出國報告（出國類別：開會）

參加 2015 年第 41 屆
國際微奈米製程與製造研討會

服務機關：國防大學理工學院機械及航太工程學系
姓名職稱：李亞偉副教授
派赴國家：荷蘭
出國期間：104 年 9 月 18 日至 9 月 26 日
報告日期：中華民國 104 年 10 月 15 日

摘要

每年於九月在歐洲舉辦之國際微奈米製程與製造研討會是一著重探討微奈米加工製造與應用等技術之學術會議，研討內容以最新微奈米工程發展與各領域應用趨勢為主軸；舉凡微奈米尺度結構製造、元件設計製作與製程創新、微電子熱傳與生醫科學等皆在其討論範圍，目的在期望產學界透過技術研討及心得交流，致力提升研究同好在微奈米應用技術與元件開發潛力。此外，為鼓勵微奈米科技能導入平常生活運用，會議亦多循往例設立「生活科技」特別議題，提供產學界在致力以微奈米科技改善生活環境等應用領域進行研究成果發表與討論。另由於生活科技相關研究往往需要跨領域專業整合，故此一設立特別議題作法不僅突破其他會議的侷限性，更大幅擴展各專業領域參與本會議之意願。再者，本會議為歐洲歷史最為悠久之微奈米工程會議，論文不僅審查嚴謹且分類明確，故每年均匯集專家學者與會進行研究發表，亦吸引設備廠商與期刊出版商參與贊助，現今早已成為世界相關研究機構技術發表與學術資源分享之重要平臺。因此，本會議所發表之研究成果不僅可以藉由交流研討、觀摩比較，達到學術交流與提升個人研究可見度目的，亦可藉此充分瞭解產業界最新設備及先進製程技術發展。

國際微奈米製程與製造研討會今年於荷蘭海牙世界論壇（World Forum）舉行，由代爾夫特理工大學（Delft University of Technology）主辦，研討會期程自 2015 年 9 月 21 起至 24 日止，共計收錄論文超過 700 餘篇。會議研討內容涵蓋微機電與微光伏系統製造、微奈米工程光蝕刻技術、製程技術、聚焦電子束誘導處理、元件設計與生活科學應用等領域，共區分 5 場區 12 場次口頭報告與 8 場次壁報研討。其中，產業界發表各類論文即達 67 篇，約占總篇數 8.6%，說明產業界重視本會議，並希望能藉此交流平臺達到展現其卓越技術之目的。然就研究領域分類，製程技術部分收錄論文達 326 篇為最多，微機電與微光伏系統製造 188 篇次之，生活科學應用類則有 124 篇，足以說明今年學術界在微奈米製程技術方面獲得許多創新突破。本次會議個人共有 4 篇論文投稿並獲會議接受，會議當日即接獲「微電子工程期刊」（Microelectronic Engineering）邀稿，其中歸屬於生醫元件設計領域之「微磁性粒子在有限空間下操縱應用之研究」與「微流體於 T 型流道生成之連續軌跡研究」係利用操控流體方式進行微流體量化研究；另歸屬於生活應用科技領域之「具備週期震盪流場特性之散熱系統創新設計」主要運用電磁場誘發流場微擾動以提升流體熱對流能力，增進散熱元件熱傳效率；歸屬於製程技術領域之「利用多層超快雷射進行石墨烯直接圖案研究」則是利用雷射加工直接寫入圖案化技術，發展複雜之奈米/微結構設計。由於上述議題均經由實驗驗證成功且展現具體成效，會議期間引起會場多位專家學者詢問與

重視，並對相關研究之創新理念與應用價值多有正面評價。

感謝科技部專題計畫經費補助以及國防大學理工學院各項研究和教學設施之支持，方使個人在充分支援下完成諸多研究與成果發表。經由國際學術交流，使個人有機會與各界專家學者研討分享研究歷程，更藉以瞭解國際一流學術單位在微奈米工程之研究進展，拓展個人研究視野。所謂「知不足然後能自反」，個人未來將秉持持續研究創新的研究態度，廣泛參與各項學術會議、學習新知，期能利用各種學術交流機會精進專業領域，俾利提升個人教學與研究能量。

目次

壹、會議目的

第 41 屆國際微奈米製程與製造研討會（MNE 2015）於荷蘭海牙世界論壇舉行，匯集產學界從事微奈米研究同好與會，共同展現一年之研究成果。會議期程自 9 月 21 日起至 9 月 24 日止，共計 4 日；共收錄論文超過 700 餘篇。會議研討重點涵蓋微機電與微光伏系統製造（MEMS and Micro Photon Voltage Systems）、微奈米工程光蝕刻技術（Lithography）、製程技術（Fabrication）、聚焦電子束誘導處理（Focused Electron Beam Induced Processing）、元件設計與生活科學應用（Life Sciences）等領域，並依上述專業領域區分 5 個講廳與 8 場壁報展示同時進行研討。本會議是世界相關微奈米工程領域歷史最悠久且最具權威之重要會議，由歐洲各國輪流舉辦，迄今已歷 41 年；其成立宗旨即為提供此一產業與學術交流之平臺，致力提升微奈米工程在生活科技之發展應用。在逐年會議收錄論文質與量不斷提升下，每年均吸引多個專業設備商與著名期刊出版社參展；其中，知名出版商 Elsevier 更是主要贊助單位，旗下「Microelectronic Engineering」期刊每年均增設特別議題收錄本會議優秀論文，鼓勵學者勇於發表相關新技術並拓展應用領域。在此相輔相成下，致使會議收錄論文條件愈加嚴謹，學術與應用價值兼具，深受世界各國相關學術與產業界人士矚目。近年來，會議更以提升人類生活為研討重心，期能跨領域整合各專長共同研究相關實務應用，故會場結合新型設備展示並設置多個研討區，能即時提供學者技術詢問與研究窒礙解答，使學術界參與意願大幅提升。

貳、會議過程

會議自 9 月 20 日中午 1230 起開放報到與壁報張貼，9 月 21 日 0830 時議程正式開始，當日即邀請多位國際知名學者就微奈米科技發展現況發表最新研究成果。其中，美國國家標準技術研究所（National Institute of Standards and Technology）Quandou Wang 研究員等人提出一種應用電漿蝕刻技術開發繞射光學元件（Diffractive Optical Elements, DOE）的新應用策略，此一創新技術係以矽硼玻璃為基材，結合雙層光照設計進行元件製作。此外，另以半導體製程技術的方式，結合垂直共振腔共面射型雷射（Vertical Cavity Surface Emitting Lasers, VCSEL）與繞射光學元件，使其成為單一光電半導體元件。其關鍵技術係利用半導體製程技術將繞射光學元件表面輪廓覆蓋在共振腔共面射型雷射層上方，使繞射光學元件表面輪廓結合於垂直共振腔面射雷射結構，成為繞射式垂直共振腔面射型雷射（DOE VCSEL），進而能將光束聚光，縮小其發散角，提高元件加工精度。義大利卡利卡特大學（Calicut University）Sajina Tinku1 教授則對於微量藥劑輸送設計進行報告，其研

