行政院國家科學委員會專題研究計畫 期末報告

自動化微流體晶片平台在化學及生化反應之應用

計 畫 類 別 ：個別型
計 畫 編 號 ：NSC 100-2113-M-040-001-
執 行 期 間 ：100 年 03 月 01 日至 102 年 01 月 31 日
執 行 單 位 ：中山醫學大學應用化學系（所）

計 畫 主 持 人：萬金鳳
共 同 主 持 人：范龍生
計畫參與人員：碩士班研究生-兼任助理人員：林政廷
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大專生-兼任助理人員：鄭力遠
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其他-兼任助理人員：鄭琪樺
其他-兼任助理人員：楊家安

公 開 資 訊 ：本計畫涉及專利或其他智慧財產權，2 年後可公開查詢

中 華 民 國 102 年 04 月 07 日

中 文 摘 要 ： 使用微小化的元件(實驗室晶片)完成實驗室微量的操作是非常引人注目的。操作小量的樣品體積可降低化學合成，生物或化學分析的時間。液體的行為在微尺吋下對於分子擴散及分子之間的作用可獲得良好的控制，同時可降低使用化學藥品的費用及化學廢液的產生量，此小型的元件相對於實驗室在分析樣品上具有較佳的應用潛力。本研究主要的目標共分類為三個範籌，第一為紫外光光路系統，此平台包含有光源、光路的設計以及構築於微機電系統之微鏡面陣列，用以調控光束的準直度及光陣列的準確位置；另外，第二個系統為設計，組裝以及自動化控制微流體晶片平台的建構，以應用於平行化多種試劑及數個步驟的生物或化學的反應程序。最後，再將以上兩個次系統之組件及功能整合在同一個系統中。

中文關鍵詞： 微機電系統； 微鏡面； 微流體晶片

英 文 摘 要 ： The ability to perform laboratory operations on a small scale using miniaturized (lab on-a-chip) devices is very appealing. Manipulation of small sample volumes can be reduced the time taken to chemical synthesis and biological or chemical analysis; the unique behaviour of liquids at the microscale allows greater control of molecular diffusion and interactions; and reduced the costs of chemical and the amount of chemical waste. Compact devices have the potential to allow samples to be analysed at the point of need rather than in a centralized laboratory. The main purpose in this research is classified into four categories. First, The UV optical path platform consists of the core components of MEMS (Micro Electro Mechanical Systems) micromirror arrays, the light source and the optical path design, its control for beam steering and accurate positioning of optical microarray. Secondly, design, fabrication and automatic control of microfluidic chip platform were use for paralleling with multiple reagents and multistep biological and chemical processings. Finally, system integration for bringing together of the component subsystems into one system and ensuring that the subsystems function together as a whole system were constructed.

英文關鍵詞： MEMS (Micro Electro Mechanical Systems)；
micromirror； microfluidic chip

行政院國家科學委員會補助專題研究計畫

□期中進度報告

■期末報告

自動化微流體晶片平台在化學及生化反應之應用

An automated microfluidic platform for chemical and biochemical reactions

計畫類別：■個別型計畫　□整合型計畫

計畫編號：NSC 100－2113－M－040－001－

執行期間：100 年 03 月 01 日至 102 年 01 月 31 日

執行機構及系所：　中山醫學大學應用化學系所

計畫主持人：　萬金鳳　助理教授(中山醫學大學應用化學系所)

共同主持人：　范龍生　教　　授(清華大學奈米微系統工程研究所)

計畫參與人員：萬金鳳, 范龍生 教授, 賴衍翰, 陳豐榮, 林政廷, 羅章耘, 鄭力遠, 洪士勳, 王靖鋒, 彭崇文, 古忠文, 鄭琪樺, 楊家安

本計畫除繳交成果報告外，另含下列出國報告，共 _0_ 份：

□移地研究心得報告

□出席國際學術會議心得報告

□國際合作研究計畫國外研究報告

處理方式：除列管計畫及下列情形者外，得立即公開查詢

■涉及專利或其他智慧財產權，□一年□二年後可公開查詢

中　華　民　國　102　年　04　月　07　日

□□□

國科會補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估
   ■達成目標
   ■未達成目標（請說明，以100字為限）
   □ 實驗失敗
   ■因故實驗中斷
   □ 其他原因
   說明：1. 已達成目標.
   2. 系統在中山醫大重新建構,重新架設.

