照護技術

預計於2050年全球1/6人口將超過65歲，在人口平均壽命不斷升高的情況下，醫療器材及照護產業的發展需求迫切。過去本中心開發出立即植牙與手術規劃系統、人工智慧超音波影像神經辨識技術、多椎節影像導航技術等，以及多項可降解、抗沾黏、低致敏之醫用材料，致力發展高階產品與技術。

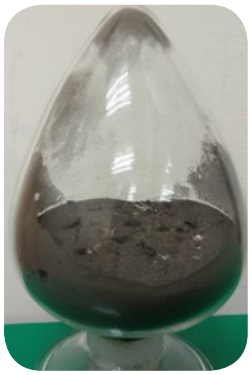
2019年本團隊重點項目為複合鎂生醫陶瓷材料開發與製程研究，修正傳統鎂合金材料之缺點，開發出新的三元高熵鎂合金，並運用合金混合熵值控制降解速率，為相關醫材打開應用大門。

中心未來將啟動可控制醫用鎂合金降解速率技術與應用開發計畫，目標是使醫用鎂合金粉末因應不同適應症進行降解速率調整，並擴增產品應用面，製成不同粉體和骨釘金屬等材料，以提升醫療服務品質。

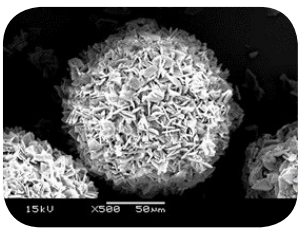
研發現況

1. 複合鎂生醫陶瓷材料開發與製程研究

- FY107製備止血夾之材料Mg-1.8%Zn-0.8%Ca並不適用於鎂合金粉末之製備，本計畫針對傳統鎂合金材料之缺點，進行修正，開發出新的三元高熵鎂合金，其中Mg-27%Zn-5%Ca已成功於本計畫的後表處及射出成型製程應用。
- 三元高熵鎂鋅鈣合金系統，發現在粉末形態下，合金混合熵值與降解速率極度相關，因此在合金成份與降解速率之控制，可以採用合金混合熵的大小進行控制。
- 由於鎂合金的高蒸氣壓及高活性，造成粉末製程上之困擾，我們已針對爐具進行新的設計，並申請相關專利，未來將能改善鎂合金粉體製備易霧化失敗及得料率偏低之問題。
- 鎂合金骨釘射出在國際上尚屬先進技術，本計畫是國內首次鎂合金射出成形研究，今年完成配方、模具及射出成形的初步研究成果，後續仍須找出更合適的binder配方及燒結條件，讓鎂合金骨釘成形技術在國內落實，推廣技術應用面。



鎂合金金屬粉末



微觀鎂合金金屬粉末

未來研究

2. 可控制醫用鎂合金降解速率技術與應用開發計畫

可控制醫用鎂合金降解速率技術與應用開發計畫。

- 新型可控制醫用鎂合金降解速率技術可依照不同適應症調解不同的降解速率。
- 開發醫用鎂合金微骨釘，可避免二次手術取出減少二次麻醉風險與降低健保支出。

可降解醫用鎂合金粉末技術開發：鎂合金粉末:10μm-50μm，D_{50}=20-30μm，成份:Mg-27Zn-5Ca。

- 可降解醫用鎂合金粉體表面處理技術開發：DCPD/Mg複合材料粉末--DCPD層厚度10nm~2μm 、粉末輪廓：球形，真圓度>0.6。
- 微骨釘金屬射出成型技術開發：開發金屬射出成型技術，Cortex Screw螺距0.30~1.50mm、ancellous Screw螺距0.50~2.00mm 、牙深0.10~2.00mm 、表速面結構平均粗糙度Ra：0.5~6.0μm 、降解率控制於0.5~1mm/y 、降伏強度>120 Mpa、延伸率>10%。
- 通過三項ISO 10993測試、完成動物功能性動物實驗、完成臨床實驗相關文件整備。

鎂合金骨釘

可降解鎂合金植入物

可降解鎂合金植入物與手術器械

綠能技術

2019年綠能技術延續近年政府推動的節能政策，共計有節能泵浦技術與風力發電技術兩個研究方向。

在泵浦技術項目，今年持續協助國內泵浦大廠進行高效率節能泵浦研發與測試，並成為國際大廠指定第三方泵浦試驗平台。未來目標聚焦在數位化/智慧化流體能源控制技術，以及小水力發電開發與產業化技術，建立泵浦數位化快速設計分析、動力電磁設計分析，與泵浦系統線上量測等技術研發。

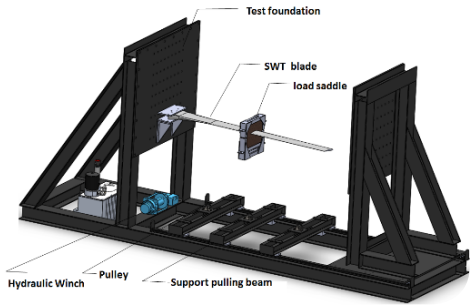
而風力發電項目則協助工業局召開「離岸風電產業關聯審查會議」審查6家開發商、10個風場，並落實離岸風電產業在地化發展。另配合標檢局完備小型風力機葉片測試實驗室，及協助國內業者進行30kW等中小型風力機型式測試。

未來將以工業局「離岸風電與太陽光電產業升級轉型推動計畫」為基礎建構本土供應鏈，發展離岸風場結構檢修與運維技術，並與挪威DNV-GL等驗證機構進行第三方驗證能力的國際合作。

研發現況

1. 中小型風力機葉片測試技術

- 完成小型風力機葉片測試實驗室，靜態拉伸及動態疲勞測試機構建置，以及樣品測試驗證功能。實驗室規格：
  - ◎測試負載-60L液壓容量油壓系統。
  - ◎最大施力荷重25KN。
  - ◎測試周期>10^6次以上。
  - ◎可測葉片長度1.5~8m。
- 未來預定研發雙軸疲勞測試及葉片損傷數位建模技術



小型風力機葉片測試實驗室

2. 中小型風力機型式測試技術

- 進行晶元綠能30kW、楷越30kW、飛躍10kW水平軸風力機，以及國電20kW垂直軸風力機型式測試。
- 協助台灣垂直軸公司進行500W垂直軸風力機，開發與研發測試。
- 依據CNS 15176-2標準，完成晶元綠能公司30KW水平軸風力機型式測試。
- 進行新版ISO 17025實驗室管理制度更新。

七股測試場概貌

協助 500W垂直軸風力機開發

3. 離岸風力機國產化推動成果

- 108年「離岸風電產業關聯審查會議」共召開8場次、審查6家開發商、10個風場。進行水下基礎、塔架、電力設施及風力機零組件在地化項目審查。推動成果如下：

  ◎建立水下基礎在地化供應鏈 22 家，離岸風力機零組件供應鏈 15 家。

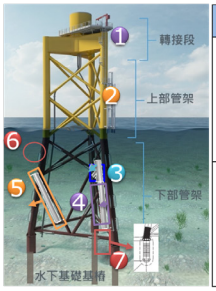
  ◎臺北港水下基礎生產基地：世紀風電(世紀鋼) 投資50億元設置單樁式、套筒式水下基礎生產廠。

  ◎臺中港離岸風電產業專區：全球風力機系統商設機艙組裝廠，預計15家以上本土業者可進入國際供應體系。

  ◎興達港水下基礎生產基地：興達海基(中鋼)投資68億元興建套筒式水下基礎製造廠房。

- 協助德國焊接協會(DVS_SLV)、臺灣焊接協會(TWS)、臺灣風電產業協會(TWIA)與金屬中心(MIRDC)，於108年3月18日～4月29日合辦國際銲接工程師(IWE)訓練課程，合計有興達海基、台船、萬機、台欣及遠東機械等國內離岸風電水下基礎業者，共計11名人員取得認證。

離岸風力機零組件供應鏈示意圖



Tier1 供應商	構件名稱	Tier 2 供應鏈廠商	Tier 3 供應鏈廠商
興達海基	① 轉接段	台船、中機、俊鼎、台欣世紀	世紀風電
	② 二次構件(上部管架)	中鋼構、世紀鋼	昌懋、剩春、錦慶、亨昌、世紀風電
	③ 接頭(Node)	中機、中鋼構、世紀鋼	剩春、如辰、亨昌、萬機、前端
	④ 柱腳管件(Leg)	中機、萬機、榮聖、世紀鋼	萬機、前端
	⑤ 斜撐(Bracing)	遠東機械、萬機、世紀鋼	萬機、前端
世紀風電	⑥ 犧牲陽極(Anode)	中鋁、匯茂	N/A
	⑦ 插樁(Stabbing Pin)	中機、銘榮元、中鋼構、世紀鋼	昌懋、良聯、如辰、柏騏、萬機、前端
	合計	12家	10家

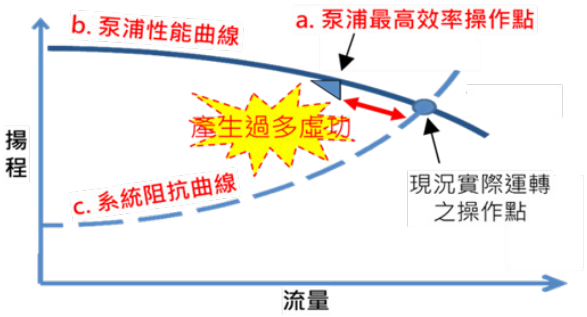
水下基礎在地化供應鏈示意圖

國際銲接工程師授證儀式

4. 高效率泵浦能效測試 & 泵浦能效驗證技術

- 全國唯一 ISO_9906 一級泵浦能效測試實驗室，國際指標廠指定第三方泵浦試驗平台。
- 流場優化技術。
- ISO標準測試實驗室輔導建置技術。
- 系統場域診斷能耗分析技術。

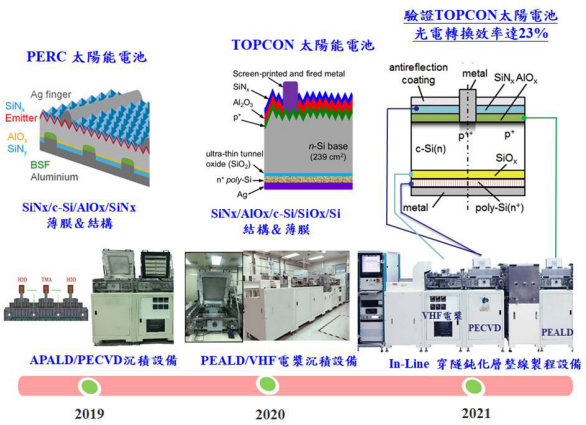
國際指標廠指定第三方泵浦試驗平台 -泵浦能效測試實驗室



系統場域診斷能耗分析實例

5. 高效能太陽電池製程設備技術開發

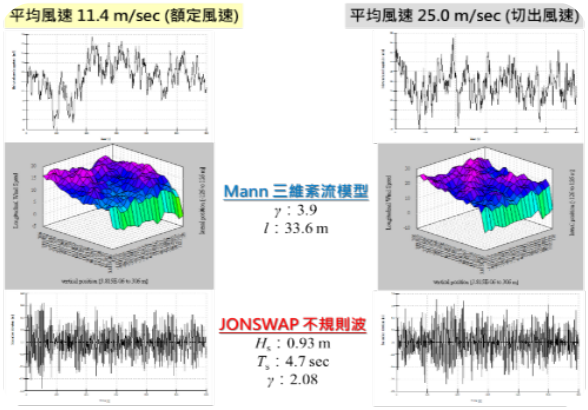
- 自主開發製程端最關鍵的兩項製程設備，包含ALD設備與超高頻電漿技術真空鍍膜系統，對應TOPCon電池的鈍化層技術包含氧化鋁薄膜之製程設備，藉由國產化開發該設備，掌握製程調控與設備整改能力，移轉至相關業者，進而提升本國業者在高效率電池之技術領先地位並維持其競爭優勢。
- 為解決衰退問題，採用N-PERT或導入TOPCon技術的穿隧氧化鈍化型電池，其中TOPCon技術已超過23%以上的元件效率。



未來研究

1. 離岸風電第三方驗證技術建立

- 參與標準檢驗局第三方再生能源檢測驗證能力建立，與DNVGL進行技術轉移。
- 未來將參與2020~2025離岸風場專案驗證審查作業。



2. 離岸風力發電產業化技術

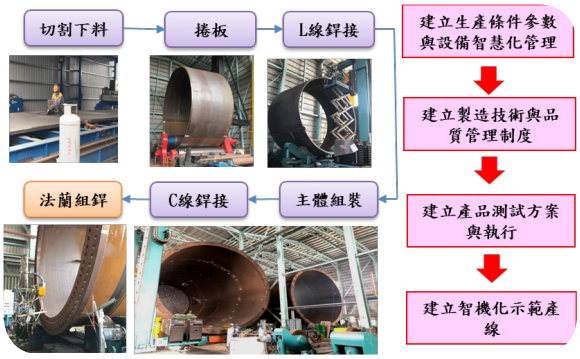
- 推動產業升級轉型，建構上中下游本土供應鏈，強化產業創新發展體系推動，109年的研發重點包含：

◎建構海洋機械鋼結構件智慧化製程技術升級。

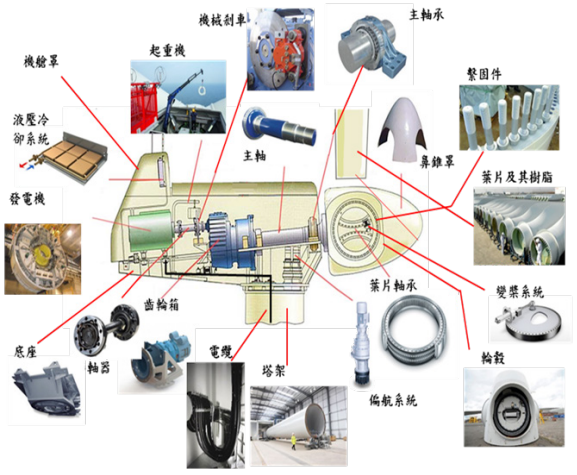
◎針對風力機零組件/相關次系統產品開發，輔導業者建立維修能量。

◎建構離岸風力機零組件/週邊設備相關智慧化技術。

◎協助國內風力機零組件業者提升製造技術及測試驗證能量，切入國際風力機系統商供應鏈體系。



海洋機械結構件銲接生產流程智慧化



離岸風力機零組件示意圖

3. 離岸風場結構檢修與運維技術

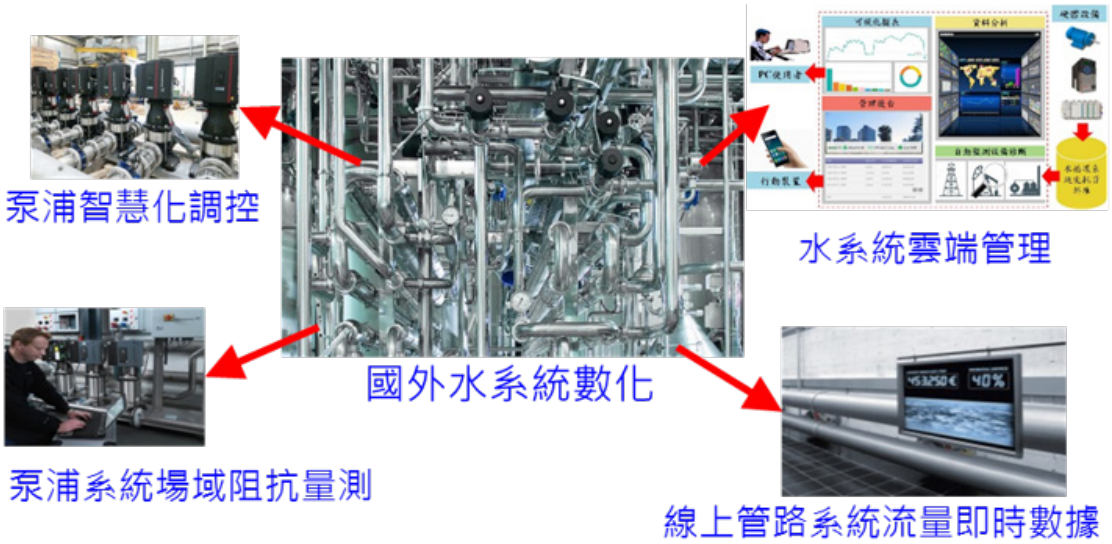
- 為因應2020~2025年建置離岸風場未來20年運維需求，研發自動化及人機介面設備，協助運維人員檢修及監控風場運轉，提升風場檢查效率。
- 開發超音波檢測環狀銲道自走機構、水下防蝕保護電化學檢測系統、穿戴式檢修人員輔助設備等運維技術。

超音波檢測環狀銲道自走機構

穿戴式檢修人員輔助設備

4. 數位化/智慧化流體能源控制技術

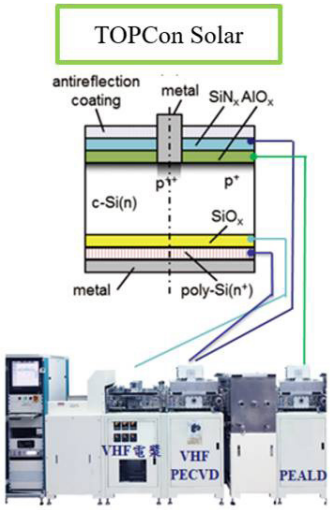
- 因應能耗規範MEPS要求，亟待提升產品能耗效率，以因應國內外市場。
- 應用環境與流體特性日趨嚴苛（高腐蝕/長效），產品性能與壽命需求提升。
- 市場朝向多功能應用，產品體積增加及結構複雜化，難以既有傳統製程方式生產。



導入數位化 /智慧化技術

5. 鈍化型電池關鍵鍍膜製程設備開發

- 研究電漿輔助化學沉積高鍍率原子層沉積（PEALD），以及超高頻電漿沉積（VHF plasma）設備用於TOPCon太陽電池鈍化及穿隧氧化製程設備，達成自主研發關鍵設備系統的目標，解決產業只能購置國外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，並在關鍵製程設備上達成全面國產化。
- 完成ALD/PECVD/Plasma Deposition電漿設備自製率達70%，建構太陽光電設備產業鏈
- 完成整合ALD/PECVD/Plasma Deposition整線設備，售價為國外設備40%，提升國際競爭力。

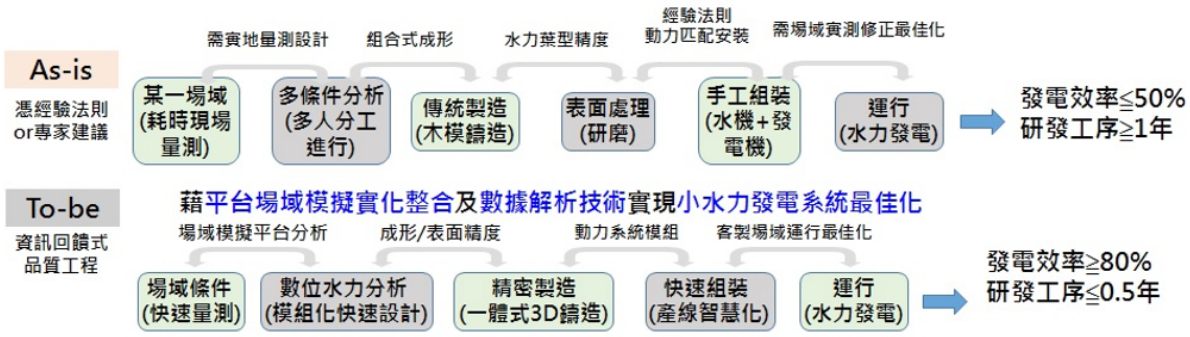


In-Line 鈍化層整線製程設備
(國產化70%)

6. 小水力發電開發與產業化技術

- 由於國內小水力業者有第三方測試驗證需求，需確認其機組性能是否合適投入場域。未來將投入建置小水力發電機測試實驗室（規劃通過TAF、TUV等國內外認證），協助業者進行機組技術研發提升。
- 建立國內小水力新興產業鏈，聚焦投入提高轉換效率之水渦輪機設計分析及開發技術研發。

水力發電機能效測試實驗室規劃圖



輔導建立小水力產業規劃流程

電化學加工技術

2019年電化學加工技術重點研發項目為航太用蜂巢芯結構之低應力複合加工技術，結合電化學自由成形和機械研削方式之複合加工技術與模組，解決傳統機械針對金屬蜂巢芯結構材切削時所遇到的瓶頸，不僅縮短了加工時間，也有效提升品質和產率。

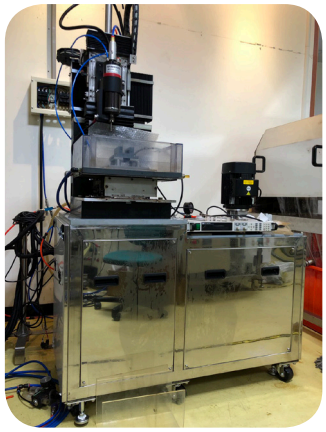
而本技術提出的電化學機械複合銑削系統，成功開發出具導電且電解液內噴功能之研削磨輪模組，其優點在可顯著降低加工間隙中堵塞的風險，並可從工件的側壁開始加工，直接一次完成所需的加工深度，提高加工效率。

由於現有技術難以滿足產業需求，未來中心將持續針對電化學複合加工領域進行研發，以噴流電漿電解表面加工技術為例，將可以解決產業面臨難加工金屬材料表面的後處理問題，幫助產業降低加工成本。

研發現況

1. 航太用蜂巢芯結構之低應力複合加工技術

- 因應航太產業對於金屬多孔結構材成形加工需求，提出電化學機械研磨複合加工技術開發。
- 新開發之技術其可於航太鋁合金蜂窩心進行加工，克服傳統機械加工之定位困難以及表面應力產生問題。
- 預期提高國內航太產業技術門檻加速業者技術提升，減少50%以上的製程成本。
- 新技術未來亦可應用於精密機械，預估可增加產能25%以上。



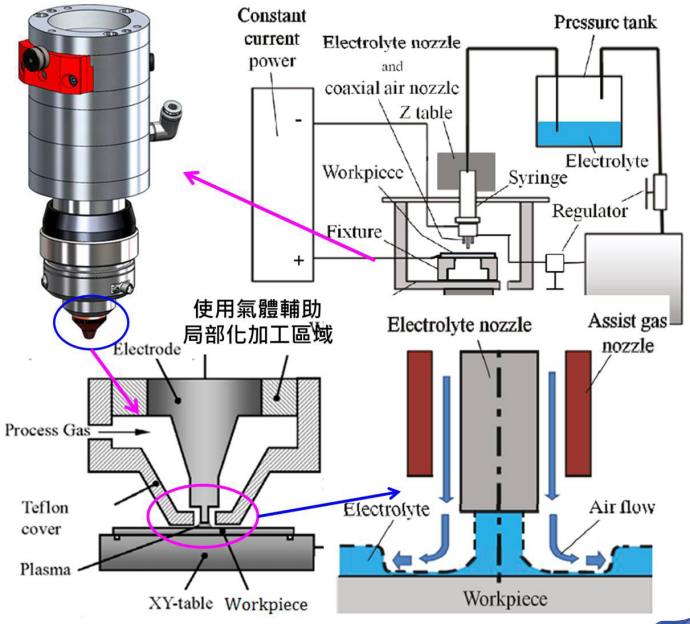
電化學機械複合銑削系統

具曲面之鋁合金蜂巢

未來研究

1. 噴流電漿電解表面加工技術

- 因應金屬製品產業對於複雜結構表面加工需求，提出電漿電解表面加工技術開發。
- 新開發之技術其可於進行加工，克服傳統機械拋光、電解拋光或化學方式拋光等之表面應力及粉塵產生和廢液處理問題。
- 預期促使國內金屬製品產業技術自主，取代進口500萬/台。
- 新技術未來亦可應用於精密機械，預估可減少30%以上的製程成本。



氣體輔助噴流電漿電解表面加工模組

2019

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Message from the Chairman

Innovation Driven Industrial Activation Striding towards Excellence

The Sino-US trade competition has deeply affected the development of the global economy, science, technology and industry. In particular, it has accelerated the adjustment of global allocation of Taiwanese and multinational enterprises, forming the short supply chain and localization. As Taiwan plays a very important role in the global industrial chain, it is not only a tough challenge, but also an important opportunity for Taiwan to attract more enterprises to invest or expand their investments in Taiwan in the face of the aggravation of the global economy and trade. As a research-oriented institution, MIRDC continuously strengthens its R&D and innovation capabilities to support the sustainable operation and development of industry and, more importantly, links the R&D capabilities to promote the transformation and upgrading of industry while accelerating the promotion of industrial added value. Besides, it drives the optimization of Taiwan's industrial structure, jointly constructs a complete scientific and technological environment for Taiwanese industry and lays a solid foundation for innovation and manufacturing by means of supporting the development of emerging industries, thus making Taiwan stand out in the trade competition and seizing opportunities in the international market.

In terms of re-enhancing R&D and innovation capabilities, MIRDC has been focusing on research and development in the fields of metal materials and fabricated metal products, high-value micro products, medical devices and healthcare, automotive, high-value equipment and green energy, and assisting in the development of science and technology as well as high-value applications of priority industries. Especially through the promotion of system integration, cross-discipline cooperation and demonstration site, we have established solid innovation strength on the basis of research and development, such as the "Intelligent 3D Visual Automation for Shoes Roughing and Cementing Equipment", which introduces automation equipment into the shoemaking industry, integrates 3D visual identification, robot arm and force compensation technology, and overcomes technical bottlenecks in the automation of the shoemaking roughing process and automatic cementing in specific areas of shoe uppers/soles, thereby successfully replacing the traditional manual roughing and cementing process, assisting the domestic shoemaking industry in breaking through the industrial threshold and winning the Edison Application Technology Award. Another R&D achievement is the "Bionic Intelligent AGV Fleet System" technology of MIRDC, which is characterized by wireless intelligence, flexible application, and agile mobility. Through the wireless intelligent collaborative transporting system, several automated guided vehicles (AGVS) can be operated synchronously in real time and a number of vehicles can be operated in series and remotely, breaking through the existing magnetic rail or vehicle handling mode, and winning the R&D 100 Awards and Transport and Logistics Category of Edison Awards. All these R&D achievements highlight the firm foundations and innovation of MIRDC's core technology.

In terms of promoting the transformation and upgrading of traditional industries, as traditional fastener industries and hand tool industries clusters are based in Southern and Central Taiwan, respectively, the above-mentioned industrial development is highly correlated with the economic growth of Taiwan. How to continuously improve the industrial competitiveness is an urgent issue at present. If we take the fasteners as an example, Taiwan is

the third or fourth largest producer of fasteners in the world, with the average export value being more than NT$120 billion in the recent three years. In order to assist in the transformation and upgrading of the traditional fastener industry, MIRDC integrates domestic equipment factories, software and hardware service manufacturers and system integrators, introduces the smart service cloud of fasteners in combination with the established "smart manufacturing demonstration production line of the metal fastener industry" to connect the information of upstream, midstream and downstream supply chains, in developing the innovation cooperation mode for the fastener industry. In addition, the hand tool industry in Taiwan is the second largest export industry of Taiwan's fabricated metal products. More than 90% of the products in related industries are exported. The average export value in the recent five years is about NT$100 billion. In view of this, MIRDC, together with China Steel, Taiwan Hand Tool Manufacturers' Association and Corporate Synergy Development Center, has established the "Hand Tools R&D Testing Center", which is the first professional R&D and testing institution in Taiwan; it provides R&D, inspection & testing, trial production and other services needed for the high-value innovation of the hand tool industry in Taiwan, as well as customized industrial solutions. Through the integration of R&D capabilities and links with local industries, the Center not only improves the competitiveness of traditional industries and small and medium-sized enterprises, but also accelerates their shares in the international market.

In terms of supporting the development of emerging industries, 98% of energy in Taiwan depends on imports, so it is very important to improve energy independence and diversification. How to promote domestic industry and economic development by means of green energy industry cultivation is an important issue at present, especially the promotion of offshore wind energy in green energy, which is regarded as the key drive for optimizing Taiwan's economy, industry and energy. To implement the Forward-Looking Infrastructure Plan of the Ministry of Economic Affairs, MIRDC has already assisted the government in setting up the Kaohsiung Marine Technology Innovation Center in Xingda Port. The short-term goal is to cultivate offshore wind energy talents and gradually move towards the development of marine science and technology in the medium and long term. At the same time, MIRDC cooperates with foreign institutions such as Maersk in Denmark, Marin in the Netherlands, DNV-GL in Norway, and other companies to carry out various maritime engineering cooperation and certification. In addition, we have established O-team, W-team, M-team, B-team and other alliances with 66 Taiwanese enterprises, such as China Steel and CSBC Corporation, to further assist Taiwan in constructing a localized and indigenous wind turbine supply chain system, so that Xingda Fishing Port can become an important offshore wind energy base in the Asia Pacific region, thus promoting the development of a new green energy industry and driving the sustainable operation of regional industrial economy.

Innovation and transformation serves as the critical role in the face of global competition. MIRDC will continue to play the key role of "value creation", provide overall solutions for the metal industry, help with industrial development, promote the upgrading of domestic metal and related industries and continue to improve core technology and technical value. By means of linking domestic and foreign technology R&D, talent and resources, we will enhance industry-university-research cooperation, help manufacturers fill the gaps in the industrial chain and act as the communication bridge between the government and industry, thus creating industrial value for Taiwan and enhancing its international competitiveness.

Chairman of
the Board Directors Ren-Ji Lin

Message from the President

Rejuvenate with Profound Dedication To Create New Industry Value

MIRDC has promoted industrial innovation through metal technology R&D for a long time. With the development of emerging industries and the rapid change of global industries, MIRDC takes the initiative in assisting the domestic metal industry in its transformation and upgrading towards high-value products and intelligent manufacturing, so as to maintain the global competitiveness of domestic industries. Facing great environmental changes, MIRDC wishes to change its culture and values through the adjustments made in the direction of technology R&D and rejuvenation of internal organization based on four major policies, in order to continuously carry out innovation and R&D and improve service capability. In terms of the four major policies, we dedicate our capabilities to cultivating talents to increase the depth of our professional competence, minimize the silo effect, and establish cross-discipline cooperation mechanisms; as for digital transformation, using big data analysis helps the operation decision-making and guides the industry to transform from traditional manufacturing processes to intelligent manufacturing and enhance competitiveness; as for increasing the technical depth, we promote the Center of Excellence (COE) to deepen the establishment and layout of key technologies, and cooperate with indicative manufacturers and international institutions to create technological values.

MIRDC has been deeply involved in electrochemical machining technology for a long period of time. Through the promotion of COE, we cooperate with leading domestic aerospace enterprises and international top institutions, and have successfully developed the domestic indigenous electrochemical machining process and module equipment technology, as well as completed the world's first compound continuous production process system technology of electrochemical machining (ECM) in combination with stamping, with the one-stop service ranging from complete patent layout to process and equipment. MIRDC adopts the innovative process technology to solve consumption problems of tools for fabricated metal products under high temperature in the aerospace industry. MIRDC also promotes cooperation with leading aerospace manufacturers to invest in the development of electrochemical machining equipment for key engine components, which effectively improves the pre-processing efficiency more than 1.5-fold and reduces manufacturing cost by over 30%, helping manufacturers to obtain more orders from international major companies, driving the development of the domestic aerospace industry towards high-end dynamic components manufacturing, and creating the blue ocean market.

In recent years, with the advent of the industry 4.0 era, intelligent manufacturing has flipped over the traditional manufacturing process, making the manufacturing industry more scientific and intelligent. Intelligent manufacturing can assist enterprises in integrating the previously independent work processes, recording and analyzing real-time data through smart machines and equipment, and helping personnel to make better decisions. Based on intelligent automation technology, MIRDC integrates professional process knowledge,

invests in relevant intelligent manufacturing technology development, shortens the time of product development through the analysis and simulation technology, and establishes equipment and process visualization technologies to cope with the industrial characteristics of traditional production lines that rely on labor and lack real-time production information application. The production information networking of process equipment improves the production process monitoring ability, and gives early warning to increase the yield rate. In addition, MIRDC assists the large domestic motorcycle manufacturers in optimizing the existing production line by introducing the intelligent management system and helping manufacturers to transform and upgrade the existing component supply chain through the intelligent application technology of the forging equipment developed by MIRDC.

MIRDC has also carried out cross-departmental technical cooperation, jointly assisting the plumbing industry in material development, production line intelligentization, product certification, marketing and promotion. In the aspect of "material development", MIRDC has obtained the international brand certification of lead-free brass material and authorized domestic leading bathroom faucet factories. In the aspect of "production line intelligentization", MIRDC assisted the plumbing industry in constructing the intelligent casting production demonstration site, which reduced production cost by 15% and increased the yield rate to 95%. In the aspect of "product certification", we helped manufacturers to obtain international inspection certification in the laboratory built by TPL of MIRDC, so as to meet the quality requirements. In terms of "marketing and promotion", we worked with Changhua County Government tourism site to establish the plumbing boutique shop and plumbing industry-theme design center to enhance the local industry value.

MIRDC has served local industries for nearly 60 years and has been playing an active role in facilitating the upgrading and transformation of traditional industries and small and medium enterprises. With the rapid changes of the global environment and industry, MIRDC will continue to bring the core spirit of value creation into full play, inject more innovation capability into Taiwanese industries and accelerate the industrial growth in overall competitiveness with the efforts of all colleagues.

President Chiu-Feng Lin

Make every effort to create value

As the key role in linking the metal industry, MIRDC is committed to integrating cross-disciplinary industries, continuously improving core technologies, supporting industry transformation and upgrading as well as establishing international R&D institution.

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METAL INDUSTRIES RESEARCH & DEVELOPMENT CENTRE

Vision, Mission and Retrospect of Priority Industries

Vision, Positioning and Mission of MIRDC

Metal Industries Research & Development Centre (MIRDC) is the only research institution headquartered in Kaohsiung among incorporated institutions affiliated to 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 micro manufacturing process & the products 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 od 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 institution.

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 20th, 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, intelligent digital manufacturing process and high-value innovative products development, make it a platform for industry-university-research exchange and demonstration, create diversified industrial development resources, and create a new dimension for the development of traditional industries in the south.

Review and Prospect of Metal Materials and Fabricated Metal Products Industries

Metal materials are indispensable for economic development. The prosperity and decline of the metal industry is highly positively related to economic growth; that explains the reason why the global economy slows down under the influence of the Sino-US trade war. In 2019, the output value of Taiwan metal industry (including basic metal industry and fabricated metal products industry) was NT$2.09 trillion, having decreased by 9.4% compared with 2018 (as shown in Table 1), among which the output value of the iron and steel industry was NT$1.13 trillion, down 10.0%; that of non-ferrous metal industry was NT$212.6 billion, dropping 13.4% and that of the fabricated metal products industry was NT$746.2 billion, declining 7.3%.

In terms of total volume, steel is the major base metal, which export value in 2019 is estimated to be NT$511.4 billion, while the import value was NT$301.7 billion, both of which declined nearly 10% compared with 2018. The main reason is the slowdown of the global economy affected by the Sino-US trade war, but the trade surplus has been observed in terms of total volume in recent years. For non-ferrous industry, the estimated export value in 2019 was NT$182.3 billion, the estimated import value was about NT$300.5 billion, and the trade surplus was about NT$-118.2 billion. As the same as the iron and steel industry, the bulk metal market also declined due to the trade war, with a slight increase in the trade deficit, indicating that the subsequent import substitution of Taiwan non-ferrous materials will be the goal to work towards in the future.

