新型壓電致動器的設計與製作

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摘 要

最近在壓電陶瓷的領域裡，已致力於提高壓電致動器的致動能力，且不失其承載力，因而有了各式各樣的製程設計，如”RAINBOW”及”THUNDER”等，它們有個共通的特點就是其外型都是類似彩虹一樣的圓弧形。由於圓弧形的壓電致動器具有較大的橫向位移量，因此本設計也將以不同於”RAINBOW”和”THUNDER”的製程設計，而以電鑄的方式，將鎳電鍍於壓電複合材料的金屬基板上，增加其內應力，使其壓電致動器具有圓弧形的結構且增加承載力。 在進行電鑄實驗上，選用全氯化物浴，以Optimas影像擷取軟體精密計算出拱起高度及鍍膜厚度，以得到電鑄時間對拱起高度及厚度的關係，進而利用Stoney所提的內應力理論得到電鑄浴的內應力。另外，在實際電鑄壓電致動器試片上，則採用三片試片來探討不同電鑄時間對壓電致動器位移量及承載力的影響，最後，更利用有限元素ANSYS分析軟體來印證實驗的結果。

關鍵詞 : 壓電、致動器、電鑄、內應力

目錄

參考文獻

[1] 姚培智,民84, "壓電陶瓷總論及應用簡介," 國防部中山科學研究院材料研發中心.

[2] Y. SUGAWARA, K. ONITSUKA, S YOSHIKAWA, Q. XU, R. E. NWENHAM AND K. UCHINO, 1992. "METAL-CERAMIC COMPOSITE ACTUATORS," J. AM. CERAM. SOC., [4] 996-998.

[3] X. RUAN, B. A. CHEESEMAN, A. SAFARI, S. C. DANFORTH AND T. W. CHOU,1999."DESIGN OPTIMIZATION OF DOME ACTUATORS," IEEE. TRANSACTION ON ULTASONIC, FERROELECTRICS AND FREQUENCY CONTROL, VOL 46, NO.6 [4] A. DOGAN, Q. C. XU, K. ONITSUKA, S. YOSHIKAWA, K. UCHINO AND R. E. NEWNHAM, 1994. "HIGH DISPLACEMENT CERAMIC-METAL COMPOSITE ACTUATOR," FERROELECTRICS VOL 156, PP.1-6.

[5] J. F. FERNANDEZ, A. DOGAN, J. T. FIELDING, K. UCHINO AND R. E. NEWNHAM, 1998." TAILORING THE PERFORMANCE OF CERAMIC-METAL PIEZOCOMPOSITE ACTUATORS,'CYMBALS', SENSORS AND ACTUATORS A65, PP.228-237.

[6] A. J. MOSKALIK AND D. BREI, JULY 1997. "QUASI-STATIC BEHAVIOR OF INDIVIDUAL C-BLOCK PIEZOELECTRIC ACTUATORS," J. OF INTELLIGENT MATERIAL SYSTEMS AND STRUCTURES, VOL.8 [7] A. J. MOSKALIK AND D. BREI, MARCH 1998. "PARAMETRIC INVESTIGATION OF THE DEFLECTION PERFORMANCE OF SERIAL PIEZOELECTRIC C-BLOCK ACTUATORS," J. OF INTELLIGENT MATERIAL SYSTEMS AND STRUCTURES, VOL. 9 [8] G. H. HAERTLING, 1994. "RAINBOW CERAMICS-A NEW TYPE OF ULTRA-HIGH-DISPLACEMENT ACTUATOR," AMERICAN CERAMIC SOCIETY BULLETIN, VOL.73, PP.93-96.

[9] Q. M. WANG AND L. E. CROSS, 1998. "DETERMINATION OF YOUNG'S MODULUS OF THE REDUCED LAYER OF A PIEZOELECTRIC RAINBOW ACTUATOR," JOURNAL OF APPLIED PHYSICS.,VOL.83,PP. 5358-5363.

