Proceedings of CHT-17
ICHMT International Symposium on Advances in Computational Heat Transfer

May 28-June 1, 2017, Napoli, Italy

CHT17-291

DESIGN, FABRICATION AND CHARACTERIZATION OF A MICRO-HEATERS ARRAY FOR PYROELECTRIC EFFECT CONTROL

Shomnath Bhowmick[*,***,§], Giuseppe Coppola[*], Mariano Gioffré[*], Orlando Leo[**], Marilena Musto[**], Giuseppe Rotondo[**] and Mario Iodice[*]
[*]Institute for Microelectronics and Microsystems, CNR, Napoli, Italia
[**]Department of Industrial Engineering, University of Naples "Federico II", Napoli, Italy
[***]Department of Information Technology and Electrical Engineering, University of Naples "Federico II", Napoli, Italy
[§]Corresponding author, fax: +39 081 6132 488 email: shomnath.bhowmick@na.imm.cnr.it

The goal of this paper is the possibility, thanks an innovative design, to induce a uniform pyroelectric effect on a large area of the crystal. Pyro-electricity is the ability to generate an electrical potential in response to a temperature change. A pyroelectric crystal exhibits a change in spontaneous polarization as a function of temperature; accordingly, an electric field is generated on the sample surface due to this polarization variation [Rosenblum 1974]. This property makes this material highly interesting, stimulates investigations and researches and inspires its use for several applications, like for example biomedical, optical and electronic [Bourim 2006, Efthymiou 2009 and Ferraro 2010]. A particular biomedical application, focused on the electro-hydro-dynamic fabrication of biodegradable microneedles, will take advantage by using the device we have optimized; it can give several benefits, as the possibility of producing microneedles array with high uniformity in shape and height, in a specific and relatively wide area, with high accuracy. We propose the realization an optimized micro-heaters array in order to control the heat distribution over a large area, about 1.5 cm^2, on a Lithium Niobate ($LiNbO_3$) crystal. The methodology we pursued to obtain this result consists of three fundamental and sequential steps: design, fabrication and characterization. We simulated the behavior of the device optimizing its geometry using a 3D Finite Element Analysis (FEA). Through a series of preliminary simulations, we initially investigated a single micro-heater, then we examined some parameters of influence, and, as final result of our simulations, we got an optimized design of the entire array geometry. The second phase of this work was the production of a first prototype of the micro-heaters array, which geometry has been defined taking into account the results of numerical simulations previously performed. The micro-heaters array was fabricated by titanium thin film evaporation on $LiNbO_3$ crystal, followed by photolithographic patterning (Figure 1). We performed on this device a series of electro-thermal characterizations; the results of the measurements showed a good agreement with the theoretical model in terms of heat distribution, making a comparison between the thermal maps coming from the two methodologies.

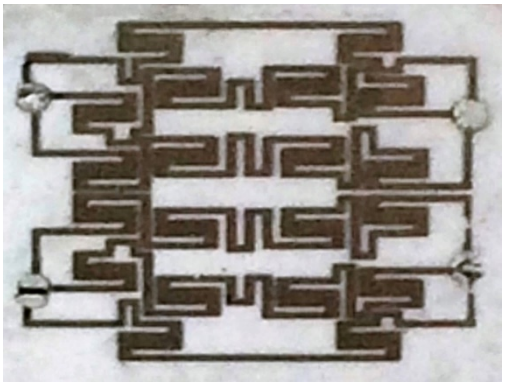

Figure 1. Prototype of a micro-heaters array fabricated on +Z face of $LiNbO_3$ crystal

REFERENCES

Rosenblum, B. [1974], Thermally stimulated field emission from pyroelectric $LiNbO_3$, *Applied Physics Letters*, Vol. 25, pp 17-19.

Bourim E. M. [2006], Pyroelectric electron emission from −Z face polar surface of Lithium Niobate monodomain single crystal, *Journal of Electroceramics*, Vol. 17, n. 2, pp 479-485.

Efthymiou S. [2009], Pulsed performance of pyroelectric detectors, *Journal of Physics*, Vol. 178, N. 1, pp 012044.

Ferraro P. [2010], Dispensing nano–pico droplets and liquid patterning by pyroelectrodynamic shooting, *Nature Nanotechnology*, Vol. 5, pp 429-435.