Investigation of PZT Actuator Applied in Microfluidic System

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ABSTRACT

With the development of ink-jet printing technology, the ejector 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, an important type of inkjet printing technology is the piezoelectric driven printing technology. In this report, a PZT actuator is applied to a proposed sub-micron droplet ejector. In order to assure the workability of the ejector, the characteristics of the actuator are well investigated. With driven by a given waveform, the actuator vibrates and the displacement and velocity transient responses at the point with maximum output displacement are obtained by both the numerical simulation and experiment. With ANSYS numerical analysis and experiment verification, the multi-layer PZT actuator ’ s output displacement and force increases with the increase of the driven electric field for various dimension designs. Comparing with single-layer ones, the multi-layer actuators generator higher force avoiding the twist as a beam actuator in microfluidic application. The multilayer beam-shaped actuator bonded to a vibration plate to form an actuating module and applied in the droplet ejector for instance.

Keywords : piezoelectric, actuator, electroforming, multilayer

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圖目錄

REFERENCES

參考文獻 [1] R. G. Sweet,“ High frequency recording with electrostatically deflected ink-jets, ” Rev. Sci. Instrum. Vol. 36, pp. 131, 1965.
[2] R. G. Sweet,“ Signal apparatus with fluid drop recorder, ” U.S. Patent 3596275, 1971.
[3] W. L. Buehner, J. D. Hill, T. H. Williams, and J. W. Woods,“ Application of ink-jet technology to a word processing output printer, ” IBM J. Res. Dev. Vol. 21, 1968-1977.
[4] H. P. Le,“ Progress and Trends in Ink-jet Printing Technology, ” J. imaging sci. technol , Vol. 42, pp. 49-62, 1998.
[5] C. W. Hansell,“ Measuring Instrument of Recording Type, ” U.S. Patent 2512743, 1950.
[6] Bartky, et al.,“ Multi-channel array pulsed droplet deposition apparatus, ” U.S. Patent 4992808, 1991.
[7] Vincent Ferrer,“ Operational properties of Piezoelectric Shear-Mode Actuator, ” Condensed Matter Physics Department of Microelectronics and Information Technology.
[8] Yong Zhou,“ Applications of Page Wide Piezo Inkjet Printing to Commercial and Industrial Market, ” Spectra Inc., www.spectra-inc.com [9] D. Wallace, H. J. Trost, and U. Eichenlaub,“ Multi-fluid Ink-Jet Array for Manufacturing of Chip-Based Microarray Systems, ” MicroFab Technologies, Inc.
[10] Kotaro Yoshimura, Mitsura Kishimoto, Toshiro Suemune,“ Inkjet Printing Technology, ” OKI Technical Review Vol. 64, August, 1998.
[11] J. Brunahl, Alex, and M. Grishin,“ Piezoelectric shear mode drop-on-demand inkjet actuator, ” Sensor and Actuator A 101, pp. 371-382, 2002.
[12] F. C. Lee,“ PZT Printing Applications Technologies, New Devices, ” Ultrasonic Symposium, IEEE, pp. 693-697, 1988.
[13] W.R. Whel,“ The Present State of the Art, ” Compeuro, 89-3rd Annual European Computer Conference Hamburg, West Germany, pp. 46-52, May, 1989.
[14] 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.
[15] D. J Hayes, D.B. Wallace, M.T. Boldman and R.E. Marusak,“ Picoliter solder droplet dispensing, ” ISHM J. of Microcircuits & Electronic Packaging, Vol. 16, No.3, pp. 173-180, 1993.
[16] D.B. Wallace and D.J. Hayes,“ Solder Jet Technology Update, ” The International Journal of Microcircuits and Electronic Packaging, Vol. 21, No. 1, 1998.
[17] 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.
[18] 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.
[19] 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.
[20] 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, pp. 89-98, 1996.
[21] 方昱仁, “ 單體單噴孔壓電致動式噴液裝置之設計與製造, ” 碩士論文，國立台灣大學機械工程研究所, 2002.
[22] 朱凱隆, “ 壓電式噴墨印相頭內外流場特性之量測研究, ” 碩士論文，國立清華大學動力機械工程研究所, 2003.
[23] 洪銘青, “ Picojet列印頭之噴墨效能分析, ” 碩士論文，私立大葉大學機械工程研究所, 2005.
[24] 蔡煒銘, “ 擠壓式壓電噴頭噴墨行為之數值研究, ” 碩士論文，私立大葉大學機械工程研究所, 2005.
[25] 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.
[26] K.Uchino and S. Takahashii,“ Multilayer ceramic actuators ”, Current Opinion in Solid State & Materials Science, Vol. 1, pp. 698-705, 1996.

[27] A. Dogan, Q. C. Xu, K. Onitsuka, S. Yoshikawa, K. Uchino and R. E. Newnham, “ High Displacement Ceramic-Metal Composite Actuator, ” Ferroelectrics, Vol. 156, pp. 1-6, 1994.
[28] J. F. Fernandez, A. Dogan, J. T. Fielding, K. Uchino and R. E. Newnham, “ Tailoring the Performance of Ceramic-Metal Piezocomposite Actuators Cymbals, ” Sensors and actuators A65, pp. 228-237, 1998.
[29] W. Zhu et al., “ Design and fabrication of a novel piezoelectric multilayer actuator by thick-film screen printing technology, ” Sensors and Actuators A86, pp. 149-153, 2000.
[30] 楊實文, “ 壓電噴墨頭-微陣列致動器之設計與製作, ” 碩士論文, 私立大葉大學機械工程研究所, 2003.
[31] 顧孝鈞, “ 壓電微致動器之製作與量測, ” 碩士論文, 私立大葉大學機械工程研究所, 2004.
[32] 許富強, “ 奈米微液滴產生器之壓電致動器模組研究, ” 碩士論文, 私立大葉大學機械工程研究所, 2005.
[33] Y. Xu, “ Ferroelectric Materials and Their Applications, ” North-Holland, New York, Vol. 10, 1991.