究係針對患者眼睛特徵發展一款可同時診斷疾病與微量施藥之多用途隱形眼鏡，其報告不僅深入探討輸藥機制設計亦設定乾眼症患者適合配戴之條件。由於本設計必須監控患者症狀，即時偵測鹽溶液輸送劑量，故其設計內部整合一款內嵌式生物傳感器與微流量控制器，可以不定時回傳訊息並依患者實際需求增減微量藥劑劑量。此一實際將微奈米技術應用於實體系統之研究成功地改善以往大劑量之施藥方法，不僅有效節省藥物成本更有助療效提升，研究成果尤其令人印象深刻。會議上午議程結束後，隨即召開歡迎午宴，由大會主席 Urs Staufer 教授與代爾夫特理工大學（Delft University of Technology）校長共同主持，期間更詳盡介紹來自世界各國之產業與學術機構，令與會人士倍感尊重。

個人於本屆會議投稿 4 篇論文均獲接受，其中「微磁性粒子在有限空間下操縱應用之研究」與「微流體於 T 型流道生成之連續軌跡研究」歸類於生醫工程領域即排訂於會議第 1 日下午以口頭發表方式進行兩場次研討。第 1 篇「微磁性粒子在有限空間下操縱應用之研究」方面，本研究主要探討微磁性粒子在擺動磁場下之運動模式，並透過實驗結果分析其操控機制。利用微米尺寸之順磁性粒子，將放置於一有限空間大小之微液滴內，先施以單一方向之外加磁場將磁性粒子串接，再施加擺動磁場進行操控粒子串之實驗。因粒子具順磁性，一旦將磁場關閉後，粒子便會失去磁性而回復原始狀態，故利用此一特性，可設計一簡易且可逆式之微機構。因此，本研究藉由實驗建立一種磁性粒子重新排列機制，更進一步對於有限空間內不同位置之磁性粒子串運動進行比較，證實位置因素對於粒子串運動模式之影響較小；反之，對於有限空間內以及無限制空間之下之粒子串運動模式而言，實驗證實位於有限空間內之粒子串運動所受到之阻力確實較位於無限制空間內之阻力為大。因此，對於本研究能利用磁場精確控制磁性粒子，有效形成序列運動之方法，未來若能運用在生醫檢測領域，將不僅能大幅減少樣本劑量，同時增加檢測精準度。另在第 2 篇「微流體於 T 型流道生成之連續軌跡研究」方面，鑒於利用微流體裝置開發微小型生化檢測技術已是目前生醫晶片設計趨勢，整合各式傳感器之微型晶片不僅具備實驗室檢驗功能，亦可執行多相材料合成操作，不但適用性高且便於攜帶，更具備快速檢測之效能。因此，本研究基於微流體流動不穩定性，在控制 T 型流道流速下進行油/水兩相微液滴成型溶劑壓力變化與成分定量研究，利用壓降變化訊號評定量化結果優劣，並進而分析微操控技術對微量流體精確配比之可行性。

會議第 2 日研討議題主要包括「奈米壓印」、「微奈米工程光蝕刻技術」與「應用生活科技」等。其中，日本放射線醫學綜合研究所 Yoshii 教授等人以三維奈米壓印技術改善二維細胞培養物高通量篩選方式，提升抗癌藥物開發效率之研究最令在場人士驚嘆。由

於原本二維方式會從體內腫瘤誘發不同的細胞特徵致使抗癌藥效降低，因此嘗試以三維奈米壓印培養方式模擬體內環境，從而增進藥物療效以研發創新之高通量篩選系統便為其研究重點。與二維培養方式相比，其研究證明以細胞系為基礎之三維奈米壓印方式提供了一種開發高通量藥物篩選系統技術，經由模仿腫瘤環境使得抗癌藥物開發更有效率，可以更有效地篩選藥物，抑制癌細胞生長。在微奈米元件設計方面，德國多特蒙德工業大學（TU Dortmund University）F. J. Giebel 教授等人製造一種可應用於微觀尺度測量電子加速過程之氣體傳感器晶片，此一量測方式經驗證可以利用平面技術設計不同氣態物質之測試設備。此外，該研究團隊更以安裝第二浮柵作為離子感測電極以進行晶片間距尺寸最佳化研究，並以改善傳感器靈敏度為目標。基於現有成果，其研究團隊未來將以電子離子化為主要研究方向，使傳感器氣體檢測精度大幅提升。此外，希臘國家科學中心（NCSR Demokritos）E. Gogolides 教授與其研究團隊發展一種等離子體蝕刻方式作為替代軟光刻方法的一種技術，使得微流體裝置製程愈加精確與快速。一般而言，軟光刻方法多運用於聚二甲基矽氧烷（PDMS）為基材之微流道製造技術中，常用於蛋白質與 DNA 檢測之生物傳感器設計。然而，本研究提出之等離子體蝕刻方式不但可將原製程工藝最佳化，亦可以運用在 PDMS 或聚甲基丙烯酸甲酯為基材之微流道製作方面，達到最大之蝕刻速率。

個人另 2 篇論文「具備週期震盪流場特性之散熱系統創新設計」與「利用多層超快雷射進行石墨烯直接圖案研究」分別歸類於元件設計與生活科技領域與製程技術領域，兩者皆排定於第 2 日上、下午分別進行海報研討。在第 1 篇「具備週期震盪流場特性之散熱系統創新設計」部分，研究目的在開發新穎之冷卻技術導入高功率機電系統，以維持其效能與功耗。由於元件傳熱能力限制，使得傳統技術發展之散熱系統難以符合複合型機電設計所要求的冷卻性能。於此，本研究提出了一種填充自組裝磁性流體之散熱系統，利用外加電磁場方式誘發流體產生週期性擾動，進一步導致系統內部流場共振而大幅提升熱擴散效應。此一利用電磁操控奈米流體提升現有散熱系統效率之方式，可用於開發前瞻性的半主動熱控制系統。在第 2 篇「利用多層超快雷射進行石墨烯直接圖案研究」方面，有鑒於石墨烯優異之熱電特性，故近年來產學界已投入相當努力開發石墨烯相關運用，如醫療用非酶檢測元件等。本研究思考微檢測裝置必須搭配必要之新製程技術，故採用雷射加工直接寫入圖案方法完成元件奈米/微結構設計。研究使用之超脈衝雷射具備非平衡能量輸送能力，可精確控制閾值並縮小熱影響區，有利於改進傳統製程之表面粗糙度，提升感測精度。當日 2 篇論文除與國外學者經驗分享外，亦與現場先進設備商討論相關製程與量測技術等，實在獲益匪淺。

會議第 3、4 日之議題以「製程技術」與「微奈米元件設計」為討論主軸。其中，義大利光子與奈米科技學院（Institute for Photonics and Nanotechnologies）M. Bollani 教授認為半導體自旋電子之生成與操控是目前自旋電子學中最先進之技術，於是其研究團隊提出一種在基於半導體材料製成之自旋光伏電池，引發現場熱烈討論。其研究說明，由於 IV 族半導體存在較大之自旋軌道與電子自旋壽命，故最適合作為其研究應用。此外，半導體自旋電流可以藉由光學定位產生光誘導反應，而此一誘導技術係取決半導體的誘導帶自旋定位電子通過圓偏振光之吸收能力。由於其研究促使電子自旋極化向量與入射光平行，故大幅降低以往半導體製程中樣品表面易產生自旋極化投射之風險。在「微奈米元件設計」方面，美國喬治亞理工學院（Georgia Institute of Technology）Z. L. Wang 教授等人認為微奈米科技是發展微型封裝技術與自生能源方法之關鍵，相關技術將有助於無線傳感器、植入生物裝置、環境監測、與個人電子產品等設計，故其研究團隊不斷致力於開發能適用於各種形式能源轉換之低功率奈米元件之創新技術。其研究不僅利用壓電氧化鋅奈米線陣列將奈米級機械能轉換成電能，同時提出提高性能轉換相關因應對策；此外，更深入探討奈米發電機之基本設計原則與潛在發展窒礙，引起在場許多學者矚目。