Current Industrial Status

Table 1: Changes in the production value of Taiwan's metal materials and fabricated products industry Unit: NTD 100 million; %

Year	Basic Metals Steel	Basic Metals Non-metallic	Fabricated Metal Product	Total	Annual Growth Rate
2009	9,536	1,845	5,615	16,997	-33.4%
2010	14,128	2,686	7,402	24,216	42.5%
2011	15,146	2,871	8,288	26,305	8.6%
2012	12,905	2,782	7,895	23,581	-10.4%
2013	12,175	2,475	7,824	22,474	-4.7%
2014	12,712	2,632	8,265	23,609	5.0%
2015	9,624	2,540	7,616	19,780	-16.2%
2016	9,166	2,093	7,409	18,667	-5.6%
2017	11,205	2,266	7,790	21,260	13.9%
2018	12,626	2,455	8,053	23,134	8.8%
2019	11,360	2,126	7,462	20,949	-9.4%

Source: Industrial Production, Shipment & Inventory Activity Survey by Department of Statistics of the Ministry of Economic Affairs by Industrial Research Section, MIRDC (2020/01)

Table 2: Changes in the import and export amounts of Taiwan's metal materials and fabricated metal products

Unit: NTD 100 million; %

Import and Export Product Categories		2015	2016	2017	2018	2019	Compound Annual Growth Rate
Export Amount	1. Basic metals - Steel (including Semi-finished Products/Primary Processing Products/ Secondary Processing Products)	4,750	4,537	5,149	5,627	5,114	1.5%
	2. Basic Metals - Non-metallic	1,724	1,682	1,897	1,997	1,823	1.1%
	3. Fabricated Metal Products	1,363	1,312	1,350	1,377	1,402	0.6%
	Total (1+2+3)	7,837	7,532	8,396	9,001	8,339	1.3%
Import Amount	1. Basic Metals - Steel (including Semi-finished Products/Primary Processing Products/ Sec-ondary Processing Products)	2,709	2,508	2,843	3,331	3,017	2.2%
	2. Basic Metals - Non-metallic	2,726	2,658	3,156	3,167	3,005	2.0%
	3. Fabricated Metal Products	234	241	232	251	246	1.0%
	Total (1+2+3)	5,669	5,406	6,591	6,749	6,268	2.0%
Trade Surplus	1. Basic metals - Steel (including Semi-finished Products/Primary Processing Products/ Secondary Processing Products)	2,041	2,030	2,306	2,296	2,097	0.5%
	2. Basic metals - Non-metallic	-1,002	-976	-1,259	-1,170	-1,182	-3.3%
	3. Fabricated Metal Products	1,129	1,072	1,118	1,126	1,156	0.5%
	Total (1+2+3)	2,168	2,126	1,805	2,252	2,071	-0.9%

Note: import and export code scope: steel semi-finished products (7201~7207, 7218, 7224), steel primary processing products (7208~7306, excluding 7218 and 7224), steel secondary processing products and fabricated metal products (7307~7326), non-metallic semi- finished products and primary/secondary processing products (7401~8113), fabricated metal products (8201~8311).
Source: Taiwan Institute of Economic Research (TIER) Import and Export Database by Industrial Research Section, MIRDC (2020/01)

Industrial Contribution and Achievements

In order to ensure the global competitive advantage of Taiwan metal materials-related products, MIRDC combines the industrial technology development program with ERC, industry-academic alliance, basic industrial technology and other resources investment through the establishment of high-value metal materials industry value creation platform and continues to promote industrial high value and added value. According to the current plan, related technologies in the field of metal materials and fabricated metal products are divided into four sub fields which includes green energy materials and components, biomedical materials and products, precision machinery materials and products, and high-value fabricated metal products. The current situation of industry and technology development in various fields is as follows:

Green energy materials and components

In 2019, MIRDC assisted manufacturers to cope with international trends and government policies, focusing on renewable energy and a circular economy. With smart energy conservation, diversified energy creation, circular regeneration and scientific energy storage as the development direction, MIRDC developed domestic key materials and process optimization technology in accordance with the needs of high efficiency, low energy consumption, cycle life extension, and so on, as well as promoted industrial material indigenousness and re-enhancing technology to build an indigenous supply chain and drove green energy industry to grow and enter the international market. To cope with the energy conservation trend of high efficiency/low energy consumption, MIRDC developed the forming technology of lightweight components, such as glass fiber thermoplastic composite (GFRTP) forming and joining technology with dissimilar metal materials (the shear strength of AB bonded parts is up to 3,102±194N/cm2 and the shear load of LAMP bonded parts is up to 3,378N), applied CAE simulation technology in the production and manufacturing of fabricated metal products, selected the most suitable process, improved the effect of waste reduction, carried out functional alloy R&D (temperature resistance/weather resistance) combined with recycling and modified life extension technology to achieve the recycling application of materials.

In terms of industrial promotion, MIRDC promoted the establishment of indigenous R&D capability of domestic high-performance materials, filled the gap in green energy component application industry, fostered local benchmarking materials manufacturers to carry out new material R&D, promoted the alliance of upstream, midstream and downstream industries, drove industrial transformation and switched into the end product supply chain system. (1) For the promotion of hot stamping technology, MIRDC promoted the manufacturers' introduction of hot stamping technology and B-pillar products into the car body structure application in domestic indigenous auto makers; the sales scale of domestic hot stamping steel products reached more than 120, 000 tons, which became the only hot stamping supplier in Taiwan, with the market share being 100%. The new product quality system has been accredited to successfully introduce into the application of small modified models, passing the supplier qualification certification of more than 8 famous auto makers. MIRDC assisted in training 2 batches of professional hot stamping personnel, finishing the complete training for 20 masters and doctoral students, who have actually worked in the die development and production process. (2) For the promotion of thermoplastic composite industry as well as innovated the heterogeneous mixing of metal and thermoplastic composite, MIRDC drove the industry towards a circular economy, promoted the construction of new production lines and new investment, and created a high level of product application (Eternal Materials, Giant, Advanced International Multi-tech, and Meifu Company). The heterogeneous joining of metal and thermoplastic composite and hybrid material technology influences the newly created output value of the industrial chain by an increase of more than NT$3 billion per year. (3) For the promotion of offshore wind energy industry, Chin Fong cooperates with the CS Wind to carry out offshore wind turbine tower production, taking Taichung Port Industrial Zone as the production base, with an investment of about NT$600 million. It has received the orders from SGRE and MVOW, and is expected to realize comprehensive mass production in 2020. The annual supply is expected to reach 100 offshore wind turbine towers, with an output value of NT$3 billion.

In terms of future prospects and planning, MIRDC will continue to promote the research and development of key materials and technologies required for the development of green energy industry, such as the research and development of high-efficiency fluid machinery materials and high-magnetically conductive steel materials, as well as the development of marine steel structure welding process technology for offshore wind turbines. It is MIRDC'S mission to develop technologies related to light components of transportation vehicles (automobiles/bicycle), such as carbon fiber thermoplastic composite forming and dissimilar material joining technology, high-strength aluminum alloy hot stamping technology, etc., so as to conform to the international development trend of lightweight and energy saving, waste reduction during the process and material recovery, as well as assisting in building local industrial supply chains.

Biomedical devices and products

In 2019, MIRDC developed biomedical 3D electron beam printing titanium alloy, degradable magnesium alloy and other metal materials and the related application technologies. For the establishment of electron beam 3D forming process technology, the density of titanium alloy can reach 99.9%. Young's coefficients database with different crystal structure and different porosity was constructed. The current Young's coefficient can be controlled within 3-15 GPa, which meets the human needs of 3-50 GPa. Meanwhile, MIRDC also assisted domestic biomedical manufacturers to obtain metal medical implant licenses from Taiwan (TFDA) and the United States (FDA), and will continue to assist demonstration manufacturers in trial productions, for international market as well as the domestic medical institutions. In the future, MIRDC will develop more related products with the technology and promote within the medical material industry in order to improve the visibility of domestic brands in the international market.

For the degradable magnesium alloy, a method patent for the composition design of degradable magnesium alloy powder has been applied. A method for controlling the degradation rate of magnesium alloy by means of the alloy mixture entropy value is used to develop degradation materials of large surface active metal powder, so that the powder can be preserved in a dry atmosphere and degraded uniformly and stably in a water solution. It is found that the degradation rate of magnesium zinc calcium alloy in SBF decreases with the rise of the entropy value, which can be used as an important index for alloy design. The alloy that is traditionally used in wires and blocks is not

applicable to magnesium alloy powder; the main reason is that the surface area of the alloy is too large. The CaMg2 phase will quickly absorb a large amount of moisture in the air, resulting in the failure of magnesium alloy powder. Secondly, magnesium alloy with high zinc calcium content has been developed and its degradation rate in water solution is the same as that of wires.

For the promotion of related technology industrialization, MIRDC assisted Paonan Biotech, a domestic manufacturer of medical materials and orthopedic materials, in establishing the electron beam 3D forming technology, conducted the trial production of porous medical materials, integrated Paonan Biotech (medical materials design), NCKU (biocompatibility) and National Taipei University of Technology (material analysis) and obtained the US FDA certification. It is hoped to lead materials and medical materials manufacturers into 3D forming technology by means of the benchmarking manufacturers' experience, strengthen their own technical capability, develop new products indigenously and effectively enhance the competitive advantage of domestic brands in the international market, with an estimated output value of more than NT$100 million. In addition, the experiences of MIRDC in establishing 3D printing technology can be used to help the customized design of biotechnology cases. Whether it is mechanical simulation analysis, porous structure distribution in implant design, or 3D printing, the relevance among the printing position, speed and the nature of the finished product can be proposed, in order to provide a reference for biotechnology and design customized 3D implant service flow that meets the needs of patients.

Materials and products for precision machinery

In 2019, the technology development direction of materials and products for precision machinery chiefly focused on improving the manufacturing technology of precision machinery parts. For example, the establishment of near net servo forging compression technology took the government's infrastructure program as the main axis to build the servo forming process optimization module by means of MIRDC's intelligent forming laboratory. It includes the application of low-speed multi-step speed control forming module and pulse speed control forming module. The harmonic gear of harmonic reducer used by robots was used as the development vehicle and the servo forging forming module and technology were developed and verified. Through the module and the harmonic gear manufactured by the near net forming technology, the size accuracy can reach ±0.015 mm and the surface accuracy could be controlled within Ra≦0.8 μm. The development of servo forming process technology could help the domestic fabricated metal product manufacturers to move forward the field of intelligent manufacturing and help to improve the ability of seizing customized orders. It was estimated that the related output value can reach more than NT$100 million. In terms of cast iron-related treatment technology, MIRDC invested in the development of cast iron temperature cycling processing technology, low casting stress technology, vibration treatment technology in 2019 and cooperated with domestic machine tool manufacturers and foundries to develop high-size stable cast iron treatment processes. For the size variation of castings with composite stabilization treatment being 30% less than those without treatment, related technology is applied to the machine tool structure castings to improve the time stability of structural casting and reduce the natural aging time by more than 70%.

The key points in promoting technology industrialization are as follows: (1) Assist the foreign company Indoseiki in the trial development of auto nuts by means of the intelligent servo forging technology, help with the production line construction and link with the on-line automation system provided by domestic equipment manufacturers to improve the production stability, increase the yield of mass production, meet the demand of high-level fabricated metal product market and cut into the global high-end market. The cooperative R&D project fosters Indoseiki's investment in related development and production line construction which reached NT$30 million; it is estimated that the annual output value will be more than NT$100 million in the future. (2) MIRDC continues to invest in the industrial application of the thick wall Austempered ductile cast iron materials-related technologies established by the Centre. In addition to continuously assisting Chenta Precision Machinery Industrial Inc. in the application of solar tracking gear for equipment in solar power plants, related derivative applications in 2019 comprised (A) castings for AGCO agricultural machinery exported by Chia Yi Steel, (B) wear-resistant pump parts used by All Star Pump, Chuanyuan, Jia Hsing, Kao-Hui, Kao Kun and other construction plants, (C) mixing arm of Jiun Feng and Rongfeng Company, (D) crankshaft of Zhenfeng Company, and (E) chain wheel of Guanglong Company. The total derivative production value is more than NT$20 million.

In terms of future prospect and planning, in addition to the continuous promotion of industrial extension and application of existing technological achievements, this field will continue to develop the new technology of intelligent servo forging forming technology and die combination, apply it to the production and manufacturing of high-level fabricated metal products, improve the added value of fabricated metal products, and assist the manufacturers in cutting into the key precision parts supply chain of electric vehicle, robot, aerospace and other industries to improve the domestic indigenous competitiveness of key components of precision equipment. Besides, in the aspect of promoting casting dimensional stabilization technology, MIRDC will continue to carry out process optimization and industrial certification promotion, plan to establish relevant R&D alliances, construct upstream, midstream and downstream industrial chains and assist domestic enterprises in establishing indigenous capability of processing high dimensional stabilization casting.

High-value fabricated metal products

In 2019, with the support of the Industrial Development Bureau, Ministry of Economic Affairs, MIRDC established an intelligent manufacturing demonstration site for the stamping die industry and carried out intelligent die development and production technology. The main equipment in the demonstration site includes a 400-ton servo punch, its peripheral feeding device, six-axis robot arm, fast 3D scanning device for finished product, etc., all of which are domestic equipment. Meanwhile, the cloud production information platform, intelligent virtual die testing and die development database, online die monitoring, etc., have been developed to achieve the three goals: high-value products, intelligent manufacturing and digital management and provide such service as visiting, die development, parts OEM, intelligent manufacturing technology guidance, and so on. It will become the cooperative R&D base for all units in the future.

The original strategy of relying solely on low price and pursuing scale economy and mass production has gradually failed and Taiwanese fabricated metal product industry has entered the stage in which intelligent manufacturing capability must be introduced to lead the industrial transformation and upgrading. In 2019, MIRDC assisted En-Fa Industrial Co., Ltd. in cooperating with Chorng-Shuoh Machinery (intelligent grinding system and workpiece grinding parameter data establishment) and Xiejun Machinery (intelligent grinding station specification design) and jointly developing a wrench intelligent grinding system, guiding Value Valves Co., Ltd. to develop the rapid intelligent machine detection equipment for butterfly valve process together with Asia Economy Technology (software and technical support for program-controlled module) and Jiahe Company (mechanism and component processing, electroplating and special hardening), instructing Zaihao Metal Co., Ltd. to jointly and intelligently manufacture the centrifugal casting mold internal sensor with Magnetic Electric (equipment), ECO Technologies (metal CNC processing) and Seyi Machinery (terminal application) and guiding Kuo Hwa Office Furniture to build an intelligent manufacturing and visual information platform for metal stamping together with Chin Fong Machine Industrial (stamping equipment)and Servtech (computer networking mobile data).

In terms of the promotion of bathroom hardware industry, MIRDC has been continuously guiding the manufacturers to inject information and communication technology (ICT) and cultural and creative aesthetic elements into the products, introduce intelligent automation and green energy environmental protection into the process, and jointly develop and innovate the business operation model by virtue of the advantages of a plumbing industry cluster. In 2019, MIRDC promoted the innovation design center of the plumbing industry and 20 plumbing enterprises; 10 makers joined in the center. At the same time, MIRDC cooperated with the College of Design in Chienkuo Technology University and Ming Chi University of Technology to jointly develop the innovation (design and technical innovation) service (B2B) business model of plumbing industry. The design center focuses on the special requirements in the high-end product market of advanced countries, such as highly complicated waterway structure (special shape), composite multifunction and materials (dezincification resistance) and harsh environment (anti-freezing), and provides the design direction and innovative process solutions for cluster manufacturers.

In terms of the promotion of hand tool industry, China steel, MIRDC, Corporate Synergy Development Center and Taiwan Hand Tool Association jointly established the hand tool R&D testing center in 2019, which carries out initial research and analysis of the problems which Taiwan hand tool manufacturers face at the current stage, conducts high value, light weight, structural optimization and innovative product design based on sleeve, iron sheet shear, spanner, pipe cutter and wrench, pneumatic tools and tool car in accordance with the demand and urgency of the product market, and assists manufacturers in improving product grade and added value through joint research and development or industry-university cooperation. In addition, it also holds seminars and exchanges on common topics in the industry to learn new trends in the international hand tool industry.

In terms of future prospects and planning, MIRDC will continue to focus on the fields in the metal industry with large output value, high export kinetic energy, large number of manufacturers and employment, obvious industrial clusters and high value potential, including the fastener industry, hand tool industry, mold & die industry, plumbing industry, industrial valve, casting industry, lock product industry, as well as the surface treatment industry and steel material industry with high common demand, assist the above industries in introducing smart manufacturing capabiity and enhance the international competitiveness of domestic metal industry.

Review and Prospects of High-value Added Micro Manufacturing Process & the Products Industry

Current Industrial Status

- The application fields of micro products include: wearable electronic devices, communication, automobile, micro-mechanics, micro-actuators, minimally invasive medical devices, optics, tooling & mold/die, etc. It is estimated that the global output value of micro products will reach US$800 billion in 2020.
- The micro products and manufacturing technology will develop towards meeting the demands of lightweight, low energy consumption and circular economy, integration of production simulation and manufacturing technology, rapid development for upgrading of intelligent manufacturing capability, etc.
- The demand for micro components in Taiwan will reach NT$800 billion in 2020 and the output value of Taiwanese manufacturing industry was approximately NT$381.2 billion (2017). The demand in 2021 is expected to be NT$522.5 billion (MIRDC MII 2017). Most of the demands are optical/optical fiber connector, connector injection mold, cell phone lens module, micro nozzle, biotechnology products, micro equipment system, and so on.
- There are approximately 145 professional manufacturers of micro components in Taiwan, 37% in Northern Taiwan, 39% in Central Taiwan and 24% in Southern Taiwan. The representative manufacturers are Largan Precision, Foxconn (Hon Hai), Foxlink (Cheng Uei), Catcher Technology, ACES Electronics, Shin Zu Shing (SZS), Chan Way, etc., which are chiefly engaged in five major sub-fields: micro machining, micro forming, micro treatment, micro joining and micro assembly.
- The production system of domestic manufacturers relies on imports and is mainly of single-function models. However, product precision, improvement of production yield rate, lack of integration talents in micro fields, lack of digital simulation and analysis capability, composite materials and unfamiliarity with the physical and chemical characteristics of micro components are the problems to be overcome by the industries.
- The mold for glass lens forming has to be subject to the glass softening temperature of 450-700℃, so the mold materials are mostly tungsten carbide materials. However, as tungsten carbide materials have high hardness, it is not easy for them to maintain high shape precision and low surface roughness during the processing, which becomes an obstacle to the development of glass forming processes for automobile, medical device and intelligent machinery industries.

Table 1: Changes in the production value of Taiwan's micro manufacturing industry Unit: NTD 100 million; %

Year	High level optical module	High-speed communication components (fine pitch connector + optical fiber)	Others	Total	Annual growth rate
2010	100	-	618	718	19.7%
2011	150	-	537	787	9.6%
2012	300	80	588	968	23.0%
2013	900	82	700	1,682	73.8%
2014	1,200	87	618	1,905	13.3%
2015	1,500	93	637	2,230	17.1%
2016	1,853	101	656	2,609	17.0%
2017	2,186	106	675	2,967	13.7%
2018	2,405	180	695	3,280	10.5%
2019	2,645	450	716	3,812	16.2%

Data source: Annual reports of companies, complied by MII, MIRDC

Table 2: Changes in the import and export amounts of Taiwan's micro manufacturing industry

Unit: NTD 100 million; %

Import and Export Product Categories		2015	2016	2017	2018	2019	Annual Growth Rate
Import Amount	1. High-order optical module	285	260	235	205	183	-10.7%
	2. High-speed communication components (fine pitch connector + optical fiber)	215	270	355	275	230	-16.4%
	3. Others	1,700	1,750	1,810	2,080	1,924	-7.5%
	Total (1+2+3)	2200	2280	2,400	2,560	2,337	-8.7%

The amount of trade surplus is temporarily unavailable owing to having no statistics about the concrete export value.

Data source: Customs Import and Export Database, complied by MII, MIRDC

Industrial Contribution and Achievements

The micro manufacturing generally refers to the technology for producing various materials (not limited to silicon-based ones), which are characterized by high precision (in μm), micro (in mm) and/or thinness (in 10 μm), 3D complex shape and/or micro groove/hole (in 50 μm), etc.; the size and precision level of components range between traditional mechanical manufacturing and silicon-based/LIGA process. Micro machining began to appear in the internal devices and components of 3C products in the 1990s. Since 2000, there has been a global trend of development towards micro and high precision (e.g. portable devices), which then expanded to the fields of biomedicine and optoelectronics (now micro components are ubiquitous); in order to increase and prepare early for the competitiveness of the domestic manufacturing industry; the establishment of micro manufacturing system technology and industry becomes an important mission.

The MIRDC expects to fulfill the mission gradually in four stages: The pilot study was carried out from 2003 to 2004, which involved technologies and equipment such as micro (traditional and non-traditional) machining, micro plastic deformation, micro welding, micro measurement, and micro assembly; from 2005 to 2010, we established micro mold & die and forming laboratories, driving the research and development of micro manufacturing technology and indigenous development of key process modules (equipment modularization) by means of vehicle product development (e.g. micro shaft fastener, micro gear, micro hydrodynamic bearing, slice motor, micro motor, micro transmission, micro pump); from 2011 to 2017, we carried out indigenous development of reconfigurable micro manufacturing equipment and integrated composite manufacturing system (including traditional/non-traditional machining, plastic deformation, welding, heat/surface treatment, measurement and assembly), during which time we combined the indigenous development of integrated composite manufacturing system (multi-machine integrated and single-machine multi-functional composite) to establish an outsourcing supply chain system and then worked with the product factory or its Tier 1 ODM factory to collectively set up a "joint development laboratory" (e.g. Chan Way, Acon, Plastron) for micro parts innovation. It was then expanded into the "micro industry cluster" (currently with more than 30 companies); since 2018, we have been proactively promoting domestic benchmark manufacturers of micro smart manufacturing in the hope of becoming the leader in the development of new operation and service modes provided by the complete solution of customized smart production systems. The specific achievements are as follows: working together with benchmark manufacturers such as SHA YANG YE and Xing Guang Industrial to invest in the research and development of establishment of micro component heat treatment equipment system technology, which is used for the tempering/carburizing continuous heat treatment of micro gear, fastener, shaft pin, spring, probe and fishhook parts; in the future it can be applied to the industries such as automobile, intelligent automation and robot, semiconductor and aerospace; we cooperated with companies such as ACON and SDI to jointly invest in the research and development of micro machining, composite machining equipment system and ultra- precision mold demonstration production line, providing optical communication products, next-generation high-speed communication and niche new product applications. We cooperated with companies such as Aris, GillionTec, Ain Tec, EPED, Chang Hsin Biotech, Delta, and C SUN to develop customized equipment, precision drive module and optical image measurement system, and integrated medical, industrial application and precision measurement fields. In 2019, the MIRDC continued to conduct in-depth research on high hardness materials and improve its process planning, construct an ultra-precision machining system platform, combined the development of key equipment modules of ultrasonic elliptical vibration-assisted machining and diamond cutter detection and compensation module, and certified the platform through the corresponding parameters and cutters of material processing, so as to realize the possibility and cumulative technology threshold of tungsten carbide facet machining. At the same time, through the change of mold shape, the MIRDC can not only deal with the formation of aspheric lenses of different sizes, but also provide the opportunity to make use of glass forming method for array micro-lenses, which increases the application of high hardness material mold and make better lenses available to light-field camera and multi-camera composite module.

Review and Prospect of Automotive Industry

Current Industrial Status

In 2019, the output value of the domestic automobile industry (including CBU industry and component industry) reached NT$380.8 billion which, together with automotive electronics industry, has become one of the leading industries in Taiwan. However, due to the small demand of the domestic market in Taiwan and the need of relying on overseas orders, which results in a big automobile sales decline of mainland China and the United States in 2019. Since the global economy is affected by the China-US trade war, so the automobile industry environment in Taiwan has become more difficult. In recent years, the sales proportion of imported cars has increased greatly, resulting in the inadequate demand of the domestic car market and the decline of the output value of the CBU industry and component industry in Taiwan. In terms of export, auto components mainly rely on after-market (AM) service parts in the overseas market. Taking 2019 for example, the benchmark auto market in Europe and America was in recession which, together with the slow recovery of global economy, led to reduced consumer confidence and the increasingly conservative attitude of auto manufacturers, and influenced the sales momentum, indirectly affecting auto components.

It is both a crisis and a turning point for the automobile industry in Taiwan as the automobile industry is facing transformation. Green energy, self-driving and internet of vehicles (IoV) which would be the future developmental trends of the automobile industry. At present, traditional automobile component manufacturers are proactively cooperating with domestic competent ICT industry, to make the products of greater intelligence, with more opportunities to cut in the international supply chain; these manufactures are also proactively investing in electrification, no-driver and lightweight, which is expected to drive the growth in the product innovation rate of the domestic automobile industry, and integrate the latest hardware and software development in order to make the automobile industry in Taiwan more competitive.

Table 1: Changes of the production value of Taiwan's CBU & auto parts industries

Unit: NTD 100 million; %

Year	CBU Industry	Auto Parts Industry	Total	Annual Growth Rate
2015	2,081	2,342	4,423	-2.8%
2016	1,906	2,279	4,185	-5.4%
2017	1,831	2,316	4,147	-0.9%
2018	1,691	2,260	3,951	-4.7%
2019	1,589	2,219	3,808	-3.6%

Data Source: Customs Import and Export Database and TTVMA

Table 2: Changes in the import and export values of Taiwan's CBU & auto parts industries

Unit: NTD 100 million; %

	Import and Export Product Categories	2015	2016	2017	2018	2019(e)	Annual Growth Rate
Export Amount	Vehicle light	340	343	357	345	367	0.7%
	Sheet metal stampings	249	267	297	292	287	-1.6%
	Rim	119	124	121	109	100	-9.0%
	Total of Top 3	708	734	774	766	754	-1.5%
	Total export amount	2,145	2,110	2,149	2,147	2,150	0.1%
Import Amount	Engine parts	156	134	129	127	142	12.0%
	Automatic gearbox	114	100	90	69	64	-6.5%
	Sheet metal stampings	51	47	51	54	54	0.6%
	Total of Top 3	321	281	270	250	260	4.5%
	Total import amount	1,017	940	924	934	1,010	8.4%

Sources: Customs Import and Export Database, TTVMA/MII of MIRDC (2020/01)

Industrial Contribution and Achievements

MIRDC established the key components of the passenger compartment structure and the key technology of rapid trial verification, cooperated with the car manufacturer (Haitec) and component manufacturers (Honley, Yung Jen and Wuu Shiang) to carry out the trial production of modular high-strength steel car body. MIRDC integrated the traditional process technological means with the new ones, such as the introduction of the common die of high-strength steel hot stamping into the metal 3D printing (3DP) to print irregular shapes and waterway of variable diameters. In order to improve the cold circulation system of the die and avoid the heat spot concentration of the process, MIRDC established and completed the process parameters to effectively meet the dimensional precision requirements of products. In addition, the visual/digital control and adjustment technology of assembly precision was established through variation analysis and automatic spot-welding technology, which has overcome the problems of assembly welding and dimensional variation of heterogeneous and different-thickness steel of high-strength vehicle body. MIRDC achieved the effects of parts modularization/lightweight/mold sharing/jig sharing, completed relevant product commercialization verification and assisted the next generation of vehicles in the OEM in achieving the Euro NCAP safety certification capacity in 2020. "URX" car mass produced (orders received > 1000 units) and "MBU" concept vehicles were launched in 2019, all of which introduced the lightweight modularization sharing platform technology.

MIRDC assisted the domestic niche vehicle manufacturer ADIVA in the design and the development of an "intelligent auxiliary vertical vehicle stability system" and designed feedback after ride adaptability adjustment with technical transfer and tutorship. Key components were installed on three-wheel commercial platform trucks to supply short-distance logistics and distribution. The niche models have also been sold in the Southeast Asian market by setting up new factories in Malaysia. In 2008, the Company cooperated with Yulong Motor to set up new production lines and promote the three-wheel niche heavy-duty vehicle market in Europe and Japan.

With the technical transfer of chassis structure and its patent authorization to companies such as LUNSUN, Motion Technology Electric & Machinery, Darmin, and L Company, MIRDC has carried out the design of high operation safety and ride comfort and the application of lightweight niche vehicle structure and solved the problems of vehicle system integration and operation safety verification. By integrating the chassis system configuration analysis, structural safety, steering system, brake and other systems into the application of niche vehicle platform, MIRDC has successfully promoted the manufacturers to invest in the development of niche vehicles of closed sites, pushing the investment through in Daliao Industrial Park and Zhongli Industrial Park, in which the factory buildings were built and production lines increased. The investment is estimated to be more than NT$150 million. At the initial stage, MIRDC aims to promote sales in overseas markets by carrying out the trial feedback in Taiwan's local closed sites.

Medical Devices and Healthcare Industry

Current Industrial Status

With the development of medicine, the decrease of birth rate and mortality rate year by year, the proportion of the global elderly population significantly increased. The United Nations statistics indicated that the elderly population will account for 22% of the total global population by 2050, while the elderly population in Taiwan is expected to exceed 20% by 2026, making the nation a "super-aged society". In addition, with the increase in the population with chronic diseases, such business opportunities as elderly medical care and health care have emerged and the annual output value of related industries in the world is as high as US$2 trillion. Every country's urgent demand for medical devices and health care equipment has driven the constant development of the medical device and medical care industries. The research report of the Business Monitor International Research (BMI Research) showed that the global market scale of medical devices in 2018 was approximately US$389.1 billion, which is estimated to grow to US$462.5 billion in 2021, and the compound annual growth rate from 2018 to 2021 is about 6.5%.

Under the global trend of aging populations, the development of medical device industry in Taiwan will drive the growth in the demand for orthopedic materials, dental materials and medical consumables. In 2018, the turnover of the medical device industry in Taiwan was NT$159.2 billion, rising by 8.8% compared with NT$146.3 billion in 2017. In 2019, contact lenses will still be the main driving force for the growth of medical devices in Taiwan, which is expected to continuously contribute to the overall turnover. Meanwhile, the global trend of aging populations will also promote the continuous growth in exports of products such as mobility assistive devices and medical catheters. In addition, manufacturers' proactive layout in emerging markets recently will also show some results. In line with the government's continuous release of incentive policies, it is expected to drive the continuous growth in the overall turnover of medical devices in 2019.

The overall import amount of medical devices in Taiwan reached NT$77.3 billion in 2018, rising by 6.6% compared with 2017. The top ten imported products of medical devices have relatively stable industry structure changes due to the high connectivity between medical demand and national health insurance. Further observations found that the top ten imported products of medical devices accounted for 56% of the total imported value in 2018. The export value of medical devices reached NT$68.6 billion in 2018, growing by 10.8% compared with 2017. Among the export items, the growth momentum of contact lens products was especially strong, ranking first, with the export amount reaching NT$12.611, rising by 15.7% compared with 2017 and accounting for 18% of the export in Taiwan.

Table 1: Changes of the production value of medical devices industries

Year	Turnover (in NT$ 100 million)	Growth rate of turnover(%)	Number of manufacturers	Number of employees
2009	825	4.4	553	22,900
2010	928	12.4	580	25,800
2011	993	7.0	626	30,250
2012	1,092	10.0	705	34,200
2013	1,163	6.5	761	35,040
2014	1,232	5.9	781	36,429
2015	1,330	8.9	1,041	38,400
2016	1,415	6.5	1,073	39,500
2017	1,463	3.4	1,090	40,300
2018	1,592	8.8	1,128	43,850

Biotechnology industry white paper of the Ministry of Economic Affairs

Table 2: Changes in the import and export values of medical devices industries

Import and Export Product Categories		2014	2015	2016	2017	2018	Compound growth rate
Export Amount	1.Contact lenses	62.31	76.35	92.5	109	126.11	19.3
	2. Diabetes test paper, cut into specific size	50.07	55.63	60.02	63.39	68.89	8.3
	3. Other plastic laboratory, sanitation, and medical care products	55.4	68.35	63.6	61.05	63.68	3.5
	4. Other parts and accessories of the products listed in Section 9018	45.71	48.5	54.66	52.27	57.51	5.9
	Total (1+2+3+4)	213.49	248.83	270.78	285.71	316.19	10.3
Import Amount	1. Other products listed in Section 9018	82.48	106.31	110.54	119.69	124.6	10.9
	2. Diagnostic or laboratory reagents on a backing and prepared diagnostic or laboratory reagents, whether or not on a backing, other than those in Section 3002 or Section 3006	49.81	53.3	56.89	58.73	61.45	5.4
	3. Lasers, excluding laser diodes	46.15	52.74	48.01	51.28	66.23	9.5
	4. Other parts and accessories of the products listed in Section 9018	31.91	36.79	35.15	43.16	36.48	3.4
	Total (1+2+3+4)	210.35	249.14	250.59	272.86	288.76	8.2
Trade surplus amount	1. Other parts and accessories of the products listed in Section 9018	13.8	11.71	19.51	9.11	21.03	11.1

Note: Section 9018 is instruments and tools for internal medicine, surgery, dentistry or veterinary medicine, including medical illustrator, other electrical medical devices, and optometer.

Source: Biotechnology industry white paper of the Ministry of Economic Affairs

Industrial Contribution and Achievements

In terms of industrial promotion and services, the MIRDC proactively provides environmental support for the development of medical devices, such as providing consultation on the technology or domestic and foreign clinical regulations, product certification and inspection & testing services and industrial talents training required by medical device manufacturers, overcoming the bottlenecks that may be encountered during the development of medical devices and providing relevant inspection & testing services required by the products of the medical device cluster. In addition, the MIRDC also helps academic and research institutes around the industrial cluster to build relevant inspection & testing and clinical guidance platforms to accelerate the forming of the medical device industry clusters in Southern Taiwan, in order to elevate the output value and increase employment.

In terms of helping the promotion of medical device industry cluster in Southern Taiwan, the turnover of the STSP biomedicine cluster was NT$9.552 billion in 2018, and NT$7.395 billion from January till October of 2019 (pharmaceuticals 57.43%, medical devices 37.58%, and biotech food 4.99%), among which the turnover of medical device manufacturers grew by 10% compared with the same period last year. From 2016 to 2019, 10 experience diagnosis lines were built in 6 medical institutions. It is expected that more products in the STSP will be included the hospital procurement system to increase its output value. In addition, MIRDC assisted the STSP in promoting clinical research projects and encouraged clinicians to adopt the products of the STSP. From 2016 to 2019, there were 19 projects in total, helping the products to increase clinical trust and product attractiveness.

In terms of the industrial application of scientific project R&D achievements, the MIRDC carried out the 2019 "key technology evaluation project for the digital oral and spinal minimally invasive navigation system development and digital orthopedic surgery auxiliary system (4/4)" with the guidance and support of the Department of Industrial Technology of the Ministry of Economic Affairs (MOEA). The R&D achievements include key items such as precision dental prosthesis, next-generation dental implant, rapid imaging intraoral scanning and spinal 3D image surgery navigation, digital pathological image screening system, and digital orthopedic minimally invasive surgery auxiliary system technology. Among these, the developed oral bone defect repair software, MAO metal implant surface treatment mass production process technology, dental implant planning guidance device technology and pre-implant planning technology, medical image tissue segmentation and implant path simulation technology, Laser-DLP Based technology were authorized to InfoFab, Deltron, Hung Chun Bio-S, ECO Technologies, and Megaforce, respectively, to assist Taiwanese enterprises in obtaining the technology and intellectual property patent license of key medical device software and hardware.

Review and Prospect of High-value Equipment Industry

High-value equipment industry includes intelligent machinery and biotechnology and pharmaceutical equipment. The "Intelligent Machinery Industry Promotion" promoted by the Ministry of Economic Affairs, plans to introduce "intelligent element" with "precision machinery" industry, upgrade it to the intelligent machinery industry and further facilitate Taiwan to be R&D and manufacturing hub of key components of global intelligent machinery and high-end equipment. The statistics of Taiwan Association of Machinery Industry indicated that the output value reached about NT$1.1 trillion in 2019 due to the impact of the China-US trade war, 7.6% lower than 2018. In addition, the export value of machinery equipment was NT$27.8 billion in 2019, 6.7% lower than 2018.

As far as the high value equipment industry is concerned, MIRDC chiefly developed forming machinery (process equipment that uses die forming), shoemaking machinery and biotechnology pharmaceutical equipment (including food machinery and parts). The data of the Department of Statistics, Ministry of Economic Affairs indicated that the output value of forming machinery, shoemaking machinery and food machinery in 2019 amounted for NT$27 billion, 3.8% lower than the same period of 2018; the export value was NT$22.3 billion, 1.8% lower than the same period of 2018. It is obvious that the 2019 decline in the output value and export of forming machinery, shoemaking machinery and food machinery was chiefly affected by the China-US trade war. It is expected that with the signing of the China-US trade agreement, Taiwan would still have considerable development potential in the export of forming machinery, shoemaking machinery and food machinery. Relevant manufacturers in Taiwan can proactively grasp business opportunities by strengthening product R&D and striving to expand overseas markets.

To cope with the rapid changes in the future market, short product life cycle, and production mode of diverse personalized items in small quantities, many countries have released industrial restructuring policies, such as Industry 4.0 in Germany, Advanced Manufacturing Partnership (AMP) 2.0 in the US, Industrial Revitalization Plan in Japan, Manufacturing Innovation 3.0 in South Korea and Made in China 2025 strategy in China. The core content of these policies is to use communication technology and strengthen the manufacturing industry system, in order to achieve the goal of intelligent manufacturing. Taiwan learns the advantages from both German Industry 4.0 which focuses on the Cyber-Physical System (CPS) and the US AMP which emphasizes information and communication value-added services, by integrating them into the core of lean management and promoting the Productivity 4.0. In 2018, Taiwan further focused on promoting the introduction of smart machinery into the industry, establishing the ecosystem of smart machine industry and changing the old master craftsmen's experiences into machine language, in order to maintain the high degree of cooperation of Taiwanese manufacturing industry in the international supply chain system and the flexible production characteristics of industrial clusters.