2. 研究成果在學術期刊發表或申請專利等情形：
   論文：■已發表 ■未發表之文稿 □撰寫中 □無
   專利：■已獲得 ■申請中 □無
   技轉：□已技轉 □洽談中 ■無
   其他：（以100字為限）

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）（以500字為限）

本研究結合微機電系統工程、化學合成技術及生物化學以及生物科技之基本知識，對於未來科技研究工作之發展甚具潛能，並兼具論文發表之學術性。生物晶片應用在疾病檢測、醫藥的篩選等對於未來之生物醫學將有莫大之幫助。

本計畫在學術研究方面之具體發展為：

·本計畫所研發之微流體晶片系統可應用於醣類化學之合成，例如抑制劑的合成。

·本計畫所研發之微流體晶片系統可應用於醣類酵素之鍵結，以製作蛋白質晶片。

·本計畫所研發之檢測系統，可用於檢測醣類酵素與抑制劑分子接合過程。

·本計畫所研發之微流體晶片系統可應用於藥物之開發。

·本計畫所研發之微流體晶片系統可結合本校醫學大學之特色，應用於生醫分子檢測。

可發展之相關技術包含有半導體製程技術之應用、微系統加工技術研發、微結構之分析設計、醣類合成化學在微系統之應用、蛋白質體與微系統之整合以及生物檢測系統技術之發展。此微流體晶片為生醫之重要檢測工具，可申請專利，並投入產業界，應用於日常生活中。

□□□

國科會補助計畫衍生研發成果推廣資料表

日期：___年__月__日

<table>
<tr><td>國科會補助計畫</td><td colspan="3">計畫名稱:　自動化微流體晶片平台在化學及生化反應之應用
計畫主持人: 萬金鳳　助理教授
計畫編號:　NSC 100－2113－M－040－001－
領域:　自然處, 工程處</td></tr>
<tr><td rowspan="2">研發成果名稱</td><td colspan="3">（中文）　說明於後面結案報告中.</td></tr>
<tr><td colspan="3">（英文）</td></tr>
<tr><td>成果歸屬機構</td><td></td><td>發明人
(創作人)</td><td>萬金鳳</td></tr>
<tr><td rowspan="2">技術說明</td><td colspan="3">（中文）
說明於後面結案報告中.

（200-500字）</td></tr>
<tr><td colspan="3">（英文）</td></tr>
<tr><td>產業別</td><td colspan="3">相關技術包含有半導體製程技術之應用、微系統加工技術研發、微結構之分析設計、醣類合成化學在微系統之應用、蛋白質體與微系統之整合以及生物檢測系統技術之發展。</td></tr>
<tr><td>技術/產品應用範圍</td><td colspan="3">生物,化學,生醫檢測分析應用</td></tr>
<tr><td>技術移轉可行性及預期效益</td><td colspan="3">此微流體晶片為生醫之重要檢測工具，預計可申請專利，並投入產業界，應用於日常生活中。</td></tr>
</table>

註：本項研發成果若尚未申請專利，請勿揭露可申請專利之主要內容。

國科會研究計畫結案報告

自動化微流體晶片平台在化學及生化反應之應用

An automated microfluidic platform for chemical and biochemical reactions

計畫編號：NSC 100-2113-M040-001-

計畫主持人：萬金鳳　助理教授(中山醫學大學應化系所)
共同主持人：范龍生　教　　授(清華大學奈微所)

計畫執行期限：100/03/01~102/01/31

Research Project (研究計畫):

@An automated microfluidic platform for chemical and biochemical reactions, 03/2011~01/2013, 國科會新進人員計畫, 主持人 萬金鳳, NSC 100-2113-M-040-001-)