本次會議場地寬廣且軟硬體設備完整，另加上場區劃分得宜，故能在緊湊之會議議程安排下，同時容納數百位與會人員在便利舒適之環境下進行意見交換。此外，各場區亦設置多個交誼點並配置多名服務人員與各式電子設備、文具等，便利與會人士進行小眾研討。個人主要研究以微熱傳元件設計與應用為主，近來更將微奈米技術與控制方法導入各項研究，使在有限經費與設備支援下，能突破設計限制並有效改進元件性能。另由於個人研究多以應用為考量，適用領域廣泛，因此會中與各學者均有深入研討，而其中尤以儲能議題最為熱烈。個人就近來儲能研究進行經驗分享，說明在既有材料與設計限制下，利用磁性流體優異之熱傳特性與可操控性作為熱儲存器熱傳介質，當在熱儲存器兩側以交錯排列方式安裝電磁裝置後，施以適當電磁場強度下會誘發流體產生局部擾動提升熱擴散效應，使導熱迴路能迅速、穩定地釋熱。另在導熱設計方面，個人則利用迴路熱管可以獨立操作、低成本與可撓性高之特點，設計導熱迴路將熱能導入熱儲存器。再者，由於迴路設計易使熱傳介質產生離心力而迫使管路中心附近區域與管壁附近流體間產生交互作用，導致周而復始地在垂直軸向速度場的平面上產生對稱渦流，使得熱傳與質傳效率遠高於相同流量與加熱條件下之直管流，因此可應用在處理高熱通量熱源之導熱設計。由於個人已成功利用此一方法發展半主動式中低溫熱儲裝置並於 2014 年完成國際期刊發表，相關研究主題尚屬新穎，發展經驗可提供相關學者參考。另在微量流體估測方面，礙於個人實驗設

備有限，實無法流場進行可視化觀測，然個人提出利用系統識別方法將流場暫態特性（如溫度、速度、壓力等）建構輸入、輸出模式，進而分析流場動力特性之方法，亦與會場學者分享。個人認為，由於量測之訊號即為流場暫態物理量，因此所建構之因果關係不僅可以獲得流場物理量間之時間關聯，當轉換之頻域後更可進一步展現流場能量變異情形，諸如熱傳遞、擾動等共振特性。因此，藉由上述方法即可有效掌握流場微尺度熱傳變化，甚或可運用於電磁熱流耦合等複雜問題；如此，不僅可以描述某一流場行為，亦可以用於流場行為預測。由於個人引用控制領域方法導入微流體熱傳問題研究，可以不用精密設備分析即能獲得微流體量化分析與預測，故吸引許多學者興趣主動參與討論，使個人有機會獲得諸多寶貴意見與研究改進參考。

參、會議心得

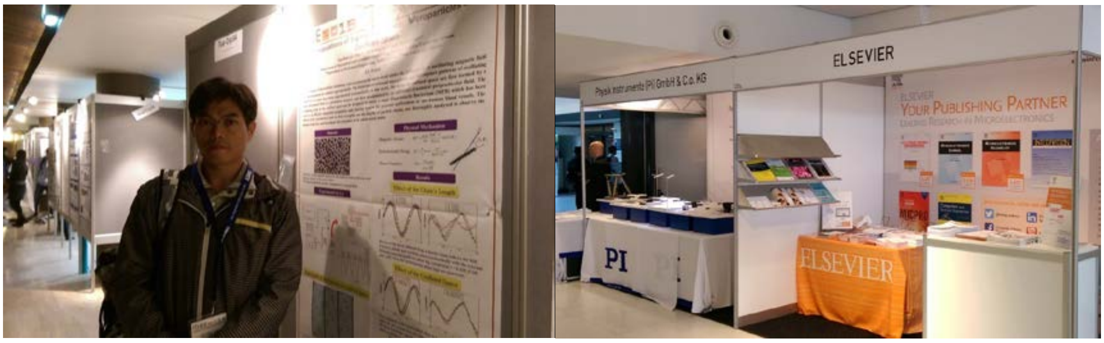
本屆國際微奈米製程與製造研討會在荷蘭海牙舉行，比鄰世界著名的國際法庭，環境樸實優美。經大會介紹瞭解，雖然荷蘭人口達 1700 萬，然僅設立 15 所大學，就讀大學者多具備主動學習動機與相當學識能力，說明其大學菁英教育品質卓越，可想見荷蘭政府對其教學與研究資源之挹注當十分豐沛。海牙是荷蘭第三大城市，亦為荷蘭中央政府所在地，相關中央政府機關與外國使館幾乎皆位於此。本次會議舉辦地點「世界論壇」占地約 2500 平方公尺，比鄰著名的聯合國國際法庭與國際刑事法院最高法院旁，是著名的國際學術會議舉辦場地。會議期間，隨處可見師生交流與討論，個人亦把握機會觀摩許多國際名校的研究成果並能親自與各國專家學者交談，對於許多學者花費十餘年專精於單一研究之堅持尤其印象深刻，試想所謂專家養成不外乎就是專注於一項學問或技術發展?相信唯有如此堅持方能有卓越之研究成果產出，此一難能可貴之學習與經驗交流機會經驗不僅增進個人視野亦將裨益後續研究。

綜觀而論，國外學術多以團隊研究為主，具有相當之研究水準與研究規模，在整合專業人力與分工合作前提下，相關研究不僅涉獵廣泛且應用性高，此一作法正與本院成立研究群相仿，其運作方式值得學習參考。實際作法方面，則建議各研究群能定期邀請相關研產單位參與議題規劃，使教師瞭解需求單位窒礙所在，使能提供適時諮詢，最終達到學術研究能與單位研產實務結合。此外，個人近年來經常參與各項學術會議，與不少國內、外學者均有學術交流，經常藉由相關學者推薦擔任著名國際期刊之審查委員，故參與本會議除能達到上述經驗交流目的外，同時亦有助於提升個人與國防大學理工學院之可見度。參與本次會議後，個人深切體認唯有厚植基礎研究方能逐步發展尖端之科技產業、培養專業

人才，可知學術研究對於國家競爭力所扮演之重要角色。就個人言，持續累積個人研究能量、拓展研究視野，培育國防研究人才並提升個人學術能力將是努力目標。綜觀會議中不乏許多研究生進行論文發表，其在面對專家學者諸多意見詢問後仍能有條不紊地輕鬆回覆，其所展現之穩健臺風與自信實令人印象深刻。因此，鼓勵教師及研究生踴躍參加國際學術研討會時有必要，不僅有助於瞭解最新研究趨勢，立即獲得許多難得寶貴意見，修正未來研究方向，也可以藉此加強與國際學者學術交流，增進個人國際觀與培養良好之學術表達能力。