Table 1: Changes in the production value of Taiwan's high-value equipment industry Unit: NTD 100 million; %

Year	Forming machinery	Shoe-making machinery	Food machinery	Total	Annual growth rate
2009	189	11.0	50	250	-30.8%
2010	300	18.8	63	382	52.7%
2011	284	15.9	68	368	-3.6%
2012	295	10.5	76	382	3.7%
2013	264	12.1	71	347	-9.0%
2014	267	17.7	73	358	3.1%
2015	244	19.5	67	330	-7.6%
2016	235	19.3	60	314	-4.9%
2017	226	15.4	60	301	-4.1%
2018	203	12.1	66	281	-6.9%
2019	179	23	68	270	-3.8%

Source: Department of Statistics, Ministry of Economic Affairs

Table 2: Changes in the import and export amounts of Taiwan's high-value equipment industry

Unit: NTD 100 million; %

Import and Export Product Categories		2015	2016	2017	2018	2019	Annual Growth Rate
Export Amount	Forming machinery	168	169	167	166	149	-10.1%
	Shoe-making machinery	37	34	31	28	40	40.1%
	Food machinery	45	39	36	33	34	3.8%
	Total	250	242	234	227	223	-1.8%
Import Amount	Forming machinery	20	19	27	27	27	-1.1%
	Shoe-making machinery	2.4	2.2	2.5	1.9	3	33.9%
	Food machinery	57	57	57	59	66	12.3%
	Total	79	78	86	88	96	8.6%
Trade surplus amount	Forming machinery	148	150	140	138	122	-11.9%
	Shoe-making machinery	-12	-11	-15	26	37	40.5%
	Food machinery	-12	-18	-21	-26	-31	23.3%
		124	121	104	139	127	-8.4%

Source: Customs Administration Database, Taiwan Food&Pharmaceutical Machinery Manufacturers'Association

Intelligent manufacturing is not merely factory automation, but also making the whole value chain among the producers, end customers and suppliers closely connect and interact without time difference and error, so as to improve the efficiency and flexibility and accurately control costs. As the main core spirit is "intelligence", it needs the operation mode development reflected in the relevant activities inside and outside the enterprise (including the supply chain system). It helps the use of various ICT tools to achieve accurate predictions through simulation analysis and online/offline integration and then conduct global optimization decision-making and implementation for early warning and prevention, which aims to create the maximum value of the enterprise.

The orientation of the intelligent machinery industry planned by the strategy of the high value equipment industry is to: integrate domestic intelligentization-related technologies (e.g. robots, Internet of things, big data, CPS, lean management, 3D printing, and sensors), strengthen the integration and introduction of process know-how/ industrial knowledge into intelligent manufacturing and provide professional intelligent manufacturing solutions for domestic manufacturing industry. Since 2017, smart machinery has focused on metal forming and machining equipment for die productions, supporting the intelligentization of equipment/systems (e.g. micro machining, green energy system, biotechnology, food and pharmaceutical equipment) in the key industry fields of MIRDC, and assisting the main industries in the discontinuous stage of technology, such as footwear industry. The technical development focuses on: (1) flexible/rapid manufacturing, such as rapid line change and calibration/adjustment (tool mold and jig, and machine process parameters), integrated visual/tactile robot application (e.g. rapidly pick and place, alignment, process machining, polishing/curved surface cementing, and assembly); (2) prediction/precision production, such as best process parameter prediction (process CPS-Twin Model), workpiece quality prediction, tool life prediction, machine health prediction and predictive maintenance, process parameter optimization (Tool Matching) before and after production line, etc.

The positioning of the biotech medical equipment industry planned by the strategy of the high-value equipment industry includes providing the biotech medical industry from the R&D to mass production stage, the technical support of the equipment required for the process and formulation, and solving the technical bridging problem of mass production equipment. Biotechnical and pharmaceutical equipment will focus on the key equipment connecting the biotechnical material/pharmaceutical industry from the trial production end, while the technical development focuses on: (1) biocompatible microcarrier preparation technology; (2) bioreactor equipment technology; and (3) microcapsule equipment technology.

Review and Prospect of Green Energy Industry

Current Industrial Status

The domestic energy supply is dominated by imports, accounting for 97.96%. The total energy supply in Taiwan from January to November of 2019 was 136,296 (1000KLOE). As domestic demand for gas power generation decreased, imported energy sources decreased 0.86%, while self-produced energy sources increased 5.08%. Major imported energy included bituminous coal-coking coal, bituminous coal (including sub-bituminous coal), coke, crude oil, petroleum products, liquefied natural gas and nuclear power, biomass energy, waste-to-energy, etc. The domestically produced energy items mainly included crude oil, refinery feed, natural gas, biomass energy, waste-to-energy, hydropower, solar photovoltaic, wind power, solar thermal power, etc., accounting for 2.04% only.

In 2019, the final energy consumption was 77,709 (1000KLOE), with total energy consumption decreasing 1.71% compared to the same period of 2018. Among these, the industrial sector had the highest consumption, accounting for 31.38% of the total consumption; the non-energy ranked second, accounting for 28.36%; the transportation sector occupied 15.94%; the energy sector took up 8.83%; the housing sector represented 7.71%; the service sector made up 6.98%; and the agricultural sector chalked up 0.79%. The power generation of renewable energy was 14,264 GWh, including 3,307 GWh from waste to energy (23.18%); 5,381 GWh from conventional hydroelectric power (37.73%); 3,812GWh from solar photovoltaic (26.72%); 1,615 GWh from wind power (11.32%); and 149 GWh from biomass energy (1.04%). In addition, the supply of regenerated oil products was 0.10 (1000KLOE). The power generation of renewable energy increased by 22.75% compared with the same period last year, among which the waste energy increased by 1.33%, the conventional hydroelectric power by 25.77%, the solar photovoltaic by 52.32%, the wind power by 13.80%, and the biomass energy by 5.37%. Besides, the renewable oil products decreased by 35.60% compared to the same period of 2018.

The energy conservation and carbon reduction aims to increase energy efficiency by more than 2% per year, reducing energy intensity by 50% by 2025 compared with 2005, and promoting the national reduction of carbon dioxide emissions. The greenhouse gas emissions are expected to be reduced by 50% compared to the current amount by 2030.

Industrial Contribution and Achievements

In order to sustainably develop green energy industry, to improve energy efficiency and develop domestic green energy application technology, MIRDC has devoted its R&D to establish the energy system development capability in 2019. According to framework of National Energy Program-Phase II, the needs include: carrying out relevant researches on high efficiency combustion, photovoltaic, wind power, geothermal energy and others under the themes of energy conservation and energy creation, developing intelligent and reconfigurable heat-storage combustion system, key processes and R&D equipment of high-efficiency silicon solar cells, repair and maintenance technology of offshore wind farm equipment, key technology for diversified development of geothermal hot spring energy and thermal regeneration chemical battery module technology for geothermal hot spring heat conduction, etc., driving industrial development and creating related projects of green energy innovation industrial ecosystem, including green energy industry promotion plan and promotion plan for upgrading and transforming the offshore wind power and photovoltaic industry, promotion plan for marine machinery industry, etc., with a total investment of 75.66 person-year and the total budget of NT$245.517 million (Table 1).

In 2019, MIRDC developed an intelligent reconfigurable heat-storage combustion system in the field of energy conservation, which could be applied to the integrated design technology of continuous industrial furnaces and help metal high-temperature combustion heating process manufacturers of large industrial furnaces and continuous furnaces save more than 35% of energy. In the field of energy creation, MIRDC developed key processes and R&D equipment of high-efficiency silicon solar cells and a key process R&D equipment platform to verify high efficiency energy 23% passivated silicon solar cell products. The development of offshore wind farm structure inspection & repair, operation and maintenance technology to meet the 20-year operation and maintenance needs of building offshore wind farms in 2020-2025, and automation and underwater detection technology to assist operation and maintenance personnel in maintaining and monitoring the operation of wind farms, in order to improve the maintenance efficiency of wind farm structure. MIRDC developed geothermal hot spring energy based on the existing technology to quickly convert geothermal hot spring energy into civil resources. In addition, the development of thermal regeneration chemical cell module technology for geothermal hot spring thermal conduction

to promote geothermal hot spring vapor thermal energy capture and conversion of renewable electric energy, adding value to the domestic geothermal hot spring water thermal power generation technology application and geothermal hot spring green energy site cultivation energy. In addition to the R&D projects, MIRDC also constructed the domestic industrial chain, including the green energy industry promotion program, which drove R&D capabilities, promoted the industrial development, and created the green energy innovation industry ecosystem in response to the industrial demand by means of tracking the ministry and department projects. The upgrading and transformation promotion program of offshore wind energy and photovoltaic industry integrated the industrial information, drove large enterprises and domestic supply chains and jointly participate in the development of offshore wind energy, promoted the service capability of new offshore wind turbine installation, facilitated international cooperation to promote the cultivation of wind turbine installation talent, improved the indigenous design and development ability of the offshore wind energy industry and assisted the enterprises in cutting into the international market supply chain. For the marine machinery industry, the promotion program could cope with the selection of wind farm developers to implement industrial linkage schemes and purchase products from local manufacturers, assisting the manufacturers in the preparation or reconstruction of plants and equipment and introduction of the intelligent process.

The main performance indicators achieved in 2019 were to assist 10 manufacturers in obtaining green energy equipment process certification and save 1,000 KLOE energy, while promoting the investment of more than NT$414.55 million in the industry and creating output value of more than NT$ 1.0135 billion by transferring technologies to industrial furnace industry, solar energy equipment industry, marine engineering industry, machinery processing equipment industry and energy-saving technology service industry, and by being specifically applied to steel industry, precision casting, fabricated metal products, solar energy products, green energy, surface treatment, electric power equipment, metal processing, accommodation, hot spring, chemical battery, offshore wind energy, seafood processing, and marine science and technology. The energy efficiency was estimated to reach 8,407 KLOE in 2019, which reduced approximately 17,772 metric tons of CO2 emissions. In the future, the investment will be continuously put in the high-value green energy technology, so as to create an environmentally friendly economy.

Table 1: The 2019 MIRDC R&D Programs inthe Energy Field

Unit: NTD

Title of Program	Intelligent reconfigurable heat-storage combustion system development project	The development project for key processes and R&D equipment of high-efficiency silicon solar cells	The development promotion project of offshore wind farm structural inspection, repair operation and maintenance technology	Key technology development project for diversified development of geothermal hot spring energy	Exploratory and innovative forward-looking project of thermal regeneration chemical cell module technology for geothermal hot spring thermal conduction	Green energy industry promotion project	The upgrading and transformation promotion project of offshore wind energy and photovoltaic industry	Talent training, industrial innovation software and hardware construction and operation Commission professional service in Kaohsiung Marine Technology Innovation Center	Total
Man-year	17	3	17.08	4	3.5	8.9	12.8	42	108
Budget	57,000	11,500	45,000	12,000	10,000	20,000	66,960	239,000	461,460
Promoted investment (NTD thousand dollars)	283,500	30,000	60,000	22,600	5,000	-	12,026	-	413,126
Created Production Value (NTD thousand dollars)	480,000	395,000	120,000	-	-	-	18,502	-	1,013,502
Assisted industries	Steel industry, chemical industry, fabricated metal industry, precision casting industry	Solar energy industry	Green energy industry	Steel industry, surface treatment industry, electric equipment industry, metal processing industry and accommodation industry	Hot spring industry, chemical cell, metal components	Offshore wind energy industry, Solar energy industry, biomass energy, geothermal industry	Offshore wind energy industry, system manufacturer/ developer, wind turbine components manufacturer and manufacturing industry	Offshore wind energy industry, seafood processing industry, marine technology industry	

Work together for sustainable development

MIRDC places great importance on domestic and foreign R&D talents and technology assets. Through innovative services and revolutionary operating organizations, we make use of industry-academe-research cooperation to create diverse industrial development resources.

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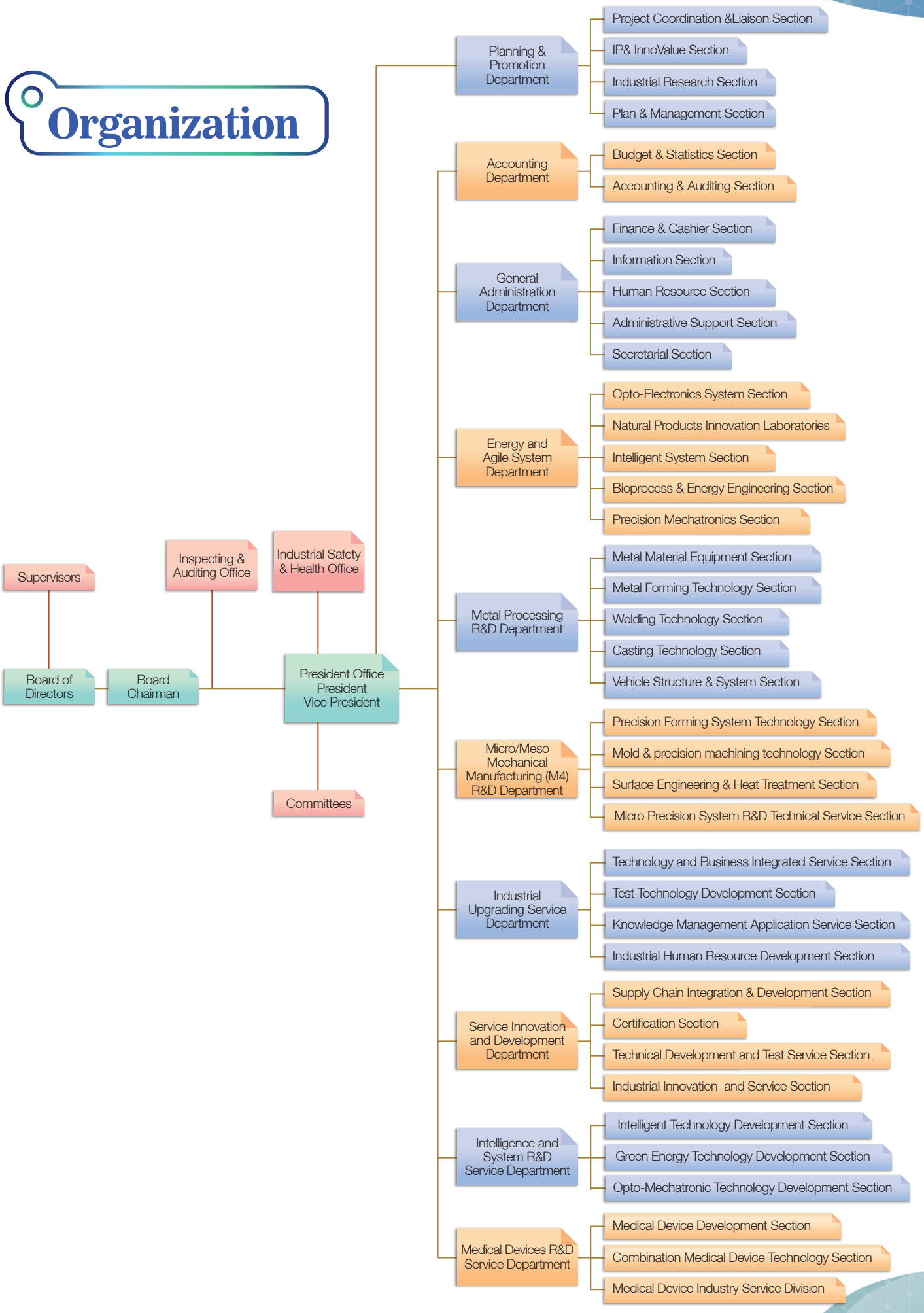
METAL INDUSTRIES RESEARCH & DEVELOPMENT CENTRE

Operational Status

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	CHEN, LING-HUI	Deputy Director General, Bureau of Standards, Metrology & Inspection, Ministry of Economic Affairs
Managing Director	CHEN,PEI- LI	Secretary General, Industrial Development Bureau, Ministry of Economic Affairs
Managing Director	LI,CHUN-LI	Deputy Director General, Bureau of Energy, Ministry of Economic Affairs
Director	CHEN,KUO-LIANG	Secretary General, Small and Medium Enterprises Administration, Ministry of Economic Affairs
Director	CHEN, QIONG-HUA	Deputy Director General, National Development Council, Department of Industrial Development
Director	WANG, SHYI-CHIN	President, China Steel Corporation
Director	MA,WAN-CHUN	President of Aerospace Industrial Development Corporation
Director	TSENG,KUO-CHENG	President of CSBC Corporation, Taiwan
Director	FONG, ZHANG-HUA	President of National Chung Cheng University
Director	JYWE, WEN-YUH	President of National Formosa University
Director	CHENG,YING-YAO	President of National Sun Yat-sen University
Supervisor	HUANG, WEN-GUU	Director, Export Processing Zone Administration, Ministry of Economic Affairs
Supervisor	YANG, CHING-YU	President of National Kaohsiung University of Science and Technology
Supervisor	CHIANG,CHING-YU	Section Chief, Department of Accounting, Ministry of Economic Affairs

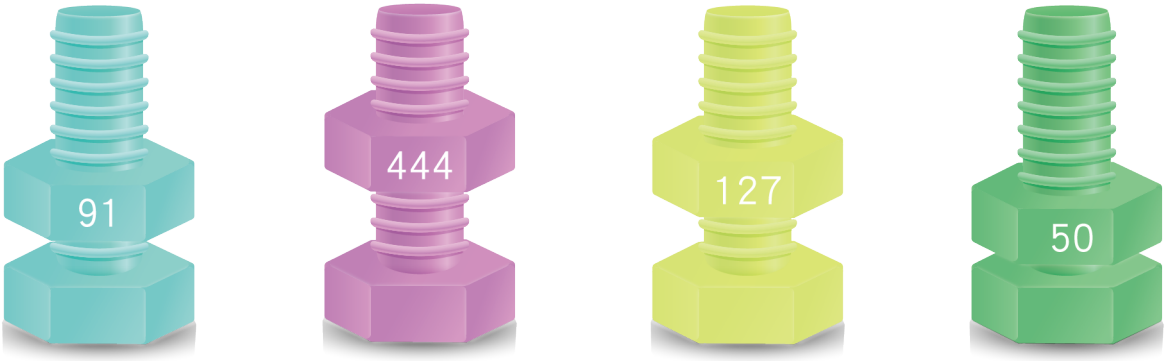
Organization



Manpower

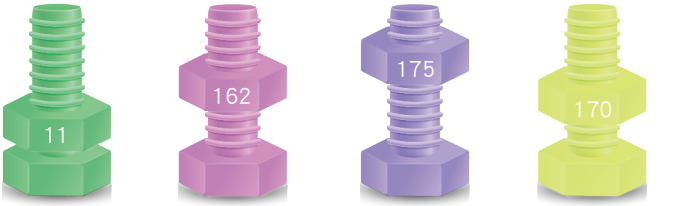
Number of Full-time Employees : 712 | Average Age : 42

Education (Number of Persons)

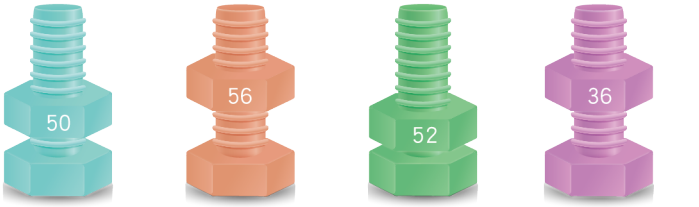


Ph.D | Master | Bachelor | Junior College & Others

Service Year
(Number of Persons)



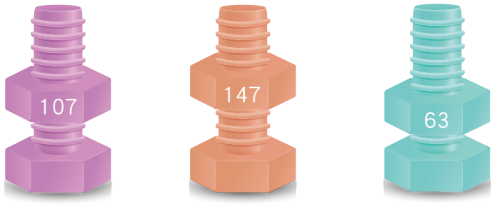
Below 1 year | 1-5 years | 6-10 years | 11-15 years



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/Otl Engineering | Management/ Marketing/ Accounting/ Statistics | Other Fields

Note: The data was published in Dec.31, 2019.

Financial Statements

Income Statement

Unit : NT

Item	Last Year Final Account		Final Account		More (less) than Budget	
	Amount	%	Amount	%	Amount	%
Operating Revenue	3,020,653,817	100.00	3,031,875,658	100.00	11,221,841	0.37
Expense	2,953,719,105	97.78	2,957,581,408	97.55	3,862,303	0.13
Net Operating Income	66,934,712	2.22	74,294,250	2.45	7,359,538	11.00
Net Non-operating Income	(2,510,542)	-0.08	2,907,586	0.10	5,418,128	-215.82
Net Income before Tax	64,424,170	2.13	77,201,836	2.55	12,777,666	19.83
Income Tax	8,467,804	0.28	14,433,084	0.48	5,965,280	70.45
Net Income after Tax	55,956,366	1.85	62,768,752	2.07	6,812,386	12.17

Balance Sheet

Unit : NT

Item	Final Account	%	Item	Final Account	%
Current Assets	1,024,653,347	54.23	Current Liabilities	526,868,633	27.88
Funds&Long-term Stock Invest	85,918,706	4.55	Long-term Liabilities	22,265,308	1.18
Property, Plant, and Equipment	668,596,725	35.38	Other Liabilities	72,583,079	3.84
Intangible Assets	66,268,737	3.51	Total Liabilities	621,717,020	32.90
Other Assets	44,147,775	2.34	Net Worth	1,267,868,270	67.10
Total Assets	1,889,585,290	100.00	Total Liabilities & Net Worth	1,889,585,290	100.00

Release full potential and win honors

Combining robust R&D capabilities with creativity, we continue to break through bottlenecks in R&D, build up international competitiveness and MIT reputation as well as create innovation value and forward-looking vision of metal technologies.

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METAL INDUSTRIES RESEARCH & DEVELOPMENT CENTRE

Glorious Achievements

Received Awards

2019 Oct.

Awarded Personnel / Unit: YANG,KUANG-HSUN; TAI,SHENG-JU; LU,CHENG-YU; SU,PING-HUA / Metal Processing R&D Department;
LU,YING-CHENG / The President Office;
LI,YUEH-HSIU; HUANG,WEI-HSIEN; YUN,KUEI-LING; WEI,YEN-LING / Planning and Promotion Department
Awarded by R&D 100 Awards

The "Bionic Intelligent AGV Fleet System" developed by MIRDC features wireless intelligence, flexible application and agile mobility. With the wireless intelligent collaborative transporting system, multiple automated guided vehicles (AGVs) can be operated simultaneously in real time to perform transporting tasks via remote control and connection. At the same time, a 360-degree mobile omni-directional wheel design is adopted, which has better performance than a traditional transporting approach for flexible use in narrow indoor spaces where traditional unmanned vehicles cannot run smoothly. For large and irregular loads, the task can be completed by simply increasing the number of vehicles. With the ability to easily overcome all difficulties, the omni-directional mobile platform not only realizes the future intelligent transporting approach, but also outlines the blueprint for convenient life with future technologies. It has won the "2019 R&D 100 Awards".

2019 Apr.

Awarded Personnel / Unit: CHIU,CHEN-CHANG ; WENG,WEI-CHAN; YANG,CHUN-MING; YIN,YUAN-SHAN; LIN,SHIH-WEI; KAO,MING-CHIEH / Energy and Agile System Department
LI,YUEH-HSIU; LI,TAO-LIN; TSAI,MENG-CHUN; YUN,KUEI-LING; HUANG,WEI-HSIEN / Planning and Promotion Department
Awarded by Edison Awards

The "Automatic Trajectory and Cementing Equipment for Specific Areas" developed by MIRDC combines fully automated equipment technologies and processes, intelligent robotic arms and 3D image vision trajectory recognition; replacing traditional manual work by quickly producing upper roughening and adopting the motion path of cementing robotic arms. The equipment shortens the time required for processes such as cementing to 6 seconds from 12 seconds, which is twice more as efficient as it used to be. To ensure precision cementing for shoe accessories, automated processes are introduced, achieving personnel cost savings of about 3 million dollars per production line and a significant increase in yield, and have won the bronze medal in the "2019 Edison Awards."

2019 Apr.

Awarded Personnel / Unit: CHIU,CHEN-CHANG; WENG,WEI-CHAN; YANG,CHUN-MING; YIN,YUAN-SHAN / Energy and Agile System Department
Awarded by Ministry of Economic Affairs

The “Intelligent 3D Visual Automation for Shoes” developed by MIRDC won “The 6th National Industrial Innovation Award by the Ministry of Economic Affairs - Team Category: Industrial Innovation Alliance Award" in "Transforming Taiwan Footwear Industry with Intelligent Technologies.”

2019 Apr.

Awarded Personnel / Unit: LIN,HENG-YU; SU,CHIH-CHIANG; TANG,SHAO-WEN; CHEN,CHIEN-CHENG; HSU,KAI-CHENG / Industrial Upgrading Service Department
Awarded by Ministry of Economic Affairs

The “High-Efficiency Combustion and Energy-Saving Technology R&D Team” developed by MIRDC won "The 6th National Industrial Innovation Award by the Ministry of Economic Affairs - Team Category: Local Industrial Innovation Model Award" in "The Best Solution for High-Temperature Waste Heat Recovery - High-Efficiency Regenerative Combustion and Energy-Saving Industrial Furnace."

2019 Apr.

Awarded Personnel / Unit: MIRDC
Awarded by Chinese Institute of Engineers

MIRDC received the honor of the "Excellence Award for Industry-Academe Cooperation Units."

2019 Sep.

Awarded Personnel / Unit: LIN,CHIH-LUNG / Vice President;
HU,PO-CHI; CHIEN,KUO-YU; TSAI,YUAN-HSUN; WANG,HSIANG-PIN; LIN,KENG-TA; TSOU,HAI-CHING / Micro/ Meso Mechanical Manufacturing R&D Department
LIN,CHIH-CHUNG; HUANG,WEN-HUI; TSAI,YUAN-PIN / Energy and Agile System Department
HSU,CHIH-FENG / Planning and Promotion Department
HUANG,I-WEN; HUANG,CHIEN-YUAN / Medical Devices R&D Service Department
Awarded by Research Center for Biotechnology and Medicine Policy

MIRDC won “The 16th National Innovation Award: Academic Research Innovation Award."

2019 Sep.

Awarded Personnel / Unit: HUNG,CHENG-HAN; LIN,YING-CHIEH; LIU,TSUNG-HSIN; TSENG,PO-HAN; LIN,YU-FU; HUANG,CHIA-HUNG / Micro/ Meso Mechanical Manufacturing R&D Department

Awarded by Research Center for Biotechnology and Medicine Policy

MIRDC won "The 16th National Innovation Award: Annual Renewal Award."

2019 Sep.

Awarded Personnel / Unit: CHUANG,YUN-CHUNG; LIN,WEI-KAI; CHEN,CHIEN-JEN; WANG,HSIN-FU; CHIEN,YU-TING; HO,SHIH-I / Planning and Promotion Department

Awarded by Ministry of Economic Affairs

Industrial Knowledge Service Pioneer Award - Group Award: Industrial Technology Foundation Research and Knowledge Service Plan (1/1), 2019 Corporate Technology Project Achievement Recognition.

2019 Aug.

Awarded Personnel / Unit: WANG, CHUN-CHIEH, Director / Metal Processing R&D Department

Awarded by Ministry of Economic Affairs

Technology Project Contribution Award - Individual: Director WANG, CHUN-CHIEH, 2019 Corporate Technology Project Achievement Recognition.

2019 Aug.

Awarded Personnel / Unit: CHIANG,CHIN-FENG, Deputy Director / Planning and Promotion Department

Awarded by Ministry of Economic Affairs

Outstanding Program Award: Key Technology Program for Intelligent Driver Assistance System (4/4), 2019 Corporate Technology Project Achievement Recognition.

2019 Aug.

Awarded Personnel / Unit: SHIH, CHING-HSIANG / Metal Processing R&D Department

Awarded by Ministry of Economic Affairs

Outstanding Program Award: New Material Development Program for Industrial Innovation (1/4), 2019 Corporate Technology Project Achievement Recognition.

2019 Sep.

Awarded Personnel / Unit: WEN,CHIH-CHUN; LIN,SHIH-WEI; CHIU,CHIEN-HSUN / Energy and Agile System Department

Awarded by Taiwan External Trade Department Council

MIRDC's "Adjusting and Guiding System for Screw Die " uses optical imaging to quickly convert the physical information of a complex forming die into die adjustment offset. After three screws are sampled according to the guiding system procedures, the system obtains the analysis results of adjustment components such as the head thickness required, rod length, eccentric X and eccentric Y; when the die adjustment time required for the original fastener is shortened from 4 hours to 1 hour, the product size requirements can be met in a fast and accurate manner. The system won the "Taiwan Innotech Expo Gold Medal Award."

2019 Sep.

Awarded Personnel / Unit: SUN,HUNG-YUAN; CHIANG,CHENG-HSUEH; SHIH,CHING-HSIANG / Metal Processing R&D Department

Awarded by Taiwan External Trade Department Council

The "High Nitrogen Low Nickel Austenite Stainless Steel Alloy Manufacturing Method" developed by MIRDC increases nitrogen solubility through alloy design and manufacturing processes. With reduced nickel content, a higher strength than carbon steel and lower corrosion rate and production cost are achieved. With enhanced corrosion resistance, this material can be applied to industries such as offshore platforms and offshore facilities, and has won the "Taiwan Innotech Expo Gold Medal Award."

2019 Sep.

Awarded Personnel / Unit: CHEN,TENG-CHIEN; HUNG,CHUN-HUNG; CHEN,CHI-HUI / Energy and Agile System Department

Awarded by Taiwan External Trade Department Council

MIRDC optimized the technology of "Biomass Oil Preparation Method," which has passed pre-heated water from the pre-heating tank into the hydrothermal liquefaction reactor, greatly shortening the processing time required. The time-saving, low energy consumption method which has received the award of "Taiwan Innotech Expo" Bronze Medal Award.

Industrial R & D Alliances

1. Motorcycle parts industry R&D alliance

The alliance is composed of KYMCO, ZCI, NKL, King Fong and other members to develop the transmission hollow shaft forging process technology for motorcycle, design of 6-pass forming die and punch, the optimization of forming forging streamlines and the feasibility of process improvement, the increase of material utilization to 92% (70%-> 92%) and the reduction of material cost by 16% that reaches the same level as Japanese YAMAHA technology.

2. Pneumatic control valve industry R&D alliance

The alliance is composed of Mindman, KSD, Nian Chin and other members to complete the development of communication-type pneumatic control valve products, to help the pneumatic control valve suppliers to introduce key Ansys simulation analysis and to complete valve body structure design, magnetic field and flow field optimization analysis. Development of communication-type pneumatic control valves aims to replace the traditional way of controlling solenoid valves by relays through industrial control integration, thus effectively reducing equipment circuit configuration costs by 20% and increasing power distribution and error detection efficiency by 30%. The technology and functionality keep pace with those of Japanese SMC.

3. LED-UV printing equipment industry R&D alliance

The alliance is composed of UV Light, PANCOLOUR, Heidelberg and other members to build domestically-made intelligent LED-UV printing curing lamps in combination with a cloud color matching platform, leading the printing machine industry towards environmental protection, energy saving and intelligence and establishing domestic LED-UV printing color quality standards to drive the transformation of the printing application industry.

4. Rehabilitation equipment industry R&D alliance

The alliance is composed of Apexcare, Medipack , Adolf and other members to integrate industry-academe-research technologies, to create an intelligent value-added system for rehabilitation equipment, to focus on the development of domestic post-stroke hand rehabilitation products, to introduce adjustable assistive rehabilitation fixing mechanism technology, to transform the traditional rehabilitation model and to provide fast inspection and communication bridge between doctors and patients as well as to facilitate the technological transformation of Taiwanese manufacturers.

5. Plastic composites industry R&D alliance

The alliance is composed of Delta, Eternal, TOPU and other members to integrate the expertise and advantages in different areas such as upstream, midstream and downstream material supply chains and design applications, to jointly develop new application products and to focus on composite materials for high-end server cooling modules which enable Taiwanese cooling module suppliers to upgrade their technologies and add value to their products.

6. Casting site optimization and technology inheritance strategic alliance

The alliance is composed of YAER SHAN, RICH SOU, Yeong Guan, MASTERTECH and other members to assist manufacturers in site optimization, to attract outstanding talents to enter the casting industry for solving manpower shortage, to shorten working hours, to ensure labor safety and health and to effectively improve the quality of talents and castings through educational trainings provided by senior experts that will facilitate the industrial upgrading.

7. Metal thermoplastic composite laminate application industry alliance

The alliance is composed of MIRDC, AD Group, Whole Man, Wen Der and other members to apply heterojunction (aluminum alloy/composite materials) niche materials to produce ultra-compact laptops with lightweight and thin structure which is expected to double the value-added rate and increase the production value by more than 160 million per year.

8. Stainless steel corrosion-resistant and non-destructive surface hardening equipment industry alliance

The alliance is composed of MIRDC, AllRing-Tech, San Hsiung, FANCY and other members to improve the surface hardness of austenitic stainless steel (from Hv200 to Hv1200) with stainless steel corrosion-resistant and non-destructive surface hardening technology, while maintaining the original corrosion resistance and non-magnetic properties. The technology is expected to increase the added value of products and enter the high-end application supply chain, increase the order amount to 50 million per year and facilitate the manufacturers to invest more than 30 million dollars.

9. Heat treatment equipment intelligence promotion industry alliance

The alliance is composed of MIRDC, SHA YANG YE, HongKuan, HI HEAT, Vincent and other members to help Taiwanese manufacturers (SHA YANG YE) to set up heat treatment equipment production lines for special microparts and to complete the implementation of the required modules according to different product needs, making production more flexible. The technology is expected to facilitate industrial investment of approximately NT$ 100 million, and create associated production value of more than NT$ 500 million from high-value, high-precision components such as carbon steel/alloy steel.

10. Commercial vehicle system components development industry alliance

The alliance is composed of MIRDC, KWONG LUNG, DA DAN, SHIN LI and other members to assist in the indigenous development of commercial vehicle system components such as high silicon-molybdenum alloy turbine casings as well as related technologies, integrating casting, precision machining and 3D printing sand molds to create an integrated process. The technology is expected to facilitate industrial investment of approximately NT$ 5 million and create production value of approximately NT$ 18 million per year from related automotive components.

11. High-strength corrosion-resistant stainless steel industry alliance

The alliance is composed of MIRDC, Chun Yu, GMTC and Yieh Hsing to develop integrated self-drilling screws, to expand other downstream suppliers (such as structural and automotive fasteners from Sheh Fung, Taiwan Shan Yin and other companies) to drive midstream and downstream R&D capabilities and increase the international competitiveness of midstream and downstream enterprises, and to provide high-strength materials with good formability and corrosion resistance. The technology will facilitate the Taiwanese industry to create green, energy-saving and eco-friendly products with high strength and corrosion resistance, transforming the traditional industry technical value and enhancing international competitiveness.

12. Intelligent manufacturing and monitoring technology industry alliance

The alliance is composed of MIRDC, Fu-Tai Engineering, Season Farm and Huei Yieh to promote the Taiwanese intelligent manufacturing and monitoring technology R&D for magnesium alloy hydrogen production reaction, to help alliance members to apply for alliance SBIR. The alliance received international orders worth 2 million from the U.S. and 5 million from China, contributed to employment of 12 people, assisted Fu-Tai Engineering in developing magnesium alloy hydrogen production technology, and gained approval for the Industrial Energy Technology Program of the Bureau of Energy, Ministry of Economic Affairs with a total amount of 20 million dollars to increase production capacity and substantial benefits.

13. Dental glass-ceramic R&D alliance

The alliance is composed of MIRDC, Department of Materials Science and Engineering, National Cheng Kung University, Coalition Technology, Good Guys Dental and other members to promote trial production planning and technology transfer implementation for the new generation of lithium disilicate glass-ceramic products. Coalition Technology invested approximately 9 million dollars to build a new trial production facility for lithium disilicate.

14. Innovative medical precision positioning technology R&D alliance

Based on MIRDC's frequency modulation radio frequency positioning technology, the alliance joins the technical team of Qisda and BWant to achieve the systematic integration of communication and medical equipment and to link clinical medicine for early evaluation cooperation mechanism to connect the user end with the estuary.

15. Intelligent monitoring bone cement infusion system R&D alliance

The alliance is composed of Yang-Ming, WeMED, MIRDC and other members to mainly integrate the development of bone cement infusion systems and intelligent trocar modules. The technology facilitated R&D investment of 45.5 million dollars and completed the construction of GMP facility this year. By linking startup and breeding programs, a price creation program is planned to be proposed in 2020 to establish a U.S.-based startup company.

16. Indigenous jet inspection and measurement alliance

NCSIST invited a total of 11 Taiwanese legal entities and public associations including TAIA, TAMI, TEEMA, TIER, NARLabs, MIRDC, ITRI, ETC, III and ARTC to jointly establish the indigenous jet inspection and measurement alliance after the opening ceremony of "TADTE 2019" on August 15, 2019, in order to integrate national inspection, measurement and certification resources, aiming to assist Taiwanese aerospace-related enterprises in obtaining international aerospace certifications.

Interactions with Industry, Academic and Research Sectors

Allied Partner：HOCHENG Corporation

January 11, 2019 / Dr. Ren-yi Lin,Chairman

On January 11, 2019, MIRDC and HCG signed an MOU to facilitate the development and long term inspection & testing cooperation for sanitary ware and home appliance industries.

Allied Partner：China Steel Corp.

March 1, 2019 / Dr. Ren-yi Lin,Chairman

On March 1, 2019, MIRDC and China Steel Corp. signed a strategic alliance agreement to effectively share the technology capabilities of two parties, increase the R&D performances of equipment and components.

Allied Partner：Season Farm Technology Co., Ltd.