研究計畫內容與研究成果

1. Development and Automation of Microelectromechanical Systems-Based Biochip Platform for protein Assay

The ability to perform laboratory operations on micro-scale using miniaturized devices (lab on-a-chip) is very appealing. Utilizing small sample volumes can reduce the time of chemical synthesis and increase the speed of biological or chemical analysis. Moreover, the unique behavior of liquids on micro-scale allows better control of molecular diffusion and interactions. In addition to high throughput analysis, performing experiments on a micro-device will also reduce the cost of purchasing chemicals as well as the amounts of chemical wastes. This research includes the following three portions: (I) the development of UV optical path platform consisting of the core components of MEMS (Micro Electro Mechanical Systems), such as micromirror arrays and the light source, as well as its control for beam steering and accurate positioning of optical microarray; (II) the design, fabrication and automatic control of microfluidic chip platform, which could be used for parallel assays with multiple reagents to achieve multistep biological and/or chemical processes; (III) the integration of optical and microfluidic chip platforms as well as the automation of the entire system for performing high through-put biological and/or chemical processes on a microfluidic chip.

a. Bio manipulation platform – Microfluidic channels, microvalves and micropump have been designed, simulated and fabricated for chemical and biochemical reaction.

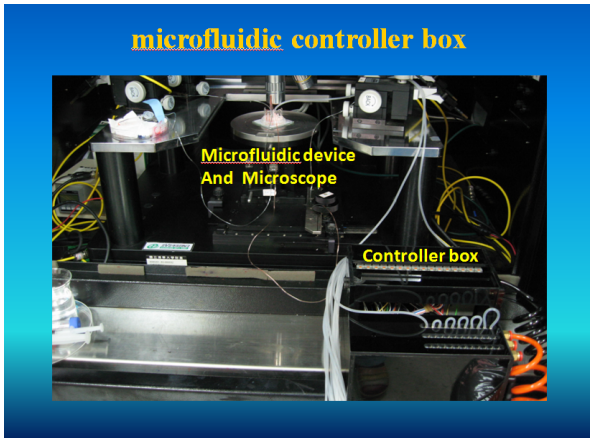


Figure 1. Microfluidic chips & Microfluidic chip platform setup and the home-made microfluidic controller box.

b. microfluidic chip

A microfluidic chip includes a base layer, a fluid layer, and a gas regulating layer. The base layer includes a microarray detecting zone. The microarray detecting zone includes a substrate, a photoresist pattern layer, a blocking layer, a bonding layer, at least one linker molecule, and a probe molecule. The bonding layer is covalently attached to the photoresist pattern layer. The at least one linker molecule is covalently bonded to the binding layer. The probe molecule is covalently bonded to the at least one linker molecule for specifically reacting with an under-test molecule. The fluid layer is disposed over the base layer, and includes plural flow channels for introducing or collecting detecting reagents. The gas regulating layer is disposed over the fluid layer for controlling open/close statuses of the flow channels, thereby controlling a flowing condition of a fluid in the fluid layer.

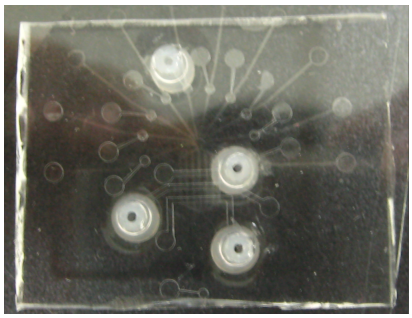
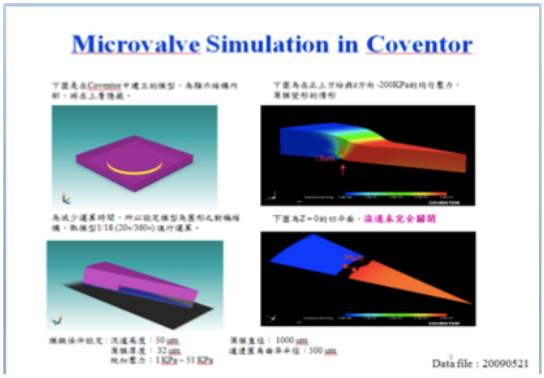


Figure 2. (a) Microfluidic chip

c. Simulation. Valve characteristics were first simulated under a wide range of conditions. We considered three major factors including (i) the width/height ratio of the microchannels, (ii) the dimensions of the microchannels, and (iii) the PDMS thickness.