日、韓等亞洲國家參與國際會議已有逐年增加趨勢，許多研究團隊在特定設備商贊助研究下，相關研究成果豐碩且品質大幅提升；在此相輔相成策略下，學術與產業均互蒙其利，學術機構地位因而逐年遞增，而產業界相關設備也獲得驗證推廣。由本屆會議收錄論文分析，日本與南韓分居 1、2，合計約有 50 餘篇；而中國大陸也急起直追，亦有近 20 餘篇論文發表；其中，學術機構不乏日本東京大學、京都大學、名古屋大學，韓國首爾大學、韓國科學技術研究院、浦項工科大學，以及北京大學、上海交通大學等國際知名大學；產業界則包括三星電子、現代工業、三菱重工等。我國參與學校則包括台大、清大、交大、師大、中原及本校等，另有工研院、台積電、鴻海精密工業等產業與會發表其研究成果。由此觀之，藉由本會議作為學術交流與產業創新發表之平臺，各國無不展現其在微奈米先進研究之技術，尤其亞洲科技大國對本會議之重視更是不言可喻。一般而言，我國與日、韓皆具備微奈米先進製程技術，因此產業界在製程領域研究成果相仿；相較之下，我國學術界許多論文則多以實務應用為主，內容涵蓋生醫、機電、材料、熱流與能源科技等領域，主題多元且能符合生活應用，故多能吸引產業界矚目。然而，在與國內與會先進研討後，個人深切認知在既有研究條件下，唯有跨領域整合研究資源與人力，多增加學術交流機會，方能創新既有思維、以不同角度深入研究問題，進而得到令人讚嘆之研究成果。此外，在與國外學者討論中得知，其所屬學系師資多可依自身條件自行選擇教學、研究、與技術等類別，年度經費更足以支應各項教學、研究工作，教師不會因缺乏校外經費補助而影響教學研究。鑒此，在既有人力、經費與設備限制下，建議不涉及機敏之學術研究應鼓勵校際合作，採整合研究資源方式進行。

本次會議議程緊湊，多場報告礙於場次重疊以致無法聆聽，所幸大會提供相關研究摘可供後續查詢參考，優秀之研究成果亦將獲邀收錄於期刊，有助於學者研究運用。



圖一、會場海報展示區與贊助出版商

圖二、參展設備商

圖一、議程報告與會場討論一隅

肆、建議事項

一、國際學者多以團隊之力執行研究，故在整合專業、分工合作下多能提升研究深度與廣度。反思本身雖然不斷鑽研新知，然在既有研究環境與人力支援限制下，單憑個人努力實難在短時間內擴展研究領域。本校現已與國內數所大專院校進行學術交流、建立策略聯盟等；建議可持續加強校際合作、廣泛進行相關系所專業領域交流，期能藉由定期研討交流與專案合作，激勵本院教學研究工作，增進整體研究能量。

二、本院每年舉辦國防科技學術研討會，是國內參與國防科技研究學者之重要交流平臺，為鼓勵優秀論文發表，今年更增設傑出論文獎。個人建議，可以比照國際微奈米製程

與製造研討會擇優邀稿方式，優秀稿件經嚴格評選後可直接邀請作者完成全文撰寫轉刊登中正嶺學報。如此，不但可以吸引優質研究論文投稿，亦可增加本院中正嶺學報優質稿件數量。

三、近年來科技部專題研究計畫申請通過不易，然為避免研究資源中斷，建議應鼓勵院內老師申請國防科技學術合作案與相關研產單位之委託案。如此，不僅可以加強本院與國軍研產單位學術交流，亦可使本院師生實際參與國防科技實務，樹立本院於國防科技之關鍵地位。

計畫編號	MOST-104-2221-E-606-009-
發表論文題目	1. 微磁性粒子在有限空間下操縱應用之研究 2. 具備週期震盪流場特性之散熱系統創新設計 3. 微流體於 T 型流道生成之連續軌跡研究 4. 利用多層超快雷射進行石墨烯直接圖案研究
出國人員姓名 服務機關及職稱	李亞偉　Lee, Ya-Wei 國防大學理工學院機械及航太工程學系 副教授
會議時間	自民國 104 年 09 月 21 日起至民國 104 年 09 月 24 日
會議地點	荷蘭　海牙
會議名稱	中文：2015 年第 41 屆國際微奈米製程與製造研討會 英文：41st International conference on micro- and nanofabrication and manufacturing using lithography and related techniques

伍、附件

1. 會議邀請函

To the Embassy of the Netherlands in Taiwan,

Delft, 1 August 2015

To whom it may concern:

I herewith confirm that
LEE, YA-WEI

Passport Number: E308533883 Date of expiry: 2024.01.02 Birthday: 1970.01.01

Affiliation:
Department of Mechanical and Aerospace Engineering, Chung Cheng Institute of Technology,
National Defense University No.75, Shiyuan Rd., Daxi Township, Tauyuan County 33551, Taiwan
Phone: +886-3-3801126
Fax: +886-3-3800647

has registered, has sent an abstract and plans to attend the 41st MNE2015 Conference in The Hague, 21-24 September 2015. We welcome him at the MNE2015 Conference in The Hague. I herewith kindly ask the authorities to grant LEE, YA-WEI a visa such that he can enter the Netherlands and attend the MNE2015 Conference (www.MNE2015.org).

Yours sincerely,

Professor Urs Staufer
Program Chair MNE2015

Delft University of Technology
Faculty 3mE,
Precision and Microsystems Engineering
Mekelweg 2, 2628 CD Delft, The Netherlands
E-mail: u.staufer@tudelft.nl

2. 註冊收據

Invoice for MNE 2015

Payment has been received from Professor Ya-Wei Lee for "MNE 2015" (21-09-2015).

Details

Name: Professor Ya-Wei Lee

Address: No.75, Shiyuan Rd., Daxi Township , 33551 Tauyuan County

Affiliation: National Defense University

Invoice date: 01-Aug-2015

Invoice total: € 710.00

Already paid through: credit card

Package: Standard Participant € 710.00 = € 710.00

Invoice number: 2015-69963-000132

Note: On your credit card receipt this payment will appear as charged by VENTILO-CHARGE.COM.

The organizer

Stichting FAST

Nachtegaallaan 3

2623GC Delft

Netherlands

0031-15-2786073

c.w.hagen@tudelft.nl

VAT number: NL816732796B01

Chamber of commerce no.: 41145846

3. 發表論文

（1）微磁性粒子在有限空間下操縱應用之研究

Manipulations of superparamagnetic microparticles in confined space

Yan-Hom Li[1], Ting-Yu Su[2], Ching-Yao Chen [2], Ya-Wei Lee[1*]

[1] Department of Mechatronic, Energy and Aerospace Engineering, Chung Cheng Institute of Technology, National Defense University, Taiwan, R.O.C.
[2] Department of Mechanical Engineering, National Chiao Tung University, Taiwan, R.O.C.

e-mail: yaweilee@ndu.edu.tw

Keywords: Superparamagnetic micro-bead, Confined spaces, Oscillating field, Magnetotactic Bacterium

The dynamics of microchains containing superparamagnetic micro-bead under the influence of an oscillating magnetic field in confined spaces are studied experimentally. The behaviors of unbound microchains and the rupture patterns of oscillating chains in free space have been experimented systematically [1-3]. In this work, the chains in confined space are first formed by a static directional field or a permanent magnet, and then manipulated by an additional dynamical perpendicular field. The oscillating chain in the confined space can be designed to mimic a single Magnetotactic Bacterium (MTB) which has been used as an effective integrated propulsion and steering system for potential applications in the human blood vessels [4]. The effects of key parameters, such as field strengths and the lengths of particle chains, are thoroughly analyzed to observe the distinct behaviors and investigate the dynamics of the constrained chains.