March 20, 2019 / Dr. Ren-yi Lin,Chairman

On March 20, 2019, MIRDC and Season Farm Technology Co., Ltd. signed a letter of intent to set up Hydrogen Industry Research Center.

Allied Partner：Connectec Japan Corporation

May 1, 2019 / Dr. Ren-yi Lin,Chairman

On May 1, 2019MIRDC and Connectec Japan Corporation signed an MOU to be jointly dedicated to the development of advanced packaging technology.

Allied Partner：Futaba Corporation

June 1, 2019 / Dr. Ren-yi Lin,Chairman

On June 1, 2019, MIRDC and Futaba Corporation signed an MOU to jointly promote the development of mutual industrial counseling business and the upgrading of industrial technologies.

Allied Partner：Aerospace & Technology Inc.

June 4, 2019 / Dr. Chiu-Feng Lin, President

On June 4, 2019, MIRDC and Aerospace & Technology Inc. signed an MOU to carry out the cooperative R&D of smart unmanned vehicle value-added application and artificial intelligence carrying system, and dispatch management platform.

Allied Partner：National Kaohsiung University of Science and Technology

July 1, 2019 / Dr. Ren-yi Lin,Chairman

On July 1, 2019, MIRDC and National Kaohsiung University of Science and Technology signed an MOU to effectively apply technologies and academic resources of two parties for jointly promoting technical development and facilitating industry technical upgrading.

Allied Partner：Vietnam Invention Association

July 2, 2019 / Dr. Ching-ming Chen Vice President

On July 2, 2019, MIRDC and Vietnam Invention Association signed an MOU to assist Taiwan-Vietnam enterprise information exchange and business matching.

Allied Partner：
COMTES FHT a.s.CZECH TECHNICAL UNIVERSITY IN PRAGUE MEDIN a.s.PROSPON, LTD. Aplus Biotechnology Co., Ltd. Digital-Can Tech Co., Ltd. Show Chwan Memorial Hospital

August 10, 2019 / Dr. Ren-yi Lin,Chairman

On August 10, 2019, MIRDC, COMTES FHT a.s., CZECH TECHNICAL UNIVERSITY IN PRAGUE, MEDIN a.s., PROSPON, LTD., Aplus Biotechnology Co., Ltd., Digital-Can Tech Co., Ltd. and Show Chwan Memorial Hospital signed an MOU to cooperate the development of small joint implants using additive manufacturing technologies.

Allied Partner：National Cheng Kung University

September 15, 2019 / Dr. Ren-yi Lin,Chairman

On September 15, 2019, MIRDC and National Cheng Kung University signed the strategic alliance to effectively apply technologies and academic resources of two parties for jointly promoting technical development and facilitating industry technical upgrading.

Allied Partner：I-Shou University

October 10, 2019 / Dr. Chiu-Feng Lin, President

On October 10, 2019, MIRDC and I-Shou University signed a letter of intent to proactively promote the talents training, introduce industry-academic exchange resources and establish the industry, academic, research and training cooperative platform based on enterprise orientation in jointly facilitating industrial academic cooperation.

Allied Partner：Evergreen Aviation Technologies Corp.

November 7, 2019 / Dr. Chiu-Feng Lin, President

On November 7, 2019, 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：
DH RegSys Pte Ltd., MD-Clinicals SA and SEQPRO Inc.

November 21, 2019 / Dr. Chiu-Feng Lin, President

On November 21, 2019, MIRDC, DH RegSys Pte Ltd., MD-Clinicals SA and SEQPRO Inc. signed an MOU to create a service platform to support medical device companies from Taiwan to obtain European regulatory approval.

Allied Partner：
Association for Kaohsiung Association of Aluminum Doors and Windows Management

November 25, 2019 / Dr. Chiu-Feng Lin, President

On November 25, 2019, MIRDC and the Association for Kaohsiung Association of Aluminum Doors and Windows Management signed the strategic alliance to facilitate mutual cooperation, exchange and sharing of industrial technical information.

Allied Partner：National Sun Yat-sen University

November 26, 2019 / Dr. Ren-yi Lin,Chairman

On November 26, 2019, MIRDC and National Sun Yat-sen University signed an MOU to facilitate the development of offshore wind energy and marine time industries and jointly promote Maritime Technology Innovation Center.

Development Milestones

Allied Partner：Groundbreaking ceremony of Maritime Technology Innovation Center

May 31, 2019

Offshore wind energy has been regarded as part of the ocean economy, with the fastest growing contribution in the gross value added (GVA) of the global ocean economy. Its development has also been a primary focus for the government in recent years. One of the current plans is to establish the Marine Technology Innovation Center at Kaohsiung's Xingda Harbor. On May 31, 2019, Ms. Chu Chen, Secretary-General to the President, officiated the groundbreaking ceremony for three centers at the center. Mr. Chi-Mai Chen, Vice Premier of Executive Yuan, Dr. Chuan-Neng Lin, Vice Minister of Economic Affairs, Dr. Kuang-Shih Yeh, Deputy Mayor of Kaohsiung City, and other distinguished guests attended the ceremony together to witness a milestone in the development of offshore wind energy.

Allied Partner：Opening ceremony of the Hand Tools R&D Testing Center

May 31, 2019

China Steel Corporation, the Taiwan Hand Tool Manufacturers' Association, the Metal Industries Research and Development Centre (MIRDC), and the Corporate Synergy Development Center (CSD) jointly established the Hand Tools R&D Testing Center. On May 31, 2019, Mr. Wen-Sheng Tseng, Deputy Minister of the Ministry of Economic Affairs, Ms. Shiow-Yen Lu, Mayor of Taichung, Dr. Ta-Sheng Lo, Director General of the Department of Industrial Technology, and Mr. Ming-Huan Chang, Deputy Director of the Industrial Development Bureau, jointly held the opening ceremony. In the future, the operation site will be set up in the MIRDC Intelligence and System R&D Service Department (in the Taichung Industrial Park), hoping to develop common technology in the industrial chain and lead Taiwan's hand tools industry to a new peak.

Allied Partner：The Offshore Wind Training Opening Ceremony

September 17, 2019

The Offshore Wind Training Opening Ceremony was held on September 17th at the MIRDC under the guidance of the Bureau of Energy, Ministry of Economic Affairs. The first mobile training facility in Taiwan was launched at the same time. As approved by the Executive Yuan under the Forward-looking Infrastructure Development Program, the Marine Technology Innovation Center will be established at Xingda Harbor. In addition, the Bureau of Energy, MOEA has commissioned MIRDC to carry out personnel training for the offshore wind energy industry. The training center will serve as a base for advanced marine engineer training and certification in Asia Pacific region to ensure supply of localized manpower and enhance the current standard of marine works in Taiwan. It will be a solid support for the development of offshore wind marine works and an effort to promote compliance with the international maritime labor safety and environment requirements.

Models of Excellence

Intelligent collaboration made great achievements
Ultra-smooth 360-degree transporting module

The "Bionic Intelligent AGV Fleet System" received the R&D 100 Awards
Winners:
YANG,GUANG-XUN; DAI,SHENG-RU; LU,CHENG-YOU; SU,BING-HUA / Metal Processing R&D Department;
LU,YING-CHENG / The President's Office;
LI,YUE-XIU; HUANG,WEI-XIAN; YUN,GUI-LING; WEI,YAN-LING / Planning and Promotion Department

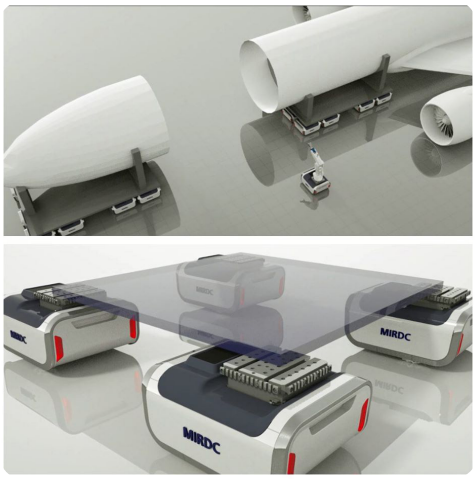
With the support of the Ministry of Economic Affairs, MIRDC fulfilled R&D achievements of the Innovation Foresight Program and by following the concept of ant colony collaboration, introduced the "Bionic Intelligent AGV Fleet System" that provides automated guided vehicle modularization and wireless intelligent connection, realizing intelligent, agile transporting. The module received the R&D 100 Awards.

Move towards Industry 4.0 and meet the demands for intelligent transporting

Driven by the Industry 4.0 concept, the global manufacturing industry is proactively moving towards computerization, digitization and intelligentization to unify industry-related technologies, sales and product experiences, optimizing supply-side resource utilization. Most Taiwanese companies have limited space, under the constraints of product diversification and complexity, manufacturing, logistics and warehousing industries all spend a lot of resources and manpower on materials transporting. With the trends of intensive global cooperation and the rapid rise of the Internet of Things in recent years, products need efficient classification and real-time transporting to meet the demands for high mobility, a more intelligent and flexible system is therefore needed to assist transporting.

Wireless flexible module completes tasks via collaboration

To meet the industrial transporting needs, inspired by ant colony cooperation, MIRDC created the "Bionic Intelligent AGV Fleet System" with the concepts of wireless intelligence, flexible application and agile mobility. With the wireless intelligent AGV fleet system, multiple automated guided vehicles can be operated simultaneously in real time and connected under remote control. The intelligent AGV module has more flexible performance than a traditional transporting approach where unmanned vehicles cannot run smoothly in narrow spaces. Mobility is no longer limited by product form, size and type and each vehicle can carry about 100 kilograms on average to quickly complete transporting tasks under coordinated operations.



Cylindrical structure and omni-directional mobility

In order to satisfy the transporting requirements in narrow and complex spaces, the collaborative transporting module adopts a cylindrical structure and an omni-directional wheel design and each wheel on the vehicle is considered as a single module. This design structure provides omni-directional 360-degree agile mobility and the ability to bear loads without tracks and mechanism links, making transporting more convenient and unhindered. For large and irregular loads, the task can be completed by simply increasing the number of vehicles. Suitable for automation technology applications such as Industry 4.0 and effectively developing the market potential of the manufacturing industry, it not only realizes the future intelligent transporting approach, but also outlines the blueprint for convenient life with future technologies.

Increase safety and reduce costs with intelligent technology

The transportation system framework of the collaborative transporting module is highly intelligent and flexible and increases or decreases the number of vehicles according to the weight of loads. Multiple vehicles can maintain a fixed distance while moving and perform handling tasks simultaneously. This helps domestic unmanned ground vehicle suppliers change from a linear motion pattern to a non-linear trackless pattern to reduce track laying costs and increase space utilization. In the future, the highly agile transportation system of this module will significantly increase safety and productivity while reducing labor costs. The capability of unmanned technology will help keep pace with international high-tech trends, assist in domestic industrial transformation and facilitate the growth of the next industrial generation.

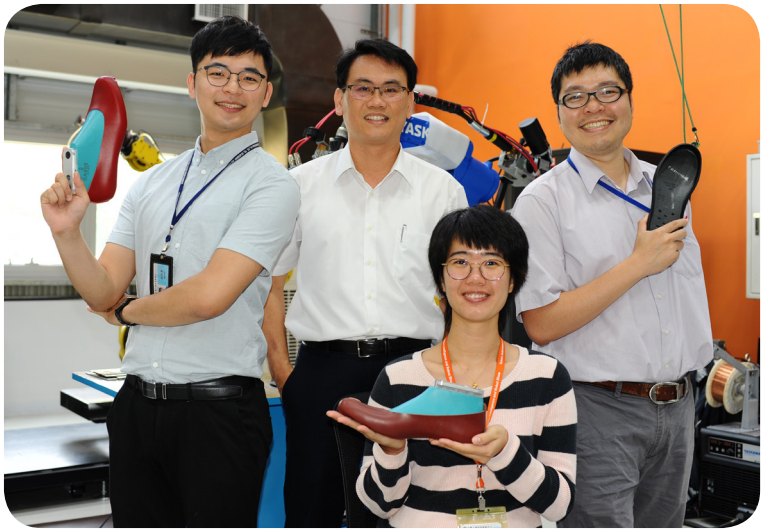
Models of Excellence

Achieve shoemaking technology breakthrough with automatic roughening

The "Intelligent 3D Visual Automation for Shoes Roughing and Cementing Equipment" won the Edison Awards in the Applied Technology Category

Winners:
QIU,ZHEN-ZHANG; WENG,WEI-ZHAN; YANG,JUN-MING; YIN,YUAN-SHAN; ZHOU,FU-YI; LIN,SHI-WEI; GAO,MING-JIE / Energy and Agile System Department
LI,YUE-XIU; LI,DAO-LIN; AI,MENG-JUN; YUN,GUI-LING; HUANG,WEI-XIAN / Planning and Promotion Department

MIRDC's remarkable achievements in the Ministry of Economic Affairs' Local Industrial Innovation and Value-added Integration Promotion Program include the " Intelligent 3D Visual Automation for Shoes Roughing and Cementing Equipment," which surpasses traditional manual roughing and cementing processes by combining automation equipment, intelligent arms and 3D image vision trajectory recognition technology, and is a bronze winner of the Edison Awards.

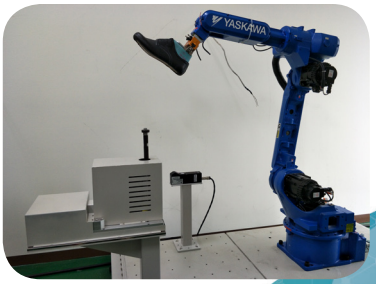


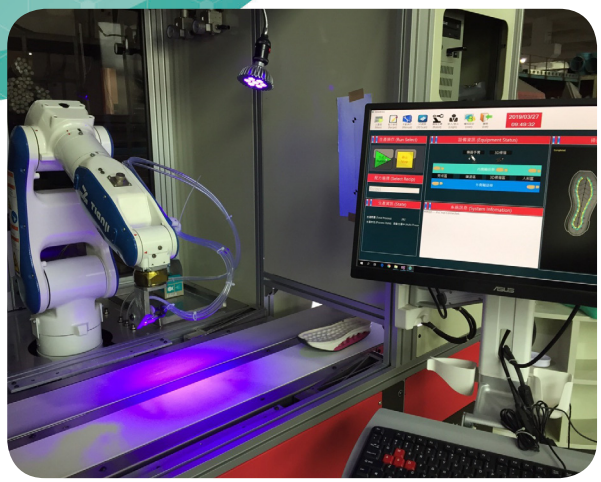
Bottleneck in the traditional labor-intensive shoemaking industry

The shoemaking industry is generally considered as a labor-intensive industry with low technical barriers, especially for roughing and cementing processes on the forming end in the traditional shoemaking industry, during which a grinder is used to rough smooth shoe materials before performing the next cementing step, which requires a lot of manual processing to complete bonding. If defects occur during roughing and cementing, the durability of shoes will be greatly reduced; at the roughing stage, the force must be exactly perfect and the amount must be carefully controlled when applying glue. In the past, all shoes are produced based on the experiences and skills of the old master craftsmen, which is extremely labor-intensive and time-consuming and requires the introduction of technology to break the bottleneck.

Integrate roughing technology that is comparable to shoemaker craftsmanship

In order to upgrade manual roughening to an automated process, MIRDC utilizes automation technology and R&D experience, proactively integrates domestic equipment system providers and shoe manufacturers for the shoemaking industry and uses intelligent 3D vision image recognition technology, robotic arms and force compensation technology. Once the roughing path is planned via software, the task is performed by robotic arms in combination with 3D line scanners, successfully overcome the bottleneck of roughing automation. The integrated automation equipment can simulate an experienced shoemaker's craftsmanship through a motion path, control the production speed according to market demands and effectively manage problems such as different material hardness, size differences and adjustment variations.



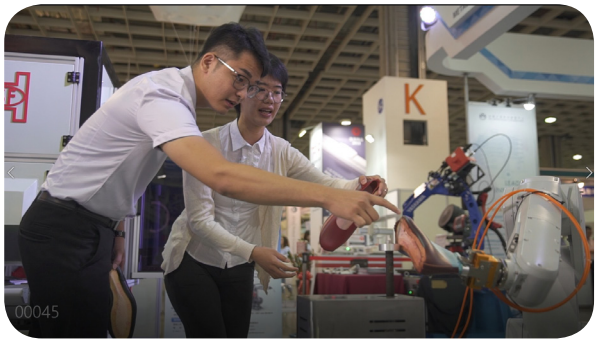


Automatic precision cementing increases speed and yield rate

With the perfect cooperation between MIRDC's sophisticated vision technologies and robotic arms, it is possible to complete automatic precision cementing for specific areas through outsoles trajectories and improve the working environment at the same time by reducing dust and chemicals that affect human health and safety. In the past, a pair of shoes took at least 12 seconds for cementing on average, which is now shortened to 6 seconds by using automated processes. The efficiency has more than doubled and precision cementing for shoe accessories is achieved. The introduction of automation enables personnel cost savings of about 3 million dollars per production line and a significant increase in production and reduces defective products caused by manual operations.

Promote industry-academe-research cooperation and support industrial transformation

By integrating various technologies developed over the years, such as automated equipment, machine vision, robotic arms and force compensation, MIRDC has successfully created an intelligent 3D visual automation for shoes roughing and cementing equipment technology, which turned roughing, cementing, accessory glue spraying and bonding of upper sole and outsole into automated processes. After a year full of challenges, MIRDC leads industry-academe-research and supplier alliance cooperation to solve the first-line problems in the shoemaking industry. The technology is currently used in five leading shoe manufacturers in Taiwan and transferred to well-known domestic OEMs. In the future, MIRDC will provide customized equipment planning to support common transformation and growth of the industry.



Models of Excellence

Recover industrial waste heat and establish an energy-saving ecosystem

The "High-efficiency Regenerative Combustion and Energy-saving Industrial Furnace" won the 6th National Industrial Innovation Award by the Ministry of Economic Affairs

Winners:
LIN,HENG-YU; SU,ZHI-QIANG; HU,GUO-XIN; TANG,SHAO-WEN ;CHEN,JIAN-CHENG ;XU,KAI-CHENG ; PAN,SHUN-SHUO ;CHEN,DING-WEN ;ZHONG,JIA-HONG; CHEN,BO-CHEN / Industrial Upgrading Service Department

In the energy technology program of the Ministry of Economic Affairs, MIRDC's R&D team for high-efficiency combustion and energy-saving technology integrated the local industrial furnace suppliers, energy-saving equipment and key component suppliers in southern Taiwan to jointly develop "the best waste heat recovery technology for high-temperature processes" that won the 6th National Industrial Innovation Award by the Ministry of Economic Affairs.

Industrial furnaces with high energy consumption cause environmental concerns

Energy saving and carbon reduction issues have been focusing on industrial energy consumption. Advances in manufacturing technology are mostly intended to enable industrial manufacturing with less pollution and lower energy consumption, in order to reduce the conflicts between economic development and environmental protection. Since the output of the steel industry in Kaohsiung ranks first in the country, industrial furnaces are often used for heating or smelting processes in materials processing and the high-temperature waste heat generated by the large number of industrial furnaces used causes environmental concerns. The long-term impacts lead to local environmental degradation, and the large amount of carbon dioxide produced can endanger human health and even intensify the greenhouse effect. Improvements are urgently needed.

Recover high-temperature waste heat for effective energy saving and emission reduction

To address the high-temperature waste heat generated by industrial furnaces, MIRDC integrates the local industrial furnace suppliers, energy-saving equipment and key component suppliers in the south to create localized regenerative combustion service capability, conducting research on high-temperature combustion, regenerative and furnace sub-systems. Through engineering theory simulation analysis and design, MIRDC's regenerative combustion system and industrial furnace integration capabilities accumulated over the years and resources from all sectors to successfully develop the best waste heat recovery technology for high-temperature processes at 700°C higher for the industry, achieving more than 30% of energy savings and accurately controlling the needs of various heated objects to ensure excellent temperature uniformity, quality and efficiency.

Regenerative batch zinc oxide furnace

Regenerative batch solution furnace

Regenerative batch oxygen sintering furnace

Regenerative batch annealing furnace

Regenerative continuous solution furnace

Develop intelligent designs and build demonstration sites

To ensure furnace energy efficiency and process stability, MIRDC introduced the cloud energy-saving monitoring system and intelligent module for industrial furnaces, which displays more than 20 data items in real time, such as fuel consumption, temperature and pressure of the furnace and regenerative system. With the intelligent algorithm, the suppliers, management personnel and technicians can keep track of the real-time furnace status and energy efficiency index for quality management, and effectively improve product stability. By developing innovative application demonstration sites that complies with international regulations, we established the energy saving and emission reduction model for industrial furnaces and reference standards for combustion, gradually creating a waste heat recovery and energy conservation ecosystem.

Customized special structure and technology transfer that promotes competitiveness

Currently, MIRDC has successfully developed 5 types of high-temperature process industrial furnaces to provide the steel industry, precision casting industry, chemical industry, fabricated metal product industry and casting industry with the best solution for high-temperature waste heat recovery. This has contributed to investments of more than NT$ 160 million, output of more than NT$ 2 billion, and a cumulative saving of 17.15 million degrees of natural gas, which is equivalent to a reduction of 32,228 tons of carbon dioxide emissions. In the future, MIRDC will provide related products such as customized burner pre-castings and special refractories to meet regenerative and energy saving goals of different processes in various industries, and continue to share our R&D results via technology transfer, bringing substantial benefits and international competitiveness to the industry.

Re-enhance technology and Implement in industry

MIRDC focuses on international trends, professionally analyzes industrial needs and obtains patents, links industry resources and facilitates cross-disciplinary cooperation, strongly promotes innovation policies and proactively develops core metal technologies.

ANNUAL REPORT 2019

METAL INDUSTRIES RESEARCH & DEVELOPMENT CENTRE

Technology and R&D Innovation

Casting Technology

In view of the demands of metal materials satisfying high controllability, high functionality and high value, the key development of melting and casting technology in 2019 focused on high-strength functional materials with corrosion resistance and compatibility. For example, corrosion-resistant and high-strength stainless steel materials can not only improve corrosion resistance and mechanical strength, but also extend the lifetime of materials; it is a developmental technology highly demanded by the industry.

In addition, the team also focuses on manufacturing technologies applicable to medical devices, aerospace and 3D printed precision castings, and proactively assists relevant domestic industries in the development of high value-added products. For instance, both the technology for titanium alloy electron beam additive manufacturing and the vacuum induction-melting inert gas atomization can be applied to the development of orthopedic materials, while 3D printed ceramic shell mold technology can solve the problem of long manufacturing time required by the traditional precision casting process.

Looking to the future, the Centre will continue to strengthen its R&D capability, research and develop automotive materials and precision mechanical fastener materials, and specialize in the development of innovative high-value materials, such as domestic automotive materials, medical devices and aerospace, in order to continuously improve the competitiveness of the industry.

Current R & D Status

1. Development of corrosion-resistant and high-strength stainless steel materials

- The development of corrosion-resistant and high-strength stainless steel materials can effectively improve the corrosion resistance and mechanical strength of stainless steel, and extend the material life (reuse), which is urgently demanded by the industry.
- Precipitation strengthening elements such as V, Nb, etc., and N elements are added to achieve high strength properties. Through the drawing process, the diameter of wire rod Ø4.42 mm is completed, with mechanical strength reaching 1,756 MPa. There is no rust phenomenon after 1,200 hours, the core hardness of the wire reaches Hv 605, and the external hardness reaches Hv 642.
- This material can be applied to integrated self-drilling screws, replacing the import cost of materials by more than 10%. The integrated self-drilling screws can reduce the replacement value of screws by up to NT$ 160 million/year.

Automotive fasteners

Integrated self-drilling screw

2. Technology for Titanium Alloy Electron Beam Additive Manufacturing

- In response to the trend of 3D printed medical devices and market demands, the titanium alloy additive manufacturing technology will be established to develop orthopedic materials.
- The newly developed 3D formed titanium alloy medical device has a mechanical property of more than 900 MPa, which is superior to medical device made from traditional processes, and conforms to the ASTM international standards.
- Medical device products made by additive manufacturing technology can increase the original product's added value by more than NT$ 500 million.
- It can be used in the medical and aerospace industries, and utilized to seize the tens of billions worth of the international market in the future.

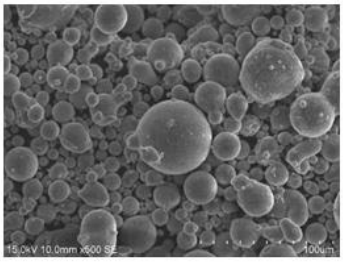
cage

Machine

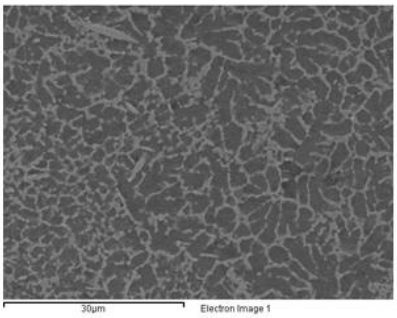
3. Vacuum Induction-melting Inert Gas Atomization

- Development of degradable magnesium alloy metal powders in response to the medical device industry's needs for highly active powders.
- The vacuum inert gas powder atomization module developed for high-active materials can be used in preparing high-quality biomedical metal powder materials according to different alloy and powder particle size requirements. The trial production of degradable magnesium alloy powder has been completed. Particle size is controlled between 10 μm-200 μm, D50 = 44 μm, and roundness below 50 μm is 0.82. The yield of the powder is 74%, the yield of the powder below 150 μm is 53%, and the yield of the powder below 50 μm is 22%. It is the domestic first success in magnesium alloy powder preparation.
- The newly developed magnesium alloy powder can be applied to the metal powder injection molding process (MIM) to prepare medical devices, such as bone nails and bone plates.

Magnesium alloy powder



SEM of magnesium alloy powder



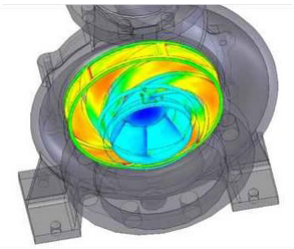
SEM of magnesium alloy powder after hot-pressing

Metallurgy powder and target gear vehicle

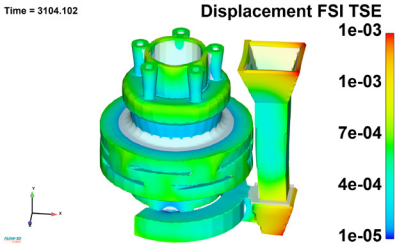
4. 3D Printed Ceramic Shell Mold Technology

- Ceramic materials of different particle diameters and different thermal expansion coefficients are mixed, so that ceramic powders with different thermal expansion degrees have a suppression effect, thereby reducing thermal deformation. The fiber powder is sintered at 1100°C, and volatilization generates fine pores, which increases the permeability of the shell mold. After the shell mold is cooled after casting, the shrinkage expands the pores and forms good disintegration. The formulation control technology for 3D printed ceramic shell mold is completed.
- The use of different shell mold thicknesses can indeed effectively control the direction of metal liquid solidification and improve the effect of feeder riser shrinkage. If the product structure has a thickness difference ratio of 1/2, the thickness of the shell mold wall is designed to be 5 times the thickness of the thick mold wall, and the effect of filling the riser can be increased more than 2-fold.
- In response to the needs of technological upgrading and transformation of the foundry industry, the development of 3D printed casting ceramic shell molds has been developed to solve the drawbacks of traditional precision casting process, including long development cycle, high cost, and difficulty of large-scale production.
- The newly developed 3D printed ceramic shell mold has a high-temperature strength of ≧ 700MPA, a thermal expansion coefficient of ≦ 2x10-6 (1/°C), a thermal stress of ≦ 3.5MPA, and a surface roughness of Ra = 3.2 to 6.3 μm.
- It is expected that the precision casting industry to which this technology is applied, will be able to reduce the cost of precision casting trial production by more than 20%.

3D printing of ceramic shell mold



Impeller structure simulation



3D printing simulation of ceramic shell mold

Impeller light-weighting

R & D Technologies in the Future

1. Industrialization of corrosion-resistant and high-strength stainless steel materials

- High-strength, free-cutting stainless steel for automotive and precision mechanical fasteners are continuously introduced and developed to meet domestic industrial requirements for materials and to accelerate the time of high-value products to launch into market.
- The high-strength, free-cutting Austenitic stainless steel materials have wire diameter ψ5.5mm, T.S ≦ 750MPa, hardness ≦ HV230.
- Through domestic application and research and development in the optimization and application of process technologies, the current material process technology is comparable to those of global leaders (Japan VIPIAS).
- Establishment of mass production lines, and development and production of high value-added fastener products through technology transfer and linking of upstream, midstream and downstream materials operators in Southern Taiwan.
- It is estimated that the output value of materials replacing imported products can reach more than NT$300 million, and the product application output value can reach more than NT$ 2 billion.

2. Technology for Titanium Alloy Electron Beam Additive Manufacturing

- In response to the trend of 3D printed medical materials and market demands, the titanium alloy additive manufacturing technology will be established to develop orthopedic materials.
- The newly developed 3D formed titanium alloy medical device has a mechanical property of more than 900 MPa, which is superior to medical devices made by traditional processes, and conforms to the ASTM international standards.
- Medical device products made by additive manufacturing technology can increase the original product's added value by more than NT$ 500 million.
- It can be used in the medical and aerospace industries, and utilized to seize the tens of billions worth of the international market in the future.

3. Vacuum Induction-melting Inert Gas Atomization

- A breakthrough from the existing batch processing of vacuum induction-melting inert gas atomization: continuous feed melting is adopted to greatly improve the production efficiency of powder.
- Fe-C-Cu alloy powder will be developed: Fluidity 25S/50g, powder metallurgy raw embryo density 7.1 g/cm3, raw embryo strength 12Mpa, and sintered hardness HV10 210, YS 500Mpa, UTS 660MPa.
- The newly developed powder can be applied to the preparation of fine metal powder metallurgy gears, and used in the automotive and machinery industries to improve dimensional accuracy (dimensional change < 0.12%).

4. 3D Printing of Ceramic Shell Molds for Lightweight Structure Development of Impellers

- In response to the market demands for energy efficiency improvement, the development of lightweight pump impeller structures will be carried out.
- Lightweight design of the structure is introduced to form the porous structure inside the impeller; this is combined with the numerical analysis technology to provide reliability analysis, such as fatigue and service life of the lightweight structure, for the stress and strain analysis of the torque generated by the impeller during operation.
- It is expected that the impeller products applying the new technology will reduce weight by 15% in product structure and increase energy efficiency by more than 10%.
- This new technology can also be applied to automotive, aerospace, and energy use in the future, with energy savings estimated to be more than 15%

Welding Technology

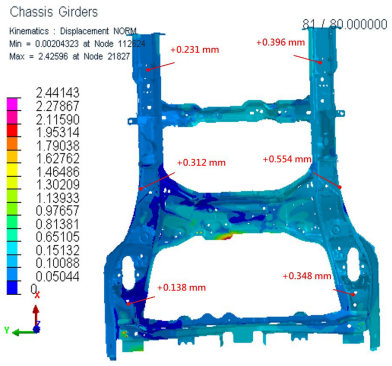
In view of large demand for international transportation, human-vehicle movement, logistics and transportation, and the rapid development of technological products, continue to pursue the trend of light weight. In 2019 welding technology aimed at the international transportation and vehicle-related industries and the 3C industry, developed fields include welding assembly variation analysis technology, friction stir welding technology, and metal thermoplastic composite lamination bonding technology.

The welding section assembly variation analysis technology can be used to control the heat input in order to solve the uneven distribution of martensite after the welding of steel components, reduce deformation, and improve the sharing of the jigs for the modular structure. Friction stir welding technology can increase the service life of the friction stir welding tools and the manufacturing process to reduce the high cost of spin tools. Metal thermoplastic composite lamination bonding technology enabled a breakthrough in realizing lighter, thinner and more strength metals, which can be applied to create high-quality light-weight laptop casing for the 3C industry. Looking to the future, the team would continue to refine the above research technologies towards the achievement of multi-functionalization, digitization and high-valued.

Current R & D Status

1. Welding Assembly Variation Analysis Technology

- The measurement analysis and certification technology of integrated passenger compartment module can achieve control of uniform heat input for component welding. Technology can solve the uneven distribution of martensite after the welding of high-strength steel and hot stamping steel components, improve the fatigue failure and prevent deformation from the heat effect by 20%, and the sharing of jigs for module structure by 55%.



Welding assembly variation analysis technology

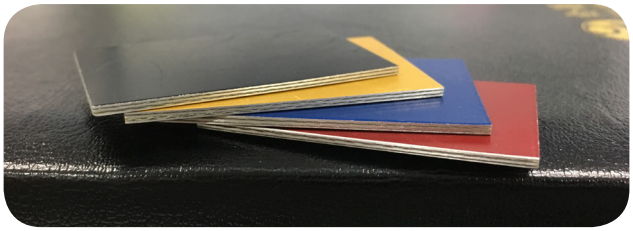
2. Friction Stir Welding Technology

- In response to the increasing demand by fabricated metal product manufacturers for friction stir welding of aluminum alloy products, the welding section has developed the high-speed, long-life FSW tools and process, which can be applied to new product development, and reduce the cost due to the high consumption rate of the spin tools in mass production.
- Welding speed (for aluminum t < 4mm): 1500mm/min.
- Spin tool life for welding (for aluminum t < 4mm): 500m/pcs.

Friction stir welding tools

3. Metal Thermoplastic Composite Lamination Bonding Technology

- Ultralight laptop casing with metal texture have accounted for more than 75% of the demand. Facing the demand for much lighter digital products, it is necessary to increase the cost-effectiveness of casing parts with better unit density and pursue the ultimate lightweight solution.
- The density and bending strength of fiber-metal laminates (thickness is <0.8mm) are < 2.2 g/cm^3 and > 270MPa, respectively. The aluminum alloy combined with thermoplastic composite material achieved weight reduction by more than 20% under the same strength.



Metal fiber composite

Metal fiber composite

R & D Technologies in the Future

1. Digitalized Welding Technology

- Combination of digital technologies, such as image monitoring, data simulation analysis and intelligent measurement aims to establish a welding database to achieve automatic welding parameter adjustment feedback compensation and optimization of the quality of the weld, enabled intelligent welding production and quality control.

Digitalized welding technology

2. Low Energy Consumption Aluminum Clean Friction Stir Welding Technology

- The development of friction stir technology for 3D curve and dissimilar materials aims to improve the joining quality of recycled aluminum, and realizing energy-saving welding for aluminum products with complex surfaces (saving 40% of process energy consumption), meanwhile, it has the advantages of no pollution during the manufacturing process and it can improve the reuse of aluminum.

Low energy consumption aluminium clean friction stir welding technology

3. Functional Metal Thermoplastic Composite Lamination Joining Technology

- In order to solve the current situation that the characteristics of the four traditional materials (metal / ceramic / polymer / composite material) can no longer meet the application requirements, the hybrid materials concept (e.g. fiber-metal laminates) is used to add functionality to the structural part.
- Heterogeneous integration of metal-based materials will be studied to obtain tensile-shear strength > 120 kgf/cm2 and bending strength > 200Mpa.
- Stacking and joining of fiber-metal laminates, while embedding functional layers, such as optical, electrical, magnetic, or thermal functions, will increase the value-added rate of the product > 30%.
- Functional fiber-metal laminates can be applied to auto and motorcycle, 3C casing, construction materials, etc.

Forming Technology

Taiwan's metal forming technology is highly developed and has entered the stage of product intelligence, complexification, high performance and high value-added. Therefore, the team is also committed to advancing towards AI intelligence and composite and functional technologies.

Among relevant forming technologies developed in 2019, besides high-precision, high-strength and lightweight press forging and stamping parts, and aluminum alloy extrusion technology, the team has also developed virtual die testing technology and intelligent monitoring of production lines. Through the introduction of intelligent design, servo forming technology, simulation analysis, and cyber-physical integration, the team will assist manufacturers in effectively improving the efficiency of forming process design, as well as research and development.

In the future, the Centre will continue to invest in intelligent forming technology and cyber-physical integration technology for high-value fabricated metal products of certain industrial scale in Taiwan, and develop related applications for high functional materials (e.g. medical magnesium alloy wire), intelligent production line and stamping die, as well as research and develop relevant process technology to assist domestic manurfacturers in shortening the R&D time and strengthening the international competitiveness of fabricated metal products.