[10] D. E. DAUSCH AND M. W. HOOKER, 1997. "LOW-FIELD AND HIGH-FIELD FATIGUE IN PZT-BASED RAINBOW

ACTUATORS," J. OF INTELLIGENT MATERIAL SYSTEMS AND STRUCTURES.,VOL.8,PP. 1044-1051.
[11] Q. M. WANG AND L. E. CROSS, 1999. "ANALYSIS OF HIGH TEMPERATURE REDUCTION PROCESSING OF RAINBOW ACTUATOR," MATERIALS CHEMISTRY AND PHYSICS. 58, PP.20-25.
[12] C. ELISSALDE, L. E. CROSS AND C. A. RANDALL,1996."STRUCTURAL-PROPERTY RELATIONS IN A REDUCED AND INTERNALLY BIASED OXIDE WAFER (RAINBOW) ACTUATOR MATERIAL," J. AM. CERAM. SOC., 79, PP.2041-2048.
[13] Q. M WANG AND L. E. CROSS, 1999."TIP DEFLECTION AND BLOCKING FORCE OF SOFT PZT-BASED CANTILEVER RAINBOW ACTUATORS,"J. AM. CERAM. SOC., 82[1], PP.103-110.
[14] G LI, E. FURMAN AND G H. HEARTLING, 1997."FINITE ELEMENT ANALYSIS OF RAINBOW CERA -MICS, "JOURNAL OF INTELLIGENT MATERIAL SYSTEMS AND STRUCTURES, VOL. 8, PP.434-443.
[15] S. A. WISE, 1998."DISPLACEMENT PROPERTIES OF RAINBOW AND THUNDER PIEZOELECTRIC ACTUA -TOR," SENSORS AND ACTUATORS A 69, PP.33-38.
[16] G. H. HAERTLING, 1996."MONOLITHIC PRESTRESSED CERAMIC DEVICES AND METHOD FOR MAKING," U.S. PATENT. NO.5589725.
[17] R. G.. BRYANT, 1995."PROCESS FOR PREPARING A TOUGH, SOLUBLE, AROMATIC, THERMOPLASTIC COPOLYIMIDE," U.S. PATENT. NO.5639850.
[18] R. F. HELLBAUM, ROBERT G AND R. L. FOX, 1997. "THIN LAYER COMPOSITE UNIMORPH FERROE -LECTRIC DRIVER AND SENSOR," U.S PATENT. NO.5632841.
[19] V. JAYACHANDRAN, N. E. MEYER, M. A. WESTERVELT AND J. Q. SUN, 1999. "PIEZOELECTRI -CALLY DRIVEN SPEAKERS FOR ACTIVE AIRCRAFT INTERIOR NOISE SUPPRESSION," APPLIED ACOUSTICS 57, PP. 263-277.
[20] E. KIELY, G. WASHINGTON AND J. BERNHARD, 1998. "DESIGN AND DEVELOPMENT OF SMART MICROSTRIP PATCH ANTENNAS," SMART MATER. STRUCT. 7, PP.792-800.
[21] R. P. BISHOP, 1999. "FOOTWEAR INCORPORATING PIEZOELECTRIC SPRING SYSTEM," U.S. PATENT NO.5918502.
[22] L. W. ERATH, G. CRAIG, M. MAPLES AND J. LUSCOMBE, 2000. "SOLID MARINE SEISMIC CABLE," U.S. PATENT. NO.6128251.
[23] A. P. NEUKERMANS, 1999. "BIOCOMPATIBLE, IMPLANTABLE HEARING AID MICROACTUATOR," U.S. PATENT. NO.5977689.
[24] K. P. LO, N. V. NECHITAILO, H. J. MOSES, L. H. DECKER, H. P. GROGER AND R. J. CHURCH -ILL, 1999."PIEZOCERAMIC VIBROTACTILE TRANSDUCERBASED ON PRECOMPRESSED ARCH," U.S. PATENT. NO.5973441.
