

# 壓電致動有閥微泵浦之特性研究

楊宗樺、note

E-mail: 346485@mail.dyu.edu.tw

## 摘要

本論文所設計之微泵浦具有雙出入水口的特性，此設計使得液體流量大幅度地提升。微泵浦利用壓電材料做為致動器，不鏽鋼蝕刻的腔體層，以及使用壓克力材料具有流道、閥座結構之流道層，還有最主要利用聚二甲基矽氧烷製作出的單向止回閥，將以上元件加以組裝即為新型壓電致動有閥微泵浦，其具有微小化、質量輕及低消耗功率等優點，後面將針對此微泵浦系統之性能深入探討研究。從實驗結果得知，微泵浦之性能會受到驅動頻率、驅動電壓、腔體深度、閥體厚度、流道大小、不同背壓所影響。當驅動電壓在160 Vpp，微泵浦搭配流道2.0mm、腔體深度300 μm以及閥體厚度0.5mm使用時有最大液體流量125.6ml/min，當微泵浦搭配流道1.0mm、腔體深度300 μm以及閥體厚度0.5mm使用時有最大空氣流量102.2ml/min。

關鍵詞：壓電、致動器、PDMS、單向閥

## 目錄

|                         |                         |                         |                         |                       |                         |                         |
|-------------------------|-------------------------|-------------------------|-------------------------|-----------------------|-------------------------|-------------------------|
| 目錄 簽名頁 中文摘要.....iii     | 英文摘要.....iv             | 誌謝.....v                | 目錄.....vi               | 圖目錄.....vii           | 表目錄.....xii             | 第一章 緒論.....1            |
| 1.1 前言.....1            | 1.2 研究動機.....2          | 1.3 文獻回顧.....3          | 第二章 微泵浦之設計與分析.....8     | 2.1 壓電有閥式微泵浦之原理.....8 | 2.2 壓電有閥式微泵浦結構設計.....9  | 第三章 微泵浦結構元件製作.....13    |
| 3.1 黃光製程.....13         | 3.2 蝕刻製程.....14         | 3.3 元件製作.....15         | 3.4 壓電致動器之製作.....17     | 3.5 PDMS特性與調配.....21  | 3.6 閥體的製作.....21        | 3.7 壓電有閥微泵浦組裝.....22    |
| 第四章 實驗結果與討論.....24      | 4.1 閥體特性探討.....24       | 4.1.1 空氣對閥體特性之探討.....24 | 4.1.2 液體對閥體特性之探討.....27 | 4.2 微泵浦之流量實驗量測.....31 | 4.2.1 腔體深度對流量之影響.....34 | 4.2.2 閥體厚度對流量之影響.....42 |
| 4.2.3 操作電壓對流量之影響.....50 | 4.2.4 壓電材料對流量之影響.....52 | 4.3 微泵浦之揚程實驗量測.....54   | 4.4 微泵浦之空氣流量量測.....58   | 第五章 結論.....60         | 5.1 結論.....60           | 參考文獻.....61             |

[1]F. C. M. van de Pol, "A pump based on micro- engineering techniques," Ph. D. thesis, Enschede, the Netherlands: University of Twente, 1989. [2]A. Olsson, G. Stemme, and E. Stemme, "Numerical and experimental studies of flat-walled diffuser elements for valve-less micropumps," Sensors and Actuators A: Physical, vol. 84, pp. 165-175, 2000. [3]R. Linnemann, P. Woias, C.-D. Se&, and J. A. Ditterich, "A self-priming and bubble-tolerant piezoelectric silicon micropump for liquids and gases," 1998 IEEE, pp. 532-537, 1998. [4]S. Guo, S. Hata, K. Sugumoto, T. Fukuda and K. Oguro, "A New Type of Capsule Micropump Using ICPF Actuator," Micromechatronics and Human Science, 25-28 Nov, pp. 255-260, 1998. [5]Sebastian Bohm, Wouter Olthuis, Piet Bergveld, "A plastic micropump constructed with conventional techniques and materials," Sensors and Actuators A: Physical, Vol. 77, Issue 3, pp. 223-228, 1999. [6]J. Shinohara, M. Suda, K. Furuta, T. Sakuhara, "A high pressure-resistance micropump using active and normally-closed valves," Micro Electro Mechanical Systems, 23-27 Jan, pp. 86-91, 2000. [7]Nam-Trung Nguyen, Thai-Quang Truong, "A fully polymeric micropump with piezoelectric actuator," Sensors and Actuators B: Chemical, Vol. 97, Issue 1, pp. 137-143, 2004. [8]Junhui Ni, Bin Wang, Beizhi Li, Qiao Lin, "A planar PDMS micropump based on in-contact low-leakage check valves," Nano/Micro Engineered and Molecular Systems (NEMS), 20-23 Jan, pp. 608-611, 2010. [9]許廷好, "壓電致動有閥微泵浦之設計與製作", 大葉大學機械與自動化工程學系碩士論文, 2010.

## 參考文獻

- [1]F. C. M. van de Pol, "A pump based on micro- engineering techniques," Ph. D. thesis, Enschede, the Netherlands: University of Twente, 1989.
- [2]A. Olsson, G. Stemme, and E. Stemme, "Numerical and experimental studies of flat-walled diffuser elements for valve-less micropumps," Sensors and Actuators A: Physical, vol. 84, pp. 165-175, 2000.
- [3]R. Linnemann, P. Woias, C.-D. Se&, and J. A. Ditterich, "A self-priming and bubble-tolerant piezoelectric silicon micropump for liquids and gases," 1998 IEEE, pp. 532-537, 1998.
- [4]S. Guo, S. Hata, K. Sugumoto, T. Fukuda and K. Oguro, "A New Type of Capsule Micropump Using ICPF Actuator," Micromechatronics and Human Science, 25-28 Nov, pp. 255-260, 1998.
- [5]Sebastian Bohm, Wouter Olthuis, Piet Bergveld, "A plastic micropump constructed with conventional techniques and materials," Sensors and

Actuators A: Physical, Vol. 77, Issue 3, pp. 223-228, 1999.

[6]J. Shinohara, M. Suda, K. Furuta, T. Sakuhara, “ A high pressure-resistance micropump using active and normally-closed valves, ” Micro Electro Mechanical Systems, 23-27 Jan, pp. 86-91, 2000.

[7]Nam-Trung Nguyen, Thai-Quang Truong, “ A fully polymeric micropump with piezoelectric actuator, ” Sensors and Actuators B: Chemical, Vol. 97, Issue 1, pp. 137-143, 2004.

[8]Junhui Ni, Bin Wang, Beizhi Li, Qiao Lin, “ A planar PDMS micropump based on in-contact low-leakage check valves, ” Nano/Micro Engineered and Molecular Systems (NEMS), 20-23 Jan, pp. 608-611,2010.

[9]許廷好, “ 壓電致動有閥微泵浦之設計與製作 ”, 大葉大學機械與自動化工程學系碩士論文, 2010.