Fgure 3. Computational model of a microvalve consisting of a $\pi X300^2X100$ μm control channel, a $\pi X300^2X10$ μm fluidic channel, and a 42-μm-thick membrane. (left) Undeformed configuration (right) Deformed configuration at actuation pressure.

d. A Virtual Mask Exposure System. A functional virtual mask MEMS-based projection system is set up. View interface and image arrays of 200 mm spots can be generated.

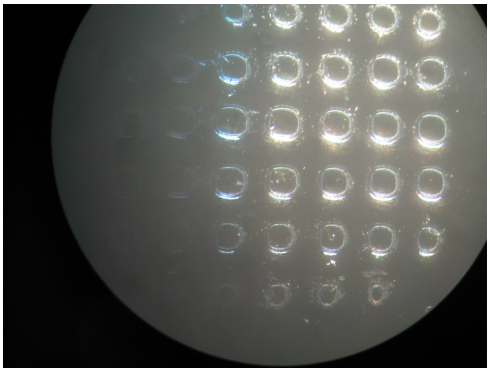


Figure 4. Optical path platform. Microarray patterns generated by our home-made virtual mask exposure system: arrays with spot size of 200 μm.

e. System integration – An user interface integrated image processing program and controller has been designed and demonstrated.

f. Biochip and fabricating method thereof

A biochip and a fabricating method thereof are disclosed. The biochip includes a substrate, a photoresist pattern layer formed on a surface of the substrate, a blocking layer formed on the surface of the substrate which is not covered by the photoresist pattern layer, a bonding layer covalently bonding to the photoresist pattern layer, at least a linker molecule covalently bonding to the binding layer, and a probe molecule covalently bonding to the linker molecule for reacting with a molecule to be detected.

g. Initial system verification using biotin-streptavidin interaction is in progress.

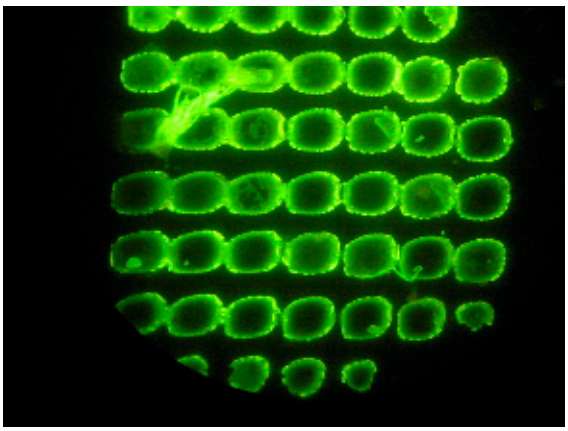
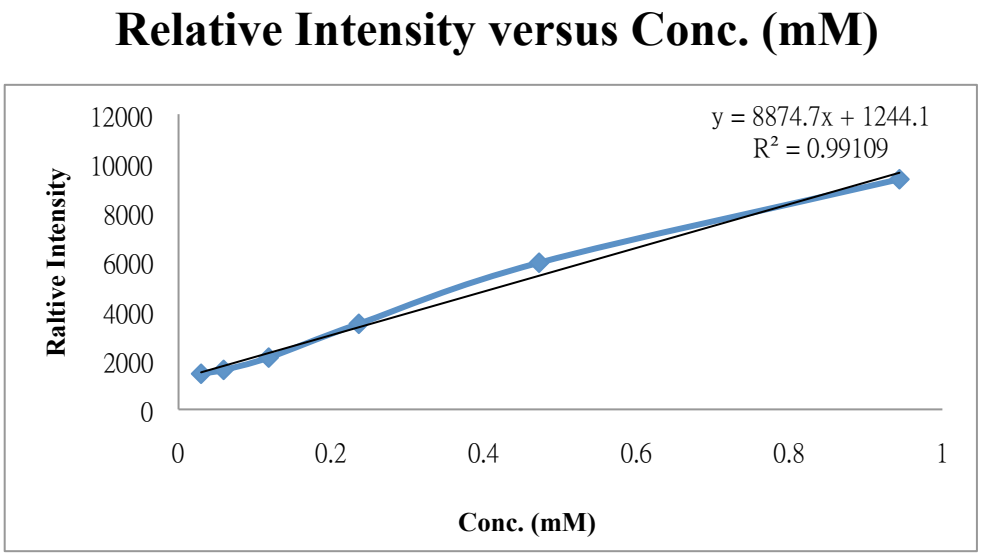