The magnetic particles used in our experiments are aqueous superparamagnetic polystyrene microspheres coated with iron oxide grains. The averaged diameter of the particles is 4.5 μm, with no magnetic hysteresis or remanence. The solvent fluid is a mixture of distilled water and sodium dodecyl sulfate (SDS) surfactants. The viscosity of this solvent fluid is g = 1.75 cp. A static unidirectional magnetic field, denoted as H_d, is generated firstly by a pair of coils powered by DC power sources. Magnetic particles magnetized by the unidirectional field tend to aggregate and form chains because of dipolar forces. To create a vibrating field, another pair of coils are placed perpendicular to the former pair and connected to AC power supplies to generate a sinusoidal dynamical perpendicular field with a maximum field strength H_p and frequency *f*, i.e. $H_p \cdot \sin(2\pi ft)$. Fig. 1 shows the sequential images of chaining of the initially dispersed magnetic particles subjected to a static directional field. The pattern is similar to the unbound chains [1-3]. On the other hand, the initially clustered particles are not easy to form a straight chain in the unbound space. In this paper, we demonstrate a simple methodology to re-disperse the clustered particles and construct the chain in confined space by applying a permanent magnet. Fig. 2 presents the 5-clustered particles re-dispersed then forming a chain in confined space. It can be generally expected that a longer chain would induce stronger drags under the same field condition, and thus leads to a larger phase angle lag between the external field and the chain. Fig. 3 shows the evolutions of the phase angle trajectories of constrained chains composed of different numbers of particles subjected to identical field strength. Apparently, because of the lower induced drag, a shorter chain follows the field trajectory closely and oscillates more synchronically with the external field and causes insignificant phase lag, except near t = 0.25P, 0.75P, and 1.25P, when the instantaneous phase lags are enormous.

The influence of the confined space on oscillating chains is also investigated in this work. Fig. 4 demonstrates the trajectories of the phase angle of unbound and constrained chain consisting of 4 particles subjected to identical field strength. It can be observed that the amplitude of the constrained chain is slightly smaller than the unbound one due to the stronger hydrodynamic drag in the confined space. In addition, the much smaller confined space would lead to the much more significant decrease of oscillating amplitude, and thus resulting in larger phase angle lag.

References:
[1]Y.H. Li, S.T. Sheu, J.M. Pai, C.Y.Chen, J. Appl. Phys. 111 (2012), 07A924.
[2]Y. H. Li, C. Y. Chen, S. T. Sheu, J. M. Pai, Microfluidnanofluid, 13 (2012), 579-588.
[3]H.C. Lin, Y.H. Li, C.Y. Chen, Microfluid Nanofluid 17 (2014), 73-84.
[4]S. Martel, C.C.Tremblay, S. Ngakeng, G. Langlois, Appl. Phys. Lett. 89 (2006), 233904.

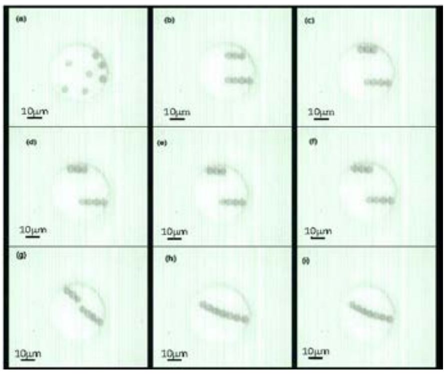


Figure 1. Images of 7 microparticles chaining under a static directional field.

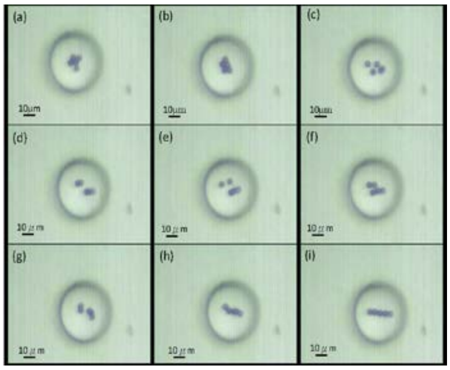


Figure 2. Images of the re-dispersion and aggregation of the 5-clustered microparticles under the application of a permanent magnet.

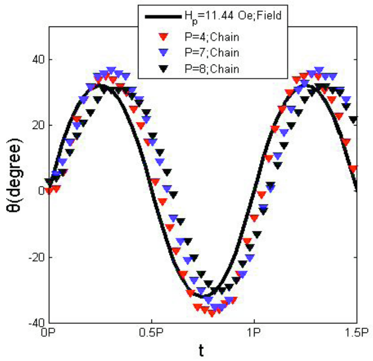


Figure 3. Trajectories of the phase angle (ɵ) of the external field and chains composed of different numbers of particle subjected to an identical perpendicular dynamical field strength of H_p=11.44 Oe.

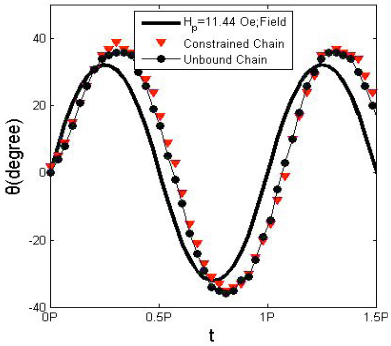


Figure 4. Trajectories of the phase angle (ɵ) of constrained and unbound chains composed of 7 particles under the static directional (H_d) and perpendicular dynamical field (H_p) strength of H_d=18.15 Oe and H_p=11.44 Oe, respectively.

（2）具備週期震盪流場特性之散熱系統創新設計

Novel design of a nanofluidic thermal system with periodic perturbations

Ya-Wei Lee[1*], Yan-Hom Li[1], Tien-Li Chang[2]

[1] Department of Mechatronic, Energy and Aerospace Engineering, Chung Cheng Institute of Technology, National Defense University, Taiwan, R.O.C.
[2] Department of Mechatronic Engineering, National Taiwan Normal University, Taiwan, R.O.C.

e-mail: yaweilee@ndu.edu.tw

Keywords: Electromagnetic controlled, Thermal system, Magnetic-based nanofluid

The need for new cooling techniques is driven by the continuing increases in power dissipation of electronic parts and systems. In many instances standard techniques cannot achieve the required cooling performance due to physical limitations in heat transfer capabilities. Recently, researchers have conducted studies to demonstrate the applicability of electronics and structural thermal controls [1-3]. This study presents an electromagnetic controlled thermal system (EMTS) with self-assembling magnetic particles (Fig. 1). The novel design of EMTS consists of a loop heat exchanger and two electromagnetic designs. Each electromagnetic design has two 1200 gauss-strength rated magnets parallel arranged on the side of the vapor/liquid line, and a nickel coated copper wire with 0.36 mm^2 cross-sectional area carried current (3-4 A) was evenly coiled on the outer surface of each magnet. Magnetic-based nanofluid (MNF) prepared by a standard co-precipitation technique was selected as the working medium. The average size of the MNF nanoparticle, determined using a high-resolution transmission electron microscope, is 23 ± 2.5nm. The hysteresis loops for 4.0 M MNF used, measured using a vibrating sample magnetometer, exhibit a satisfactory superparamagnetic behavior of 14.5 emu/g at 300 K and ±15000 Oe (Fig. 2(A)). To avoid the agglomeration, the iron ferrite nanoparticles are carried with the evaporating fluid under a low saturated vapor pressure [4]. A vacuum/charging system was used to evacuate the EMTS and to charge a controlled amount of MNF with 50% volume ratio into it. In the evaporator, heat is conducted through a combination layer of liquid and porous wick and then removed in the form of latent heat through evaporation from the menisci, which formed at the surface of the porous wick. Following a one-way circulation, the rectangular grooves on the wick were used to guide the flow. The porosity of the wick is controlled at 0.65, and the average pore dimension of the porous wick was 14 ± 2 μm, as shown in Fig. 2(B). The porous wick in the evaporator is crucial for providing high specific capillary pumping, which can increase the effective evaporation surface area and significantly enhance the heat transfer process.

