

Parametric Simulation of PZT Diameter to Hole Ratio for Optimized Membrane Displacement

A. Arevalo¹, D. Castro¹, D. Conchouso¹, I. G. Foulds²

¹Computer, Electrical and Mathematical Sciences and Engineering (CEMSE), King Abdullah University of Science and Technology (KAUST), Saudi Arabia

²The University of British Columbia, School of Engineering, Okanagan Campus, Saudi Arabia

Abstract

Introduction:

The loud-speaker design has not changed for approximately 90 years. Nevertheless, improvements to digital components in the audio reproduction cycle has been implemented and the only missing device to catch up with the digital era advancements is the acoustic transducer. The concept of Digital Sound Reconstruction could help with existing problems tagged along with the current speaker design such as: the frequency response and linearity [1-3]. This concept needs an array of micro membranes to be implemented. In this simulations we focus on the actuation of a single element of this array. The membranes are composed of a bottom electrode a piezoelectric layer, a top electrode and a structural layer made of polyimide. The structural layer has been used elsewhere [4-], with demonstration of great potential for Micro Electro Mechanical Systems (MEMS).

Results: We have fabricated the devices but the performance was not as expected. Through the analysis and modeling in COMSOL Multiphysics software we were able to see that the design was out of the optimal range for higher acoustic energy intensity. In Fig. 1, a graph of the PZT diameter to Hole ratio for different dimensions of holes is shown.

Conclusions: New designs are needed for a better array device. Future simulations would be on the acoustic energy generated by these transducers. Also looking in to the beam forming area, which has a great potential for our micro-loudspeakers.

Reference

[1] B. M. Diamond, et al., “Digital sound reconstruction using arrays of CMOS-MEMS microspeakers,” pp. 292– 295 (2002).

[2] H.Kim, et al., “Piezoelectric microspeaker with a high-quality PMN-PT single-crystal membrane,” Journal of Korean Physical Society, vol. 54, p. 930 (2009).

[3] F. Kontomichos, et al., “Alternative Encoding Techniques for Digital Loudspeaker Arrays,” Journal of the Audio Engineering Society (2007).

[4] A. Arevalo and I. G. Foulds, “Parametric Study of Polyimide-Lead Zirconate Titanate Thin Film Cantilevers for Transducer Applications”, 2013 COMSOL Conference Rotterdam, (2013).

[5] A. Arevalo, et al., “Towards a Digital Sound Reconstruction MEMS Device: Characterization of a Single PZT Based Piezoelectric Actuator,” in 10th IEEE International Conference on Nano/Micro Engineered and Molecular Systems NEMS2015, Xia’an, Apr. 2015.

Figures used in the abstract

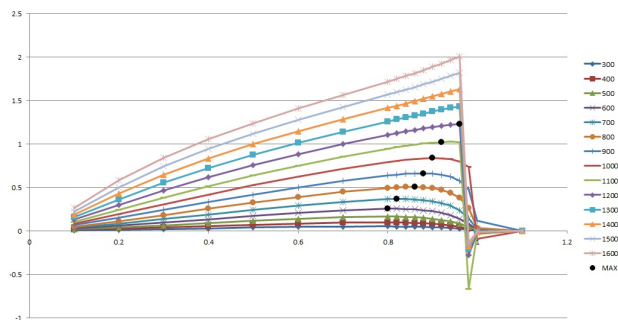


Figure 1