Current R & D Status

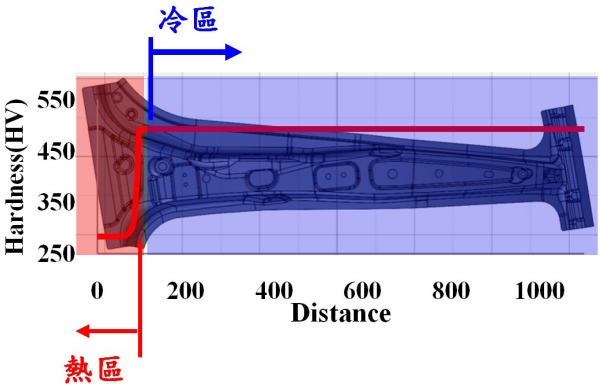
1. Intelligent servo-forming system for near-net-shape forging products

- Development of intelligent servo-forming technology and module intends to improve the R&D and manufacturing capability of manufacturing industry, and accelerate the application of smart manufacturing in this field.
- The servo-forming module and forming technology is developed for metallic bipolar plate in fuel cells. The manufactured parts could reach a flatness within 2.2 mm/95 mm, and maximum thinning rate below 33%, which meets the dimensional tolerance requirement of the industry.
- MIRDC assists domestic manufacturers to upgrade their manufacturing technology for high-end metal products. The dimensional accuracy could reach ±0.015 mm, and surface roughness (Ra) below 0.8 μm.
- The developed technology and modules can improve dimensional accuracy of manufactured parts, and reduce manufacturing processes for effective cost reduction, which could lead to improved production efficiency. The developed technology could be used in industries such as electric vehicles, robots, and aerospace.

Metal bipolar plate

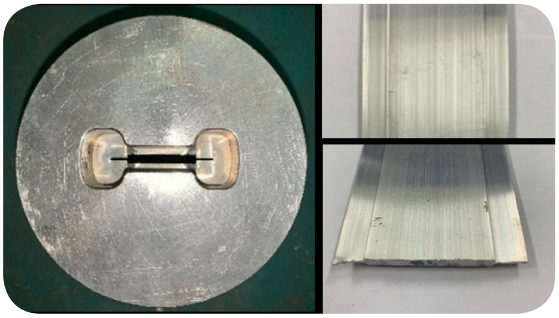
2. Hot stamping forming technology for ultra-high strength automotive parts

- Improvement of the hot stamping forming technology for ultra-high-strength automotive parts intends to enhance the safety of automotive parts, and to improve the energy efficiency of automotive by weight-reduction.
- The newly developed ultra-high-strength automotive parts could have strength variation design in different zones. The ultimate tensile strength in hard zone could reach 1300 MPa, while the value could be decreased to below 1000 MPa in the soft zone.
- The in-mold punching technology is developed for hot stamping process, so that sheet forming and leftover-parts punching could be accomplished without changing the die or secondary laser cutting process. The process cost could be greatly reduced to 60% or less than the original cost.



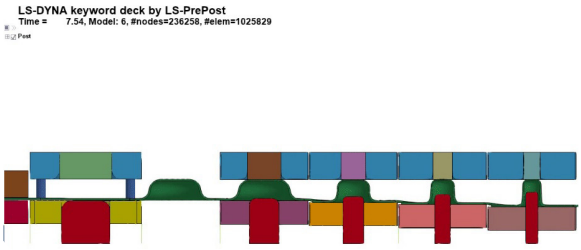
3. Extrusion technology for large thickness-variation aluminum parts

- The aluminum profiles with large thickness-variation and ultra-thin thickness sections are developed to meet market demands for the weight reduction of complex shape structural components.
- After T5 treatment, the tensile strength of aluminum profiles developed could reach 280 MPa, while the thickness of the thinnest part is only 0.9 mm, with a thickness variation ratio up to 4 times (thickest/thinnest).
- Profiles could be utilized as curtain wall or frames; it could also be utilized as general-use products like tent support rods. Its weight-reduction effect could reach above 15% (compared with conventional profile products).



4. Intelligent virtual die testing technology for forming die

- The test and verification of die design require a professional to perform the trial and modification for the die to meet the quality requirements of the finished product.
- MIRDC applies AI methods (genetic algorithm or neural network) to the optimization program, and optimize the parameters (such as die size, servo curve, etc.) of the preprocessor of a finite element analysis software to obtain a better die and process design.
- The system is applied to production lines for 3C or automotive electronic parts, which can avoid the blind spots of human experience and reduce the number of trials and costs.



Intelligent virtual die testing technology for forming die

5. Intelligent supervision technology for metal stamping product production line

- At present, the production quality management system of the domestic metal stamping industry is often managed by manual methods. It is not only inefficient but also prone to poor control and inability to meet the high-quality requirements of automotive or industrial products.
- The development of the online monitoring system for stamping production line can provide real-time monitoring of the punch status, die status, feeding status, number of punching, working speed, and other production line information.
- It is expected to be applied to production lines of 3C or electronic parts for automotive, and to increase the average operating rate of the machine by more than 10%.

6. In-line Continuous Stamping and Adhesive-bonded Stacking Technology for Motor Iron Core

- At present, the domestic production method of the adhesive-bonded iron core is off-line stacked and bonded after the electrical sheet (ES) being stamped.
- To improve stacking accuracy and productivity, in-line continuous stamping and adhesive-bonded stacking die for the motor iron core are developed in accordance with the developmental direction of foreign technologies.
- The adhesive-bonded iron cores are measured to remain within more than 95% of stacking ratio and have more than 0.34 MPa of tensile strength.

Partitional motor stator bonding core (50x40x150mm)

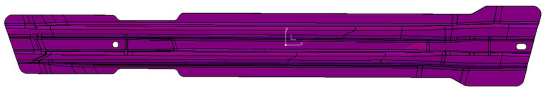
R & D Technologies in the Future

1. Intelligent servo-forming system for near-net-shape forging products

- The intelligent servo-forming trial production platform for domestic/foreign manufacturers is developed to achieve flexible testing and manufacturing, so that the capability of manufacturers could be improved, and the local content rate of high added-value products elevated.
- The features of the established platform are: high precision, high flexibility and great stability. The dimensional accuracy could be controlled within ±0.01 mm, and the surface roughness could reach Ra 0.6 μm.
- Establishment of a trial production site with the facilities embedded with the latest intelligence technologies has been planned. Manufacturers could utilize this platform to develop high-end products and enhance their competitiveness in aerospace, automotive and robot (automation) supply chains.

2. Thermoforming technology for high-strength aluminum alloy parts

- The thermoforming technology for high-strength aluminum alloy parts is developed to meet the market need for high energy consumption efficiency, and the global trends of the automotive industry in the new energy era.
- The ultimate tensile strength of manufactured aluminum parts could reach 400 MPa, and be manufactured in one pass, which is its major difference compared to the conventional cold stamping process.
- The aluminum parts manufactured through thermoforming technology could be utilized in automotive structural parts, and be fully recycled. The estimated benefit for weight reduction could reach 25% of its original mass.

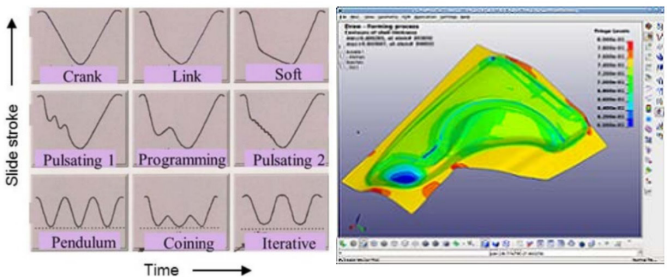


3. Extrusion technology for degradable Mg alloy

- To extend the applications of extruded degradable medical materials, MIRDC's research focused on its compound design for magnesium (Mg) alloy and its corresponding wire drawing process.
- The ultimate tensile strength of developed Mg alloy wire could reach 200 MPa, and with an elongation around 20%. A post-process surface treatment is conducted to control the degradation time.
- Mg alloy wires could be applied to minimally invasive surgery. Because of the degradable merit, the image of MRI and tomography would not be affected while conducting postoperative diagnosis.
- Mg alloy wires could also be applied to general-use products, which would have a weight reduction improvement of more than 20% compared with aluminum alloy.

4. Virtual servo forming module technology

- The test and verification of die design require a professional to perform the trial and modification for the die to meet the quality requirements of the finished product.
- By introducing the large-deformation finite element analysis software (LS-Dyna), this technology is expected to establish standardized analysis processes for virtual die testing with many kinds of stamping curves of servo press, which can be used for sheet metal or other forming dies. It can reduce the average number of actual die tests (from 5 times or more to fewer than 3 times), greatly reducing the test time and cost.
- The system is applied to production lines for 3C or electronic parts for automotive, which can avoid the blind spots of human experience and reduce the number of trials and costs.



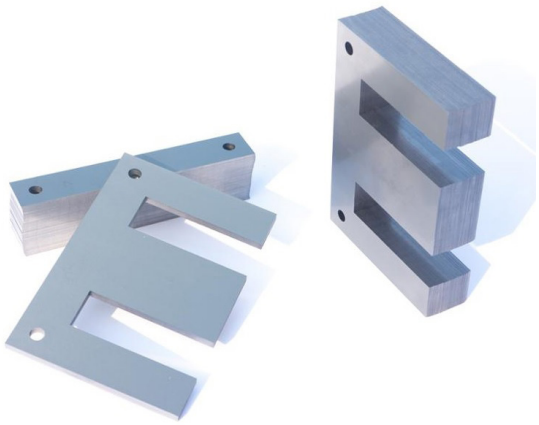
5. Application of intelligent stamping manufacturing demonstration production line

- In recent years, mold & die technology in Japan and Korea has continued to advance, while development in China, Thailand and Vietnam has not stopped. In order to master existing technologies and retain existing customers, Taiwan needs to continue to improve its mold & die development and production capabilities.
- All equipment of the demonstration field is made in Taiwan by domestic companies, including servo presses, automated robotic arms, 3D scanning devices, etc. In the meantime, MIRDC has developed a cloud platform for production information, a system of intelligent virtual mold & die testing, databases of mold & die development, and an online mold & die supervision and diagnosis system. The demonstration production line can become the basis for collaborative research and development among industry, academia and research sectors.
- MIRDC has been deeply involved in the mold & die industry for many years, and possesses multi-system integration technology. It can help manufacturers upgrade and transform technology according to the specific needs of customers. It will also optimize solutions and implement an innovation service model to take Taiwan's mold & die and machinery industry to a new level.

Application of intelligent stamping manufacturing demonstration production line

6. Stamping and Adhesive-bonded Stacking Die Development for Other Kinds of Iron Cores

- Compared with the interlocked iron core, the motor using adhesive-bonded iron core is estimated to improve the torque by 1 to 5% and efficiency by 1 to 2%.
- According to different types and sizes of iron cores, two crucial, adhesive-coating and stacking-curing modules will continuously be developed for embedding and integrating into the stamping die.
- The priority industry promotion is high-value motors, such as vehicle power motors, servo motors, machine tool spindle motors, etc. The technology shall be extended to the generator and transformer iron cores.



Transformer riveting core (35x30x15mm)

Surface Treatment Technology

To meet the needs for complex and highly functional metal materials, the processing technology in 2019 is devoted to the development of composite high-functional processing projects to increase the strength and stability of metal materials to promote the added-value of the industry.

For example, the development technology of a non-destructive surface hardening treatment system for corrosion-resistant stainless steel will increase the corrosion resistance and wear resistance of stainless steel, reduce the high wear rate of parts, and improve the material service life and fastening performance. Temperature cycle size stabilization technology can increase casting's processing efficiency and stability. In addition, the team also studied the modification method of graphite carbon felt surface to improve the power of the vanadium redox flow battery and saved 30% of the component cost.

The Centre will continue to refine the functional research and development technology of metal materials, such as high temperature resistance, wear resistance, corrosion resistance and scratch resistance, to provide high-efficiency composite processing methods for the manufacturing of fasteners, castings, valves or mold & die. In the future, the Centre will also aim at development of coating technology for semiconductor testing probes to fully prepare for the AI and 5G tech generation.

Current R & D Status

1. Development of corrosion resistant surface hardening equipment for stainless steels

- For the requirement of corrosion protection of the heavy-wear stainless steel parts market, MIRDC has developed deep corrosion resistant surface hardening treatment technology for stainless steels. The caburizing depth has been increased to 30μm, and the surface hardness is maintained at about $Hv_{0.1}$ 800~1000.
- The technology application on lock washer products has promoted the fastening property by 5-fold.
- The technology application on the stainless-steel impeller blades of pumps has resulted in increasing service life by 3-fold and cost by 1.5-fold.

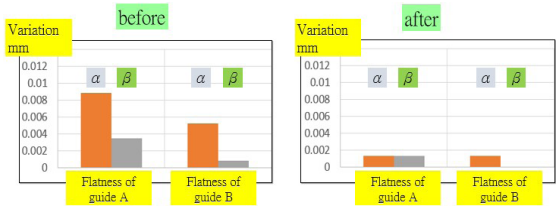
lock washer

pump parts

2. Thermal Cycling Process for Dimension Stability of Castings

- Development of dimensional stability of structural castings in response to the high value machine tools and market demand.
- Newly developed casting stability technology has reduced its natural aging schedule from the traditional one year to about half a month with similar results.
- It is expected that the casting products applied to the machine tool will be able to increase the dimensional stability by more than 70%.
- The thermal cycling process for dimension stability can also be applied to wind turbines and industrial valve castings in the future, with a predicted reduction of more than 50% in deformation.
- Combining vibration with temperature cycling can further improve stability.

saddle casting



Comparison before and after adapting

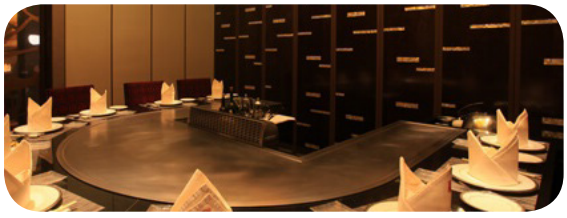
3. Graphite felt electrode surface graphene modification technology

- Development of the graphite felt surface modification treatment technology in response to the demand for VRFB to increase power density.
- After modification, the current density of graphite felt is increased to 80 mA / cm^2, which is 4 times that of untreated felt, and the maximum uniform treated area is 100*100 mm^2.
- This technology is applied to VRFB. With a working area of 100 x 100 mm^2, the power of a single battery is 12.8 W, which is 4 times the original. This processing technology can save about 30% of the component cost of a VRFB stack with the same power.

R & D Technologies in the Future

1. Special hardening processing techniques for Austenitic stainless steel

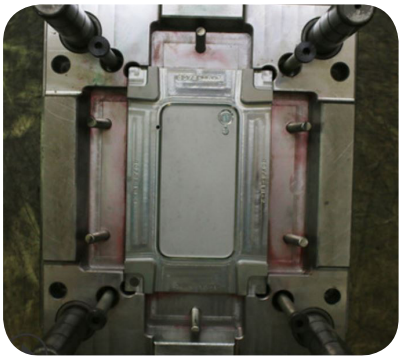
- Development of a special hardening treatment technology for Austenitic stainless-steel surface in response to the market demand for wear-resistance and scratch-resistance of the food-grade Austenitic stainless steel.
- Via special nitriding, carburizing or carbonitriding technology, the optimal depth of the nitrided layer is obtained, and the surface hardness is maintained at $Hv_{0.1}$ 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.



Stainless steel food cooking plate.

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 will aim to develop duplex surface treatment to further extend the lifetime of mold & die.
- The duplex surface treatment of molds comprises nitriding of a substrate and surface coating. Wear resistance will increase by 20%, with corrosion rate ≤ 0.26 mg/cm^2/hr.
- It can be expected that the lifetime of mold & die will increase above 20%, compared with non-duplex-treated ones.
- The applications of the duplex surface treatment on plastic injection molds/stamping dies/hot-forging dies/ die-casting molds can increase the utilization and productivity of equipment by more than 20%.

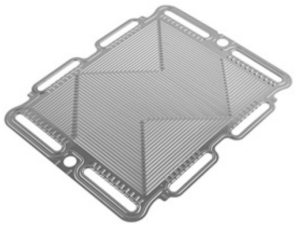


The potential application:
plastic injection mold for cell phone case

3. Development of Coating Technology for Advanced IC Test Probe

- With the evolution of AI and 5G technologies, we will develop coating technology for advanced IC test probes to provide accurate and stable testing.
- Cr-C based coating with hardness > HV1700 (much harder than Au plating~ HV90), contact resistance < 200 mΩ and water contact angle > 90°.
- It can be expected that the lifetime of contact probes will improve over 3-fold due to the properties of wear resistance and anti-sticking. The applications of Cr-C based coating technology on contact probes/electrical connectors/metal bipolar plate of fuel cell can reduce coating costs by over 35%, compared with Au plating.

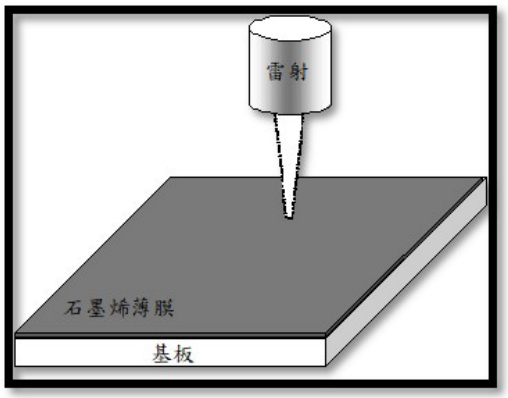
Contact probes



Metal bipolar plate

4. Graphite felt electrode surface graphene modification technology

- MIRDC developed the graphite felt surface modification treatment technology in response to the demand for VRFB in increasing power density.
- The graphite felt was originally designed to increase the current density to 80 mA / cm^2. After the modification, it is expected to reach 150 mA / cm^2 and the uniform treated area will reach 200 x 300 mm^2.
- This technology is expected to be applied to VRFB with a working area of 200 x 300 mm^2 and a single cell power of 144W. This processing technology can save about 60% of component costs for VRFB stacks of the same power.



Graphene modification by excimer laser

Mold & Die and Micro-machining Technology

In 2019, the development of the mold & die and micro-machining technology mainly aimed at the needs of the mold & die industry, precision machining & forming equipment industry, semiconductor industry, and medical industry. Projects that achieved technological breakthroughs include advanced manufacturing technology of metal components for high temperature, digital teeth scanning and teeth manufacturing technology and an ultra-precision cutting system for optical glass lens forming mold.

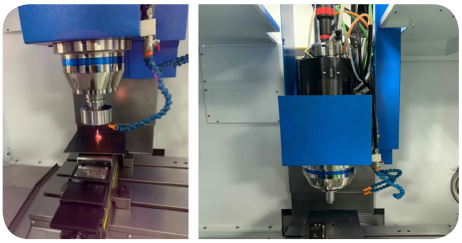
The advanced manufacturing technology of metal components for high temperature can improve the machining efficiency and reduce the cost and product development time; the digital teeth scanning and teeth manufacturing technology can achieve real-time prosthesis and real-time treatment for patients; and the ultra-precision cutting system for optical glass lens forming mold overcame the limitation in mold manufacturing, which is conducive to the development of small optical glass components and molds.

In the future, MIRDC will be focusing on advanced manufacturing technology for metal components, a cyber-physical system for machining process decision-making, and contact lens forming quality preliminary evaluation technology of rubber and plastic mechanical equipment via AI value-adding, with corresponding R&D deployment.

Current R & D Status

1. Advanced manufacturing technology for of metal components for high temperature

- In line with the national policies for the development of aerospace and energy industries, the indigenous research and development of high temperature/high-pressure resistant metal components of high temperature alloys is taken as the principal axis; the technology capabilities of Taiwan industrial chains in product materials, forming, machining and post treatment are strengthened, and contract manufacturers of aluminum/titanium alloy parts are assisted to be transformed and upgraded to manufacturers of high value added metal products of high temperature alloy components to enhance the international competitiveness of the industry.
- The high temperature alloy 718Plus composite process rough machining, as well as key component characteristics of aerospace engines as certification vehicles, numerical models of machining and virtual manufacturing are established, the machining and virtual manufacturing system architecture of 718Plus with cutting force and temperature is completed, the machining efficiency is effectively improved, and cost and time of product development are reduced.
- Numerical models of pure cutting and composite cutting of high temperature alloys are developed and verified practically, Deform 3D cutting model finite element solution simulation of auxiliary cutting is integrated, Georgia analytic solution correction and experimental cutting force measurement, and the cutting experiment comparison completed; the goodness fit of cutting force reaches 80%. The new technology can also be applied to the process development and application of various kinds of materials difficult to be machined or emerging materials in the future.



Laser auxiliary milling equipment spindle

2. Chair side Dental Total Digital Solution

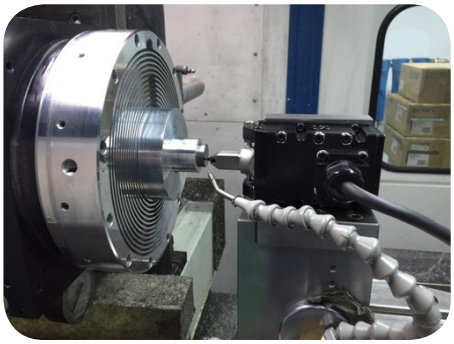
- In response to the demand for instant treatment/instant prosthesis which will become the mainstream in the future, MIRDC has completed the processing of a single tooth of lithium disilicate/full sintered zirconia ceramic tooth material, as well as the instant restoration treatment combining an intraoral scanner and a clinic-side micro-tooth milling machine for prosthesis treatment. All the cases have been completed at the clinic.
- The processing time of a single tooth of lithium disilicate/full sintered zirconia ceramic tooth material was 4 hours, and the appearance processing accuracy was about ≤ ± 0.1mm. Roughness measurement was about Ra4.39 ± 0.53um, and finished roughness was Ra3.05 ± 0.25um.

The processing method of a single tooth of lithium disilicate/full sintered zirconia ceramic tooth material

The processing equipment of a single tooth of lithium disilicate/full sintered zirconia ceramic tooth material

3. Ultra-precision cutting system for optical glass lens forming mold

- Aiming at the market demands for a car view system and machine vision, the micro glass lens mold or micro textures glass mold would be developed in overcoming the limitation of manufacturing process.
- The surface roughness is less than 20 nm Ra, and the form error could be controlled to less than 0.5μm. It is helpful for developing smaller optical glass elements and molds.
- Accompanied with matching gas and liquid turning auxiliary modules, MIRDC has used CO_2 for gas cooling to establish turning parameter optimization experiments to improve tool life and tool life analysis (turning force and surface roughness) of tungsten carbide turning, establish ability test for BLUPC tool cutting tungsten carbide mold (M78), and collect multiple sets of different parameters and their measured PV values after cutting.The learning algorithm is subsequently established for predicting the future turning processing benefits. And the tungsten alloy and tungsten carbide could also be cut by using a diamond tip tool to improve cutting efficiency and accuracy.

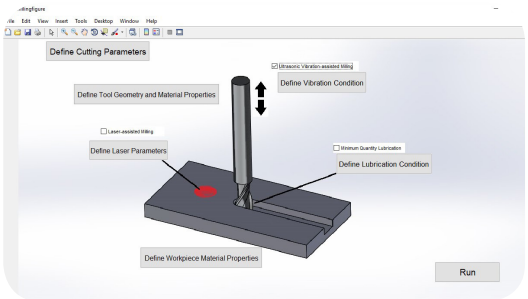


Ultra-precision cutting system for optical glass lens

R & D Technologies in the Future

1.The Development of advanced manufacturing technology for metal components

- In response to the requirements for new products and component material performance, a numerical model for laser-assisted cutting residual stress and tool wear, a numerical model for ultrasonic vibration-assisted cutting, and a virtual manufacturing system for auxiliary cutting, which are established to improve cutting efficiency and reduce cutting force, as well as decrease the cost and solve other high temperature alloy processing problems.
- The cutting force and temperature field prediction of the 718Plus material were compared with experimental values to verify that the cutting force value accuracy can reach 81% and the temperature field value accuracy can reach 74%.
- On the mathematical model of virtual manufacturing for auxiliary cutting, the first fusion of traditional milling/laser-assisted milling and ultrasonic-assisted milling virtual manufacturing system architecture, and calculation of related physical quantities, can increase processing speed by more than 30% and reduce processing wear costs by more than 30%.



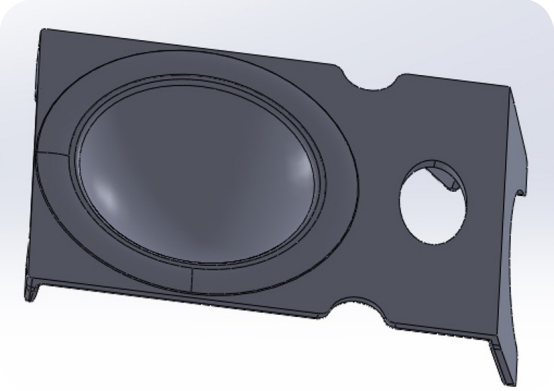
Virtual manufacturing system for auxiliary cutting

2.The Development of decision-making system for processing process with CPS

- To establish a technology solution for CPS-based auxiliary intelligent manufacturing, we provided high-speed multi-point data processing technology and IMS synchronously measuring module for auxiliary cutting processing equipment, which had 14 analog synchronous sampling channels, while a single channel has a resolution of 16 bits. According to the current situation of the machine, MIRDC has completed the integration of device parameter information and sensing data through the IMS measurement module, which has been combined with the analytical solution model and Grafana online visualization. MIRDC estimated the imaginary measured cutting force value through the orthographic model to assist the process to master more information and achieve smart and precise manufacturing.
- MIRDC has also completed the intelligent integration of advanced manufacturing equipment systems for high-temperature alloy components, which can collect online process status data, extract composite process processing features, and achieve online visual monitoring. To be able to shorten the pre-processing test duration, to reduce test waste, and to improve the future, the optimized parameters can improve material removal efficiency, maintain process stability, and reduce downtime. It can provide advanced process system equipment module monitoring and improve process efficiency.

3. AI value-added technology applied on rubber and plastic machinery and equipment -quality pre-diagnosis technology development

- With the rapid changes in the global consumer ecology driving a small and diverse production demand in the supply chain, the rubber and plastic supply chain is facing challenges. MIRDC aims to fully introduce the Internet of Things technology to the equipment, the entire line and the entire plant, to digitize the know-how of the rubber and plastics industry, to connect the real-time data of all machine equipment, backed by strong intelligent manufacturing technology, and to become flexible, customized, and efficient with low energy consumption and environmentally friendly innovative manufacturing capabilities.
- The injection molding cycle is short, and the size inspection takes time. Only quality inspection is used to maintain quality control. Through in-mold sensing technology and algorithms, combined with multi-cavity molding, the pressure and temperature changes in the mold are monitored. The accuracy of the quality prediction is expected to reach more than 95%, providing a method close to full inspection to solve the problem of product quality assurance in mass production.



Pre-diagnosis technology for contact lens forming quality

Management Technology

Management technology is centered on innovation, driving traditional castings to improve quality, the local development of robot arms, and the transformation and upgrading of aerospace power supply units, while promoting the cross-discipline ecological integration of the plumbing industry. The team also continues to carry out operation guidance for enterprises, such as strategic planning, intelligent application, regeneration and energy saving as well as e-process.

In addition to product upgrades and breakthroughs in market gaps, the industry will be further accelerated in the future to enhance the added value of products, and assist enterprises in opening up new paths by taking technology application management (human-machine collaboration / pain point analysis / networking mechanism), operation system management (AS 9100/AS 9110), innovative business model management (cross-discipline alliance /virtual reality integration) as the main axes for promotion.

I. 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
- Consulting of Mittelstand enterprise, Taiwan Excellence Award National SME Award, Taiwan Excellence Award, Rising Star Award

2. Enterprise process management digitization value-added services

- Setup of Business Process Reengineering (BPR)
- Setup of Global logistics Management (GLM)
- Setup of 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)

Big data analysis:

- 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

3. Development technology of intelligent reconfigurable regenerative combustion system

- Assist large metal processes and high temperature (above 800℃) to develop regenerative combustion waste heat recovery systems and reduce energy consumption by more than 30%.
- The reconfigurable and efficient regenerative combustion system module can achieve an energy saving rate of 30-40%.
- The intelligent decentralized temperature equalization control technology and operating parameter optimization model can further save 5% of energy.
- The design certification technology of the regenerative combustion industrial furnace system module shortens the development schedule by 50% (from 110 days to 51 days).
- The first demonstration site of intelligent reconfigurable heat regenerative combustion system is established in Taiwan: The measured energy consumption has saved 35.4%.
- The reconfigurable regenerative combustion industrial furnace can be applied to high-end products such as auto and motorcycle parts industry, metal fabricated products industry, heat treatment industry, etc. which is estimated to save energy more than 30%.

Regenerative continuous solution heat treatment furnace

R & D Technologies in the Future

1. Assisting enterprises in conducting innovative operation and transformation

- MIRDC realizes customers' expectations and industrial innovative operation to establish the paradigm model and demonstration site and assist the enterprises in upgrading and transformation.
- Use of big data acquiring and analyzing method, tracking priority industries and companies, and identifying new products and new technologies by industry, conducting public opinion analysis to support operational decision making.
- Innovative operation model: MIRDC will build the testing site to develop high-value industrial chain through O2O model.
- Intelligent reconfigurable regenerative combustion technology: MIRDC develops standardized heat regenerative burners, heat regenerative modules and intelligent control technology to tremendously reduce the setup time, increase the energy efficiency and facilitate the promotion of industrialization.

II. Innovative service

Current R & D Status

1. Development of a robotic arm for precision sandblasting (Human-Robot collaborative management)

- To renovate the 3K image of the traditional casting industry and improve the casting quality, MIRDC establishes intelligent sandblasting technology to conduct precision sandblasting via the program-driven intelligent path, and coordinating with human-robot collaborative management to meet actual operation requirements. The productivity can not only be improved by 150%, but the casting quality yield can also be improved from 95% to 99%.
- By assisting traditional foundry equipment and material suppliers in transforming into technical service providers and spreading to planning system application operators, the following benefits can be achieved, namely cost savings of NTD 2.95 million, revenue growth of NTD 93 million and investment promotion of NTD 21.1 million.

Robotic arm for precision sandblasting

Precision sandblasting operation in casting production

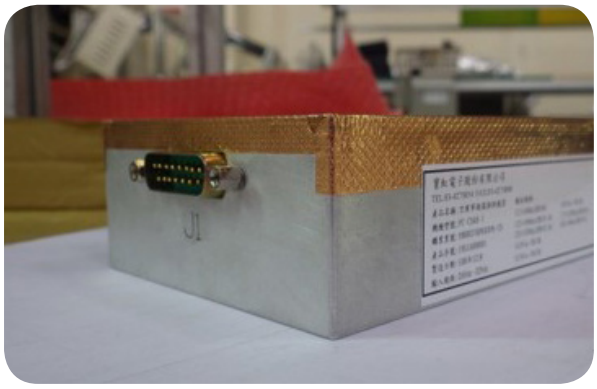
2. Development of intelligent equipment for hemodialyzer manufacturing (Process pain point analysis)

- To eliminate the dilemma of lack of international market competitiveness of hemodialyzers, the localization development of intelligent equipment for hemodialyzer manufacturing is carried out.
- Development of robot workstations and utilizing robotic arms to discharge materials result in increased production capacity by 17% and the capacity utilization rate by 13%, while the number of semi-finished products with bacteria is < 500 CFU.
- By introducing automatic optical inspection and establishing an O-Ring image judgment mechanism and statistical quality visual chart, the operating time can be shortened by 25% with an error detection rate less than 0.5%.

Hemodialyzer intelligent robot workstation

3. Development of the aerospace power supply unit (AS 9100)

- In response to the industrial policy and market demands, MIRDC assists manufacturers in using the AS 9100 system to transform and upgrade from the traditional power supply unit for transportation to the aerospace UAV power supply unit and increase the value.
- It is expected that the life cycle of the power supply unit product developed can be increased by more than 50%.



Aerospace power supply unit

4. An ecosystem for cross-discipline innovation (interdisciplinary cooperation management)

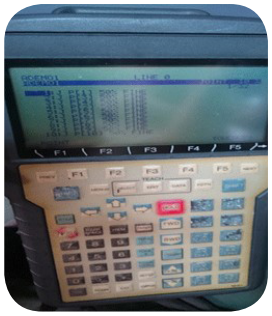
- In response to the cross-discipline transformation needs of small and medium-sized traditional industries, the cross- discipline ecosystem is promoted with the plumbing industry as the target, enabling the traditional plumbing industry to transform and provide integrated services to meet the highly complex, multi-functional and special needs of innovative market products. It creates and improves three innovative products needed of the high-end market, more than NTD 50 million of output value can be increased.
- More than 40 manufacturers are gathered, and 36 cross- discipline innovative talents are jointly cultivated; MIRDC guides operators to develop overseas markets, international orders grow by more than 6%.

Multifunctional faucets for catering

R & D Technologies in the Future

1. Development of the technology of sandblasting picking through visual identification and quality inspection (Human-robot collaborative management)

- Due to the time consuming and deficiency risk of artificial sandblasting type judgment and visual inspection of casting quality, the technology of sandblasting picking through visual identification and quality inspection is developed. The intelligent system integration scheme is launched by combining with the precision sandblasting arm.
- It is expected that the complete intelligent operation of casting surface sandblasting treatment can further increase the production capacity by 200% and reduce the sandblasting failure cost by NTD 6 million.
- It is estimated from the integrated system that the accuracy rate of sandblasting type judgment can be increased from 95% (manual) to 99% (visual), and the detection rate of defects can be increased from 90% (manual) to 97% (visual).



Casting image and identification classification data

2. Development of the intelligent cloud platform (network mechanism planning)

- To create the first “Intelligent IoT Hemodialyzer Production Line” in Taiwan for continuous advancement, MIRDC assists in the introduction of the networking intelligent cloud platform to carry out the system integration and intelligent interconnection of the hemodialyzer production equipment.
- The platform introduction is estimated that the per capita output value can increase by 10%, the equipment operation rate can increase by 20% and the scrap ratio can be reduced by 25%. The platform is also possessed of equipment preventive maintenance and repair functions.

Networking intelligent cloud platform

3. Development of power supply units for the cooling/communication devices (AS 9110)

- In the future, the product development can be applied to power supply units, including those for the cooling system and communication devices; it is estimated that the output value can increase by more than 15%.
- AS 9110 maintenance certification system service certification can be added to the system.

Power supply units for cooling and communication devices

4. Development of a User Experience (UX) platform (Clicks-and-mortar businesses management)

- In response to the needs of cross-discipline transformation of small and medium-sized industries, the cross- discipline ecosystem is promoted through the organic open innovation network system driven by experience and value co-creation.
- Development of Virtual and real integrated platform services, tools and technologies so that all members in the business ecosystem can use them to improve the performance of participating manufacturers.

Cross- discipline media service platform

III. System certification

Current R & D Status

1. Management System Certification Technology

MIRDC continuously carried out the improvement and strengthening of the certification technology in response to the revision of various ISO standards:

- ISO45001/TOSHMS occupational safety and health management system, ISO50001 energy management system certification
- MIRDC continuously improves the certification technologies for ISO9001, ISO14001, ISO27001 and other management systems
- More than 620 customers have been certified and 850 certificates were issued

2. Product Certification Technology

MIRDC plans and establishes the product certification capabilities according to ISO17065 accredited by TAF and obtains product certification qualification according to governmental regulations.

(1) Machinery safety certification and establishment of inspection & testing capabilities designated by the Ministry of Labor

- Type testing of automatic voltage reducing device
- Type testing of stacker
- Type testing of mobile elevating work platforms

(2) H-beam product safety certification and testing for BSMI.

3. Medical Device Certification Technology

MIRDC establishes the certification technology in response to the Medical Devices Act:

- Improve the GMP inspection techniques of domestic medical devices manufacturers
- Improve the QSD reviewing techniques of imported medical devices manufacturers
- Establish the inspection techniques for imported high-risk medical devices manufacturers
- Establish the inspection techniques of GDP for medical device distributors
- Make plans for the Medical Device Readiness System

R & D Technologies in the Future

1. Risk Management Assessment Technology for Machinery and equipment

- MIRDC develops risk management assessment technologies for machinery and equipment in accordance with the international standards to ensure and improve labor safety.
- MIRDC conducts research and introduces international standards for machinery safety, promotes machinery and equipment safety protection concepts and technologies, and develops safety strategies required for risk assessment.

Electric Vehicle Technology

In view of the fully-launched electric vehicle policy at home and abroad, the sale of electric vehicle is expected to be positively promoted by creating the opportunities to transform and upgrade Taiwan's auto parts and component industry, and facilitate Taiwan's technological integration with major international auto makers. In terms of research and developmental trends, electrification and automation are currently the focus of vehicle research and development. In addition to the consolidating development of the electric control sub-system of wire transmission chassis in 2019, the electric vehicle technology also aimed at improving the safety and flexibility of the dynamic control of niche vehicle chassis systems, and developing an adaptive suspension system to enhance the accuracy of damping control.

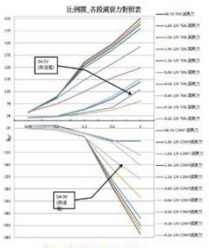
To meet the future demands for electric vehicle development as well as the needs of science and technology, MIRDC proactively develops a chassis electronic control suspension and suspension system by gathering professional experience and collocating with related core technological capabilities, which would not only effectively improve the vehicle control safety and ride comfort, but also avoid the problem of vehicle tilting when passing a curve. To make the industry smoothly connect with the future development trend of electrified and intelligent vehicles, it is conducive to enhancing the global competitiveness of the industry.