The performance comparisons between the thermal system with and without electromagnets are shown in Fig. 3. At a low heat load of 10 W, the EMTS nearly stays in a stagnation condition, showing such a heat load is too low to create a circulating two-phase flow, and merely cause the pool of working fluid to boil even under electromagnetic fields (EMFs). When the heat load achieves 20 W, an obvious difference existed in the comparisons of system performances by the electromagnetic induction. Particularly after the heat load arrived to 100 W, the thermal system without electromagnets achieves an optimal performance of 1.31°C/W and then it gradually change into worse as the heat load increased. However, the EMTS not only extend the heating range from 120W to 150W but yield a maximal enhancement of 65.4% at 120W.

An observation shows T1-T6 fluctuate more regularly compared with T7, implying that the EMFs alleviate the thermal instability and guide the working medium to follow a periodic mode. All the perturbations vary simultaneously and remain a specific resonance for each heat load. At the optimal heating condition of 120W, around 15 dominant flow perturbations occur at T1-T6 during 200 s (sampling rate is 5Hz), corresponding to a resonant frequency of 0.075Hz (Fig. 4). This study paves the advanced way for a host of flow control studies cultivating forward-looking and innovative applications. Such a self-excited flow can further be manipulated for developing kinds of thermal control systems.

References:
[1] Y.W. Lee, T.L. Chang, Energ. Convers. Manage. 50 (2009), 1069-1078.
[2] S.W. Lee, S.D. Park, S. Kang, I.C. Bang, J.H. Kim, Int. J. Heat Mass Transfer 54 (2011), 433-438.
[3] M. Bahiraei, M. Hangi, Energ. Convers. Manage. 76 (2013), 1125-1133.
[4] Y.W. Lee, Int. J. Appl. Electrom. 47 (2015) 593-605.

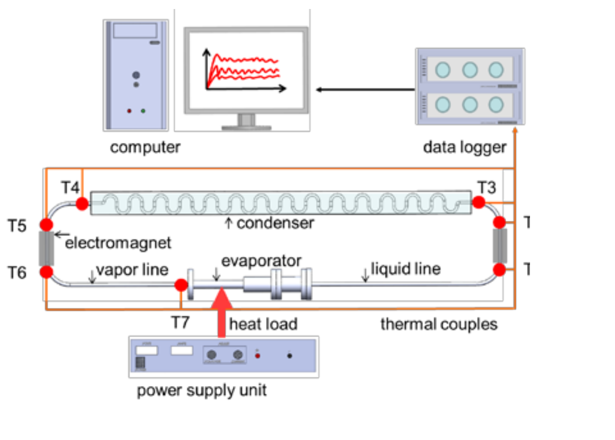


Figure 1. Schematic of integrated EMTS and the details of experimental setup.

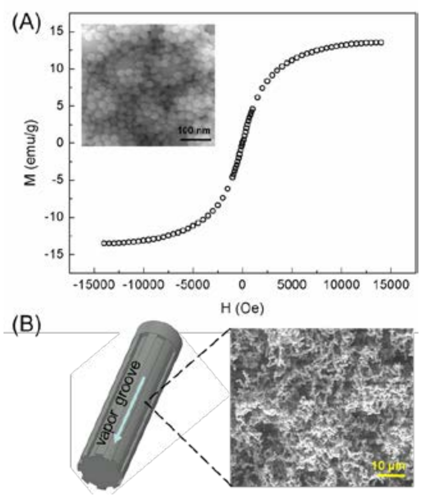


Figure 2. (A) TEM image of MNF and Magnetic hysteresis loop of 4.0 M MNF. (B) Geometry and structure of the wick.

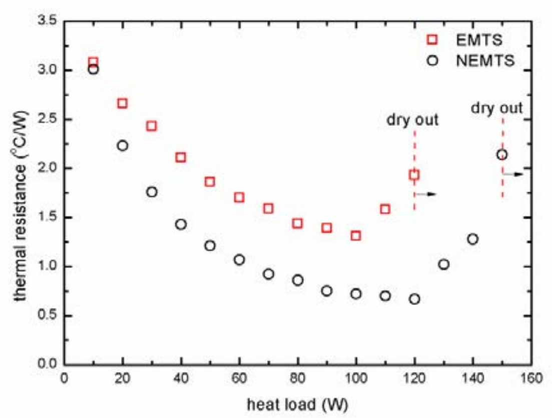


Figure 3. Comparisons of thermal resistances with heat loads for the thermal system with and without electromagnets.

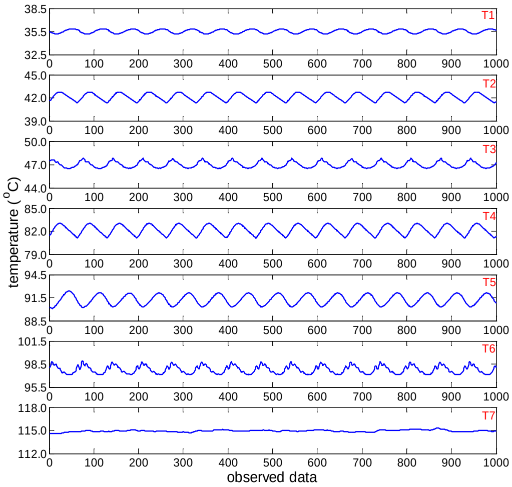


Figure 4. Comparisons of temperature responses along the EMTS at a heat load of 120 W, where all the data were selected during a 200 s period.

（3）微流體於 T 型流道生成之連續軌跡研究

Continuous tracing of emulsion formation in a microfluidic T-junction

Ya-Wei Lee[1*], Tien-Li Chang[2], Wun-Yi Chen[2], Zhao-Chi Chen[2]

[1]Department of Mechatronic, Energy and Aerospace Engineering, Chung Cheng Institute of Technology, National Defense University, Taiwan, R.O.C.
[2]Department of Mechatronic Engineering, National Taiwan Normal University, Taiwan, R.O.C.

e-mail: yaweilee@ndu.edu.tw

Keywords: Emulsion, Microfluidic, Droplet, Microflow

The miniaturization of biological and chemical processes has been a trend in design of microfluidic devices recently [1]. The microchip, like a lab-on-a-chip, performing multiphase material synthesis operations with integrated transducers leads a wide use of microfluidics [2]. Based on the flow instabilities for forming the droplets, the study aims a quantitative approach on an emulsion flow in a microfluidic T-junction. The experiment setup shown in Fig. 1, where polydimethylsiloxane (PDMS) T-junction is fabricated by using soft lithography. The inlet channel in T-junction containing the dispersed phase perpendicularly intersects the mainly channel which contains the continuous phase. Herein the dispersed phase and continuous phase are liquid phase and oil phase solutions, respectively. The aspect ratio of inlet and main channels indicate that the value is 0.5 (100 μm / 200 μm). Two differential pressure transmitters with ± 0.17% uncertainty set at both ends of main channel, in which the fluctuations of the emulsion flow are measured at a sampling rate of 100 Hz.

