

Title (en)

ACTUATION OF PIEZOELECTRIC STRUCTURES WITH FERROELECTRIC THIN FILMS HAVING MULTIPLE ELEMENTS

Title (de)

BETÄTIGUNG EINES PIEZOELEKTRISCHEN STRUKTUREN MIT FERROELEKTRISCHER DÜNNESCHICHTEN MIT MEHREREN ELEMENTEN

Title (fr)

ACTIONNEMENT DE STRUCTURES PIÉZOÉLECTRIQUES À L'AIDE DE FILMS MINCES FERROÉLECTRIQUES AYANT PLUSIEURS ÉLÉMENTS

Publication

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Application

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Priority

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Abstract (en)

A method for driving piezoelectric elements of a micro-system. The piezoelectric elements comprising a ferroelectric thin film, and being configured to be part of any one or a combination of items of a list comprising: a cantilever, a bridge, a diaphragm, a manifold of complex patterns of plates that may include trenches, slits, and include plate elements having different thickness; and being further configured to comprise at least 2 types of parallel plate electrode capacitors, the first type of capacitor having on a first side of the ferroelectric thin film a first type of electrode and the second type of capacitor having a second type of electrode electrically disjoined from the first type of electrode, forming a patterned surface of electrodes of the first side, and the first and second type of capacitors having a common electrode on a second side of the ferroelectric thin film opposite to the first side, and configured to face both the first type of electrode and the second type of electrode. The ferroelectric thin film is fixed on an elastic layer, forming together an elastic structure. The method comprises exciting in at least an exciting burst of an alternating electrical driving signal distributed to a first and a second signal, each active in different halves of the vibration period, and of one polarity only, thus substantially zero, in the other half period when it is not active, whereby the first and the second signal may have either one of the same polarity in their active half period, or opposite polarity, the first signal driving the first type of capacitor during a first half of a vibration period, and the second signal driving the second type of capacitor during a second half of the vibration period, thereby enabling an excitation of a flexural elastic structure, therewith enabling a deformation of the elastic structure, whereby further the vibration period is configured to correspond to a basic resonance of the elastic structure, the exciting burst comprising a determined number of resonance cycles.

IPC 8 full level

**B06B 1/06** (2006.01)

CPC (source: EP)

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Citation (applicant)

