Pyroelectric Potential Decay vs $LiNbO_3$ Crystal Dimensions

Volodymyr Tkachenko[1], Romina Rega[2], Simona Itri[2], Reinhard Schwödiauer[3], Pietro Ferraro[2], Simonetta Grilli[2]
CNR-ISASI, via Campi Flegrei 34, 80078 Pozzuoli (NA), Italy, v.tkachenko@isasi.cnr.it;
CNR-ISASI, via Campi Flegrei 34, 80078 Pozzuoli (NA), Italy
Johannes Kepler University, Altenbergerstraße 69, 4020 Linz, Austria

Recently the pyroelectric-based high voltage source was applied to electro-hydrodynamic system for the deposition and accumulation of small liquid volumes onto a restricted area of a functionalized deposition slide, thus increasing sensitivity of biosensors. Since the pyroelectric crystal is in contact with the ambient atmosphere, the decay of the surface potential due to attracted charges from the environment is a serious effect which has to be considered for any system-design of practical relevance. Here we report for the first time the results of experimental study of surface potential decay in dependence on the dimensions of a square $LiNbO_3$ plate at standard laboratory conditions. The temperature of a pyroelectric crystal was changed from the ambient temperature 25°C to 40°C with constant temperature rate and then kept constant by a programmable heater (see Fig.1A). Surface electric potential of the thermally stimulated crystal was measured by an electrostatic Kelvin probe-based voltmeter. We demonstrate that characteristic decay time grows with increasing side length and decreasing thickness of the crystal plate (Fig.1B, 1C). The experimental results are explained by surface accumulation of ions generated by corona discharge at the crystal plate edges. Numerical simulations of electric field strength around the crystal surface confirm qualitatively the decay time dependence on the crystal dimensions. The obtained results can be useful for understanding dynamics of electric field generated by pyroelectric crystals.

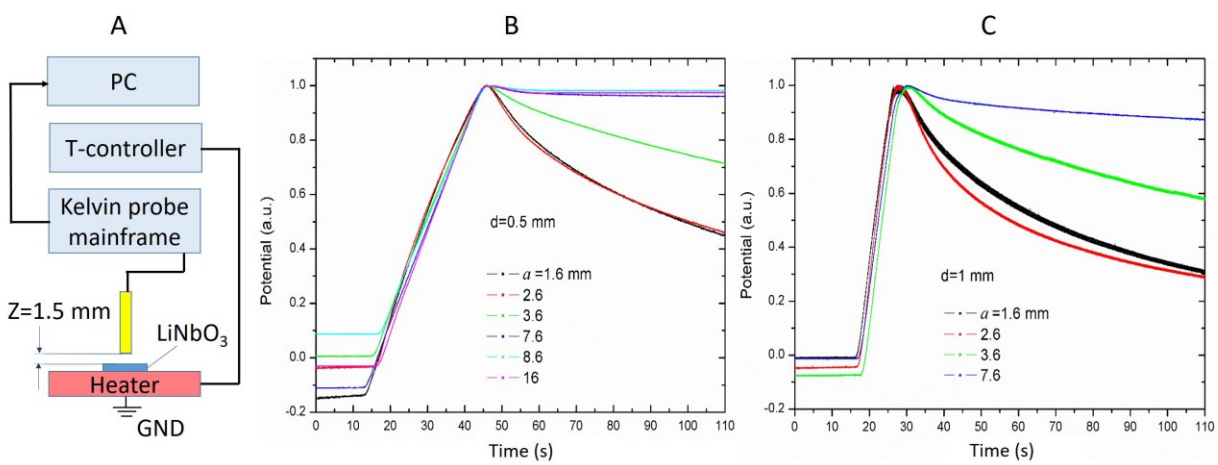

Fig.1. Experimental set-up for pyroelectric potential decay investigation (A) and time dependences of normalized potential measured at Z=1.5mm from square $LiNbO_3$ crystal with thickness *d*=0.5 mm (B) and *d*=1.0 mm (C) for different side length, *a*.