Emulsions consist of small liquid droplets evenly immersed in another liquid, typically oil in water or water in oil. When the shear stress from the continuous phase is large enough to affect momentum, it leads to the interfacial instability of the forefront portion of coming liquid stream to be dispersed. Here, the flow rate of dispersed phase, Q_B, was only adjusted for changing the flow pattern of emulsion at a constant continuous phase. Fig. 2 shows the droplet size was changed by altering Q_B, causing the fraction of dispersed phase in emulsion flow was also changed. The breakup of dispersed phase was expanded and the droplet sizes are elongated with flow rate ratios of dispersed phase to continuous phase. This figure indicates Lw increases in proportion to flow rate ratio of dispersed phase to continuous phase Q^* ($Q^*= Q_B/Q_A$). Moreover, the volume fraction of dispersed phase in emulsion L^* ($L^*=Lw/Lc$) can be regarded as a quantitative control used in fabrication of emulsions. With increasing Q^*, droplet sizes were increased. Lw/Lc also increased with Q^* and followed a trend, shown in Fig. 3(A). A critical value of L^* achieved was around the ratio of 0.85-0.87. Note that pressure drop occurs when frictional forces, caused by the resistance to flow, act on the fluid as it flows through the microchannel. The main determinants of resistance to fluid flow are fluid velocity through the channel and fluid viscosity. Pressure drop increases proportional to the frictional shear forces within the flow and channel wall. It indicates high flow velocities /viscosities could result in a larger pressure drop across the channel. Fig. 3(B) shows the variation of pressure drops with Q^*, where a slow variation can be found as the ratio achieves 2.0. Fig. 4 shows the transient pressure drops of emulsion flow in the main channel with Q^* of 0.667, 1.667, and 2.667. It is clearly shown that the fluctuating range of total pressure drops during several formation processes of emulsion. These periodic fluctuations can be corresponded to the formation time of dispersed droplets.

The method proposed is based on an adjustment of flow rates that forms emulsion with different constituent ratios, resulting in changes of flow patterns. Corresponding to the measurement of pressure drops, demonstrated periodic fluctuations are consistently appeared and deeply related to the regularity of emulsion dynamics. Therefore, the emulsion quality can be precisely controlled by inspecting the flow resonances that can be helpful to design the functional on-chip microfluidic system.

References:
[1] K Mogi, Y Sugii, T Yamamoto, T Fujii, Sensors Actuat. B: Chem, 201 (2014), 407-412.
[2] H. Wang, H. Zhou, Y. Zhang, D. Li, Microelectron. Eng., 87 (2010), 2602-2609.

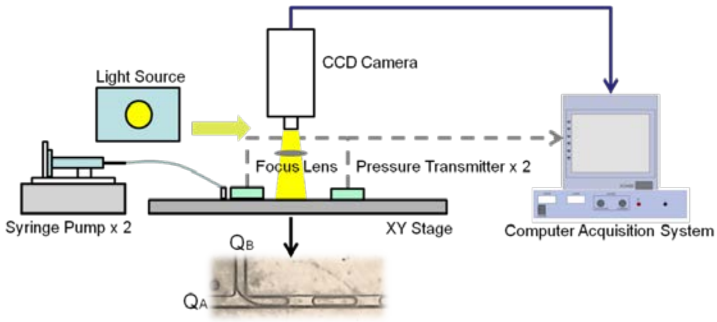


Figure 1. Schematic of experimental setup.

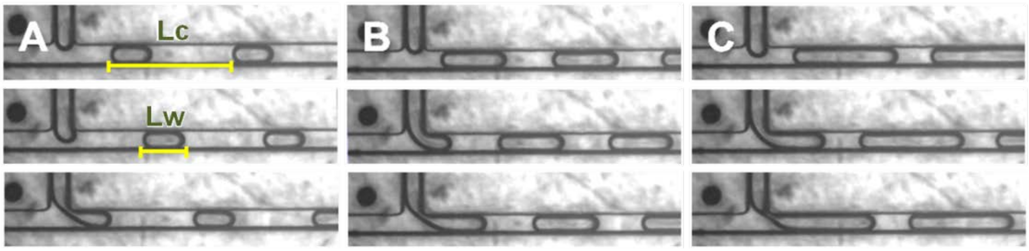


Figure 2. Comparisons of dispersed phase droplets in emulsion flow at different fill conditions: (A) Q^* = 0.333, (B) Q^*= 1.667, and (C) Q^*= 2.667.

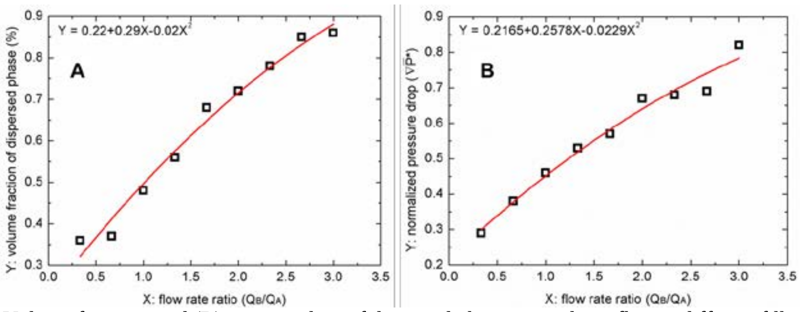


Figure 3. (A) Volume fractions and (B) pressure drop of dispersed phase in emulsion flow at different fill conditions.

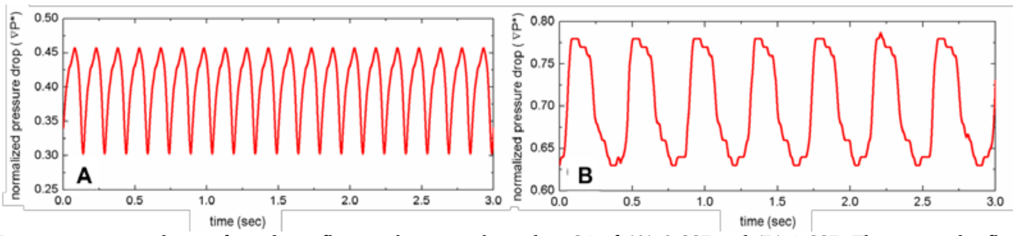


Figure 4. Transient pressure drops of emulsion flow in the main channel at Q^* of (A) 0.667 and (B) 2.667. These periodic fluctuations related to flow behaviors can be used to ensure the quantification of emulsion.