- WO 2016054448 A1 20160407 - CHIRP MICROSYSTEMS [US]
- US 2016262725 A1 20160915 - BOSER BERNHARD E [US], et al
- US 2012053393 A1 20120301 - KALTENBACHER DOMINIK [DE], et al
- MURALT, P.: "Ferroelectric thin films for microsensors and actuators: a review", MICROMECH.MICROENG., vol. 10, 2000, pages 136 - 146, XP020068545, DOI: doi:10.1088/0960-1317/10/2/307
- MURALT, P.: "Recent progress in materials issues for piezoelectric MEMS", J.AM.CERAM.SOC., vol. 91, 2008, pages 1385 - 96
- MURALT, P.: "Piezoelectric thin films for MEMS", INTEGR. FERROELECTR., vol. 17, 1997, pages 297 - 307
- MURALT, P.KHOLKIN, A.KOHLI, M.MAEDER, T.: "Piezoelectric actuation of PZT thin film diaphragms at static and resonant conditions", SENS. ACTUATORS A, vol. 53, 1996, pages 397 - 403
- DUBOIS, M.-A.MURALT, P.: "Measurement of the effective transverse piezoelectric coefficient  $e_{31,f}$  of AlN and PZT thin films", SENS. ACTUATORS A, vol. 77, 1999, pages 106 - 112
- PRUME, K.MURALT, P., F., C.SCHMITZ-KEMPEN, T.TIEDKE, S.: "Piezoelectric thin films: evaluation of electrical and electromechanical characteristics for MEMS devices", IEEE TRANS UFFC, vol. 54, 2007, pages 8 - 14, XP011381540, DOI: doi:10.1109/TUFFC.2007.206
- MENG, Q.MEHREGANY, M.DENG, K.: "Modeling of the electromechanical performance of piezoelectric laminated microactuators", J.MICROMECH.MICROENG., vol. 3, 1993, pages 18 - 23, XP020069344, DOI: doi:10.1088/0960-1317/3/1/005
- DUBOIS, M.-A.MURALT, P.: "PZT thin film actuated elastic fin micromotor", IEEE TRANS ULTRASON. FERROELECTR. FREQ. CONTROL, vol. 45, 1998, pages 1169 - 1177, XP011437806, DOI: doi:10.1109/58.726440
- MURALT, P. ET AL.: "Piezoelectric micromachined ultrasonic transducers based on PZT thin films", IEEE TRANS UFFC, vol. 52, 2005, pages 2276 - 88, XP011367560, DOI: doi:10.1109/TUFFC.2005.1563270
- LEDERMANN, N.MURALT, P.BABOROWSKI, J.FORSTER, M.PELLAUX, J.-P.: "Piezoelectric PZT thin film cantilver and bridge acoustic sensors for miniaturized photoacoustic gas detector", J.MICROELECTROMECH.SYSTEMS, vol. 14, 2004, pages 1650 - 1658
- SCHACHTELE, J.GOLL, E.MURALT, P.KALTENBACHER, D.: "Admittance Matrix of a Trapezoidal Piezoelectric Heterogeneous Bimorph", IEEE TRANS UFFC, vol. 59, 2012, pages 2765 - 2775
- FUJII, E. ET AL.: "Preparation of (001)-oriented PZT thin films and their piezoelectric applications", IEEE TRANS UFFC, vol. 54, 2007, pages 2431 - 2438
- TAGANTSEV, A. K.STOLICHNOV, I.COLLA, E.SETTER, N.: "Polarization fatigue in ferroelectric films: Basic experimental findings, phenomenological scenarios, and microscopic features", J.APPL.PHYS., vol. 90, 2001, pages 1387 - 1402, XP012053917, DOI: doi:10.1063/1.1381542
- KOHLI, M.MURALT, P.: "Poling of ferroelectric films", FERROELECTRICS, vol. 225, 1998, pages 155 - 162
- MAZZALAI, A.BALMA, D.CHIDAMBARAM, N.MATLOUB, R.MURALT, P.: "Characterization and fatigue of the converse piezoelectric effect in PZT films for MEMS applications", J.MEMS, vol. 24, 2015, pages 831 - 838, XP011664505, DOI: doi:10.1109/JMEMS.2014.2353855
- HALLER, M. I.KHURI-JAKUB, B. T.: "A surface micromachined ultrasonic air transducer", IEEE TRANS UFFC, vol. 43, 1996, pages 1 - 6, XP000557488, DOI: doi:10.1109/58.484456
- BELGACEM, B.CALAME, F.MURALT, P.: "IEEE Ultrasonics Symposium", vol. 922-925, 2006, IEEE, article "Thick PZT sol-gel films for pMUT transducers performances improvement"
- BELGACEM, B.CALAME, F.MURALT, P.: "Piezoelectric micromachined ultrasonic transducers with thick PZT sol-gel films", J ELECTRO CERAM, vol. 19, 2007, pages 369 - 373, XP019574704

Citation (search report)

- [XY] WO 2018163963 A1 20180913 - KYOCERA CORP [JP]
- [Y] WO 2006123299 A2 20061123 - KOLO TECHNOLOGIES INC [US], et al
- [Y] JP 2013098508 A 20130520 - KONICA MINOLTA HOLDINGS INC
- [A] WO 2008054395 A1 20080508 - DAUSCH DAVID [US], et al

- [YD] MURALT P ET AL: "Ferroelectric thin films for micro-sensors and actuators: a review; Ferroelectric thin films for micro-sensors and actuators", JOURNAL OF MICROMECHANICS & MICROENGINEERING, INSTITUTE OF PHYSICS PUBLISHING, BRISTOL, GB, vol. 10, no. 2, 1 June 2000 (2000-06-01), pages 136 - 146, XP020068545, ISSN: 0960-1317, DOI: 10.1088/0960-1317/10/2/307

Cited by  
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