Current R & D Status

1. Design technology of adaptive suspension system

- The damping control system can be adjusted in real time according to the road conditions, which can effectively refrain the vehicle from tilting when passing a curve and improve the comfort level.
- Output of adjustable damping electronic control suspension shock absorber control module, with accurate control of damping force up to: ±25%+40 N@0.3 m/s; continuous adjustment of damping force control resolution: ±25~30%@0.3 m/s. Also, for vehicle posture adaptation sensing control technology, sampling frequency >1 kHz, controller-driven energy consumption can be reduced by >20%.
- Indigenous innovative modular design of laminated damping control valve plate, and high elasticity model matching, the common parts utilization rate >50%, high cost performance in modular design.

連續阻尼可調模組



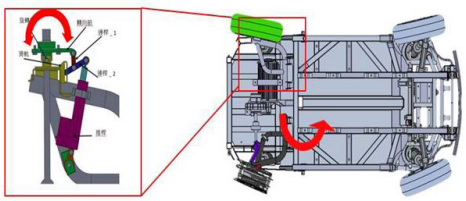
連續阻尼可變

懸吊控制驅動模組

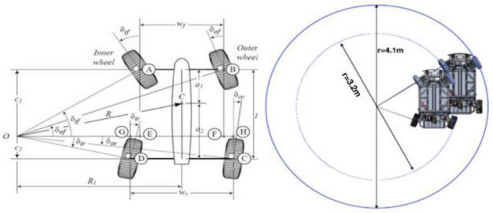
Electric vehicle

2. Chassis technology with high operating safety and comfort

- Improve the safety and flexibility of dynamic control of niche vehicle chassis system
- On the basis of common chassis, a rear wheel assistance steering mechanism is designed. During the steering process, the rear wheel changes the toe angle (+7.3°~-12.59°), the roll direction posture changes, the instantaneous center of the steering changes, and the steering radius is reduced; according to the ISO 7457 standard, the design result has a minimum steering radius of 3.2 m and understeer coefficient: 2.63 deg/g.



後輪轉向機構設計（專利申請號：108137331）

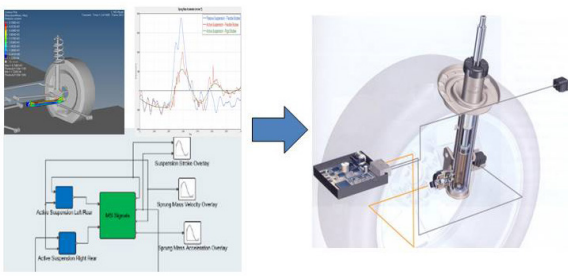


Chassis technology with high operating safety and comfort

R & D Technologies in the Future

1. Adaptive suspension electronic control system module

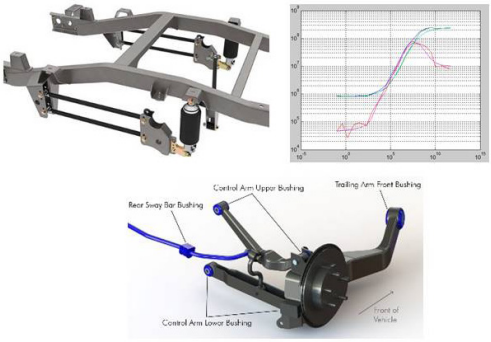
- This allows better performance of vehicle traction control, handling stability and comfort.
- Trial production of adaptive suspension system module is designed according to SKYHOOK control theory, response speed: >5Hz, precise control of single damping force: ±20%+40 N@0.3 m/s.
- Through electronic control suspension real vehicle loading and adjustment, ride comfort and controllability are confirmed, weighted root mean square value of overall acceleration is aw<0.8 m/s2 (according to ISO 2631-1), vehicle control tilt angle ≤10°@0.3 G (according to ISO 3888).



Electronic control system module

2. Suspension key components and validation

- Meet the requirements of vehicle control safety, ride comfort and shock absorption.
- The development of flexible components of the trailing arm solves the problem of tilt inhibition in roll direction due to insufficient lateral support. Vibration reduction ability increases from 10dB to 15dB.
- When the vehicle acceleration is 0.3G, the body tilt angle changes ≤4°.
- The development of the air spring embedded sensor technology improves the controllable parameter limitation of pure mechanical air spring to achieve the digital integration of the stress/strain/limit sensing interface.



Electric vehicle

Precision Electromechanical and Automation Technology

The research and development of precision mechatronics and automation technology in 2019 focused on the integration of mechatronics control and intelligent technology, and concentrated on the photoelectric semiconductor component processing technology and medical projection imaging field, including a number of intelligent high-value key module equipment and technology development, such as photoelectric probe automatic processing system technology, robot arm combined with 3D visual automatic path generation technology, IOT-type industrial solenoid valve system, shoe intelligent automatic roughing and vehicle solenoid valve detection and validation.

In line with the developmental trend of industrial intelligent manufacturing, the Centre will continue to promote intelligent automation in the future, and use digital technology, automation technology, sensing technology, artificial intelligence (AI) optimization technology, and cloud-related technology for the Internet of Things, combining professional knowledge in various application fields, to develop special equipment, provide high production rate and yield rate system solutions by upgrading technological capability, and accelerate industrial application to meet the needs of industrial intelligent manufacturing, high value-added products and industrial automation.

Current R & D Status

1.Photoelectric probe automatic processing system technology

- To improve the machining quality and yield rate of semiconductor alloy probes, probe automatic assembly system technology was developed.
- The alloy probe tip automatic machining system, equipped with an index rotary table aims to carry out multiple machining processes, including loading/unloading, rough grinding, fine grinding/finishing and shorts checking, could improve yield rate to over 4 pc/min compared to the traditional manual operation of 1 pc/min, and also enhance a highly stable quality without human negligence.
- The automatic probe tip machining system technology can not only be applied to probe parts, but also to other precision metal tip parts fabrication in the future. It could contribute the yield improvement by more than 4-fold, and can be further equipped with online inspection capability.

Tiny photoelectric probe

Photoelectric probe automatic processing system technology

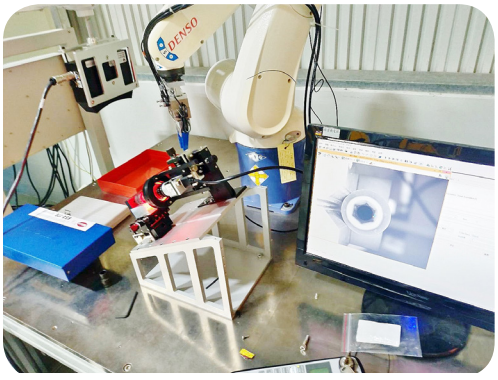
2.SaaS-based optical aid molding system

- The simple and friendly guiding interface can help operator to carry out the right adjusting process, and decrease the training time by at least 50%.
- The mold-adjusting technology with optical inspection was developed with an accuracy of ≤±0.12 mm.
- The friendly guiding process raises the efficiency by at least 70% via the developed mold-adjusting technique.

3.Process high-performance

Flexible Automatic Assembly System

- Because the assembly process is becoming more and more complicated and meticulous, the operator has to spend a lot of time and cost on equipment adjustment; a simpler and more flexible automation technology is needed.
- MIRDC has developed the AOI technology and force feedback control technology of robot arm for automatic locking and assembly of metal components, improved assembly accuracy and yield rate via visual alignment technology and force control technology, reduced dependence on personal experience, ensured quality and stability, achieved the efficiency of automated assembly, and improved production efficiency by more than 30%.

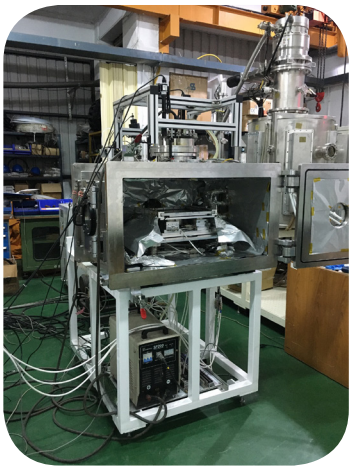


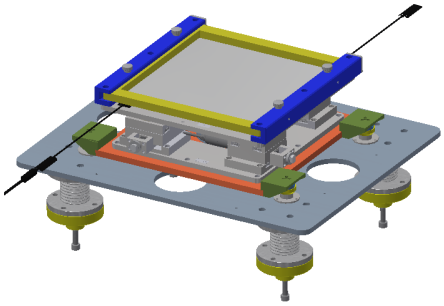
Flexible automatic assembly system

4.Precision alignment module technology for vacuum process equipment

Precision alignment module technology for vacuum process equipment

- MIRDC developed the precision visual feedback alignment module for use under the vacuum process environment, established key technologies, such as isolation of external vibration and cavity deformation, direct-drive XXY platform in vacuum cavity, visual feedback alignment, and assisted domestic vacuum equipment manufacturers to establish high-level aligned process industrial application supply chain capabilities.
- The automatic vision feedback and stage control alignment module has an applied process precision of ≦±0.01 mm for vacuum evaporation or sputtering process equipment of OLED, Chip-R, Wafer, precision measurement, etc.

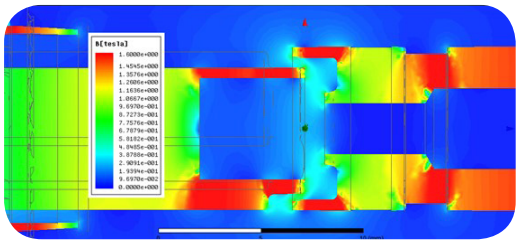




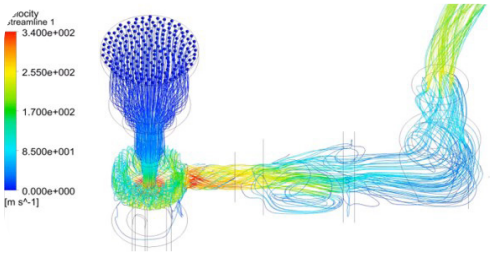
The design of precision alignment module for vacuum process equipment

5.Solenoid valve simulation technology with development of communication control integration software

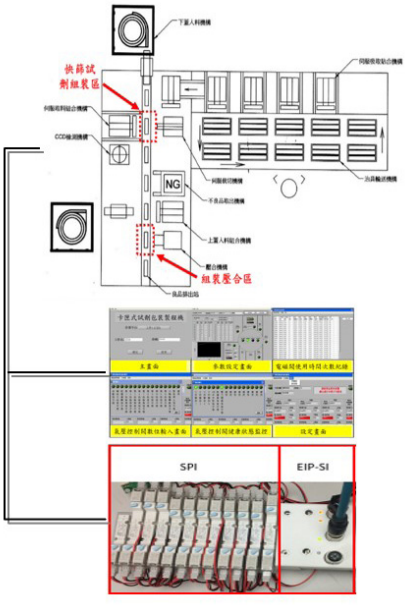
- MIRDC assisted industries to establish CAE simulation technology and develop advanced solenoid valve devices.
- Development of the solenoid magnetic field simulation technology upgraded the magnetic attraction 2-fold via the optimization simulation method.
- MIRDC developed solenoid valve structure simulation technology in the flowing field, and improved structure design in the flowing field via the optimization simulation method.
- To upgrade products to digitization, development of IoT-type advanced solenoid valve and controlling equipment integration software, monitoring, counting, timing and warning of solenoid valves can be accomplished.



The optimum design of magnetic flux density



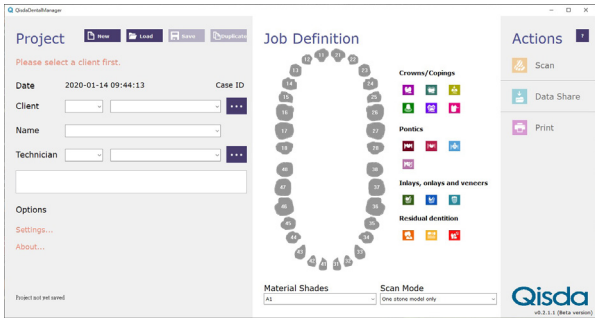
The optimum design of structure in flowing field



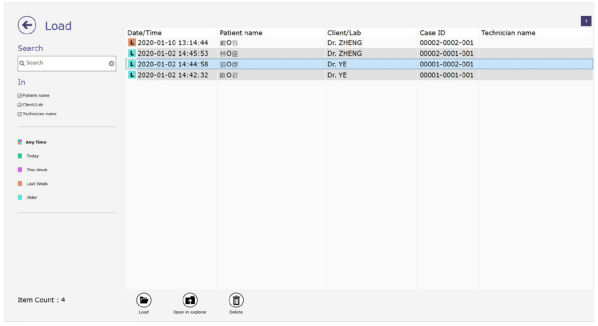
The development of communication solenoid valve with equipment of control integration software

6.Development of image project and capture method

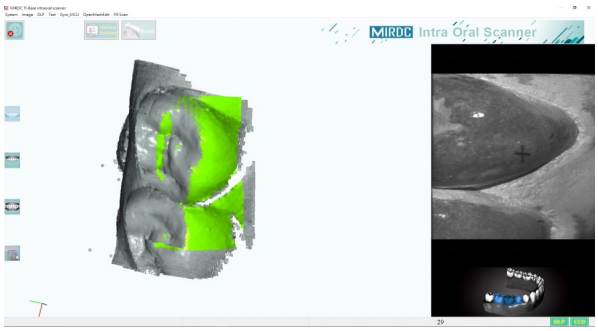
- A new generation of advanced technology capability in 3D intra-oral scanning system is established to meet the needs of clinicians in digital dental clinics, and a friendly interface for medical record order management is also indigenously developed to provide users with simple operation methods and establish the reliability of the software system.
- The system modules include TI DLP miniature projection module, thin high-speed CMOS modules, high-quality CMOS imaging lens group, and embedded computation modules.
- The intra-oral scanning program platform was completed using the analysis method of hybrid structure light. The single-direction scanning accuracy of intra-oral scanning system can achieve ≤± 20 um.



Intra Oral Scanner (IOS) Order Management GUI



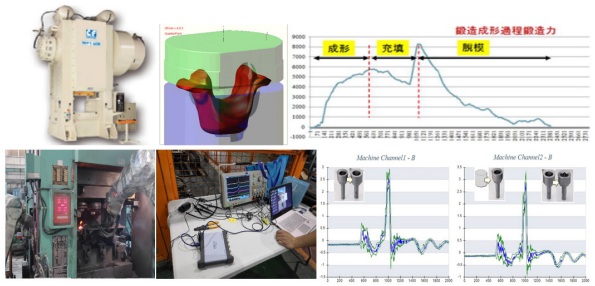
Intra Oral Scanner (IOS) Order Job Creation



IOS Scanner Frame

7.Monitoring technology of forging forming process

- In the face of industry's labor shortage and the smart manufacturing trend, this project could help industry to build a sensing and monitoring technology for the forging process to improve the current sampling method.
- MIRDC assisted industry to develop sensing and monitoring modules for forging process, allowing the forging quality of each forging piece to be monitored in real time and avoiding the situation of mixing parts.
- The forging process sensing enhanced the manufacturing technology of the industry and enabled control of the quality of forgings through the actual signal data, subsequently enhancing customer trust and business opportunities.

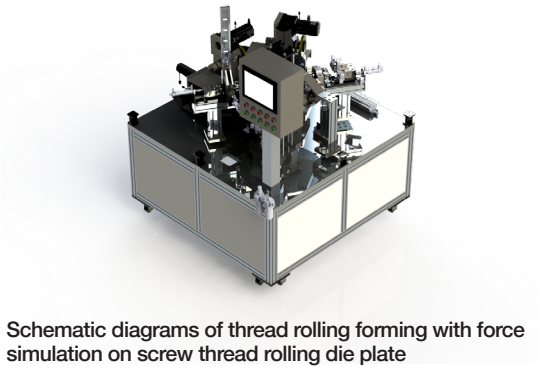


The schematic of forming process monitoring

R & D Technologies in the Future

1.Photoelectric probe intelligent machining and quality inspection system integration

- An integration solution for intelligent machining and quality inspection system of semiconductor alloy probe parts will be developed to facilitate the semiconductor probe parts automated manufacturing industry to upgrade to the smart manufacturing level.
- Development of an integration solution for intelligent machining and quality inspection system of parts with the ability of automated machining, online inspection and data visualization capability is being planned.
- Based on the smart manufacturing technology, the integration solution for intelligent machining and quality inspection system of probe parts could support the industry to establish high-quality product production regulation and quality control capability.

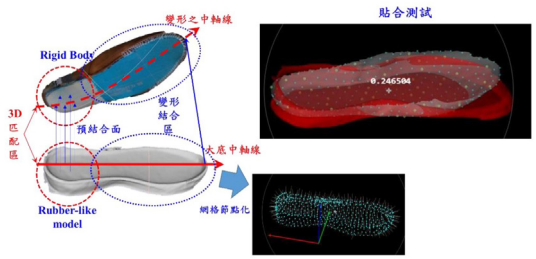


Schematic diagrams of thread rolling forming with force simulation on screw thread rolling die plate

3.Intelligent robot and manufacturing application by using an AI system

Soft material manufacturing technique by using robot technique - the virtual lamination technique, for shoe upper

- The technique involved calculation of the material deformation using virtual 3D shoes' upper and sole for the processing boundary of the upper.
- The technique will raise the efficiency of manufacturing process by at least 30%.

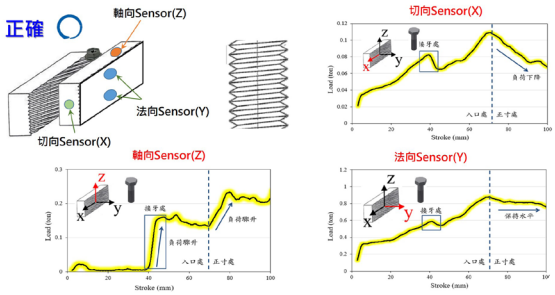


The virtual lamination of shoes' upper and sole

The cyber-physical model

2. Mold-adjusting technique for threading machine

- A mold-adjusting technique for threading machine will be developed through optical inspection and force measurement methods. This technique will help the operators to quickly guide the mold-adjusting process.
- The mold-adjusting technique for threading machine will increase the adjusting efficiency by at least 20%.
- This technique will decrease the operator training time by at least 30%.



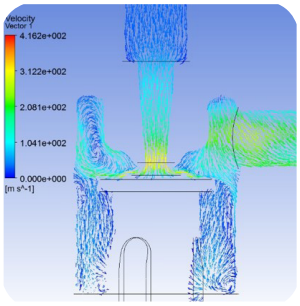
Schematic diagrams of thread rolling forming with force simulation on screw thread rolling die plate

4.Integration of industry technologies

MIRDC will develop key technologies for proportional valve

- In linking industries to apply the software and hardware of the CAE cloud services center platform, MIRDC will assist with the structural modeling of electronically controlled proportional valve and analysis of magnetic and flowing field to fill the technological gaps and shorten research schedules (keeping pace with the world)
- MIRDC will establish a certification and field test
- MIRDC will establish a platform for product leakage and reliability certification testing platform (keep pace with the world)
- MIRDC will introduce electrical device certification/ demonstration to display actual results and shorten the market acceptance period (to become the domestic leader)

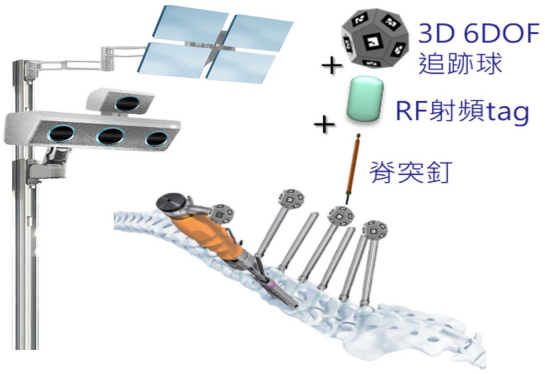
To establish standards for product leakage and reliability certification



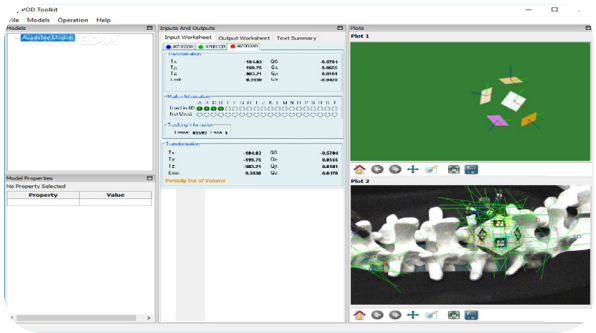
For linking industries to apply the CAE cloud services center platform

5.Optical surface positioning technology and software engineering

- In response to the needs of clinical orthopedic surgery, the development of key technologies for intelligent orthopedic surgery assistance systems will aim to establish an indigenous and integrated optical composite positioning system for domestic medical positioning system owners to replace the Canadian NDI system and increase the market share of autonomous positioning systems.
- MIRDC will establish 3D point cloud stereo vision positioning technology, including: (1) the real-time image positioning system GUI and 6DOF attitude algorithm for space mark blind spot attitude detection module, which imports the main and sub-mark real-time recognition algorithms, and uses four curved sub-marks on space surface with the detection technology to calculate the attitude space coordinates of the main target in real time, to achieve pre-alignment processing; (2) the 3D point cloud scanning and segmentation module, the embedded point cloud pre-processing module and the attitude conversion module, which will integrate MIRDC's indigenously developed 6DOF non-blind spot attitude calculation to finally achieve a positioning accuracy of RMS ≤ 1 mm.



3D 6DOF system



GUI (Real-time image positioning GUI)

6.Forging process sensing and modeling application

- Facing the global smart manufacturing trend, the project will assist the industry in the modeling and application of forging process sensing data, and improve the current manual judgment.
- MIRDC will install sensors in the process equipment for sensing the forming force status, and recognizing forming quality at the same time.
- MIRDC will integrate forging sensing and modeling technology, and establish a forging process failure model to improve production efficiency.

Inspection Technology

To ensure that product contents and specifications of domestic enterprises meet the standards, MIRDC has set itself the goal of developing the core inspection technology that offers AI intelligent inspection and high value-added development. In order to gradually facilitate the transition of metal industries to high value-added industries, the Centre provides services of various items related to product safety and manufacturing capacity, including the standards, testing, inspection, calibration, verification, etc.

In 2019, this team focuses on technical researches and development of inspection technologies in five major categories: medical and surgical assistive devices, the plumbing industry certification, industrial valve inspection and certification, offshore wind farm project certification and project certificate review as well as Homi appliances inspection technology, so as to improve quality, processing, management efficiency, product yield rate and the result of process quality indicators.

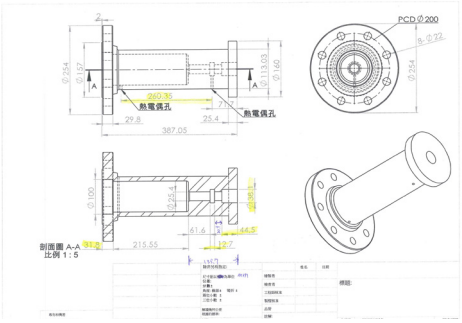
In the future, MIRDC's inspection technology will continue to establish the development of domestic machinery and equipment, intelligent technology, as well as assist the completeness of reviewing and certification mechanism for product qualification documents. Besides, the team will also help enterprises apply for professional certification abroad to enhance the international competitiveness, and open up business opportunities for Taiwan's industries and to build MIT's reputation.

Current R & D Status

1.Industrial valves inspection and certification technology

- In response to domestic industrial product design certification requirements , MIRDC establishes the design certification technology for valves and pipe fittings.
- MIRDC develops API 622 packing dissipation measuring technology to improve valve stem packing design, the low emission design decreases to 100ppmv.
- The newly developed test measurement method will increase the product certification efficiency by more than 35%.
- The new packing emission measuring equipment can also be applied to other ball valve products in the future, which is expected to facilitate product quality improvement by more than 10%.

Packing dissipation measuring equipment

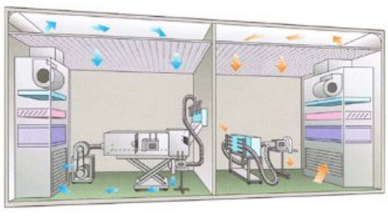


Packing dissipation measuring equipment - packing box module

2.Homi appliances integrated inspection technology– air conditioning

- In response to regulatory standards, industrial demand and industrial policy promotion, MIRDC establishes an air-conditioning testing laboratory. In addition to acting as a third-party certification unit, MIRDC can also assist manufacturers in improving their process and design and analyzing product data records.
- Linking with the MIRDC's electrical safety laboratory, electromagnetic compatibility laboratory, and motor testing laboratory enhances and expands the testing technology and services, including product energy efficiency, component capacity testing, temperature rise, durability, voltage resistance, structural safety, electromagnetic interference and other test verification.
- Corresponding to product regulations, the air-conditioning testing operations and evaluation precautions are elaborated from the accuracy requirements of measuring instruments, calibration requirements of measuring instruments, test conditions, test operating procedures, test results and other items.

Indoor environment testing room



Outdoor environment testing room

3.Homi appliances integrated inspection technology - electronic toilet

- In response to regulatory standards, industrial demand and industrial policy promotion, MIRDC establishes a unified service information platform, which includes standard technologies for home appliances, 3C products, air-conditioning, and toilet products.
- The built-up capability of the testing technical services includes product certification against electric shock protection, temperature rise, durability, power consumption, structural strength, leakage current and voltage withstand test, constant temperature and humidity, uniform force in the vertical direction of the toilet, vertical average force of the cushion, heating cushion, heat and flame resistance and corrosion resistance.
- Through a unified information platform, MIRDC provides domestic industry with detailed standards, testing, inspection, calibration, verification and other related services to assist domestic businesses to meet various certification standards such as product safety. Ultimately, it will enable domestic manufacturers to speed up the market launching cycle of product, enhance industrial competitiveness and build international reputation of MIT products.

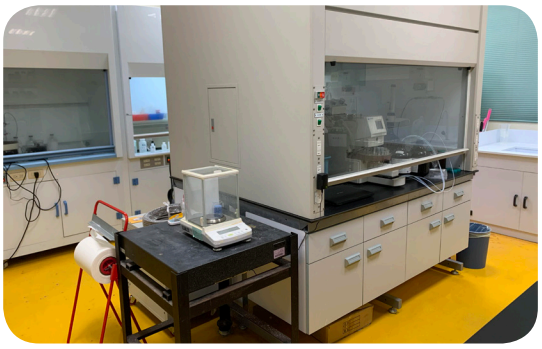
Bidet toilet testing

4.The testing module establishment and technical R&D for AS 4020 drinking water plumbing product

- According to AS4020 from Australia, this project will establish the drinking water plumbing testing module and technical R&D, the system capabilities include:

  (1)Environment temperature: 20 ± 2℃

  (2)Resistance of DI water: 18 .2 MΩ · cm
- Every drinking water plumbing product can go through this system for exportation to Australia and New Zealand in the future.
- This system can increase 1~2% of Taiwan water plumbing industrial export value in Australia and New Zealand export markets.



Laboratory Pretreatment Area

5.Offshore wind farm project certification and project certificate review

- Offshore wind energy is proactively developed in Taiwan. In addition to the construction of wind farms and industrial development, it is urgent to establish a domestic testing and certification system. In 2019, MIRDC continued to assist the BSMI to develop 3rd party certification systems, including:

  1.Held the DNV GL offshore wind farm project certification (PC) technique training and consultation, including 17 training sessions of 8 PC modules, and 15 real-case training sessions for 3 working groups. The participating units include MIRDC and 3 domestic professional non-profit organizations.

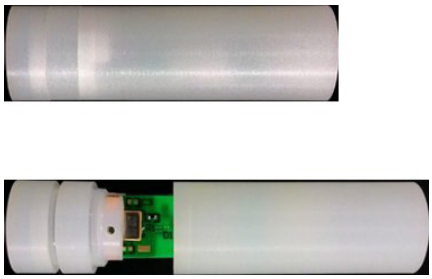
  2.MIRDC entrusted NTUT to execute the “Research on offshore wind turbine structure-foundation-soil interaction analysis and talent development”; NCU was commissioned to execute the “Research on offshore wind farm wind conditions, ocean parameters and load analysis technology”; and NCREE was entrusted to carry out the "Research on-site response and basis earthquake analysis". Through academic and professional research units and the educational system, offshore wind farm PC capabilities are strengthened, and the effect of talent development is achieved, respectively.

  3.Quality system documents and technical documents of the certification body has been established and applied for TAF accreditation; 12 modules of certification scheme have been submitted and 5 certification scheme review meetings have been performed.

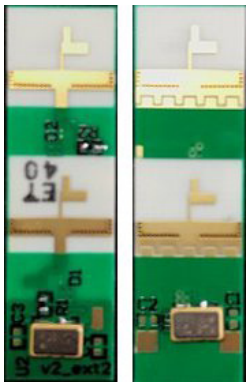
  4.Help has been provided to BSMI to establish a domestic PC review system with reference to the approaches of Germany’s and Denmark’s systems. It also accepts applications from developers, reviews PC technical documents, holds technical meetings, and issues review reports and recommendation reports.

6.Radio Frequency Positioning System

The development of a radio frequency positioning system in 2019 consisted of the miniaturization of tag circuitry, housing of tag and radar transceiver, 6-ID RF positioning, safety regulation pretest and animal experiment. The dimension of minimized tag circuitry on which 2 antennae reside is 35×10 mm (circuitry area of 1 antenna is reduced by 37.5%). The housing dimensions of tag and radar transceiver are15×50 mm and 160×160×40 mm, respectively. The precision of 6-ID RF positioning is 0.07 mm and the accuracy is 1.75 mm (tested on tag displacement of 20 mm).



Housing of positioning tag



Micro-RF circuit of positioning tag

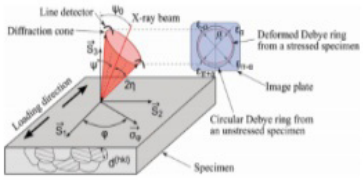
7.Development of High Temperature Resistant Cavity Pressure Sensors for Die-casting Process

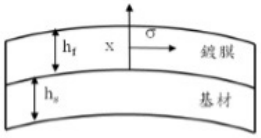
Currently, the die casting industry has to overcome the insufficiency of yield rate as it cannot grasp the changes of process parameters and environmental parameters. As such, MIRDC developed the high temperature resistant cavity pressure sensors. By measuring the pressure within the die, MIRDC could provide the key factor to judge the quality of die-casting.

pressure sensing prototype

8.An Approach to Measuring the Residual Stress of Curved Surface by Using a Portable X-ray System

Improve the problem that the current process cannot immediately discriminate residual stress and surface morphology caused by stress quantization distortion. Increase production efficiency by controlling surface treatment quality standards, and provide effective data to assist parameter optimization and process improvement. This technology combines a portable X-ray diffraction residual stress device with a curved residual stress treatment formula to establish a set of non-destructive residual stress detection and verification methods suitable for curved coatings on portable devices. The minimum measurement radius of curvature is 1.5 mm, and the residual stress repeatability error is less than ±4%.



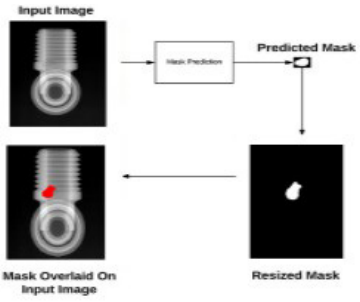


$$\sigma = E_f[(\varepsilon_0 + \varepsilon) + (x - t_n)k]$$

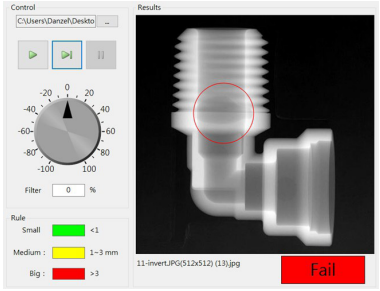
Curved surface residual stress analysis diagram

9.Intelligent identification technology applied in internal defect detection

In response to the AI intelligent detection and high value development of rubber and plastic products, the requirement for comprehensive and automated inspection of internal defect has increased. Thus, CT will be combined with AI discriminant application. With the collection of real-time digital images to form big data, in combination with the AI auto defect detection technology, it is estimated that the AI module discriminant rate will be ≥ 85%, with reaction time ≤ 10 s, which can improve the detection efficiency by 50%.



Defect marking of CT imaging

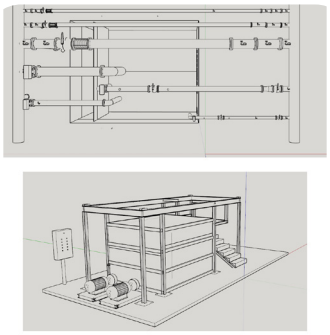


Identification module

R & D Technologies in the Future

1.Industrial valves inspection and certification technology

- In response to the design certification requirements for the domestic valve industry, the development of CV measurement technology for control valve products will be established.
- The developed CV measurement technology for ISA 75.02 control valve can enhance the design of control valve products, and provide certification control product structure design. The volume flow rate (gallons per minute) when the pressure difference between the two ends is 1 psi.
- It is expected that the newly developed test measurement method can improve the efficiency of product performance certification by more than 35%.
- The new CV measurement equipment can also be applied to other pipeline fluid control products in the future, which is expected to improve the product quality by more than 15%.



Planning of CV measuring equipment

Development of control valve product

2.Motor detection technology for air-conditioning

- In response to the trend of energy-saving and high-efficiency motor systems of international electrical products, MIRDC aims to establish and improve the product system efficiency detection technology and certification capability in the future, and assist domestic industry manufacturers to cooperate with academia to create a mutually beneficial relationship between industry and academia to facilitate industrial development and enhance competitiveness.
- The test data from each development stage will be fed back to the product development end to help analyze the cause and improvement, and get rid of the trial & error loop.
- Integration of various laboratories to provide product certification requirements, and offer assistance in obtaining certification and labeling.
- Assist domestic manufacturers to record and collect product adaptation processes, establish databases and experience to reduce subsequent similar machine development time
- Assist domestic manufacturers in obtaining product-related certifications and labels, and increase product value by 10-15% through brand effects.
- Assist domestic manufacturers to obtain product-related certifications to reduce the difficulty of entering the market, the difficulty of obtaining bids, and the overall product certification schedule, which can increase revenue by NT$1 billion each year, and promote investment to drive the overall industrial benefits of NT$4.5 billion per year.

Motor detection technology for air-conditioning

3.Development of fast sieve test for extraction testing of NSF 61-9 in the United States

- Provide domestic vendors with a quick overview of product quality during the development stage, and shorten the time from development to certification.
- The MDLs of 14 elements can reach below 1ppb.

Inductively coupled plasma mass spectrometry

4.Offshore wind farm management system and critical component testing and certification capability

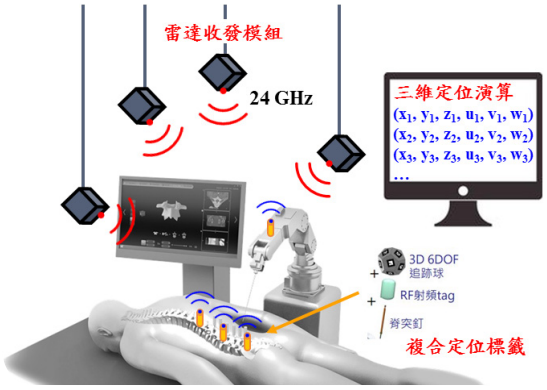
1.Establish certification of offshore wind farms life cycle and assist in establishing management system.

2.Develop testing and certification technology for offshore wind farm from operation and maintenance to decommissioning.

3.Expand the testing and certification of critical components of offshore wind energy.

5.Radio frequency positioning module technology

The future research consists of: (1) Multiple targets positioning (10 ID) for determining the position and orientation of affected parts and tools. (2) Composite positioning that incorporates optical and RF positioning to fulfill the clinical need of surgical navigation. (3) Host development that integrates power modules, hardware circuitry, housing mechanism and software API interface.



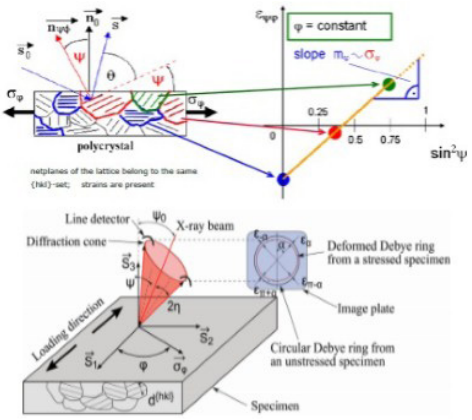
RF positioning module of medical positioning system

6.Development of High Temperature Resistant Cavity Pressure Hybrid Sensors for Die-casting Process

Currently, the die casting industry has to overcome the insufficiency of yield rate as it cannot grasp the changes of process parameters and environmental parameters. As such, MIRDC developed the high temperature resistant cavity pressure sensors. By measuring the pressure within the die, MIRDC could provide the key factor to judge the quality of die-casting.