（4）利用多層超快雷射進行石墨烯直接圖案研究

Direct patterning of multilayer graphene by ultrafast laser irradiation

Ya-Wei Lee[1], Tien-Li Chang[2], Wun-Yi Chen[2],
[1]Department of Mechatronic, Energy and Aerospace Engineering, Chung Cheng Institute of Technology, National Defense University, Taiwan, R.O.C
[2]Department of Mechatronic Engineering, National Taiwan Normal University, Taiwan, R.O.C.
e-mail: yaweilee@ndu.edu.tw

Keywords: Ultrafast laser, Picosecond laser, Ablation, Multilayer graphene, Thin films

Graphene has attracted significant interest as a promising material for the greatly anticipated all-carbonbased electronic applications. Recently, considerable efforts have been devoted to develop various graphene-based devices for medical sensing applications [1], such as the non-enzymatic detection of hydrogen peroxide [2]. It is noteworthy that the scale-down of detection devices has driven the need to the new manufacturing techniques. Unlike the complex manufacturing processes, the laser machining is a direct-write patterning technique to form the nano/micro-structures [3]. With the rapid development of ultrashort-pulsed technology, the advanced ultra-pulsed laser (typically < 10 ps) with its non-equilibrium energy transport, precise threshold and small heat-affected zone has opened new paths for the surface or bulk of material to be modified [4].

To assist and require the industrial process, the aim of this study is to use the direct patterning of multilayer graphene with an ultra-pulsed UV picosecond laser (PS-laser) irradiation. The ultrafast laser system is composed of the PS-laser, galvano-mirror scanner and high-precision stages, in which the laser delivers a beam of a center wavelength of 355 nm at a maximum power of 4 W and is capable of producing pulses of 15 ps duration at 200 kHz. Before PS-laser ablation process, the homogeneous multilayer films on the glass are papered with graphene ink by the screen-printed process. The experimental setup of laserablation system, screen-printed process and laser process are shown in Fig. 1a, 1b and 1c, respectively. The Raman spectroscopic characterization of multilayer graphene films shown in Fig. 2a, in which the two characteristic peaks of graphene are the G band (1580 cm^{-1}) and the 2D band (2720 cm^{-1}). In addition, the Gaussian pulse profile shown in Fig. 2b can be determined by the fluence controlled for patterning of graphene-based devices. Consequently, the surface morphology of the multilayer graphene under the laser fluence of 10.4 J/cm^2 can be characterized by the image of field-emission scanning electron microscope (FE-SEM) in Fig. 2c. When the thickness of graphene decreased with laser ablation process, the optical transmittance can increase, as shown in Fig. 3a. Furthermore, the electrical response of graphene-based devices can be performed by laser ablation process, as presented in Fig. 3a. It can be found that the lowest resistance is 1300 Ω when the energy fluence is 5.2 J/cm^2, as shown in Fig. 3b. In summary, using the UV Ps-laser patterning of screen-printed graphene films, we have directly fabricated graphene-based devices. Based on this direct laser patterning approach, it can provide a great opportunity to develop and use for the electrical, fast and small-volume detection in portable and implantable in the new fields of optoelectronic applications.

References

[1] K. Matsumoto, K. Maehashi, Y. Ohno, K. Inoue, Phys. D: Appl. Phys., 47, 094005 (2014).
[2] F. Xi, D. Zhao, X. Wang, P. Chen, Electrochem. Commun., 26, 81-84 (2013).
[3] M. H. Kwon, H. S. Shin, C. N. Chu, Appl. Surf. Sci., 288, 222-228 (2014).
[4] F. Caballero-Lucas, C. Florian, J. M. Fernández-Pradas, J. L. Morenza, P. Serra, Appl. Surf. Sci., 336, 170-175 (2015).

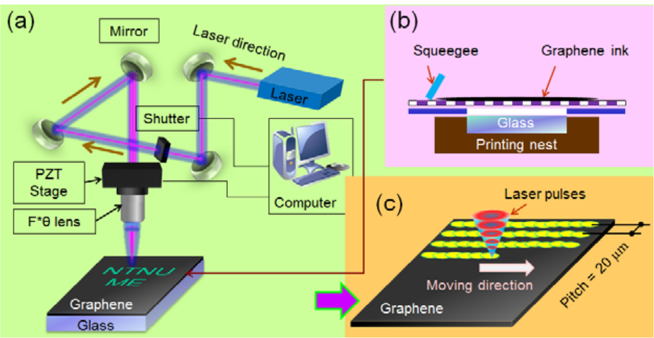


Fig. 1 (a) Experimental setup of UV picosecond laser system for mask-free and programmable patterning electrode structures of multilayer graphene. (b) Preparation procedure of multilayer graphene films on glass substrate with screen-printed and a focus laser beam. (c) The laser process by controlled laser overlap and scanning.

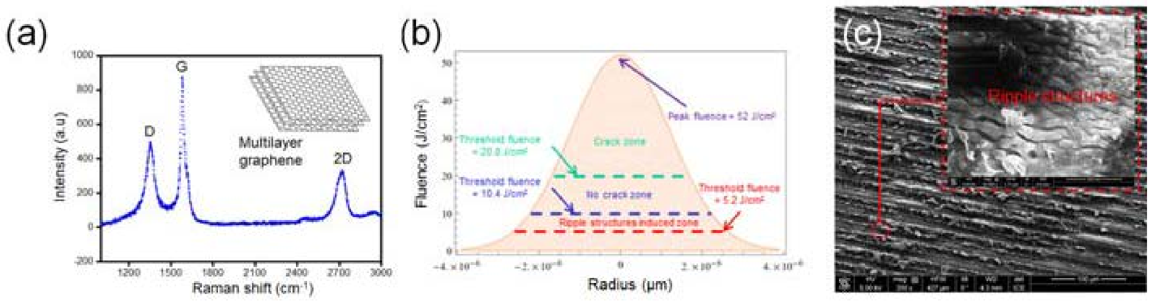


Fig. 2 (a) Raman spectroscopy of multilayer graphene films after screen-printing on glass substrate where the excitation wavelength is 514 nm with the number of layer. (b) Gaussian pulse profiles for patterning of graphene-based devices. (c) FE-SEM images show the surface morphology of the multilayer graphene under the laser fluence of 10.4 J/cm2. Inset image is its magnification that reveal the ripple nanostructures.

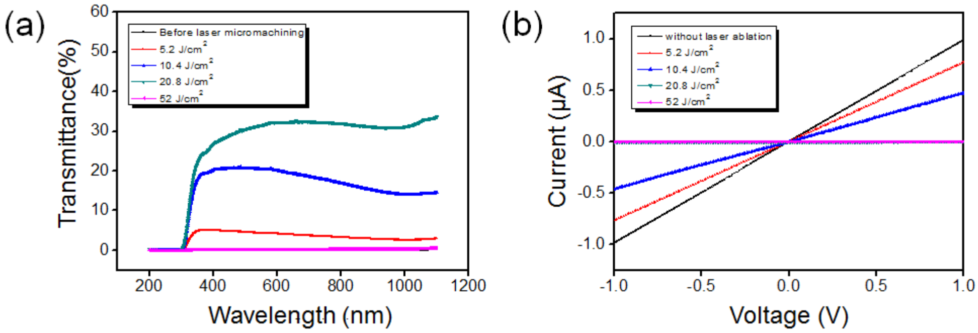


Fig. 3 (a) Optical transmittance spectrum of ablated graphene films is measured by a spectrometer, in which the spectral range are from 200 nm to 1100 nm. (b) *I-V* curves of graphene electrode device under the energy ablation where the laser fluence can be 0, 5.2, 10.4, 20.8, and 52 J/cm2, respectively.