KFM 3: Focus Session II: Ferroics - Domains and Domain Walls

The Focus Sessions: Ferroics - Domains and Domain Walls is dedicated to the detection of multiferroic and ferroelectric domain pattern, their manipulation as well as the modeling of domains. These domains and domain walls are fascinating building blocks for novel (nanoscale) electronics ranging from switches, memristive elements towards diodes and reconfigurable wires.

Chairman: Donald M. Evans (University of Augsburg)

Time: Tuesday 13:30–14:00 Location: H2

KFM 3.1 Tue 13:30 H2

Tunable conductive domain wall switches in 200- μm-thick lithium niobate single crystals — •Henrik Beccard[1], Benjamin Kirbus[1], Ekta Singh[1], Zeeshan Amber[1], Michael Rüsing[1], Elke Beyreuther[1], and Lukas M. Eng[1,2] — [1]Institut für Angewandte Physik, Technische Universität Dresden, Nöthnitzer Str. 61, 01187 Dresden, Germany ct.qmat — [2]ct.qmat Dresden-Würzburg Cluster of Excellence EXC 2147, TU Dresden, 01062 Dresden, Germany

In the ferroelectric model material lithium niobate (LNO), state-of-the- art techniques allow the targeted poling of ferroelectric domains, as well as the enhancement of domain wall (DW) conductivity over several orders of magnitude [1]. Imaging and analyzing these properties can be performed with piezoresponse force microscopy (PFM) and confocal 3D second harmonic generation (SHG) microscopy [2]. The correlation between DW geometry and electrical DW conductivity is well established. Moreover, it can be simulated e.g. using a resistor network model [3]. Hence, an increasing focus in the ferroelectrics community is set on the realization of DW-based nanoelectronic devices. Recently, tunable DW switches have been reported for LNO thin films [4]. On the contrary, we report on tunable DW switches inside of 200-μm-thick LNO single crystals, relying purely on solid electrodes [5].

[1] C. Godau et al. ACS Nano 11, 4816 (2017)
[2] T. Kämpfe et al. Phys. Rev. B 8, 035314 (2014)
[3] B. Wolba et al. Adv. Electron. Mater. 4, 1700242 (2018)
[4] H. Lu et al. Adv. Mater. 1902890 (2019)
[5] B. Kirbus et al. ACS Appl. Nano Mater. 2, 5787 (2019)

KFM 3.2 Tue 13:45 H2

Lithium Niobate(LiNbO3) under uniaxial Stress — •Ekta Singh[1], Michael Lange[1], Sven Reitzig[1], Henrik Beccard[1], Michael Rüsing[1], Clifford Hicks[2], and Lukas M. Eng[1,3] — [1]Institut für Angewandte Physik, Technische Universität Dresden, 01062 Dresden, Germany — [2]Max Planck Institute for Chemical Physics of Solids, Dresden, Germany — [3]ct.qmat: Dresden-Würzburg Cluster of ExcellenceEXC 2147

Ferroelectric properties can be tuned by external fields such as light, dc electric fields, or mechanical strain. Amongst these, strain engineering plays an important role, where a correlation between strain and polarization has been a subject of study in recent years [1, 2]. Conventionally, strain is applied by lattice-mismatched epitaxial growth of thin films on selected substrates, which limits the method to certain materials.

Here, we present a prospective alternative based on piezoelectric actuators that is suitable to apply both compressive and tensile strain to single crystals in a controlled manner, while simultaneously performing dedicated optical or AFM experiments in-situ. To demonstrate the functionality of this device, we present shifts in phonon frequencies with applied strain on stoichiometric Lithium Niobate, measured by Raman spectroscopy. Such control of strain will provide valuable new insights into ferroelectric domain walls and their properties such as electrical conductivity.

[1] V. Stepkova et.al.; J. Phys.: Condens. Matter 24, 212201 (2012)
[2] A. Alsubaie et.al.; Nanotechnology 28, 075709 (2017)