Figure 5. Microarray patterns generated by our home-made virtual mask exposure system: arrays with spot size of 300 um. Magnetic Particles as Labels in Bioassays: Interactions between a Biotinylated Substrate and Streptavidin Magnetic Particles.

h. Fluorescence detection and data analysis. The fluorescent images were captured using a CCD camera cool SNAP HQ2 (Nikon, Tokyo, Japan) with a 400 ms exposure time. Relative fluorescence intensity was used to quantify the yield of biotin-4-fluorescein, which was calculated by scaling the intensity of the fluorescent particles to that of the reference area on the device. Data were analyzed by NIS-Elements BR410 Image analysis software.

The intensity values were calculated to average the intensity of each pixel for each spot. The density of the reactions was quantified by reporting the mean values of fluorescence density on a calibration curve, which was manually produced by spotting a dilution series of biotin-4-fluorescein on a glass substrate (0.5 μl/spot).



2. Identification of the essential groups in the family 54 alpha-L-arabinofuranosidase from *Trichoderma koningii* by labelling and tandem mass spectrometric analysis

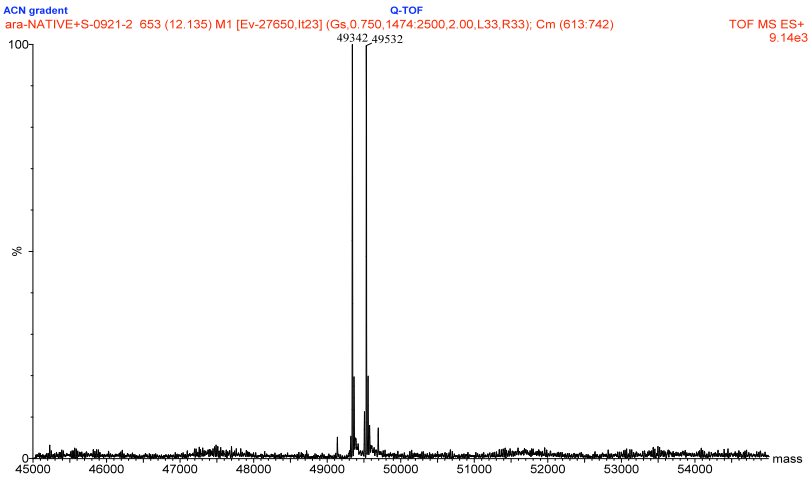


Figure 1. Native enzyme with labeling inhibitor

3. Hydrolysis of cellulose in synergistic mixtures of β-glucosidase and endo/exocellulase Cel9A from *Thermobifida fusca*

The synergism between the endo/exocellulase, Cel9A, and β-glucosidase (βgl) of *Thermobifida fusca* was investigated. Wild type βgl or S319C, a βgl mutant with significantly improved cellobiase activity, were added to Cel9A. Both wild type and mutant βgl enhanced the Cel9A hydrolysis of carboxymethyl cellulose (CMC) and filter paper by 50-100% compared to Cel9A alone. No enhancement occurred with addition of E388A, an inactive form of βgl. HPLC analysis showed that, with Cel9A alone, the resulting hydrolysate of glucose and cellobiose contained about half glucose; after addition of equimolar amounts of either wild type βgl or mutant S319C to Cel9A, the hydrolysate contained more than 85% glucose. Our results indicated that βgl acted synergistically with Cel9A by converting cello-oligomers to glucose; this reduced the soluble sugar accumulation during hydrolysis of cellulose.