7.Residual stress detection and process technology

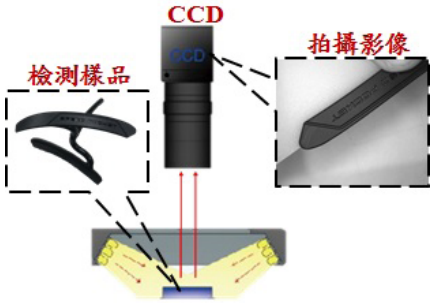
In response to the growing demands for the casting and forging industries, MIRDC develops residual stress detection technology and process to be used as factor analysis factors for abnormal characteristics. For large castings and forging products applied with the expected measurement technology can perform surface stress measurement and process parameter linking to establish quality analysis targets and process quality indicators. Residual stress measurement can also be applied to automotive and aerospace products in the future. It can develop technologies such as quality and process improvement.



Residual stress analysis diagram

8.Smart identification technology applied in external defect detection

In response to the AI intelligent detection and high-value development of rubber and plastic products as well as the increasing requirement of comprehensive and automated external inspection. MIRDC will combine with AI discriminant application of reverse engineering technology and real-time digital image collection to form big data. The AI module discriminant rate is estimated to be 90% and the reaction time is ≤10s, which can improve the detection efficiency.



External defect and intelligent image recognition diagram

Food (Biotechnology) Equipment Technology

In response to the market demand for the production of powder raw materials in industries of nutrition and health food, and cosmetics, as well as recently in the field of food (biotechnology) equipment technology, the first supercritical fluid micro powder generation equipment that applies the CPF process has been manufactured in Taiwan. The technical difficulty of powder generation of high-viscosity extract and readily oxidizable substance is solved with improved micro powder generating technology, which adds another option, powder generating technology, for the industry.

In addition, sodium alginate has been more widely used in food manufacturing for the purpose of coating functional ingredients into spherical food granules to preserve the food and create new taste. Therefore, this team has also started to develop a sodium alginate microsphere forming process and related equipment and technology, including the development of rotary-cutting & granulating and plunger-propulsion granulating equipment, to provide domestic enterprises with powdered food granulation technologies.

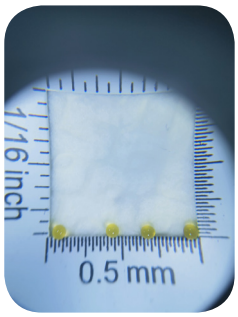
In addition to achieving the goal of equipment localization and reducing the dependence on imported equipment, the Centre will further develop the basic formulas and technologies, in seeking to fill the gap in industrial technology, and support the innovation of trendy industries, such as health food and cosmetics.

Current R & D Status

1. Sodium alginate microspheres forming process and equipment technology

- In response to the demand for granulation of functional ingredients of vegetarian gel, MIRDC developed the sodium alginate microspheres forming technology
- With high human compatibility, suitable capsulation of water & oil-soluble ingredients, sodium alginate microspheres are an important functional food technology that needs the support of domestic process and equipment.
- Currently, available sizes range from 1.5 to 12 mm to meet the needs of food granulation manufacturing.
- It can be applied to biotechnology and food manufacturing industries to solve the dilemma of no corresponding domestic equipment.

Microsphere-sized particles



1.5 mm carrot microspheres

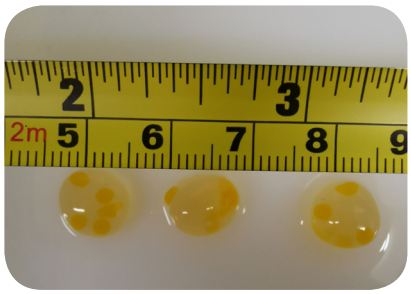
2. Powder Generation by Supercritical Fluid Spray Processes

- Functional raw materials and spices are mainly imported in Taiwan. Powder generation by supercritical fluid spray processes can fill the gap in the upstream industry. This technology can be applied to spray high viscosity extracts. The technology also has the advantage of a low temperature process to prevent oxidation.
- Modified starch is used to embed oil-soluble functional substances, and the particle size of the finished powder can be controlled within 50 to 500 μm. The embedding rate of oil-soluble functional ingredients is over 30.0%.
- The Supercritical fluid (SCF) powder products can be applied to health food and cosmetics.

R & D Technologies in the Future

1. Sodium alginate microspheres forming process and equipment technology

- MIRDC continues the development of sodium alginate microspheres forming technology, other heterogeneous particles are added to the microspheres to capsulate various functional components.
- As a new type of food granules, excluding the controllable particle size range, water & oil-soluble substances can be capsulated in addition to multiple functional ingredients.
- In addition to the capsulation of functional ingredients, the food's visual packaging and chewing taste can create topics of discussion; and the development of new forms of food particles can lead the trend.



Heterogeneous capsulation micro beads

2. Powder Generation by Supercritical Fluid Spray Processes

- The high temperature requirement of the traditional manufacturing process can easily destroy the active ingredients in the product. Powder generation by supercritical fluid spray processes can fill the gap in the industry.
- Powder generation by supercritical fluid spray processes replaces the traditional fluidized bed process to minimize the destruction of active ingredients caused by the heating process.
- The Supercritical fluid (SCF) powder products can be applied to the development of nutrition and health products.

Optoelectronic System Technology

The developed opto-electronic technology in 2019 included three key items. First one was the development of key coating process equipment for the highly effective solar cells; MIRDC developed the ultra-highly frequency vacuum coating equipment for TOPCon solar cells with the target efficiency over 23%. Second one was the composite microwave thermal curing system; the indigenous R&D of composite microwave curing equipment saves up to 50% of processing time. The final one was the non-contact RF inspection technology for metal thin-film thickness. The application of high-frequency electromagnetic sensing technology by non-contact rapid measurement of metal surface characteristics and defects can increase the detection resolution up to 10μm.

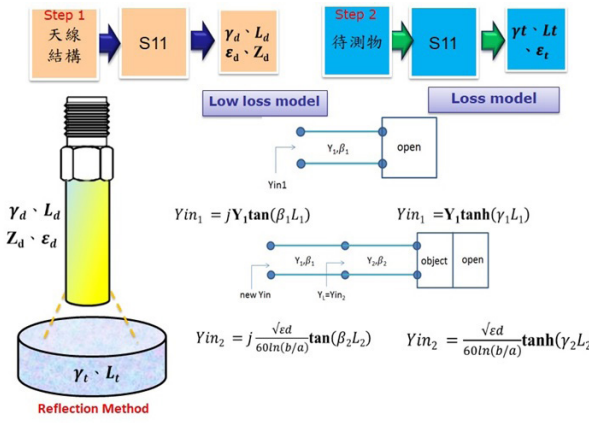
Current R & D Status

1. Composite microwave thermal curing system

- The usage of the composite microwave thermal curing system in the drying process of coating wet films will have the specific functions of rapid solvent removal and rapidly curing, which can effectively resolve the problems of the traditional baking process time and equipment space. The process time could save up to 50%.
- Hybrid microwave thermal curing technology can quickly do heating applied on the coatings or events with partial microwave absorption or non-microwave absorption. The technologies can be used not only in the spraying industry, but with heating and drying processes involving materials such as sludge, textiles, plastics, food, and paper products can also be effectively applied and promoted.
- The current commercially available microwave equipment was only controlled by the absorbent by the amount of microwave energy to achieve the target temperature. If the target is not a microwave-absorbing material, the situation of heat curing cannot be achieved. This research and development technology can perform and keep constant temperature treatment regardless of whether the processed target has microwave absorptivity or not, so it can be applied on the wide range of applications. This composite microwave application technology can greatly be promoted the energy reuse efficiency and resolve the high energy consumption problem during the traditional hot wind method and infrared heating.

2. Development of non-contact RF detecting technology for metal thickness

- In response to the requirement of non-contact micrometer level inspection of thickness measurement on metal and heat treatment test, MIRDC developed the RF antenna and circuit modules.
- MIRDC expected that this RF technique could be used on fastener industry to define the metal material properties (e.g. PCB, fastener) of heat-treated components and carburizing depth of products. It's frequency range is about10~12MHz, gain power range is about 0-100dB.
- The RF inspection technique could be integrated to an in-line quality measurement system to retrieve real-time information, such as surface property and carburizing depth resolution (10 -120μm).
- This detecting technology will improve the yield rate of the fastener, iron and steel industries, as well as the automotive parts industry in the future.

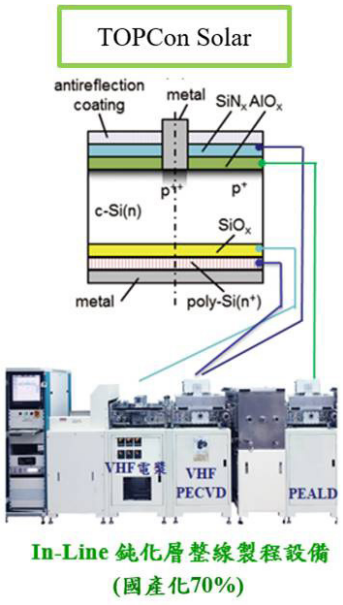


Development of non-contact RF detecting technology

R & D Technologies in the Future

1. Development of key coating process equipment for passivated solar cell

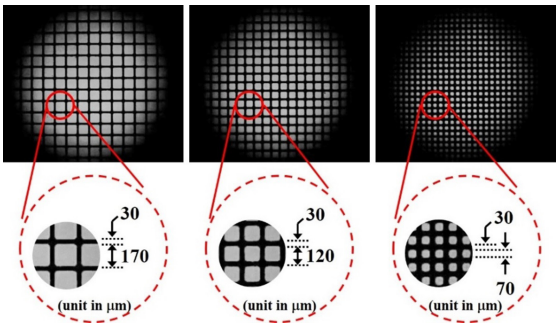
- To become a pioneer in domestic research on plasma-assisted chemical deposition, the high plating rate atomic layer deposition (PEALD) and VHF plasma deposition equipment used for TOPCon solar cell passivation and tunnel oxidation process equipment, MIRDC achieved the goal of indigenous research and development. The goal of the equipment system is to solve the high development cost caused by the industry's sole purchase of foreign equipment.
- MIRDC will overcome foreign patent deployment of high-efficiency passivation type silicon solar cells, and achieve full localization of key process equipment.
- MIRDC will complete the local content rate of ALD/PECVD/plasma deposition equipment at 70%, and establish the solar photovoltaic equipment industrial chain.
- MIRDC will complete the integration of ALD/PECVD/Plasma Deposition complete line equipment. The selling price is 40% that of foreign equipment, improving international competitiveness.



Development of passivated cell key coating process equipment

2. Development of 5G transparent micromesh structure antenna device

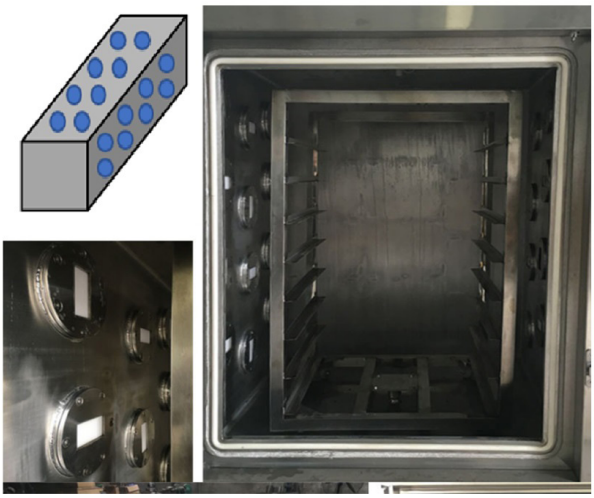
- In response to the 5G communication industry demands (self-driving cars, Next-gen networks), MIRDC will develop transparent 5G antennae.
- The central frequency of the new transparent antenna is at the high-band level of 5G with high return losses.
- The operating bandwidths of the new 5G transparent antenna will be expected to improve from kHz to MHz.
- The 5G high-band frequency has attracted a lot of attention due to multi-gigabit communication services including high definition multimedia interface, uncompressed high definition video streaming, high-speed internet, wireless gigabit Ethernet, and close-range automotive radar sensor.



Development of 5G transparent micromesh antenna elements

3. Vacuum microwave drying equipment technology for rapid fruit production

- This technology solves the problem of imbalance in production and sales of domestic pineapple and other fruits in real time. Through the combination of vacuum and microwave equipment technology, MIRDC aims to develop vacuum microwave drying equipment with fast fruit production efficiency, and conduct practical certification tests through academic cooperation to ensure the development of equipment efficiency.
- This equipment development technology uses the unique penetrating heating characteristics of microwave and the low-temperature evaporation environment by vacuum to establish a fast, energy-saving, safe and stable drying process, thereby solving the current problems of low production rate, long processing time and high energy costs.
- The development technology can be used in the drying processes of various agricultural products and has a wide range of uses. In the future, MIRDC can combine farmers, public associations, dry fruit manufacturers and equipment manufacturers to conduct practical fruit production certification and sales promotion, and apply the research and development results to the industry, thereby improving the added value of Taiwan 's agricultural products, and solving the dilemma of imbalanced fruit production and sales and the inability to extend storage time.



Vacuum microwave fruit drying equipment

Medical Devices and Healthcare Technology

It is estimated that one sixth of the world's population will be over 65 years old by 2050. As average life expectancy increases, medical devices and healthcare technology are also in increasingly urgent demand. This Centre has developed an immediate dental implant and surgical planning system, artificial intelligence nerve ultrasound imaging identification technology, multiple spine sections imaging navigation technique, as well as a number of degradable, anti-adhesion and hypoallergenic medical materials, and is committed to the development of high-end products and technologies.

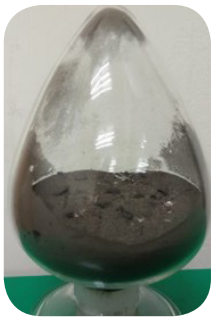
The key projects of this team in 2019 are the development and process research of magnesium-based bio-ceramics which solves the shortcomings of traditional magnesium alloy materials, the development of new ternary high-entropy magnesium alloy, and the application of the mixed entropy value of alloy to control the degradation rate, which unlocks the potential for the application of related medical materials.

In the future, the Centre will launch the development plan of medical magnesium alloy technology that controls the degradation rate and its application. The goal is to adjust the degradation rate of medical magnesium alloy powder according to different indications, and expand the application range of the product to make different powder and metal materials of bone nails, so as to improve the quality of medical service.

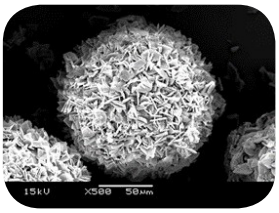
Current R & D Status

1. Development and Process Research of Magnesium-based Bioceramics

- The magnesium alloy composition (Mg-1.8%Zn-0.8%Ca) of the previous study (FY107) for surgical clips has several limitations in other medical applications. Therefore, a high entropy magnesium alloy powder, Mg-27%Zn-5%Ca, is introduced for metal forming and has successfully extended the application of magnesium alloy.
- The degradation rate of the high entropy Mg-Zn-Ca alloy powder can be well controlled with the entropy of mixing value.
- The magnesium alloy is difficult to process due to the high activity and vapor pressure. Therefore, a patented and new designed furnace can significantly improve atomization ability and yield productivity in the future.
- This project focuses on the magnesium alloy metal injection molding (MIM) process that is an internationally leading technology of the metal forming process in magnesium alloy screw manufacturing. First, a reliable composition, mold, and MIM parameters could be determined in 2019. The next step would be to look for a suitable binder and sintering parameters. In general, the aim is to put into effect the promising magnesium alloy forming technology and transfer this technology to other applications to create even more industrial value.



Magnesium alloy metal powder



Micro magnesium alloy metal powder

R & D Technologies in the Future

2. The development of degradation-controlled magnesium alloy for medical application

The development of degradation-controlled magnesium alloy for medical application

- A series of degradation-controlled magnesium alloy systems can be applied for different indications.
- The development of mini bone screw will save the need for a second surgery, reduce the risk from second anesthesia, and save medical resources.

The development of degradation-controlled magnesium alloy powder for medical application: powder size 10 μm-50 μm; D_{50}=20-30 μm; composition Mg-27Zn-5Ca

- Surface treatment for magnesium alloy powder: DCPD/Mg powder; layer of DCPD: 10 nm to 2 μm; powder shape: spherical; roundness: >0.6
- The development of mini bone screw via MIM: MIM technology; cortex screw pitch: 0.30 to 1.50 mm; cancellous screw pitch: 0.50 to 2.00 mm; channel depth: 0.10 to 2.00 mm; surface roughness Ra: 0.5 to 6.0 μm; degradation rate; 0.5 to 1mm/y; yield strength >120 MPa; Elongation: >10%
- To pass the biocompatibility test ISO-10993 (3 items); the validity of preclinical animal experiments; and prepare essential documents for the Institutional Review Board (IRB)

Magnesium alloy bone nail

Degradable magnesium alloy implant

Degradable magnesium alloy implant and surgical devices

Green Energy Technology

In 2019, in the field of green energy technology, MIRDC continued to adopt the energy efficiency and conservation policy promoted by the government in recent years. There are two research directions: energy-efficient pump technology and wind energy technology.

In terms of pump technology projects, the Centre continuously assists major domestic pump manufacturers in developing and testing of high-efficiency and energy-efficient pumps, became a third-party pump testing platform designated by international large manufacturers in 2019. In the future, MIRDC's targets are to focus on research and development in the following fields: digital/intelligent fluid energy control technology, development of small hydropower generation and industrialization technology, establishment of fast digital design analysis for pumps and dynamic electromagnetic design analysis, and on-line measurement technology for pump systems.

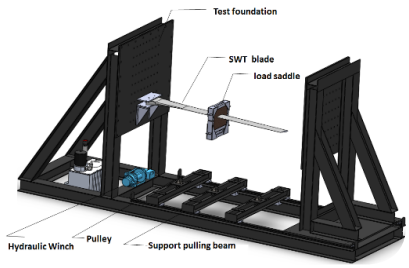
In terms of wind energy projects, the Centre assisted the Industrial Development Bureau (IDB) in convening the "Offshore Wind Energy Industry Relevance Review Meeting" to examine 6 developers and 10 wind farms, and to implement localizing development of offshore wind energy industry. In addition, MIRDC worked with BSMI to complete the establishment of small wind turbine blade testing laboratories to assist domestic manufacturers in performing 30kW small and medium-sized wind turbine testing.

In the future, based on IDB's "Upgrading and Transformation Promotion Plan for Offshore Wind Energy and Solar Photovoltaic Industry," the Centre will build local supply chains, develop structural inspection ,repair, operation and maintenance technology for offshore wind farms, and carry out international cooperation on third-party certification capabilities with DNV-GL from Norway and other certification organizations.

Current R & D Status

1. Testing Technology of small and medium-sized wind turbine blades

- Complete the establishment of small wind turbine blade testing laboratory and static tensile and dynamic fatigue testing mechanism, as well as sample testing and certification functions. Laboratory specifications:
  - ◎ Test load: 60L hydraulic capacity of hydraulic pressure system.
  - ◎ Maximum load of force application is 25 KN.
  - ◎ Test cycle >10^6 times.
  - ◎ Measurable blade length: 1.5 – 8 m.
- Future development of biaxial fatigue testing and digital modeling technology for blade damage



Testing laboratory of small and medium-sized wind turbine blades

2. Testing Technology for small and medium-sized models of wind turbine

- Carry out testing of horizontal axis wind turbines for Ark Green Energy Technology Inc. (30kW), Kai-Yue Technology Co. Ltd. (30 kW) and Fei Yue Technology Co. Ltd. (10 kW), and testing of vertical axis wind turbine models for China Guodian Corporation (20 kW).
- Assist Taiwan Vertical Axis Wind Turbine Co. Ltd. in the development, research and testing of 500W vertical axis wind turbines.
- Complete the testing of 30 kW horizontal axis wind turbine for Ark Green Energy according to CNS 15176-2 standard.
- Update the certification of the new ISO 17025 for laboratory management system.

Overview of Qi Gu Test Site

Assist the development of 500W vertical axis wind turbines

3. Achievements of offshore wind turbine localization promotion

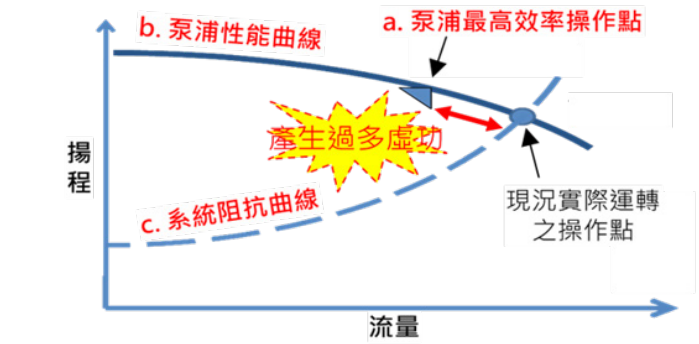
- In 2019, 8 sessions of "Offshore Wind Energy Industry Relevance Review Meeting" were held to examine 6 developers and 10 wind farms. Localization projects including underwater foundation, towers, power facilities and wind turbine components were reviewed. The results of the project are as follows:
  - ◎ 22 local supply chains of underwater foundation and 15 supply chains of offshore wind turbine components were established.
  - ◎ Underwater Foundation Production Base at the Port of Taipei: CWP (CT) invested NTD 5 billion to set up a single-pile and jacket underwater foundation production plant.
  - ◎ Offshore Wind Power Industrial Zone in the Port of Taichung: Global wind turbine system developers and operators set up nacelle assembly plants, and more than 15 local operators are expected to enter the global supply chain.
  - ◎ Underwater Foundation Production Base at Xing-Da Port: SDMS (CSC) invested NTD 6.8 billion to set up a jacket underwater foundation manufacturing plant.
- Assisting DVS_SLV, TWS and TWIA, MIRDC jointly organized the IWE training session from March 18th to April 29th, 2019. Domestic offshore wind power underwater foundation operators, including SDMS, CSBC, WANCHI, Tai-Shing and FEMCO, sent personnel to attend the training, and a total of 11 persons obtained the Certificate.

IWE Certificate-awarding Ceremony

4. High efficiency pump energy efficiency test & pump energy efficiency certification technology

- MIRDC has ISO9906 first-class pump energy efficiency test laboratory in domestic, a third party pump test platform designated by international leading manufacturers.
- Flow field optimization techniques.
- Construction tutoring technology of ISO certified test laboratory.
- Energy consumption diagnosis and analysis technique of the system field.

Third party pump test platform designated by international leading manufacturers - pump energy efficiency test laboratory



Examples of energy consumption diagnosis and analysis of the system site

5. Development of key process equipment for high efficiency solar cell

- The two most critical self-developed process equipment are ALD equipment and high-frequency plasma technology vacuum coating system. The passivated layer technology corresponding to PERX solar cell contains equipment of Al2O3 processing technology; the equipment is developed by local industries. With the process control and equipment rectification capabilities, the technology was transferred to relevant industries to enhance the technological leadership of high-efficiency solar cells and maintain their competitive advantage.
- BY using N-PERT TOPCon technology, or the tunneling oxidation passivation to solve the ageing problem, the TOPCon technology has achieved component efficiency of more than 23%.

R & D Technologies in the Future

1. Establishment of third-party certification technology for offshore wind power

- Participation in the establishment of the third-party renewable energy testing and certification capability training program organized by BSMI, and technology transfer with DNVGL.
- In the future, MIRDC will participate in the certification and review of offshore wind farm projects from 2020 to 2025.

2. Industrialization of offshore wind power generation technology

- Promote industrial upgrading and transformation, build up local upstream, midstream and downstream supply chains, and strengthen industrial innovation and development system. The key points of R&D in 2020 include:
  - ◎ Intelligent process technology upgrading for the manufacturing of marine mechanical structural steel components.
  - ◎ Focus on development of wind turbine components/related subsystem products to tutoring manufacturer build up maintenance capacity.
  - ◎ Establishment of intelligent technology of offshore wind turbine components / related peripheral equipment.
  - ◎ Assist domestic wind turbine component operators in upgrading manufacturing technology and testing and certification capability, so as to enter the supply chain of international wind turbine system suppliers.

3. Offshore wind farm operation and maintenance technology

- To meet the future 20 years of maintenance demand for offshore wind farm built during 2020 to 2025, automatic and human-machine interface are developed to assist O&M personnel to inspect and monitor wind farms and increase the inspection efficiency of annual or non-schedule inspection.
- Automatic ultrasonic welding bead inspection mechanism, underwater electrochemical corrosion protection monitoring, and wearable O&M personnel auxiliary device are developed.

Ultrasonic test of circular welding run of a self-guided machinery

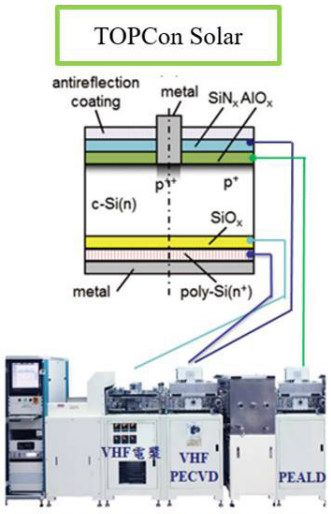
Maintenance personnel's wearable auxiliary device

4. Digital/intelligent fluid energy control technology

- To fulfill the requirements of MEPS, it is urgent to improve the energy efficiency of products in order to meet the domestic and foreign market demands.
- Product performance and service life need to be improved because the conditions of application environment and fluid characteristics have become more stringent (high corrosion resistance/long-lasting product).
- The market is shifting towards multifunctional applications, the volume of products has increased and the structure has become more complicated, which makes it difficult to produce in the traditional manufacturing process.

5. Development of key coating process equipment for passivated solar cel

- Becoming a pioneer in domestic research on plasma-assisted chemical deposition, high plating rate atomic layer deposition (PEALD) and VHF plasma deposition equipment for TOPCon solar cell passivation and tunnel oxidation process equipment will achieve the key to indigenous research and development. The goal of the equipment system is to solve the high development cost caused by the industry's purchase only of foreign equipment.
- MIRDC will break through the foreign patent deployment of high-efficiency passivation type silicon solar cells, and achieve full local production of key process equipment.
- The Centre will achieve the local content rate of ALD/PECVD/plasma deposition equipment at 70%, and establish the solar photovoltaic equipment industry chain.
- MIRDC will complete the turnkey integration of ALD/PECVD/plasma deposition equipment. The selling price is 40% of foreign equipment, improving international competitiveness.



Development of key coating process equipment for passivated cells

6. Small hydropower development and industrialization technology

- Due to demands for the third-party testing and certification put forward by domestic small hydropower operators, it is necessary to confirm whether the performance of their machine unit is suitable to be put into the site. In the future, MIRDC will make investment in the establishment of small hydropower generator test laboratories (to be certified by TAF, TUV and other domestic and foreign certification organizations) to assist operators in the research and development of the machine technology for machine units.
- Establish domestic emerging chains for small hydropower generator industry, and focus on water turbine design analysis and related research and development technology that improve conversion efficiency.

Electrochemical Machining Technology

In 2019, development of electrochemical machining technology is as follows: for metal honeycomb core structural materials using traditional mechanical processing methods in terms of processing time, quality, yield rate, etc., the development of mechanical grinding-assisted electrochemical free forming processing technologies and modules that combine electrochemical free forming and mechanical grinding methods have been developed to solve the problem of metal honeycomb core structures.

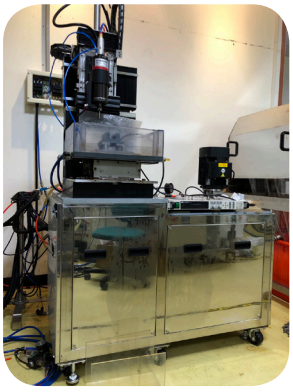
This technology proposes an electro-mechanical composite milling system, which will develop a grinding wheel module with conductivity and electrolyte spray function. The advantage is that the risk of clogging in the machining gap is significantly reduced, and machining can be started from the side wall of the workpiece, thereby improving the processing efficiency by passing the required depth in one pass.

As the electrochemical composite processing technology can make up for the shortcomings of the existing electrochemical processing technology, research and development in the field of electrochemical composite processing will continue in the future, and the jet plasma electrolysis surface processing technology will be used to solve the industry's problem of surface treatment of difficult-to-process metal materials.

Current R & D Status

1. Low Stress Complex Machining Technology for Aerospace Metallic Honeycomb Sandwich Structure

- In response to the aerospace industry for the metal porous structural material forming processing requirements, MIRDC proposed the development of the electrochemical mechanical abrasive composite processing technology.
- The newly developed technology can be used in the processing in the aerospace aluminum honeycomb core to overcome the positioning difficulties and surface stress problems of traditional machining.
- It is expected to raise the technical threshold of the domestic aerospace industry and accelerate the industry to enhance technology, thereby reducing processing cost by more than 50%.
- The new technologies can also be applied to precision machinery in the future, which is expected to increase production capacity by more than 25%.



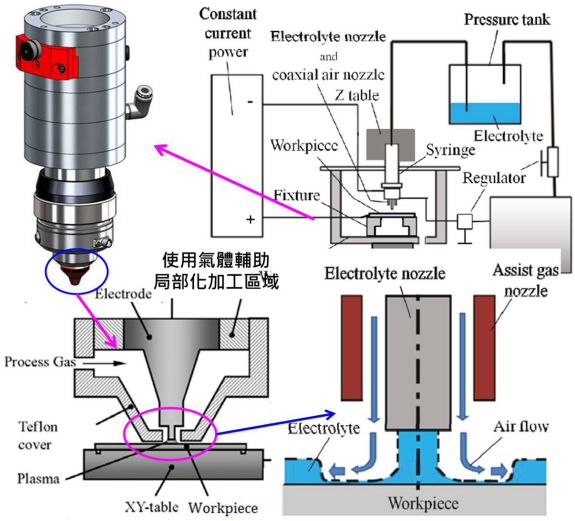
Electrochemical mechanical composite milling system

Aluminum alloy honeycomb with curved surface

R & D Technologies in the Future

1. Jet-flow plasma electrolytic surface machining technology

- In response to the metal product industry's needs for surface processing of complex structures, the development of plasma electrolytic surface processing technology was proposed.
- The newly developed technology can be used in processing to overcome the problems of surface stress, dust generation and waste liquid treatment of traditional mechanical polishing, electrolytic polishing or chemical polishing.
- It is expected to promote the technological self-reliance of the domestic fabricated metal product industry, replacing 5 million imports per unit.
- The new technology can also be applied to precision machinery in the future, which is estimated to reduce process costs by more than 30%.



Atmospheric plasma jet flow module for electrolytic surface treatment

ANNUAL REPORT 2019

Appendix

附錄

科專成果統計表

成果項目					計畫名稱	金屬中心產業環境建構計畫	金屬中心創新技術研究計畫	數位口腔暨脊椎微創導航系統開發與數位骨科手術輔助系統關鍵技術評估計畫	細胞治療影像與微創醫材開發計畫	雲嘉南地方產業創新提升推動計畫	產業創新材料開發計畫
成果產出	A、學術成果	論文	國內	篇數		-	-	-	-	-	-
			國外	篇數		-	-	-	-	-	-
		研究報告		篇數		-	-	-	-	-	-
	B、技術成果	專利申請	國內	件數		4	18	11	2	1	1
			國外	件數		4	9	10	2	0	1
		專利獲得	國內	件數		9	25	11	1	2	1
			國外	件數		3	7	10	-	0	0
	C、產學研合作	合作研究		件數		-	-	-	-	-	-
				配合款		-	-	-	-	-	-
		分包研究（國內）		件數		1	1	11	3	-	-
				金額		500	500	8,400	3,000	-	-
	D、國際合作	合作開發		件數		-	-	-	-	-	-
				金額		-	-	-	-	-	-
	F、機構認證	持續參與	國內	件數		21	-	2	-	-	-
			國外	件數		14	-	-	-	-	-
		新增提案	國內	件數		2	-	-	-	-	-
			國外	件數		-	-	-	-	-	-
成果擴散	G、推廣研討	研討會議		場次		2	-	3	3	6	3
				人次		60	-	273	150	334	171
		廠商訪視推廣		家數		-	-	45	10	21	9
		媒體曝光		篇數		-	-	5	-	-	-
	H、人才培育			人次		-	-	105	25	-	-
	I、學術成果被引用			篇數		-	-	-	-	-	-
研發應用	J、專利應用	國內		件數		20	2	19	4	17	3
		國外		件數		-	1	1	1	-	-
		應用收入		金額		12,329.274	1,862.285	20,037.142	1,628.571	6,182.857	1,690.476
	K、技術移轉	國內		件數		18	4	11	3	18	6
		國外		件數		-	-	-	-	-	-
		移轉總收入		金額		12,329.274	3,038.476	20,608.57	1,628.571	6,532.857	4,590.476
		繳庫數		金額		6,164.639	430.133	9,917.379	710.543	2,124.801	2,295.238
	L、委託及工業服務			件數		65	-	25	8	13	2
				家數		52	-	21	8	13	2
				金額		20,107.54	-	27,494	11,303	4,797	1,085
	M、開放實驗室	設備使用	業界	次數		680	-	-	-	-	-
				時數		5,766	-	-	-	-	-
			學界	次數		286	-	-	-	-	-
				時數		1,805	-	-	-	-	-
			其他機構（含執行單位）	次數		1,428	-	-	-	-	-
				時數		11,923	-	-	-	-	-
	N、推動學產參與科專研發	研提通過研學產創新鏈結型法人科專計畫		件數		-	-	-	-	-	-
				金額		-	-	-	-	-	-
		研提通過 A+企業創新研發專案		件數		-	-	-	-	-	-
				金額		-	-	-	-	-	-
		研提通過學界科專計畫		件數		-	-	-	-	-	-
				金額		-	-	-	-	-	-
		研提通過其他計畫		件數		-	-	8	2	1	1
				金額		-	-	50,430	4,500	1,695	8,750
	O、研發成果總收入			金額		12,329.274	3,038.476	20,608.57	1,628.571	6,532.857	4,590.476
經濟效益	P、促成產業聯盟			件數		-	-	4	-	-	1
	Q、新創事業（含衍生公司、新事業部門之設立）			家數		-	-	2	-	-	-
				資本額		-	-	70,000	-	-	-
				員工數		-	-	20	-	-	-
	R、促成廠商投資	件數				13	-	25	2	34	4
		廠家數				13	-	25	2	34	4
		投資金額				571,441	-	469,800	102,000	185,000	88,000
		增加就業人數				15	-	88	16	33	10
		衍生產值				1,956,000	-	757,500	150,000	820,000	0
S.其他		滿意度	研究報告	5分量表		-	-	-	-	-	-
			研討會議	5分量表		-	-	-	-	-	-
		獲獎	學術成果	項數		-	-	-	-	-	-
			技術成果	項數		-	-	-	-	-	-

成果項目 \ 計畫名稱					利基車輛底盤自主技術暨產業化計畫	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	下世代汽車自主整合創新研發計畫	電動車輛線傳底盤關鍵次系統技術開發計畫	綠能科技技術分析與策略推動研究發展計畫	維新傳統產業創新加值發展計畫
成果產出	A、學術成果	論文	國內	篇數	-	-	-	-	-	-
			國外	篇數	-	-	-	-	-	-
		研究報告		篇數	-	-	-	-	-	-
	B、技術成果	專利申請	國內	件數	2	1	3	1	-	4
			國外	件數	1	6	1	1	-	2
		專利獲得	國內	件數	6	1	1	2	-	5
			國外	件數	-	3	2	-	-	2
	C、產學研合作	合作研究		件數	-	-	-	-	-	-
				配合款	-	-	-	-	-	-
		分包研究（國內）		件數	3	2	1	1	4	2
				金額	1,600	1,000	900	500	20,207	7,000
	D、國際合作	合作開發		件數	-	-	1	-	-	-
				金額	-	-	4,818	-	-	-
	F、機構認證	持續參與	國內	件數	-	-	-	-	-	-
			國外	件數	-	-	-	-	-	-
		新增提案	國內	件數	-	-	-	-	-	-
			國外	件數	-	-	-	-	-	-
成果擴散	G、推廣研討	研討會議		場次	-	1	1	-	1	6
				人次	-	58	97	-	200	264
		廠商訪視推廣		家數	-	3	-	-	10	46
		媒體曝光		篇數	-	-	-	-	-	-
	H、人才培育			人次	-	58	-	-	-	38
	I、學術成果被引用			篇數	-	-	-	-	-	-
研發應用	J、專利應用	國內		件數	15	2	6	1	4	17
		國外		件數	1	1	3	-	-	-
		應用收入		金額	5,047.619	2,500	3,198	880	271.43	8,153.076
	K、技術移轉	國內		件數	8	2	5	2	4	21
		國外		件數	-	-	-	-	-	-
		移轉總收入		金額	6,047.619	2,500	3,674.19	2,380	271.43	10,165.171
		繳庫數		金額	2,056.106	1,250	1,800.122	936.923	38.422	3,485.753
	L、委託及工業服務			件數	6	1	2	1	-	39
				家數	6	1	2	1	-	37
				金額	5,358	2,000	3,600	2,000	-	11,948.2
	M、開放實驗室	設備使用	業界	次數	-	-	-	-	-	-
				時數	-	-	-	-	-	-
			學界	次數	-	-	-	-	-	-
				時數	-	-	-	-	-	-
			其他機構（含執行單位）	次數	-	-	-	-	-	-
				時數	-	-	-	-	-	-
	N、推動學產參與科專研發	研提通過研學產創新鏈結型法人科專計畫		件數	-	-	-	-	-	-
				金額	-	-	-	-	-	-
		研提通過 A+企業創新研發專案		件數	-	-	-	-	-	-
				金額	-	-	-	-	-	-
		研提通過學界科專計畫		件數	-	-	-	-	-	-
				金額	-	-	-	-	-	-
		研提通過其他計畫		件數	-	-	-	-	-	4
				金額	-	-	-	-	-	29,761
	O、研發成果總收入			金額	6,047.619	2,500	3,674.19	2,380	271.43	10,165.171
經濟效益	P、促成產業聯盟			件數	-	-	-	-	-	1
	Q、新創事業（含衍生公司、新事業部門之設立）			家數	-	-	-	-	-	-
				資本額	-	-	-	-	-	-
				員工數	-	-	-	-	-	-
	R、促成廠商投資	件數			7	1	5	2	-	-
		廠家數			7	1	5	2	-	-
		投資金額			173,384	50,000	190,000	60,880	-	-
		增加就業人數			17	4	10	3	-	-
		衍生產值			220,000	85,000	240,000	18,000	-	-
S.其他		滿意度	研究報告	5分量表	-	-	-	-	-	-
			研討會議	5分量表	-	-	-	-	-	-
		獲獎	學術成果	項數	-	-	-	-	-	-
			技術成果	項數	-	-	-	-	-	-

