A Study of Piezoelectric Actuator for Nano-Droplet Generator

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ABSTRACT

With the development of ink-jet printing technology, the inkjet printhead is not only used in the traditional printing requirement, but applied in a lot of emerging fields, such as new organic/polymer lighting emitting display, liquid crystal display, optical communication devices, and MEMS devices etc. In many kinds of inkjet printing technology, the most favor type of inkjet printing technology is the piezoelectric driven printing technology. PZT actuator with the lateral polarization had been fabricated by surface poling technique. Its shear deformation is introduced to actuate a vibration plate in droplet ejecting system. By ANSYS numerical simulation, the optimum dimension of actuating module is obtained for the fabrication. The actuating module is designed to be capable of ejecting a droplet with 1 μm diameter. The process for actuator by scraping PZT slurry through a blade has been introduced. The processed actuator was tested, and its displacement and piezoelectric coefficient varying with actuating field were obtained. And, by adjusting the actuating voltage waveform, the preferred output displacement and velocity can be acquired. Using the characteristic of volume displacement magnification in the relatively smaller chamber by the shear mode actuator, the nano-droplet ejection is expected.

Keywords : piezoelectric ; poling ; ink-jet head

Table of Contents

REFERENCES

[1] 呂世源,“奈米新世界,”科學發展期刊,11月,359期,pp4-7,2002。

[2] D.J Hayes, M.E. Grove and W.R. Cox, “Development and Application by Ink-Jet Printing of Advanced Packaging Materials”, International Symposium on Advanced Packaging Materials, 1999.

[3] Q.L. Ming, C. Leu, “High Precision Solder Droplet Printing Technology: Principle and Applications”, International Symposium on Advanced Packaging Materials, 2001.

[4] 曾元宏,“脈衝電流應用於微電鑄最適化之研究”, 國立清華大學化學工程研究所碩士學位論文, 2001。

[5] 謝文馨,“UV-LIGA應用於生物晶片之製程研究”, 中正大學機械系碩士論文, 2004。

[6] 陳宗聖,“利用電鑄技術製作壓電微噴頭之微小零件,”私立大葉大學機械工程研究所碩士論文, 2004。

[7] 鄭江河,“壓電式噴墨列印頭之振動板的設計,”大葉學報,第十卷,第一期, 2001。

[8] 方昱仁,“單體單噴孔壓電致動式噴液裝置之設計與製造,”國立台灣大學機械工程研究所碩士論文, 2002。

[9] 鄭江河,胡榮章,葉東昇與林烜鵬,“壓電式噴墨頭及其製作方法,”中華民國,專利194947, 2004。

[10] D.J. Hayes, D.B. Wallace, M.T. Boldman and R.E. Marusak, “Picoliter solder droplet dispensing,” ISHM J. of Micro- circuits & Electronic Packaging, Vol.16, No.3, 173-180, 1993.

[11] D.B. Wallace and D.J. Hayes, “Solder Jet Technology Update” The International Journal of Microcircuits and Electronic Packaging, Vol. 21, No. 1, 1998.

[12] D.J. Hayes, D. B. Wallace and W.R. Cox, “MicroJet Printing of Solder and Polymers for Multi-Chip Modules and Chip-Scale Packages”, IMPAS '99, 1999.

[13] W.R. Cox, D.J. Hayes, T. Chen, D.W. Ussery, D.L. MacFarlane and E. Wilson, “Fabrication of micro-optics by microjet printing, ” SPIE

Proceedings, Vol.2383, pp.110-115, 1995.
[14] W.R. Cox, T. Chen, D. Ussery, D.J. Hayes, J.A. Tatum and D.L. MacFarlane, “ Microjetted lenslet tipped fibers, ” Optics Communication, Vol.123, pp.492-496, 1996.
[15] W.R. Cox, T. Chen, D.W. Ussery, D.J. Hayes, R.F. Hoenigman, D.L. MacFarlane and E. Rabinovich, “ Microjet printing of anamorphic microlens arrays, ” SPIE Pro., 2687, 89-98, 1996.
[16] 陳俍鈞, 林智堅, 陳富港, 鄭兆凱, “ 噴墨列印技術於工業應用之系統發展, ” 工業技術研究院光電工業研究所。
[17] 張棋榕, “ 以噴墨方法製作彩色濾光片的利基與挑戰, ” 化工資訊月刊, 2001。
[18] J. Voigt, F. Shi, K. Edinger, P. Guthner, I.W. Rangelow “ Nanofabrication With scanning nanonozzle ‘ Nanojet ’ , ” Microelectronic Engineering, SDOS, pp. 1035-1042, 2001.
[19] O. Rabinovych, R. Pedrak, I.W. Rangelow, H. Ruehling, M. Maniak “ NANOJET as chemical scalpel for accessing the internal 3D-structure of biological cells, ” Microelectronic Engineering, SDOS, pp. 843-846, 2004.
[20] T.H. Fang, W.J. Chang, S.C. Liao “ Effects of temperature and aperture size on nanojet ejection process by molecular dynamics simulation, ” Microelectronic Journal, SDOS, pp. 687-691, 2004.
[21] F.C. Lee, “ PZT Printing Applications, Technologies, New Devices, ” Ultrasonic Symposium, IEEE, pp. 693-697, 1988.
[22] W.R. Whel, “ The Present State of the Art, ” Compeuro ’89-3rd Annual European Computer Conference Hamburg, West Germany, pp. 46-52, May, 1989.
[23] F.C. Lee et al., “ The Application of Drop-on-Demand Ink Jet Technology to Color Printing, ” IBM J. Res. Develop., Vol. 28, No. 3, pp. 307, May, 1984.
[24] Y. Takeuchi, H. Masumori and N. Takahashi, “ Method of Producing a Piezoelectric/Electrostrictive Actuator, ” U.S. Patent No. 564379, Jul. 1, 1997.
[25] Y. Takeuchi, H. Masumori, N. Takahashi, H. Sonehara, and K. Kitahara, “ Ink Jet Print Head, ” U.S. Patent No. 5933170, Aug. 3, 1999.
[26] Harvey, et al., “ Method of making a multi-channel droplet deposition apparatus, ” U.S. Patent 5855713, 1999.
[27] Takeuchi, et al., “ Piezoelectric/electrostrictive actuator having at least one piezoelectric/electrostrictive film, ” U.S. Patent 5691593, 1997.
[28] Q.M. Zhang, W.Y. Pan, S.J. Jang and L.E. Cross, “ Domain wall excitations and their contributions to the weak-signal response of doped lead zirconate tltanate ceramics, ” J. Appl. Phys., Vol. 64, No. 11, pp. 6445-6451, December, 1988.
[29] V. Mueller, and Q.M. Zhang, “ Shear response of lead zirconate titanate piezoceramics, ” J. Appl. Phys., Vol. 83,No. 7, pp. 3754-3761, April, 1998.
[30] A.E. Glazounov, Q.M. Zhang and C. kim, “ Torsional actuator based on mechanically amplified shear piezoelectric response, ” Sensor and Actuators A 79, pp. 22-30, 2000.
[31] D. Damjanovic, “ Stress and frequency dependence of the direct piezoelectric effect in ferroelectric ceramics, ” J. Appl. Phys., Vol. 82, No. 4, pp. 1788-1797, August, 1997.