4. A highly selective and sensitive fluorescent chemosensor for Hg^{2+} in aqueous solution

A new indole-based fluorescent chemosensor **1** has been prepared and its metal ion sensing properties were investigated. It exhibits high sensitivity and selectivity toward Hg^{2+} among a series of metal ions in H_2O-EtOH (7:1, v/v). The association constants of the 1:1 complex formation for **1**-Hg^{2+} was calculated to be 9.57×10^{3} M^{-1}, and the detection limit for Hg^{2+} was found to be 2.25×10^{-5} M. Computational results revealed that **1** and Hg^{2+} ion formed with a central tetrahedron-coordinated Hg^{2+}.

5. A Turn-on Schiff base Fluorescence Sensor for Zinc Ion

A simple Schiff base type fluorescent receptor 1 was prepared and evaluated for its fluorescence response to heavy metal ions. Receptor 1 exhibits an "off-on-type" mode with high selectivity in the presence of Zn2+ ion. The selectivity of 1 for Zn2+ is the consequence of combined effects of chelation-enhanced fluorescence (CHEF), C=N isomerization and inhibition of photoinduced electron transfer (PET).

6. A turn-on and reversible Fluorescence sensor for Zinc Ion

A simple Schiff base type fluorescent receptor 1 was prepared and evaluated for its fluorescence response to heavy metal ions. Receptor 1 exhibits an ''off-on-type'' mode with high selectivity in the presence of Zn^{2+} ion. The addition of EDTA quenches the fluorescence of receptor 1–Zn^{2+} complex, making receptor 1 a reversible chemosensor. The selectivity of 1 for Zn^{2+} is the consequence of combined effects of CHEF, C=N isomerization and inhibition of ESIPT.

研究成果

Patents (專利):

1 Chin-Feng Wan*, (2013) Microfluidic chip, The United States Patent, Application number PUS11302/811, Application Date Sep., 2012.
2 Chin-Feng Wan* (萬金鳳), (2013) Biochip and fabrication method thereof (生物檢測晶片及其製造方法), The Taiwan Patent, Application number 100130793, Application Date 20110826.
3 Chin-Feng Wan* (萬金鳳), (2013) Biochip and fabrication method thereof , United States, Application number 13/560,711, Filing or 371(C) Date 07/27/2012, Publication Number US-2013-0053279A1, Publication Date Feb. 28, 2013~
4 Chin-Feng Wan* (萬金鳳), (2013) Microfluidic chip automatic system with optical platform (結合光學平台之微流體晶片自動化系統), The Taiwan Patent, Application number 101212200, Application Date 20120625, Patent number M445178, 20130111~20220624.
5 Chin-Feng Wan* (萬金鳳), (2013) Maskless lithography system (無光罩微影系統), The Taiwan Patent, Application number 101210891, Application Date 20120606, Patent number M445196, 20130111~20220605.
6 Chin-Feng Wan* (萬金鳳), (2012) An automated microfluidic chip platform (微流體晶片之自動化檢測系統), The Taiwan Patent, Application number 101202353, Application Date 20120209, Patent number M 432834, 20120701-20220228.
7 Chin-Feng Wan* (萬金鳳), (2012) Microfluidic chip (微流體晶片), The Taiwan Patent, Application number 100219167, Application Date 20111013, Patent number M 426766,

20120411-20210826.