成果項目 \ 計畫名稱					在地產業創新加值與學界協助中小企業科技關懷推動計畫	關鍵產業用高值金屬材料暨製造技術國產自主研發計畫	高溫用金屬零組件之先進製造技術開發與整合計畫	工業伺服電機節能驅控關鍵組件開發計畫	機械與系統領域工業基礎技術研究計畫	智慧製造系統關鍵技術開發計畫
成果產出	A、學術成果	論文	國內	篇數	-	-	-	-	-	-
			國外	篇數	-	-	-	-	-	-
		研究報告		篇數	-	-	-	-	-	-
	B、技術成果	專利申請	國內	件數	5	4	2	1	-	2
			國外	件數	2	4	3	-	-	1
		專利獲得	國內	件數	8	3	-	-	2	2
			國外	件數	1	1	3	-	-	-
	C、產學研合作	合作研究		件數	-	-	-	-	-	-
				配合款	-	-	-	-	-	-
		分包研究（國內）		件數	4	1	3	1	2	1
				金額	25,591	800	1,050	600	1,000	500
	D、國際合作	合作開發		件數	-	-	1	-	-	-
				金額	-	-	2,500	-	-	-
	F、機構認證	持續參與	國內	件數	-	-	-	-	-	-
			國外	件數	-	-	-	-	-	-
		新增提案	國內	件數	-	-	-	-	-	-
			國外	件數	-	-	-	-	-	-
成果擴散	G、推廣研討	研討會議		場次	8	2	1	-	3	1
				人次	530	72	100	-	95	40
		廠商訪視推廣		家數	203	23	-	-	6	-
		媒體曝光		篇數	5	-	1	-	-	-
	H、人才培育			人次	-	-	2	-	2	-
	I、學術成果被引用			篇數	-	-	-	-	-	-
研發應用	J、專利應用	國內		件數	8	13	4	-	9	8
		國外		件數	-	1	-	-	2	-
		應用收入		金額	6,422.381	9,965.619	2,920	-	4,971.01	3,740.047
	K、技術移轉	國內		件數	9	14	5	2	6	7
		國外		件數	-	-	-	-	-	-
		移轉總收入		金額	8,780.381	12,775.143	3,620	1,000	4,971.01	3,740.047
		繳庫數		金額	3,408.262	6,008.47	1,684.463	500	2,251.704	1,759.445
	L、委託及工業服務			件數	-	30	7	2	11	11
				家數	-	29	7	2	11	11
				金額	-	18,950.3	4,922.03	2,200	10,752.389	11,137
	M、開放實驗室	設備使用	業界	次數	-	-	-	-	-	-
				時數	-	-	-	-	-	-
			學界	次數	-	-	-	-	-	-
				時數	-	-	-	-	-	-
			其他機構（含執行單位）	次數	-	-	-	-	-	-
				時數	-	-	-	-	-	-
	N、推動學產參與科專研發	研提通過研學產創新鏈結型法人科專計畫		件數	-	-	-	-	-	-
				金額	-	-	-	-	-	-
		研提通過 A+企業創新研發專案		件數	-	-	-	-	-	-
				金額	-	-	-	-	-	-
		研提通過學界科專計畫		件數	-	-	-	-	-	-
				金額	-	-	-	-	-	-
		研提通過其他計畫		件數	81	3	2	-	1	1
				金額	198,873	7,400	8,260	-	24,000	2,900
	O、研發成果總收入			金額	8,780.381	12,782.117	3,620	1,000	4,971.01	3,740.047
經濟效益	P、促成產業聯盟			件數	5	4	-	-	-	-
	Q、新創事業（含衍生公司、新事業部門之設立）			家數	-	-	-	-	-	-
				資本額	-	-	-	-	-	-
				員工數	-	-	-	-	-	-
	R、促成廠商投資	件數			741	8	11	1	4	6
		廠家數			737	8	11	1	4	6
		投資金額			2,722,416	348,000	118,500	20,000	30,000	57,535
		增加就業人數			1,230	52	14	2	12	6
		衍生產值			4,513,327	630,000	325,000	1,000	68,000	43,000
S.其他		滿意度	研究報告	5分量表	-	-	-	-	-	-
			研討會議	5分量表	-	-	-	-	-	-
		獲獎	學術成果	項數	-	-	-	-	-	-
			技術成果	項數	-	-	-	-	-	-

成果項目 \ 計畫名稱					產業技術基磐研究與知識服務計畫	水五金先進金屬模具鑄造提升計畫	主動式力量輔助上肢復健機器人先期研究計畫	即時補綴 3D雷射雕銑系統暨酸鋰基底陶瓷開發計畫	高熵合金材料暨製造技術前導應用研發計畫	微型晶圓快速試煉場域前期研究計畫
成果產出	A、學術成果	論文	國內	篇數	-	-	-	-	-	-
			國外	篇數	-	-	-	-	-	-
		研究報告		篇數	-	-	-	-	-	-
	B、技術成果	專利申請	國內	件數	-	1	2	2	-	1
			國外	件數	-	1	1	2	1	1
		專利獲得	國內	件數	-	-	-	1	-	-
			國外	件數	--	-	-	-	-	-
	C、產學研合作	合作研究		件數	-	-	-	-	-	-
				配合款	-	-	-	-	-	-
		分包研究（國內）		件數	-	-	2	1	1	1
				金額	-	-	700	1,000	1,500	9,000
	D、國際合作	合作開發		件數	-	-	-	-	-	-
				金額	-	-	-	-	-	-
	F、機構認證	持續參與	國內	件數	-	-	-	-	-	-
			國外	件數	-	-	-	-	-	-
		新增提案	國內	件數	-	-	-	-	-	-
			國外	件數	-	-	-	-	-	-
成果擴散	G、推廣研討	研討會議		場次	7	1	-	1	1	-
				人次	478	42	-	200	40	-
		廠商訪視推廣		家數	-	5	-	5	-	-
		媒體曝光		篇數	-	-	-	4	-	-
	H、人才培育			人次	-	-	-	-	-	-
	I、學術成果被引用			篇數	-	-	-	-	-	-
研發應用	J、專利應用	國內		件數	-	1	2	1	-	-
		國外		件數	-	-	-	-	-	-
		應用收入		金額	-	1,000	2,116.317	666.667	-	-
	K、技術移轉	國內		件數	-	1	2	1	-	-
		國外		件數	-	-	-	-	-	-
		移轉總收入		金額	1,030.748	1,000	2,116.317	666.667	-	-
		繳庫數		金額	412.299	500	1,000	9.524	-	-
	L、委託及工業服務			件數	-	4	1	1	1	-
				家數	-	4	1	1	1	-
				金額	-	1,180	73	900	525	-
	M、開放實驗室	設備使用	業界	次數	-	-	-	-	-	-
				時數	-	-	-	-	-	-
			學界	次數	-	-	-	-	-	-
				時數	-	-	-	-	-	-
			其他機構（含執行單位）	次數	-	-	-	-	-	-
				時數	-	-	-	-	-	-
	N、推動學產參與科專研發	研提通過研學產創新鏈結型法人科專計畫		件數	-	-	-	-	-	-
				金額	-	-	-	-	-	-
		研提通過 A+企業創新研發專案		件數	-	-	-	-	-	-
				金額	-	-	-	-	-	-
		研提通過學界科專計畫		件數	-	-	-	-	-	-
				金額	-	-	-	-	-	-
		研提通過其他計畫		件數	-	-	-	2	-	-
				金額	-	-	-	35,000	-	-
	O、研發成果總收入			金額	1,030.748	1,000	2,116.317	666.667	-	-
經濟效益	P、促成產業聯盟			件數	-	-	-	-	-	-
	Q、新創事業（含衍生公司、新事業部門之設立）			家數	-	-	-	-	-	-
				資本額	-	-	-	-	-	-
				員工數	-	-	-	-	-	-
	R、促成廠商投資	件數			-	2	1	6	2	-
		廠家數			-	2	1	6	2	-
		投資金額			-	132,000	4,000	94,700	1,525	-
		增加就業人數			-	75	2	52	3	-
		衍生產值			-	420,000	500	246,000	2,000	-
S.其他		滿意度	研究報告	5分量表	-	-	-	-	-	-
			研討會議	5分量表	-	-	-	-	-	-
		獲獎	學術成果	項數	-	-	-	-	-	-
			技術成果	項數	-	-	-	-	-	-

成果項目 \ 計畫名稱					智慧接駁車輛平台關鍵技術整合應用先期研究計畫	無人載具科技創新實驗推動計畫	金屬扣件 SaaS應用與金屬製品產業雲系統研究計畫
成果產出	A、學術成果	論文	國內	篇數	-	-	-
			國外	篇數	-	-	-
		研究報告		篇數	-	-	-
	B、技術成果	專利申請	國內	件數	-	-	-
			國外	件數	-	-	-
		專利獲得	國內	件數	-	-	-
			國外	件數	-	-	-
	C、產學研合作	合作研究		件數	-	-	-
				配合款	-	-	-
		分包研究（國內）		件數	-	4	-
				金額	-	10,000	-
	D、國際合作	合作開發		件數	-	-	-
				金額	-	-	-
	F、機構認證	持續參與	國內	件數	-	-	-
			國外	件數	-	-	-
		新增提案	國內	件數	-	-	-
			國外	件數	-	-	-
成果擴散	G、推廣研討	研討會議		場次	-	-	-
				人次	-	-	-
		廠商訪視推廣		家數	-	-	20
		媒體曝光		篇數	-	19	-
	H、人才培育			人次	-	-	-
	I、學術成果被引用			篇數	-	-	-
研發應用	J、專利應用	國內		件數	-	-	-
		國外		件數	-	-	-
		應用收入		金額	-	-	-
	K、技術移轉	國內		件數	-	-	-
		國外		件數	-	-	-
		移轉總收入		金額	-	-	-
		繳庫數		金額	-	-	-
	L、委託及工業服務			件數	-	-	3
				家數	-	-	3
				金額	-	-	4,420
	M、開放實驗室	設備使用	業界	次數	-	-	-
				時數	-	-	-
			學界	次數	-	-	-
				時數	-	-	-
			其他機構（含執行單位）	次數	-	-	-
				時數	-	-	-
	N、推動學產參與科專研發	研提通過研學產創新鏈結型法人科專計畫		件數	-	-	-
				金額	-	-	-
		研提通過 A+企業創新研發專案		件數	-	-	-
				金額	-	-	-
		研提通過學界科專計畫		件數	-	-	-
				金額	-	-	-
		研提通過其他計畫		件數	-	-	-
				金額	-	-	-
	O、研發成果總收入			金額	-	-	-
經濟效益	P、促成產業聯盟			件數	-	-	-
	Q、新創事業（含衍生公司、新事業部門之設立）			家數	-	-	-
				資本額	-	-	-
				員工數	-	-	-
	R、促成廠商投資	件數			1	-	1
		廠家數			1	-	1
		投資金額			5,500	-	3,500
		增加就業人數			2	-	1
		衍生產值			6,000	-	5,000
S.其他		滿意度	研究報告	5分量表	-	-	-
			研討會議	5分量表	-	-	-
		獲獎	學術成果	項數	-	-	-
			技術成果	項數	-	-	-

工服案統計表

計畫名稱	輔導項目	輔導案數
離岸風電與太陽光電產業升級轉型推動計畫	因應風場運維需求，進行風力機維修零組件備品開發，透過輔導業者建立認證測試文件，切入風場運維供應鏈。推動產學研合作補足國內產業技術落差，協助產業升級轉型，建構風力機維修零組件自主技術開發能量，發展在地維修備品供應體系。輔導國內具有風力機維修零組件製造能量之業者，透過技術提升增加產業競爭優勢，建立認證測試文件切入風場運維供應鏈。	4
產業園區廠商競爭力推升計畫	依據產業園區之產業特性、群聚等因素，以園區價值鏈為標的，發掘園區廠商轉型所需共通且迫切之關鍵技術，帶動園區產業上中下游或水平聯盟整合，包含跨園區產業合作、營運或技術加值應用、特色產業轉型等示範推動。	6
利基生技醫藥產業輔導與國際化推動計畫	輔導安盛生科 (POCT糖化血色素產品開發計畫)、傑奎科技 (脊椎 3D影像建構之椎弓根植入引導夾持器套組開發)、安克生醫 (智慧化甲狀腺結節自動辨識系統)、可成生科 (3DP客製化多孔結構髖臼杯關鍵技術開發計畫)、大心生物科技 (臥床自動排泄盥洗裝置開發計畫)、酷手科技 (肌力復健感測裝置開發計畫)、期美科技 (具智慧場域感測之移位輔具開發計畫)、仁寶電腦 (應用於沾黏性關節囊炎之行動快篩軟體與穿戴模組開發計畫)等智慧醫材 /輔具產品開發輔導共 8案，以提升相關開發製程 /產品之良率外，同時加速利基型醫材 /輔具產品之上市時程。	8
電子設備產業推動計畫	全球各大知名半導體設備商紛紛擴大在台布局，為扶植國內 OEM廠成為合格供應鏈，達成迅速提供在地化技術服務支目標，因此以協助輔導國內廠商開發產業相關設備或零組件，提升國內電子設備產業的自主研發能力。	3
先進封裝設備計畫	藉由本計畫深入了解國內先進封裝製程業者之需求，媒合國內設備業者進行開發，並透過技術輔導、國際合作、強化國內供應鏈等推動作法，同時整合國內研究法人如工研院及金屬中心等技術量能，協助國內設備業者發展整機設備。此外，將積極促成上中下游產業鏈業者組成聯盟，擬定設備開發目標、整合研發能量及降低研發風險，藉此凝聚國內供需雙方共識，針對先進封裝製程設備國產化之目標共同努力，增加國內半導體先進封裝產業之國際競爭力。	3
中小企業即時技術輔導計畫	為協助企業技術升級轉型，提供短期程、小額度、全方位之技術輔導，協助業者排除急迫性之技術障礙，並運用科技、美學、新材料、新營運模式等創新元素，以提升附加價值。輔導標的為凡企業升級轉型所需之研發、生產、物流、設計（限產品設計等）、節能減碳、自動化及電子化等。	13(通過一般輔導案 7家，及 1件共通輔導案含 6家廠商)
加強輔導產業技術升級轉型個案計畫	為協助加強輔導型產業 (本中心主要針對家電產業)提升產品品級，建立臺灣製產品優良之形象，配合行政院推動之傳統產業特色化，提供企業短期程、小額度、全方位之輔導，協助業者提升產品設計之能力或排除急迫性之技術障礙，及運用科技、美學、新材料、新營運模式等創新元素加值傳統產業，發揮具特色化及提升附加價值。	4
產業競爭力整合服務推動計畫 -辦理企業升級轉型訪視及診斷服務	協助廠商提出服務案件申請，並提供業者即時電話諮詢及洽談服務14案；完成訪視報告書14案，並繳交本計畫期中與期末檢討報告。包含泰翔工業、山野電機、金晶矽砂、永久綠能、帕克國際、佳進、鑫綠泰、大甲永和、恆峰、瀨上、可成、通易及春雨、駿華。	14
金屬製業智機化提升分包計畫 -金屬製品業智機化升級轉型	輔導/服務國內產業界廠商建立國際法規驗證、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。	4
金屬產業智機化提升分包計畫 -家用機械智慧製造能力提升計畫	促成 3案智慧化技術應用，推動產業智機化，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 6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。	9
智慧運具產業製造競爭力推升計畫 -機車產業供應鏈智機化技術能量提升輔導	輔導機車零組件產業業者建置機車主體線自動端子鉚壓壓力即時監測系統開發。績效提升及價值創造包括：掌握產線變異資訊及控管生產變異、降低人工檢測成本、減少檢測材料成本、降低因不良品導致之違約罰款。	1
AI加值智慧製造產業推廣計畫	輔導三個產業，協助表面處理業者完成 1 種製程、2 案次導入環保製造 AI 之品質預測模組，藉由建立大數據收集系統、製程追溯系統；協助橡塑膠業者完成 1 種橡塑膠設備 AI智慧調機與排程模組，2 案次橡塑膠設備 AI導入應用；協助扣件者完成 1種製程模組，2案次導入 AI之品質預測模組，藉由建立大數據收集系統、製程追溯系統、每年依序完成各製程品質預測模組建置及導入等作法，目的將既有的經驗法累積傳承並數位化，並有能力承接高端產品 (如汽車、航太螺絲)。	6

工業訓練人才培訓業務執行

政府委辦案

1.	108年度維新傳統產業創新加值發展計畫-基盤加值分項，針對球墨鑄鐵製程技術以及澆流道設計及模擬分析技術傳承，於傳承課程中以砂模實際案例探討，透過個案學習，掌握及瞭解產業重點及關鍵技術問題，共培育38位鑄造製程工程師，另成立「鑄造場域優化及技術傳承產業聯盟」。透過籌組聯盟，鏈結台灣鑄造品公會、台灣鑄造學會，協助整合產業傳承與場域優化需求，鏈結鑄造領域資深專家，提供專業技術服務。計畫執行過程順利亦遵照如期辦理完成。
2.	108年度創新分離式蓄熱燃燒計畫，辦理熱處理爐設計規劃工程師培訓系列課程共五班，完成68人次，協助熱處理爐設備廠與使用端人才養成，並於課程中介紹中心之蓄熱以及爐體性能及相關驗証技術。
3.	108年度經濟部工業局地區產業整合發展計畫，規劃出「扣件製程技術經理」之課程學習地圖，並針對產業界急需之課程進行辦理，為「扣件製程知識與技術概論」學員23人；「扣件成型設計概念」學員23人。
4.	108年度財團法人工業技術研究院委託之金屬產業智機化提升計畫-機械產業專業人才培訓分項(金屬產業人才培訓)，執行期間：108年1月2日至108年11月30日，計畫目標在職班13班次(含以上)，培訓270人次(含以上)，授課時數3,240人時(含以上)，課程(教材)更新率20%(含以上)，實際辦理人才培訓18班，完成310人次，5,244人時，課程及教材更新率達60%以上。
5.	108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」，本計畫依照高雄市勞工局訓就中心作業規定辦理，主要目的為培訓失業者取得天車及堆高機期滿證明，幫助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：108年6月12日~108年7月1日，結訓人數23人，取得天車證照21人、堆高機證照20人，就業追蹤期90天至108年9月29日，就業人數13人，就業率57%。
6.	108年產業人才投資方案提升勞工自主學習計畫至12月底止，開辦了1. 扣件品質分析手法系列訓練班學員25名,2.SolidWorks 3D繪圖設計學員28名;3. 扣件品質管理規範系列訓練班學員22名,4.扣件進階知識系列訓練班學員26名。
7.	108年度即測即評及發證技術士技能檢定術科測試至11月底止，已報名10梯次堆高機操作、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2,244人；堆高機操作檢定合格可發證人數共995人，固定式起重機操作－架空式（地面操作）檢定合格可發證人數共24人，固定式起重機操作－架空式（機上操作）檢定合格可發證人數共487人，移動式起重機操作－伸臂可伸縮式檢定合格可發證人數共128人，第一種壓力容器操作檢定合格可發證人數167人，總合格率為82.8%。資料來源：勞動部勞動力發展署技能檢定中心。

民間委辦案

1.	工業安全訓練課程108年度至12月底止共辦理591班，上課人數共計14,060人；臨廠工業安全訓練課程共辦理88班，上課人數共計2,612人，課程執行過程順利。
2.	管理類課程108年度至12月底止共辦理28班，上課人數共計542人；臨廠管理類課程共辦理1班，上課人數共計25人，課程執行過程順利。
3.	技術類訓練課程108年度至12月底止共辦理99班，上課人數共計1,626人；臨廠技術類訓練課程共辦理14班，上課人數340人，課程執行過程順利。
4.	108年，總開班數：821班，總上課時數：10,826小時；總報名人數：21,967人，總上課人數：19,205人。

前瞻技術之學研合作

學校	總計畫名稱	研究名稱
國立中央大學	高溫用金屬零組件之先進製造技術開發與整合計畫 (1/2)	無應力加工電極模組絕緣材料之研究
國立中央大學	新及再生能源前瞻技術掃描評估及研發推動 -地熱溫泉熱導引於熱再生化學電池模組技術探索創新前瞻計畫 (1/1)	化學電池恆溫機構設計分析研究
財團法人工業技術研究院	無人載具科技創新實驗推動計畫 (1/1)	無人機技術標竿與實驗品質管理
財團法人工業技術研究院	無人載具科技創新實驗推動計畫 (1/1)	物流用自駕車技術標竿與實驗品質管理
財團法人車輛研究測試中心	無人載具科技創新實驗推動計畫 (1/1)	接駁用自駕車技術標竿與實驗品質管理
財團法人船舶暨海洋產業研發中心	無人載具科技創新實驗推動計畫 (1/1)	自駕船技術標竿與實驗品質管理
大葉大學	用於高效能矽晶太陽電池的關鍵製程研發設備開發計畫 (1/3)	鈍化層薄膜製程研究及其應用於太陽電池之特性探討
國立成功大學	108年度「離岸風場結構檢修與運維技術開發推動計畫」	電化學技術運用於風力機結構件防蝕系統之檢測技術研究
國立勤益科技大學	地熱溫泉能源多元開發關鍵技術研發計畫 (1/3)	半封式構型軸流式渦輪機技術開發
國立中山大學	高雄海洋科技專區人才育成、產業創新軟硬體建置及營運委託專業服務案 (2/3)	興達港周邊產業活化發展可行性評估
高雄榮民總醫院	數位口腔暨脊椎微創導航系統開發與數位骨科手術輔助系統關鍵技術評估計畫 (4/4)	微創創傷復位骨科手術臨床需求與復位路徑建立
國立中山大學	智慧型可重組蓄熱燃燒系統開發計畫 (1/3)	工業爐內不同區段不同升溫條件對工件之影響研究分析
遠東科技大學	智慧型可重組蓄熱燃燒系統開發計畫 (1/3)	爐內區域均溫控制系統 AI演算模型分析
國立屏東科技大學	智慧型可重組蓄熱燃燒系統開發計畫 (1/3)	不同熱處理連續爐用熱需求 AI模型建立與分析
財團法人工業技術研究院	綠能科技技術分析與策略推動研究發展計畫 (1/4)	主要綠能關鍵技術重點指標分析計畫
財團法人中華經濟研究院	綠能科技技術分析與策略推動研究發展計畫 (1/4)	我國綠能產業科技發展與前瞻技術研究
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 (1/4)	國際綠能趨勢與我國重要技術研究
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 (1/4)	綠能科技計畫成果查核推廣及人才培育規劃
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 (1/4)	車輛乙太網 AVB設計與實作
嘉南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 (1/4)	車輛模擬軟體 (PreSCAN)與 AVB異質感測資料庫需求
國立中山大學	108年度「離岸風場結構檢修與運維技術開發推動計畫」	聲學技術運用於海床探測研究
國立高雄科技大學	金屬中心創新前瞻技術研究計畫 (1/1)	鎂合金骨釘射出成型研究
國立雲林科技大學	電動車輛線傳底盤關鍵次系統技術開發計畫 (1/4)	懸吊磁電可調阻尼分析
國立高雄科技大學	關鍵產業用高值金屬材料暨製造技術國產自主研發計畫 (3/4)	多孔功能梯度鈦合金材料壓縮破壞行為研究
國立成功大學	高溫用金屬零組件之先進製造技術開發與整合計畫 (1/2)	高溫合金特徵高效減材複合製程技術開發
國立臺灣大學	利基車輛底盤自主技術暨產業化計畫 (3/4)	車用避震系統動態特性之量測及建構監測和即時通報系統
國立臺北科技大學	利基車輛底盤自主技術暨產業化計畫 (3/4)	懸架緩衝塊之變形分析與應力量測
國立中正大學	細胞治療與微創影像醫材開發計畫 (3/4)	定位標籤模組設計開發
國立中正大學	細胞治療與微創影像醫材開發計畫 (3/4)	FMCW收發機開發

學校	總計畫名稱	研究名稱
國立中正大學	細胞治療與微創影像醫材開發計畫 (3/4)	定位演算軟體開發
國立高雄科技大學	在地產業創新加值與學界協助中小企業科技關懷推動計畫 (3/4)	中空件鍛造製程於機車傳動軸件應用之研究
國立臺灣科技大學	金屬中心產業技術環境建構計畫 (3/3)	諧波齒輪之參數化伺服成形製程設計軟體
中華大學	機械與系統領域工業基礎技術研究計畫 (3/3)	撓性減振動剛性資料庫分析與程式化
國立臺灣大學	機械與系統領域工業基礎技術研究計畫 (3/3)	鑄鐵尺寸安定化處理之監控方式探討
國立臺灣大學醫學院附設醫院金山分院	數位口腔暨脊椎微創導航系統開發與數位骨科手術輔助系統關鍵技術評估計畫 (4/4)	大範圍骨缺損臨床人因評估
佛教慈濟醫療財團法人台北慈濟醫院	數位口腔暨脊椎微創導航系統開發與數位骨科手術輔助系統關鍵技術評估計畫 (4/4)	軟骨重建臨床現況與仿生軟骨植入物先期開發
國立陽明大學	數位口腔暨脊椎微創導航系統開發與數位骨科手術輔助系統關鍵技術評估計畫 (4/4)	精進口腔補綴植入物與可吸收式生醫陶瓷填補物動物實驗評估
高雄榮民總醫院	數位口腔暨脊椎微創導航系統開發與數位骨科手術輔助系統關鍵技術評估計畫 (4/4)	多椎節導航系統測試評估
高雄榮民總醫院	數位口腔暨脊椎微創導航系統開發與數位骨科手術輔助系統關鍵技術評估計畫 (4/4)	臨床超音波神經影像資訊收集 I
國立成功大學	數位口腔暨脊椎微創導航系統開發與數位骨科手術輔助系統關鍵技術評估計畫 (4/4)	組織光譜分析研究
奇美醫療財團法人奇美醫院	數位口腔暨脊椎微創導航系統開發與數位骨科手術輔助系統關鍵技術評估計畫 (4/4)	口內掃描機臨床測試計畫 (金工 IOS107) ：先期性試驗
國立成功大學	工業伺服電機節能驅控關鍵組件開發計畫 (1/4)	高速油泵輸出油壓追跡穩定技術
高雄醫學大學	數位口腔暨脊椎微創導航系統開發與數位骨科手術輔助系統關鍵技術評估計畫 (4/4)	四肢主要周邊神經術中超音波影像辨識與定位技術可行性研究
國立成功大學	數位口腔暨脊椎微創導航系統開發與數位骨科手術輔助系統關鍵技術評估計畫 (4/4)	臨床超音波神經影像資訊收集 III
中國科技大學	在地產業創新加值與學界協助中小企業科技關懷推動計畫 (3/4)	中小企業需求與發展策略研析 -重點產業中小企業發展與在地鏈結策略分析
國立高雄科技大學	智慧製造系統關鍵技術開發計畫 (3/4)	金屬扣件成形製程與品質失效狀態遠端分析預診之研究
國立高雄科技大學	利基車輛底盤自主技術暨產業化計畫 (3/4)	車載系統雲端即時監控技術研析

專　利

專利名稱	案別	國別	證書號
矽基疊層的形成方法及矽基異質接面太陽能電池的製造方法	發明	中華民國	I647327
硬度測量設備以及硬度測量方法	發明	中華民國	I647451
術前規劃設備以及術前規劃方法	發明	中華民國	I647654
動態控制空壓機之系統	發明	中華民國	I649495
傳動裝置	發明	中華民國	I649245
燃燒機結構	發明	中華民國	I649517
萃取方法及裝置	發明	中華民國	I650167
真空鍍膜系統	發明	中華民國	I651430
衝擊吸能裝置	發明	中華民國	I651224
電助自行車及其輔助動力的控制方法	發明	中華民國	I651237
魚體處理設備	發明	中華民國	I651051
調整扣件成形機之模座相對位置的方法	發明	中華民國	I651153
通用型 C-ARM校正座	發明	中華民國	I651072
複合式固體生質燃料及其製備方法	發明	中華民國	I651404
照護床墊 ,照護床及照護床系統	發明	中華民國	I652028
緩衝防撞裝置及其能量吸收板的製造方法	發明	中華民國	I652417
黏合式積層鐵芯之製法與沾膠模組	發明	中華民國	I652879
伺服追隨熱輥彎模組及線上形成不等強度結構彎管之方法	發明	中華民國	I652125
大尺度細胞影像分析方法及其系統	發明	中華民國	I652627
資訊備份方法及資訊備份系統	發明	中華民國	I653541
對位方法與對位裝置	發明	中華民國	I653190
螺旋齒輪成形裝置	發明	中華民國	I653108
電動輔助之阻力式復健裝置及其方法	發明	中華民國	I654013
牙材製造裝置及牙材製造方法	發明	中華民國	I653970
生質油的製備方法	發明	中華民國	I654295
夾持構造	新型	中華民國	M575732
微動仿真脊椎植入物	發明	中華民國	I653973
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輥軋成形之彎形伺服機構及應用其之彎形機	發明	中華民國	I655976
以生理監測結合車輛控制之方法	發明	中華民國	I656050
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光輔助加工構造	發明	中華民國	I658895
多晶矽層的製造方法、異質接面太陽能電池及其製造方法	發明	中華民國	I660075
熔湯輸送導管及應用其之合金粉末製造設備	發明	中華民國	I660773
微粒成形裝置及其微粒成形方法	發明	中華民國	I660789
球狀顆粒食材造粒裝置及其造粒模組	發明	中華民國	I660684
抗菌不銹鋼合金及其製造方法	發明	中華民國	I662137
不鏽鋼表面處理方法、電磁熱消融針之製造方法及其電磁熱消融針	發明	中華民國	I663271

專利名稱	案別	國別	證書號
輥抽裝置	發明	中華民國	I663003
金屬基複合材料	發明	中華民國	I663290
輔助銑削主軸裝置	發明	中華民國	I664040
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高氮低鎳沃斯田鐵不銹鋼合金及其製造方法	發明	中華民國	I665314
具高導熱率與高散熱率之轉軸散熱系統	發明	中華民國	I665050
輕金屬接合方法及其接合填料	發明	中華民國	I665046
口內掃描裝置	發明	中華民國	I666005
骨科植入物	發明	中華民國	I666004
軌道車輛的減振裝置	發明	中華民國	I666394
虛實影像整合裝置	發明	中華民國	I667497
背壓輔助成形裝置	發明	中華民國	I667086
合金的製造方法	發明	中華民國	I667352
循環式散熱刀把裝置	發明	中華民國	I667089
加工設備	發明	中華民國	I668169
微水力發電機	發明	中華民國	I668942
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生質沼氣精煉提純分離系統	發明	中華民國	I669148
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電解拋光液組成物及其應用	發明	中華民國	I669421
具氣流導引散熱作用之轉軸散熱系統	發明	中華民國	I669184
金屬線材連鑄裝置	發明	中華民國	I669170
殘留應力檢測裝置及其檢測方法	發明	中華民國	I669501
砂輪除屑削銳裝置	發明	中華民國	I669189
雷射預熱控制方法及雷射預熱控制裝置	發明	中華民國	I670135
電化學研削裝置及其導電研磨輪	發明	中華民國	I671151
熱交換裝置	發明	中華民國	I672471
複合沖壓成形裝置	發明	中華民國	I672183
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藥物投遞裝置	發明	中華民國	I674909
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光學顯影裝置以及光學顯影方法	發明	中華民國	I675644
具有氣旋裝置之蓄熱式燃燒器	發明	中華民國	I676770
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纖維軟骨縫合器	發明	中華民國	I676457
虛實影像整合裝置	發明	中華民國	I677711
肌力分級檢測裝置及方法	發明	中華民國	I677322
骨科手術輔助系統及末端效應器	發明	中華民國	I677317
顯微裝置以及自動對焦方法	發明	中華民國	I677706
鋁基複合材料及其製造方法	發明	中華民國	I678419

專利名稱	案別	國別	證書號
碰撞緩衝裝置	發明	中華民國	I679136
球墨鑄鐵的熱處理方法及其所製成的鑄件	發明	中華民國	I680189
车体前大梁模块及其组装方法	發明	中華人民共和國	CN106938668 B
可製成一體成型的彈簧的模具結構	發明	中華人民共和國	CN107839204B
金屬板材輥軋彎曲成形回彈補償機構	發明	中華人民共和國	CN108607903B
成形裝置	發明	中華人民共和國	CN108237181B
穿刺針定位裝置	發明	中華人民共和國	CN106852702B
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植入物載具、混合罐以及植入物載具組件	發明	中華人民共和國	CN 106725927 B
擊釘裝置	發明	中華人民共和國	CN106852712B
用以製造可變曲率擠型件之擠型裝置及擠型方法	發明	中華人民共和國	3292086
擷取動態振動頻率之方法	發明	中華人民共和國	3468962
運用於精確子宮頸細胞核輪廓擷取之發炎細胞排除方法	發明	美國	10,234,442B2
ELECTRICITY AIDED BICYCLE AND AUXILIARY POWER CONTROLLING METHOD THEREOF	發明	美國	10,322,770B1
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微粒噴頭	發明	美國	10,335,754 B2
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OPTICAL SENSING DEVICE FOR PHYSIOLOGICAL SIGNAL	發明	美國	10,470,693 B2
複合管材及其製造方法	發明	美國	10,232,422 B2
振動線棒塗佈方法及塗佈裝置 (COATING METHOD AND COATING DEVICE)	發明	美國	10,413,933 B2
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擷取動態振動頻率之方法	發明	美國	10,317,370 B2
METHOD FOR PREDICTING PRECISION OF ELECTRICAL DISCHARGE MACHINE	發明	美國	10,413,984 B2
除塵裝置、集塵器及集塵器的清潔方法	發明	美國	10,272,379 B2
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股骨支撐裝置	發明	美國	10,258,475 B2
頷骨固定裝置	發明	美國	10,258,379 B2
通用型 C-ARM校正座	發明	美國	10,456,104 B2
LARGE SCALE CELL IMAGE ANALYSIS METHOD AND SYSTEM	發明	美國	10,402,623 B2
螺旋齒輪成形方法	發明	日本	特許第 6487525號
運用結構光感測障礙之倒車警示方法	發明	日本	特許第 6474766號
基於深度值之手勢操作方法及其系統	發明	日本	特許第 6600342號

出版品

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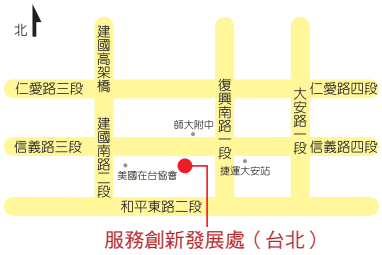

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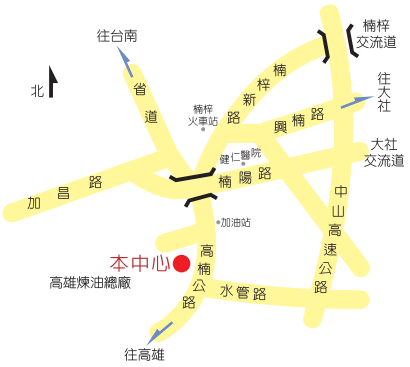

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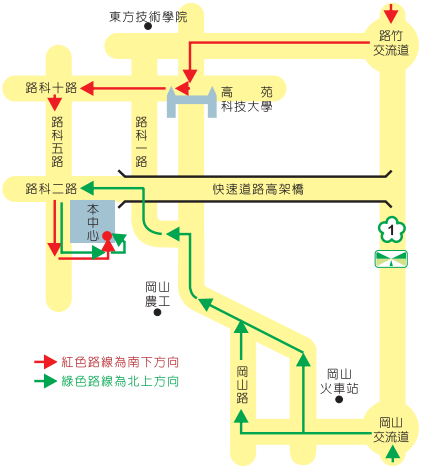

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