[25] G. H. HAERTLING, 1996. "MONOLITHIC PRESTRESSED CERAMIC DEVICESAND METHOD FOR MAKING SAME," U. S. PATENT. NO.5589725.
[26] R. P. BISHOP, 1998. "SNAP-ACTION FERROELECTRIC TRANSDUCER," U.S. PATENT. NO.5831371.
[27] T. D. BRYANT, "MOTOR MOUNTING FOR PIEZOELECTRIC TRANSDUCER," U.S. PATENT. NO.6140745.
[28] L. W. ERATH AND G. CRAIG, 2000."HYDROPHONE WITH FERROELECTRIC SENSOR," U.S. PATENT. NO.6151277.
[29] J. R. MORTON AND R. G. PROVOST, 1999. "DIAPHRAGM PUMPED AIR COOLED PLANAR HEAT EXCH -ANGER," U. S. PANTENT. NO.59144856.
[30] M. S. PHADKE, 1989. "QUALITY ENGINEERING USING ROBUST DESIGN", AT & T BELL LABORATOR -IES.
[31] S. MOAVENI, 1999. "FINITE ELEMENT ANALYSIS THEORY AND APPLICATION WITH ANSYS", PRENT -ICE-HALL, INC.
[32] ANSYS, INC. 1994."COUPLED FIELD ANALYSIS GUIDE-RELEASE 5.3" [33] 方景禮, 民84. "電鍍添加劑理論(6)," 表面技術雜誌, 第141期,PP.154-170.
[34] 方景禮, 民84. "電鍍添加劑理論(8)," 表面技術雜誌,第144期,PP.148-177.
[35] H. YANG, S. W. KANG, 2000."IMPROVEMENT OF THICKNESS UNIFORMITY IN NICKEL ELECTROFORM -ING FOR THE LIGA PROCESS," INTERNATIONAL JOURNAL OF MACHINE TOOLS & MANUFACTURE 40, PP.1065-1072.
[36] R. WEIL, "THE ORIGINS OF STRESS IN ELECTRODEPOSITS(REVIEW OF THELITERATURE DEALING WITH STRESS IN ELECTRODEPOSITED METALS) PART Ⅰ," PLATING, 57, PP1231-1237.(DEC. 1970) [37] R. WEIL, "THE ORIGINS OF STRESS IN ELECTRODEPOSITS(REVIEW OF THELITERATURE DEALING WITH STRESS IN ELECTRODEPOSITED METALS) PART Ⅱ," PLATING, 58, PP50-56.(JAN. 1971) [38] R. WEIL, "THE ORIGINS OF STRESS IN ELECTRODEPOSITS(REVIEW OF THELITERATURE DEALING WITH STRESS IN ELECTRODEPOSITED METALS) PART Ⅲ," PLATING., 58, PP137-146.(FEB. 1971)
[39] D. S. GARDNER, P. A. FLINN, 1990."MESHCANICAL STRESS AS A FUNCTIONOF TEMPERATURE FOR ALUMINUM ALLOY FILMS," J. APPL. PHYS. 67(4) [40] G. A. DIBARI, 2000. "NICKEL PLATING", METAL FINISHING, VOLUME98, ISSUE:1, PP270,272, 274-276,278-288.
[41] G. G. STONEY, PROC., ROYAL SOCIAL LONDON., A82,172(1909).
[42] 方維倫, 85.12.,"微機械製造結構於薄膜殘餘應力量測之應用",科儀新知第十八卷三期.
[43] 王大倫, 民78."實用電鍍學",徐氏基金會出版社.

[44] 許倍誠, 民89,2."電鍍鎳組織與機械性質之研究," 大葉大學碩士論文.
[45] 吳朗,民83, "電子陶瓷壓電," 全欣資訊圖書股份有限公司.
[46] 林烜鵬,民84, "PZT 壓電陶瓷元件加工," 國防部中山科學研究院材料研發中心.
[47] 盧宏柏,民84, "PZT 壓電陶瓷製作技術," 國防部中山科學研究院材料研發中心.