Publications:

1 Chin-Feng Wan[a*], Yen-Han Lai[b], Kuo-Chu Hwang[c], Jhang-Yun Luo[a], Li-Yuan Cheng[a], Long-Sheng Fan[b*] (2013) Development and Automation of Microelectromechanical Systems-Based Biochip Platform for Protein Assay, (Submitted, Nov, 01, 2013, SCI; Impact Factor; Ranking:)

2 Chang-Hung Chen, De-Jhong Liao, Chin-Feng Wan* and An-Tai Wu* (2013) A turn-on and reversible Schiff base fluorescence sensor for Al^{3+} ion, Analyst, accepted (SCI; 2013 March 14; Impact Factor 4.23; Ranking: 8/73)

3 Hsiang-Yi Lin, Pi-Yun Cheng, Chin-Feng Wan and An-Tai Wu* (2012) A turn-on and reversible Fluorescence sensor for Zinc Ion, *Analyst* 137, 4415-4417 (SCI; 2012 Oct 7; Impact Factor 4.23; Ranking: 8/73)

4 Yi-Jen Hsieh, Ming-Yeh Yang, Yann-Lii Leu, Chin-Piao Chen, Chin-Feng Wan, Meng-Ya Chang,Chih-Jui Chang* (2012) Kalanchoe tubiflora extract inhibits cell proliferation and viability by inducing multipolar spindles, leading to mitotic catastrophe, *BMC Complementary and Alternative Medicine* **12**(149), (SCI; 10 September 2012 Impact Factor 2.24;)

5 Wei Hsun Hsieh; Chin-Feng Wan; De-Jhong Liao; antai Wu* (2012) A Turn-on Schiff base Fluorescence Sensor for Zinc Ion, *Tetrahedron Letters*, **53(44)**, 5848-5851 (SCI, 2012; Impact Factor 2.618; Ranking: 20/56)

6 Hsiu-Han Wu, Yao-Lin Sun, Chin-Feng Wan, Shih-Tse Yang, Shau-Jiun Chen, Ching-Han Hu, An-Tai Wu* (2012) A highly selective and sensitive fluorescent chemosensor for Hg^{2+} in aqueous solution, *Tetrahedron Letters* 53(9), 1169-1172 (SCI, 29 February, 2012, SCI; Impact Factor 2.618; Ranking: 20/56)

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Conference papers:

1 Chin-Feng Wan*[1](萬金鳳), Yen-Han Lai[2](賴衍翰), Kuo-Chu Hwang[3](黃國柱), Long-Sheng Fan*[2](范龍生) (2011) Design, fabrication and automatic control of microfluidic chip platform for bioassay, 2011 Annual meeting of Chinese Chemical Society, Poster No. AN204, p121, Hsinchu, Taiwan (poster, Register No. C101006, 03 December 2011~04 December 2011)

2 Chin-Feng Wan*[1](萬金鳳), David Woei-Ming Liang*[2](梁偉明) (2011) Study of Sulfonyl Radical Cyclization in Unsaturated Carbohydrates, 2011 Annual meeting of Chinese Chemical Society, Poster No. OR072, p64, Hsinchu, Taiwan (poster, Register No. C100636, 03 December 2011~04 December 2011)

3 Hsun-Shih Hung (洪士勛), Jhang-Yun Luo (羅章耘), Chia-Lin Lin (林佳霖), Cheng-Ting Lin (林政廷), Chin-Feng Wan*(萬金鳳) (2011) 葡萄糖酵素性質的探討與抑制劑的研究, 2011 Annual meeting of Chinese Chemical Society, Poster No. AN139, p117, Hsinchu, Taiwan (poster, Register No. C100975, 03 December 2011~04 December 2011)

4 Ching-Feng Wang (王靖鋒), Li-Yuan Cheng (鄭力遠), Chung-Wen Peng (彭崇文), Cheng-Ting Lin (林政廷), Chin-Feng Wan*(萬金鳳) (2011) β-木糖苷酶(β-xylosidase)性質的探討與抑制劑的研究, 2011 Annual meeting of Chinese Chemical Society, Poster No. AN140, p117, Hsinchu, Taiwan (poster, Register No. C100977, 03 December 2011~04 December 2011)

5 Chin-Feng Wan*[1](萬金鳳), Yen-Han Lai[2](賴衍翰), Kuo-Chu Hwang[3](黃國柱), Long-Sheng Fan*[2](范龍生) (2011) An automated microfluidic platform for chemical and biochemical reactions, The 17th annual conference for technical communication on Analytical Chemistry, P41, Nantou, Taiwan (oral presentation, 14 May 2011~15 May 2011)

6 Chin-Feng Wan*[1](萬金鳳), Yen-Han Lai[2](賴衍翰), Kuo-Chu Hwang[3](黃國柱), Long-Sheng Fan*[2](范龍生) (2009) A MEMS-Based Oligomer Biochips Generator Platform Development, 2009國科會分析小組秋季會議, P16-23, National Pingtung University of Science and Technology, Taiwan (Invited speaker, 19 September 2009)

國科會補助計畫衍生研發成果推廣資料表

日期:2013/01/28

國科會補助計畫	計畫名稱: 自動化微流體晶片平台在化學及生化反應之應用
	計畫主持人: 萬金鳳
	計畫編號: 100-2113-M-040-001- 學門領域: 感測器及微型分析系統

無研發成果推廣資料

100 年度專題研究計畫研究成果彙整表

計畫主持人：萬金鳳	計畫編號：100-2113-M-040-001-
計畫名稱：自動化微流體晶片平台在化學及生化反應之應用	

成果項目			量化			單位	備註（質化說明：如數個計畫共同成果、成果列為該期刊之封面故事...等）
			實際已達成數（被接受或已發表）	預期總達成數(含實際已達成數)	本計畫實際貢獻百分比		
國內	論文著作	期刊論文	0	0	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	7	7	100%		
		專書	0	0	100%		
	專利	申請中件數	1	1	100%	件	
		已獲得件數	4	4	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（本國籍）	碩士生	1	1	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		
國外	論文著作	期刊論文	7	6	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	0	0	100%		
		專書	0	0	100%	章/本	
	專利	申請中件數	2	1	100%	件	
		已獲得件數	1	1	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（外國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		

其他成果 (無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。)	無

	成果項目	量化	名稱或內容性質簡述
科教處計畫加填項目	測驗工具(含質性與量性)	0	
	課程/模組	0	
	電腦及網路系統或工具	0	
	教材	0	
	舉辦之活動/競賽	0	
	研討會/工作坊	0	
	電子報、網站	0	
	計畫成果推廣之參與（閱聽）人數	0	

國科會補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

■達成目標

□未達成目標（請說明，以 100 字為限）

□實驗失敗

□因故實驗中斷

□其他原因

說明：

2. 研究成果在學術期刊發表或申請專利等情形：

論文：□已發表 ■未發表之文稿 □撰寫中 □無

專利：■已獲得 □申請中 □無

技轉：□已技轉 □洽談中 ■無

其他：(以 100 字為限)

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）(以 500 字為限)

本研究結合微機電系統工程、化學合成技術及生物化學以及生物科技之基本知識，對於未來科技研究工作之發展甚具潛能，並兼具論文發表之學術性。生物晶片應用在疾病檢測、醫藥的篩選等對於未來之生物醫學將有莫大之幫助。

本計畫在學術研究方面之具體發展為：

絆本計畫所研發之微流體晶片系統可應用於醣類化學之合成，例如抑制劑的合成。

絆本計畫所研發之微流體晶片系統可應用於醣類酵素之鍵結，以製作蛋白質晶片。

絆本計畫所研發之檢測系統，可用於檢測醣類酵素與抑制劑分子接合過程。

絆本計畫所研發之微流體晶片系統可應用於藥物之開發。

絆本計畫所研發之微流體晶片系統可結合本校醫學大學之特色，應用於生醫分子檢測。

可發展之相關技術包含有半導體製程技術之應用、微系統加工技術研發、微結構之分析設計、醣類合成化學在微系統之應用、蛋白質體與微系統之整合以及生物檢測系統技術之發展。此微流體晶片為生醫之重要檢測工具，可申請專利，並投入產業界，應用於日常生活中。